Austrian Research and Technology Report 2013

Report under Section 8(1) of the Research Organisation Act, on federally subsidised research, technology and innovation in Austria

This report was commissioned by the Federal Ministry of Science and Research (BMWF); the Federal Ministry for Transport, Innovation, and Technology (BMVIT); and the Federal Ministry of Economy, Family, and Youth (BMWFJ). It was written by JOANNEUM RESEARCH (JR), the Austrian Institute of Technology (AIT), the Centre for European Economic Research (ZEW) and with the participation of Statistics Austria.
Team of authors: Andreas Schibany (Coordinator, JR), Martin Berger (JR), Bernhard Dachs (AIT), Brigitte Ecker (JR), Jürgen Egeln (ZEW), Helmut Gassler (JR), Sandra Gottschalk (ZEW), Karl-Heinz Leitner (AIT), Bettina Müller (ZEW), Christian Rammer (ZEW), Christian Reiner (JR), Gerhard Streicher (JR), Georg Zahradnik (AIT)

Imprint

Owners, Authors and Publishers:
Federal Ministry of Science and Research
Federal Ministry for Transport, Innovation and Technology
Federal Ministry of Economy, Family and Youth
1010 Vienna

Designed and produced by
Peter Sachartschenko & Susanne Spreitzer OEG, Vienna

Translated by Young Translations LLC, Vienna

Cover photos: © DrHitch – Fotolia.com

Printed by:
Gugler GmbH, 3390 Melk/Donau

Vienna, 2013

Preface

The Austrian Research and Technology Report 2013, as a status report pursuant to section 8(1) of the Research Organisation Act (FOG), is devoted to assessing the current challenges for national and international research and technology policy by analysing current developments and trends and presenting extensive data on research and development and other specific areas of focus.

Total expenditures for research and development in Austria will rise 2.9% to an estimated record level of €8.96 billion in 2013, predicts Statistics Austria in its recently published global estimate. The ratio of R&D expenditure to gross domestic product, which has shown a noticeable resurgence of late, would then be 2.81%. On the international stage, this gives Austria the fifth-highest R&D intensity in the EU-27, well above the EU average of 2.03%.

This welcome trend reflects the renewed engagement of the federal government in recent years, with counter-cyclical research investments during the economic crisis that saw R&D investments rise 14.2% between 2011 and 2012.

An equally welcome trend is the renewed uptick in 2013 of business enterprise sector investments in R&D, growing an estimated 3% to some €3.93 billion. When you add in foreign funding of some €1.3 billion, which flows largely from foreign businesses to Austrian subsidiaries, total funding from the business enterprise sector comes to about 59% of overall R&D funding. R&D expenditures by the federal government will rise 2.8% to a new high of €3.09 billion. The entire public sector will fund some 41% of R&D expenditure.

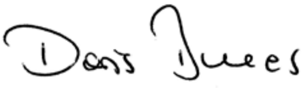
This year's Austrian Research and Technology Report summarises the steps taken in the past year and earlier to reach the goal set forth in the federal government's strategy for research, technology, and innovation (RTI) to become one of the most innovative EU countries by 2020. This includes the themes addressed in this report: establishing important new governance and funding tools for Austrian universities under the Austrian University Plan; implementing capacity-driven, student-oriented university funding; setting the focus and priorities of R&D programmes; creating a research infrastructure plan; and restructuring the Austrian Academy of Sciences. Another topic of growing national and international significance is the online publication of scientific results (open access). This report presents a comprehensive analysis of pros and cons and examines various strategies for dealing with open access.

Another important focus of this year's report is the role of the manufacturing sector in the innovation system. The global economic and financial crisis led to a reassessment of economic policy options and structural change, and the role of manufacturing in innovation, exports, and employment is once again the focus of economic policy discussions. Many countries, and even the European Commission, are pursuing a strategy of reindustrialisation. Internationally, Austria is among the countries with the highest share of manufacturing relative to total value added. Austria is well positioned among the key enabling technologies defined by the European Union – especially the fast-growing segment of green manufacturing.

The overall picture of innovation practices in the Austrian business enterprise sector, including at small and medium-sized enterprises (SMEs), is healthy. Austria has a horizontally oriented funding system that results in less discrepancy in the innovation practices of large corporations and SMEs than in most other highly industrialised nations in Europe. The share of innovating firms in Austria is significantly above the average for the EU-27, with a high innovator ratio in all industries.

This year's Austrian Research and Technology Report underscores our determination in implementing the RTI strategy. But even more extraordinary efforts and targeted investments are needed by 2020 to make Austria a top research destination in the EU. Evaluations, annual reports, and statistical analyses help us take stock of where we are in this upward process and – together with the relevant reports from the funding entities of the Austrian Science Fund (FWF), the Austrian Research Promotion Agency (FFG), AWS, CDG, and PROVISO regarding EU funding – form a complete picture of current trends in research, technology, and innovation in Austria in 2013.

Dr. Karlheinz Töchterle
Federal Minister for
Science and Research



Doris Bures
Federal Minister for
Transport, Innovation, and Technology

Table of Contents

Executive Summary

The Austrian Research and Technology Report 2013 is a status report on Austria's federally funded research, technology, and innovation. Relevant trends in development and specific aspects in Austria's system of innovation are described with the help of current data and findings, and examined in the international context. This report was commissioned by the Federal Ministry of Science and Research (BMWF); the Federal Ministry for Transport, Innovation, and Technology (BMVIT); and the Federal Ministry of Economy, Family, and Youth (BMWFJ). All input was discussed and agreed upon in inter-ministerial workgroups involving all the aforementioned entities.

Global estimate of R&D expenditure in 2013

The current global estimate published by Statistics Austria in April 2013 predicts a **total expenditure on research and development in Austria of € 8.96 billion** in 2013. This represents a nominal increase of some €255 million or 2.9% over 2012. With the nominal GDP growth of 3% to € 319.15 billion expected for 2013[1], this represents a **research intensity** (gross domestic expenditures for research and development relative to gross domestic product) **of 2.81%**. The research intensity was adjusted to 2.81% for 2012 as well (from 2.80% in the global estimate for 2012). The ratio was 2.72% in 2011 due to the stronger growth in the gross domestic product. R&D expenditure has risen since the start of the economic and financial crisis, keeping research intensity at consistently high levels.

The highest rate of growth in 2013 was seen in **business enterprise sector funding** with a 3% uptick. This sector provided funding of €3.93 billion, **contributing nearly 44% of funding for research and development in Austria.** The business enterprise sector thus accounted for the largest share of funding. Although the growth rates of business enterprise sector R&D funding are lower than in the years preceding the economic and financial crisis, the stagnation at the depth of the crisis in 2009 and 2010 has passed, and R&D funding from the business sector is once again growing at a rate corresponding to (nominal) GDP growth.

The **federal government is providing €3.09 billion in funding in 2013, approximately 34% of overall expenditures on research and development** in Austria. In absolute figures, this represents a rise of some €83 million or 2.8% over 2012. This follows a 2012 increase in federal R&D funding of 14.2% or €374 million in absolute figures (due in part to the increase in the research premium from 8% to 10%). All told, public-sector R&D funding (with the federal government accounting for the lion's share) has greatly expanded since the crisis. Public-sector R&D funding will be nominally some 36% higher in 2013 than during the recession in 2009.

Funding from foreign sources (primarily foreign firms that co-finance the R&D of their Austrian subsidiaries and to a lesser extent returns from EU research framework programme) accounts for € 1.36 billion or some 15% of Austrian R&D funding.

Overall, Austria was well above the EU average of 2.03% in 2011 (the last year for which

1 See WIFO economic forecast, March 2013.

comparative international figures are available), though Finland, Sweden, and Denmark had R&D intensities of over 3%. After Germany, which edged out Austria at 2.84%, **Austria has the fifth-highest ratio in the EU-27**.

Implementation of the Austrian government's RTI strategy

The federal government's RTI strategy adopted in March 2011 takes a broad-based, systematic approach to organising and supporting the system of innovation. Contemporary RTI policies are not focused solely on funding science and technology. They also take into account multilateral cause-and-effect chains and work alongside other areas of policymaking such as education policy and related regulatory frameworks such as the tax and revenue system.

That's why the **RTI Task Force** was created to hone and coordinate implementation of the strategy at a high administrative level under the leadership of the Chancellor's office in collaboration with the relevant federal ministries. This panel engages in constant comprehensive exchange with the Austrian Council for Research and Technology Development, which is also included. In addition, all RTI-related programs and initiatives have been merged under the umbrella of the RTI strategy, with nine working groups established in specific key areas.

Austria's position in the Innovation Union Scoreboard

The Innovation Union Scoreboard (IUS) compiles annual ratings of the performance of EU countries when it comes to innovation. Austria is ranked number 9 in the current Innovation Union Scoreboard, remaining securely entrenched **in the first half of the group of "innovation followers"** (together with the Netherlands, Luxembourg, Belgium, the UK, and Ireland in 5th to 10th places). These groupings have been quite stable for years, and the shifting of rankings within these subgroups that occurs with each annual comparison should not be weighed too heavily. The absolute differences within this group relative to the overall indicator are, in fact, very low. The individual indicators confirm the pattern of Austria's strengths and weaknesses already seen in earlier reports of the IUS and EIS (European Innovation Scoreboard, predecessor to the IUS): **Strengths** include **scientific publications, business enterprise sector R&D expenditures, and intellectual property indicators**.

Certain **weaknesses** remain **in tertiary education, the availability of venture capital, license and patent revenue, and knowledge-intensive service exports.** Over time, Austria has shown significant fluctuation among the indicators derived from the Community Innovation Survey (CIS). (Four of six CIS indicators relate to the innovation practices of SMEs.) But part of this pattern is attributable to changes to the overall design and implementation of the survey. It should be noted that the IUS focuses on structural aspects of the innovation system, so many indicators take a long-term perspective. For this reason, we should not always expect changes in the political environment to produce an immediate reaction in the form of short-term improvements in the IUS.

Globalisation and internationalisation of R&D

Global R&D expenditure rose more than 50% from about US $800 billion in 2002 to over US $1.2 trillion in 2009 (at purchasing power parity). The fast-growing economies of Asia, above all China, posted the strongest gains in their shares of global R&D expenditure, while the shares of the US, Japan, and the EU-27 declined. Given this trend, it is noteworthy that Austria was one of the few EU countries that managed to maintain its share of global R&D expenditure. Fuelled by strong growth in its R&D expenditure, Austria increased its share of total R&D expenditure in the EU-27 by 3% and in the OECD countries by 0.75%.

The rise in global R&D expenditures was accompanied by an internationalisation of R&D activities driven primarily by large multinational corporations, many of which now operate global networks of research sites. The importance of such foreign R&D investments is especially pronounced in smaller and medium-sized EU countries. **In the case of Austria, foreign-owned firms already account for about one-third of total R&D expenditure**, making them a key driver of the surge that occurred between 2002 and 2009.[1a] After the US, Austria is the second most important destination country for cross-border R&D expenditure by German firms. German companies account for over 50% of all foreign R&D investments in Austria.

New governance instruments for Austrian universities

The **development of the Austrian University Plan**, begun in 2011, is an important academic and education policy project that aims to ensure top-quality education and research by coordinating partnerships, setting priorities, and bundling resources. The growing diversity of stakeholders, the internationalisation of research, changes to the systems of financing, initiatives and policies at the European level, and ambitious research policy goals make it necessary for university partners to work with policymakers to hone their efforts and move forward by bundling resources. The Austrian University Plan is conceived as an ongoing, evolving planning tool that brings together key stakeholders in the higher education sector. One of the key challenges for the plan is to facilitate cooperation in education, research, and the setting of priorities. Universities, and above all the various campuses, need to work together and coordinate the focuses of their research and the courses they offer. One priority of national higher education policies is to introduce funding for university admissions, with a phased implementation scheduled through 2021.

The **Higher Education Conference** was constituted in the spring of 2012 to help achieve the goals set forth in the Austrian University Plan and implement the coordinating measures. The conference is a coordinating, advisory body that develops policy briefs on key issues of science policy, prioritises problem areas, and offers suggestions and solutions for the Austrian University Plan.

Funding universities

University funding for 2013 to 2015 is defined by two key attributes: First, universities are agreeing to a new, three-year performance agreement period. Second, formula-based budgets are being replaced by the new tool of higher education area structural funding.

Performance agreements, which allocate global budgets for a period of three years, are the key tool for funding and managing public universities in Austria. The federal government uses the Austrian University Plan and the RTI strategy to define the overall strategy to manage universities. The key research objectives to which the universities commit, sometimes also through their performance agreements, are to uphold the defined focuses and priorities, intensify partnerships, expand internationalisation, strategically expand research infrastructure, and continue to develop the quality and quantity with which third-party funding is raised. The universities support the goals and measures set forth in the performance agreements by creating development plans.

The tool of **higher education area structural funding** was introduced through an amendment of the Universities Act in the summer of 2012. This replaced performance-oriented funding through the formal budget with a new allocation mechanism, with the higher-education sector structural funds supplementing the overall amount available for funding the universities. The objective of the new regulation is to enable comprehensible calculation of the existing complex indicator-related funding via the formal

1a This figure is not to be confused with R&D funding from the so-called foreign sector, which describes actual funds flowing from foreign countries into Austria.

budget using a few indicators. The total amount available to universities in the performance agreement period of 2013 to 2015 consists of a core budget component and a higher education area structural funding component. In addition to the core budget, which is still defined on the basis of performance agreements, higher education area structural funding of €450 million is being distributed for the performance agreement period of 2013 to 2015.

Repositioning of the Austrian Academy of Sciences

The Austrian Academy of Sciences has a long tradition in the nation's science system. Founded in 1847, the Academy today hosts a scholarly society, funds a research board, promotes young talent, and offers services. The research board has grown especially fast since 2000 and now includes many highly successful scientific research institutes active in areas such as molecular biology, biomedicine, physics, applied mathematics, space exploration, material sciences, humanities, social sciences, and cultural studies. This massive expansion of the Academy's highly successful research arm made it necessary to also modernise and adapt the Academy's management structures. This led to the adoption in 2011 of a new charter and rules of procedure necessitated by the implementation of modern, transparent structures at the management level. A performance agreement for the period from 2012 to 2014 was also adopted, a key step in the process and a first in the history of the Academy.

Renaissance of industrial policy

The global economic and financial crisis led to a reassessment of economic policy options and structural change. The manufacturing sector was at the heart of this global reorientation. A large manufacturing sector was long considered a sign of sluggish structural reform. This viewpoint has since shifted 180 degrees. The renaissance of industrial policy is accompanied by a parallel technological paradigm shift in manufacturing also referred to as the "**third industrial revolution**" defined primarily by a convergence of various technologies such as material technologies, the Internet, 3D printing, and technologies associated with renewable energies. The role of manufacturing and its contribution to innovation, exports, and employment is once again at the centre of economic policy debates. Many countries, and even the European Commission itself, are currently pursuing a strategy of reindustrialisation.

Role of manufacturing in Austrian innovation system

Internationally, Austria is among the countries with the highest share of manufacturing relative to total value added. But the importance of manufacturing has declined over the long term, even though its contribution to value added has stabilised over the past 15 years or so, mirroring the trend in Germany and Switzerland. Employment in manufacturing, on the other hand, has fallen both in absolute terms and as a percentage of the overall job market. A technological shift is playing out within manufacturing, with a sharp increase in medium-tech industries and a comparatively small share in the high-tech segment. The **medium-tech industry in Austria is relatively R&D-intensive**, however. In general, manufacturing in Austria has undergone a successful process of internationalisation since 1990, an expression of its solid competitiveness that has prevented a further unravelling of the industrial core.

Manufacturing drives the technological evolution of an economy to a degree far exceeding its relative size in the economy. Most R&D and innovation in Austria is carried out by the manufacturing sector – often, of course, in close cooperation with the service sector. This above-average innovation is propagated to the extent that **manufacturing drives the growth of productivity** in Austria. The role of manufacturing for R&D and innovation is also underscored by the fact that the innovation leaders are considerably more industrialised than the innovation followers, moderate innovators, and modest innovators.

Austria's position with key enabling technologies

Austria is well positioned in the key enabling technologies recently defined by the European Union, in terms of both R&D and production capacities. In the past decade, the Austrian manufacturing sector has **greatly expanded its patent activities in the area of key manufacturing technologies**. This has given Austria greater weight in the global production of new technological expertise in these key fields of technology, accompanied by a broad expansion of exports of Austrian products based on these key technologies.

An equally welcome sign is the **solid performance** of the Austrian manufacturing sector **in a very high-growth segment: green manufacturing**. An empirical study of the internationalisation of Austria's green manufacturing shows positive dynamics and ever greater competitiveness. High growth expectations for environmentally friendly merchandise products on global markets opens up options to expand state-of-the-art, ecologically sustainable manufacturing.

Austria's manufacturing sector is a success story

Overall, the Austrian manufacturing sector is a success story. Its success hinges primarily on motivated, service-oriented, skilled entrepreneurs and technicians, coupled with favourable conditions thanks in large part to European integration and the social compact partnership in Austria between employers and labour. The opening of Eastern Europe and the European single market have helped **energise the domestic manufacturing sector** through increased competitive pressure. Further improvements to the human capital pool will be critical going forward. Special attention must be given to schools and internships as well as the education of scientists and engineers at universities and universities of applied sciences. Industrial policy – which in Austria is primarily innovation policy, and quite rightly so – can set the tone and provide incentives for further improvement of international competitiveness. The necessary instruments and institutions are already in place. We need to continue the successful course of recent years and take a flexible, collaborative approach to meeting the challenges facing the manufacturing sector in Austria.

Innovation as driving force behind long-term economic success

The ongoing transformation of innovations into marketable products and services is the driving force behind the long-term success of the business enterprise sector, which ultimately brings economic growth and employment. The empirical analyses of the Community Innovation Survey (CIS) show that Austria has a good (to very good) position among its fellow EU states, especially when it comes to the **performance of the Austrian SME sector**. The share of innovating firms in Austria is significantly above the average for the EU-27, with a high innovator ratio in all industries.

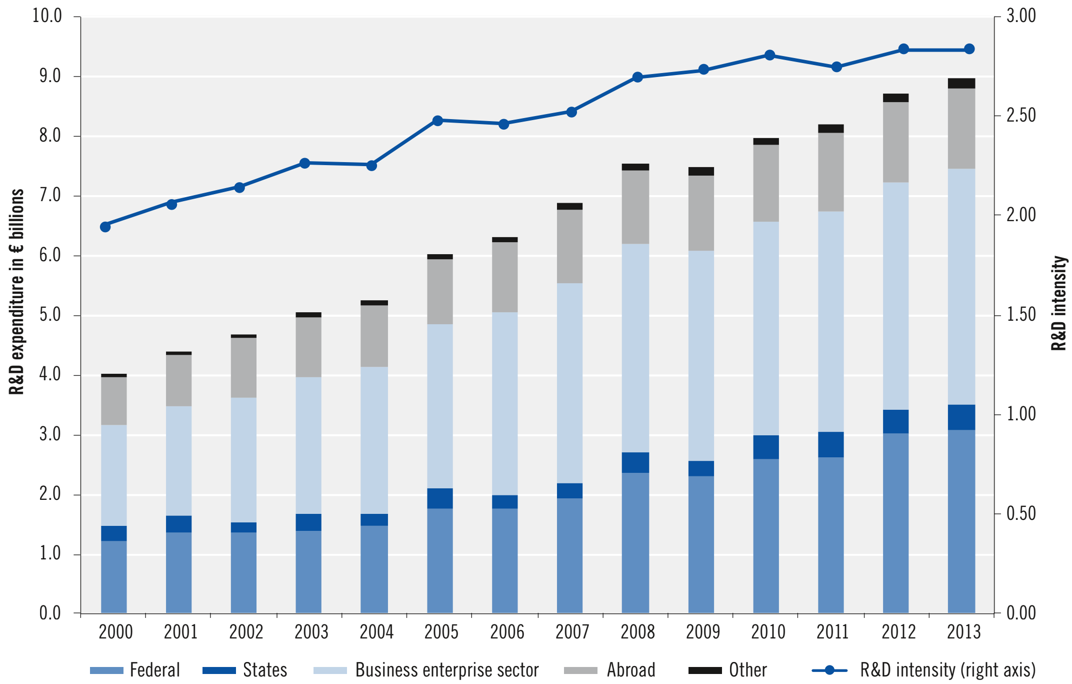
Spending on innovation is also characterised by the large role of R&D expenditure. An analysis of the link between R&D intensity and employment trends indicates the importance of R&D. R&D-intensive firms show much higher employment growth. This means Austria is defined by a modern system of innovation whose businesses are constantly generating new knowledge through in-house R&D and bringing this expertise to market through new products and services. Austrian companies also have well-established innovation networks with their suppliers and customers and with the university sector. Austrian economic policies have long recognised the important role of corporate innovations and used diverse instruments to encourage businesses to innovate. The result is a **funding system with tremendous reach** – innovations are addressed horizontally. Austria has among the highest percentage of firms receiving innovation-specific funding in the EU. This horizontal impact of funding is a key reason why the discrepancy in innovation practices between large corporations and SMEs is lower in Austria than in most other highly industrialised nations in Europe.

1 Current trends

1.1 Trends in R&D expenditure in Austria – global estimate

According to Statistics Austria's current global estimate of April 2013, the expenditures for research and development carried out in Austria in 2013 will amount to €8.96 billion. This is an increase of approx. €255 million, or 2.9%, over 2012. The nominal GDP growth expected for 2013 of 3% to €319.15 billion[2] corresponds to a research intensity (gross domestic expenditures for research and development in relation to gross domestic product) of 2.81%. For 2012 research intensity has now also been revised to 2.81% (from 2.80% in the global estimate); in 2011 it was 2.72% on account of the greater increase in gross domestic product. Figure Fig. 1 shows the development of research intensity as well as the absolute contributions from individual sources of funds. R&D expenditure has been increased and research intensity maintained at a constant level since the outbreak of the financial and eco-

Fig. 1: Expenditure on research and development in Austria by sources of funds



Source: Statistics Austria, Global Estimate as at 11 April 2013, nominal values.

2 Austrian Institute of Economic Research (WIFO), economic forecast March 2013.

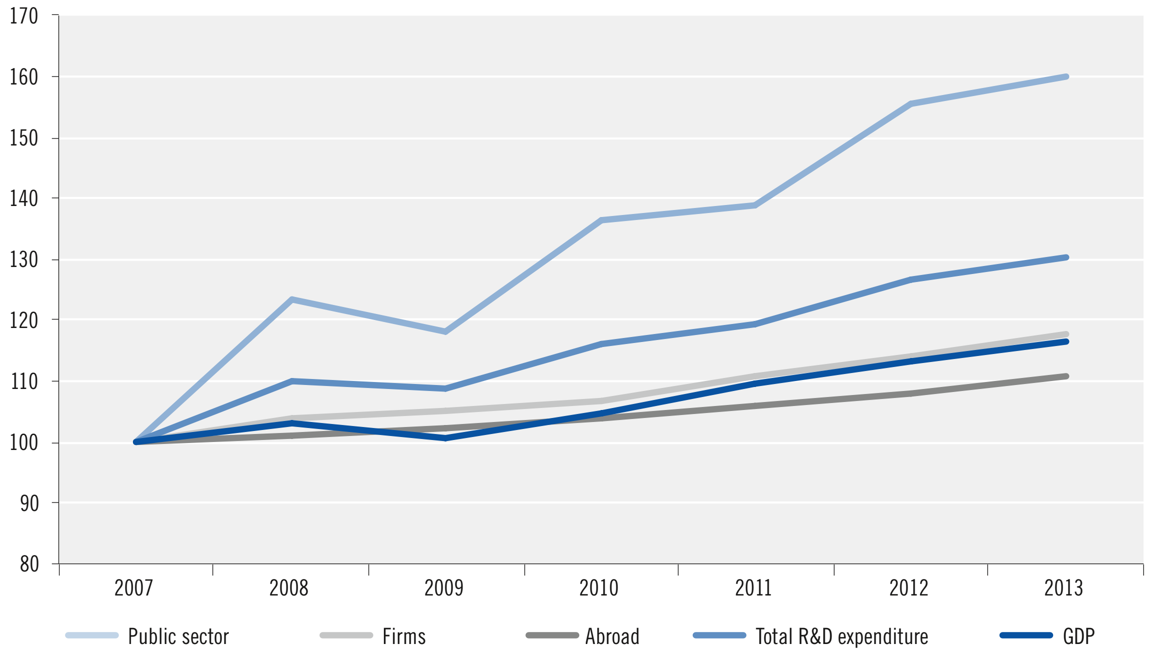
nomic crisis. With a forecasted research intensity of 2.81%, Austria is significantly above the average for the EU-27 countries, which was 2.03% in 2011, and as such is in fifth place behind Finland, Sweden, Denmark and Germany.

The following picture is revealed when the overall expenditure is considered for research and development in Austria divided into the different sources of funds (see Fig. 2 and Fig. 3):

- The federal government is expected to finance 34.4% of the total expenditure on research and development in Austria for 2013, which amounts to €3.09 billion. In absolute numbers this means a rise of approx. € 83 million, or 2.8%, compared with 2012. This rise must be viewed against the fact that the federation reported a rise in its R&D funding of 14.2% in 2012, i.e. an increase of € 374 million in absolute figures (not least as a result of the increase in research premiums from 8% to 10%). Overall the public sector (with the overwhelming majority of this being attributable to the federation) has significantly expanded its R&D funding since the crisis (partly as an economic policy response to this). R&D funding in the public sector will be nominally higher by approx. 36% in 2013 in comparison with 2009, which was a recession year (see Fig. 2).
- The business enterprise sector is expected to provide €3.39 billion of funding for research and development in 2013, making it the biggest contributor, providing 43.9% of the available funds. Funding rose by approx. €115 million compared with 2012, representing a percentage growth of 3%, i.e. in line with the estimated nominal GDP growth. It is worth noting that – since the nominal growth in 2009 and 2010 remained below 1.5% as a direct consequence of the crisis – the increase in R&D funding from the business enterprise sector has now returned to a growth trajectory of 3% and higher since 2011 (although these growth rates are not at the levels of the period before the crisis).
- The sources of funds from abroad (overwhelmingly involving foreign firms affiliated with Austrian firms and, to a lesser extent, return flows of funds from the EU research framework programmes) contribute 15.2% towards the overall volume of Austrian research and development, amounting to €1.36 billion. The growth is €36 million in absolute figures or an increase of 2.7% in relative terms.
- The states are expected to provide €0.43 billion, which represents 4.8% of the funding. The level of their growth compared with 2012 is €15 million, or 3.6%.
- With €0.15 billion, the sector Other (other public funding, e.g. by municipalities or social insurance providers, private non-profit sector) contributes approx. 1.7% towards the overall volume of Austrian research funding. Its growth rate for 2013 is estimated at €5.5 million, or 3.7%.

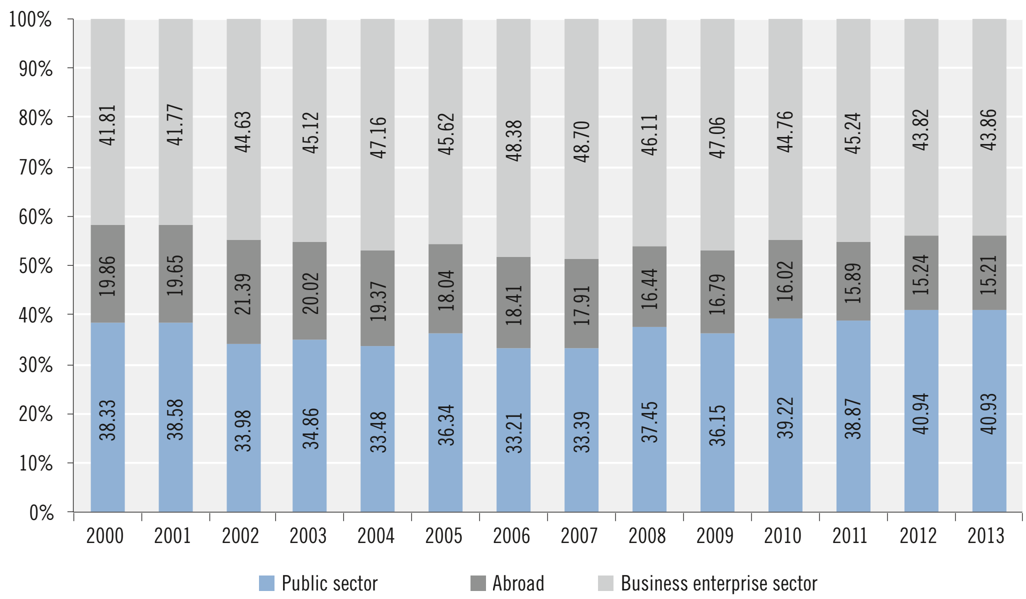
A look at the funding structure for R&D expenditure in Austria reveals that it has been possible to halt the trend towards a relative decrease in the proportion of funding provided by the business enterprise sector as caused by the crisis (see Fig. 3). While the business enterprise sector provided a 48.7% share in 2007 before the crisis, this dropped gradually to 43.8% in the period following the onset of the crisis. Since stronger growth in R&D funding is forecast for the business enterprise sector for 2013 in overall estimates provided by Statistics Austria, this share now marginally increases again to 43.9%. If sources abroad are also included (the funding for which overwhelmingly originates from foreign firms, largely from international corporations which co-finance the research and development projects of their Austrian subsidiaries), the share for the private sector is around 60%. As such, the funding structure for research and development in Austria is currently not too far removed from the general target set out in EU research and technology policy or from the Austrian federal government's RTI strategy, namely a rough distribution of one-third public, two-thirds private funding.

Fig. 2. Development of R&D in Austria by funding source (Index, 2007=100)



Note: The funding source "Other" (which includes municipalities or social insurance carriers as well as the private non-profit sector) was counted under the "Public Sector" here.
Source: Statistics Austria, Global Estimate as at 11 April 2013.

Fig. 3: R&D funding shares in Austria by funding source (as a percentage)



Source: Statistics Austria, Global Estimate as at 11 April 2013.

1.2 Implementation of RTI strategy

As already outlined in detail in the last Austrian Research and Technology Report, the federal government's RTI strategy adopted in March 2011 follows a broad and systematic approach to supporting and structuring the system of innovation. Current RTI policy is not focused exclusively on promoting science and technology, but is instead implemented in coordination with other policy areas such as education, competition and corresponding regulatory issues such as the tax and financing system, and also takes mutual interdependencies into account.

As a result, the RTI Task Force was set up for the purposes of implementing and coordinating the strategy at a high administrative level under the auspices of the Federal Chancellery together with the relevant federal ministries. This panel engages in constant comprehensive exchange with the Austrian Council for Research and Technology Development, which is also included.

The time period set for the current RTI strategy ends in 2020, meaning that the overall development and effects of the individual measures will in many cases only be capable of being assessed over the longer term.

Which implementation steps were actually put in place over the last year?

Overall, the well-established cooperation between RTI-related departments was given a sturdier structure, generally stepped up and further expanded, thus becoming an essential, useful tool in facing up to the increasing complexity of research, technology and innovation.

In concrete terms, this first of all meant merging all RTI-related programmes and initiatives under the overall RTI strategy. Nine working groups (WGs) were set up in specific areas of importance following discussion of all of the targets and measures involved in the RTI strategy from a strategic perspective:

- **WG 1** "Human Potential" deals with the importance of education as a fundamental building block for a powerful innovation system. One initial central priority is cooperation between all departments within the scope of measures and projects which affect the MINT disciplines (mathematics, informatics, natural sciences, technology). This above all involves introducing students to, creating enthusiasm for, and improving teaching and learning methods for the MINT disciplines. Naturally this applies to all stages of education, has very close interdependencies with the associated job profiles, and therefore their attractiveness for men and, in particular, for women. As such, an important long-term culture change is introduced in the areas of vocational training, education, research and the working environment for Austria as an innovation location. The objective of the WGs in this is, above all, to achieve coherence and sustainability for these measures which introduce structural change.
- **WGs 2 and 3** are concerned with the cross-departmental priority issues set out in the RTI strategy of "Climate Change/Scarcity of Resources" (WG 2) and "Quality of Life and Demographic Change" (WG 3): All RTI initiatives were initially merged into these relevant issue areas in these WGs, with the aim of establishing a clear overall picture of the existing programmes and exploring the potentials for coordination and cooperation. Tying issue management in with the departments where this makes sense and using synergies more effectively in the funding system are also priorities for both working groups. "Active mobility" emerged as a central issue for WG 3 "Quality of Life and Demographic Change".
- **WG 4** is essentially concerned with major research infrastructures (over €100,000.00). The presence of and access to modern, high-tech research infrastructures provide an essential foundation for excellent research and competitive technology development in Austria. However, these require cost-intensive investments with longer investment and usage periods. The aim of the WG therefore is to ensure efficient cross-departmental monitoring for

implementation of the measures stated in this regard in the RTI strategy. The WG deals with integrating infrastructure and expanding cooperation in the area of infrastructure usage among the research institutions as well as with the funding models and statutory frameworks for the use of research infrastructure. To this end, the WG carries out a mapping of existing measures or those to be implemented in the short term and will put forward a proposal for the purposes of a national roadmap for research infrastructure.

- **WG 5** "Knowledge Transfer and Start-ups" was established against a background where the start-up dynamic for new and innovative firms in Austria is below average, but where this would be very important in terms of a structural change towards more RTI-intensive products with greater added value. In this respect, the task of WG 5 is to improve coordination of the funding measures among different departments, close any loopholes and make the most of any synergy effects.
- **WG 6** "Corporate Research" is essentially aimed at further optimising the cooperation between science and industry. In concrete terms this means the following: The WG is dedicated to further development of the cooperative sector in association with developments in the universities and to working out proposals related to how tax concessions for research activities can become more efficient and effective.
- **WG 7a** "Internationalisation and RTI Foreign Policy" and WG 7b "Action Plan Austria and the European Knowledge Area 2020" are working on strategies to position Austria in the European research area and on a global Austrian RTI foreign policy and presence. The working groups are being supported by prestigious non-university research institutions through analyses. The central Austrian RTI stakeholders are also actively incorporated in the process. Both working groups will present their final reports in July 2013 with recommendations for the Task Force.
- **WG 8** "International Rankings" has been set up for the purpose of adopting various national and international RTI rankings and indicators. The primary objective is to develop a common understanding of the potentials and defects of these instruments. Over the past year, this group also concentrated on examining the set of indicators included in the first monitoring report of the Austrian Council for Research and Technology Development and which has now been specified in even greater detail.

The relevant federal ministries are members of all the WGs in all cases, and many of the WGs also include stakeholders and research institutions as members. The charge that no existing coordination processes be duplicated was also an important factor in establishing the WGs. All nine working groups are closely associated with the RTI Task Force or with a part of the RTI Task Force. A joint workshop between the chairs of the WGs and the members of the Task Force was held for this purpose in June 2012, where the first interim results and additional plans were intensively discussed and coordinated.

The Task Force is also involved in ongoing discussions on those measures and targets of the RTI strategy which are not part of the working groups from a thematic point of view and also assesses the areas where measures have already been put in place and the extent to which new short, medium or longer-term initiatives need to be considered. Those projects which affect multiple departments are in particular subject to joint coordination on a regular basis, including last year's "Long Night of Research" project, the OST (Office of Science and Technology) China and various research funding programmes, for example.

In addition the Task Force also regularly deals with the recommendations from the Austrian Council for Research and Technology Development. This means that the recommendations are discussed first of all among all departments at an expert level, and the Task Force then provides a written opinion on them and submits this to the Council.

The current "Innovation Leaders" from Scandinavia clearly show that small, open and innovative national economies not only hold their own against global competition, but are also able to expand the wealth in their societies even further. Austria is continuing along this road through implementation of the RTI strategy.

A review of implementation of the RTI-related measures and initiatives in the departments over the last year is provided below. The review of structural measures is followed by a summary of the most significant projects and new programmes.

1.2.1 Structural innovations

Tax concessions for research activities

Tax exemptions for research were abolished with the Public Finance Act 2011, and the research premium was raised from 8% to 10%. The first Stability Act in 2012, which has been in force since 1 April 2012, introduced a new procedure related to tax research incentives intended to ensure more stringent controls over the eligibility criteria. The Austrian Research Promotion Agency (FFG) is now involved in reviewing applications for research premiums. The Austrian Research Promotion Agency (FFG) will assess whether the research projects warrant funding as well as the quality of internal research. Official determination of the amount of the assessment base is also used along with the official decision on confirmation of the research as an eligibility criterion for the research premium: the new regulations related to applications, confirmation and granting of the research premium apply from 1 January 2013 for financial years from 2012.

New university funding

The funding of universities in Austria is put on a new footing with the 2013 amendment to the Universities Act (UG) for gradual implementation of capacity-oriented, study-related university funding ("funding for university places"). The objective is for university funding to be organised with a more transparent and robust focus on service, quality and capacity than has been the case previously. At the same time, the intention during a test phase is to improve the support situation in five fields of study which are in heavy demand – on the one hand through additional staff resources, and on the other by specifying capacity levels for new students and options for entry requirements when those numbers are exceeded. An essential premise in this is not to reduce the number of students overall across the whole of Austria.

The funding of university places will be comprehensively implemented over multiple performance agreement periods. The amendment adopted by the Austrian National Council on 27 February 2013 provides the basis for this. Implementation across the board will begin as of the performance agreement period 2019–2021. A "quality package" has been put in place for the five fields of study with the heaviest demand – business studies, architecture, information technology, biology and pharmacology – with the aim of improving the available support. This will be accomplished on the one hand through additional staff resources (approx. €36 million has been provided overall as part of the performance agreements for additional teaching staff for 2013 to 2015), and on the other by designating the number of new places on courses. If these numbers are exceeded, the universities can implement additional entry requirements, which they may largely organise autonomously. The long-term objective is to provide an adequate number of university places under study conditions that are appropriate in terms of international comparison. This should allow more efficient teaching and enable students to complete their studies within a reasonable timeframe. The number of places for new students is stipulated by law for the subjects mentioned. The target value across the whole of Austria is for 20,220 admissions places, i.e. in-line with the figures for new first-year students in 2011/12. Distribution of these places among the individual universities is regulated within the framework of the performance agreements.

Higher education sector structural funds

The higher education sector structural funds instrument was introduced in summer 2012 as part of an amendment to the UG. This replaced performance-oriented funding through the formal budget with a new allocation mechanism, with the higher-education sector structural funds supplementing the overall amount available for funding the universities. The objective of the new regulation is to enable comprehensible calculation of the existing complex indicator-related funding via the formal budget using a few indicators. Thus the overall amount available to the universities for the performance agreement period from 2013 to 2015 is made up of a partial amount for the basic budgets and a partial amount for the higher education sector structural funds. A detailed presentation of this new governance instrument can be found in chapter 3.2.2.

Structural reform of the Austrian Academy of Sciences (ÖAW)

Approximately one year after the signing of the performance agreement with the Federal Ministry for Science and Research (BMWF), a significant objective was achieved in December 2012 with the completion of the transfer of 13 ÖAW facilities and ÖAW research groups to nine Austrian universities in the ÖAW restructuring process, i.e. for the purposes of strengthening the focus of the research institutions. This encourages priority setting at Austria's higher education and research facilities and allows existing strengths at universities to be enhanced even further. In turn the ÖAW will focus more heavily on its core areas as enshrined in the performance agreement. In the place of the 63 research units that existed at the start of 2012, one year later there were just 28 institutions under the umbrella of the ÖAW.

Structural reform at the Academy has been in discussion since mid-2012; the aim of the reform process is to unbundle the academic community from the research institutions under the joint umbrella of the ÖAW. The policy resolution in this respect was passed in October 2012 at a joint session of the Academy. In future the academic community should strengthen its commitment to corporate and political consulting. Further details on structural reform at the ÖAW and on the performance indicators in particular can be found in chapter 3.5.

Innovation-orientedpublic procurement

In September 2012 the Austrian Council of Ministers passed the guidelines for innovation-oriented public procurement, which had been developed by the Federal Ministry of Economy, Family and Youth (BMWFJ) and the Federal Ministry for Transport, Innovation and Technology (BMVIT) as part of the stakeholder process. Some of the concrete measures agreed to in the guidelines for the purposes of making public procurement more open to innovation were as follows: The Federal Procurement Act should be expanded to include "innovation" as a secondary criterion; a central service agency should be set up for innovation-oriented public procurement; themed workshops should be set up with the providers and procurers of innovative products and services with regular events focused on information and coordination. The pilot call for tenders for the traffic infrastructure research project that started in 2011 is in the second phase, i.e. prototype development. When this instrument of pre-commercial procurement was first used, it provided important insights for the stakeholders involved (Federal Ministry for Transport, Innovation and Technology (BMVIT), Austrian Federal Railways (ÖBB), Autobahn and Motorway Financing Corporation (ASFINAG) and the Austrian Research Promotion Agency (FFG)), who funded and/or implemented the call for proposals. Research results are expected in 2014. Burghauptmannschaft Österreich, the authority responsible for conserving historic buildings in Austria, has begun a pilot project in collaboration with the BBG procurement agency on the issue of cold and heat in historic buildings.

1.2.2 Selected new measures

MINDT initiative

Essential components for improving the teaching of mathematics, informatics, science, German and engineering (known as the MINDT-Initiative in German) were developed in the "Innovations Make Top Schools" project (IMST), which has been running in multiple phases for around ten years. As of 2013 a new MINDT initiative undertaken by the Federal Ministry of Education, Arts and Culture (BMUKK) will ensure that these results are expanded to additional Austrian schools as well as to those teachers who have not yet come into contact with IMST. As a result, between 80 and 100 school projects will be implemented and supported academically in a collaborative effort among teacher training institutions and universities, and the 17 regional specialist didactics centres already in place at teacher training institutions and universities will be expanded in terms of quantity and quality. The regional networks set up in all nine federal states (along with a few district networks and a gender network) will also be supported, since they make an essential contribution to the further development of MINDT teaching at the regional level and to networking among the stakeholders in the region.

Increased funding for Doctoral candidates and junior academics

The Austrian Science Fund's Doctoral Programmes (DPs) are an established tool in creating top quality, internationally visible educational centres for highly qualified junior academics in Austrian research institutions with a right to award doctorates. In contrast to traditional doctoral studies in Austria, doctoral candidates receive support from an entire team as part of a DP. This team is made up of between 5 and 20 members of the faculty staff who work together based on a clearly defined research priority, which ideally spans multiple disciplines in an intensive exchange. The maximum duration of a DK is three funding periods of four years each. Since 2004, the Austrian Science Fund (FWF) has funded 38 DPs at just under €108 million; there are currently around 380 doctoral candidates being trained in the structured doctoral programmes. In future the Austrian Science Fund (FWF) will be provided with an additional €18 million for DPs through the new "DK Profile" initiative, which will create up to 100 new places for doctoral candidates.

The ÖAW program "New Frontiers Groups", which received €8 million in funding from the National Foundation for Research, Technology and Development, was unveiled in 2012. The aim is to enable highly talented young academics to set up and lead a research group under the umbrella of the ÖAW with all decisions as to the themes involved and the use of awarded funds to be decided at their own discretion. The idea behind the programme, which is focused on cutting-edge research, is that it will seize upon issues that are relevant to society and are of seminal importance for the future, and that will contribute to constant renewal of the research portfolio at the ÖAW. Each New Frontiers Group formed as part of this scheme will last a maximum five years with a maximum funding amount of €4 million.

Patenting and commercialisation structures at universities

Efforts to establish well functioning commercialisation structures at the universities and also to enshrine these in the performance agreements with the universities have been successful in recent years. Further professional development of universities' property rights and commercialisation strategies, and thus the targeted expansion of the knowledge and technology transfer at universities, are therefore an important priority for the 2013–2015 performance agreements.

This should ensure a comparable, appropriate and attested level of professionalisation for the transfer of knowledge at public research institutions. Establishing clear regulations for dealing with intellectual property (in particular with new establishments) is an important part of the property rights and commercialisation strategy plans. Universities thereby make a sometimes significant contribution in the implementation of EU recommendations (IP recommendation). In other words, provided that there are no justified interests on the part of the universities regarding confidentiality standing in the way, then the strategy plans should be published both inside the university as well as externally in order to ensure communication which is as open as possible, particularly with partners from industry.

New Josef Ressel Centres

Josef Ressel Centres should be used to reinforce universities of applied sciences with proven research facilities as regional R&D partners to industry using stable and long-term R&D cooperation initiatives. Building up competence in applied research should also improve the quality of education at universities of applied sciences at the same time (in particular in terms of promoting young talent and providing research positions for the region). Following a positive evaluation, all three of the Josef Ressel Centres currently in the pilot initiative were extended for a total duration of five years. The new version of the Josef Ressel Centre programme also started in early 2012.

The new Josef Ressel Centres receive support from the Christian Doppler Research Agency as part of an independent programme. The direction and implementation are based on the well-established CDG model in its essential points. As is the case with the CD laboratories, centres are funded at universities of applied sciences for a limited period following a competitive selection procedure; these centres cooperate intensively with firms on research issues and develop concrete solutions for technical problems in industry. At five years, their duration is somewhat shorter than is the case with the CD laboratories, and the focus is on high-level applied research. The amount of funding involved per centre is less than that of the CD laboratories. In addition there are no benefits *in-kind* provided by corporate partners, meaning that participation is essentially only possible where monetary payments are made.

Production for the future

In order to meet current challenges (globalisation, demographic developments and an ageing society and labour market, increased scarcity of resources, required energy efficiencies and the highest environmental standards) in an appropriate manner, the Federal Ministry for Transport, Innovation and Technology (BMVIT) has developed a strategy for a framework initiative "Production for the future" together with experts from research and industry. The objective is to seize on themes and issues related to production research in Austria in a more targeted manner than previously and to promote them strategically at the interface between industry and science. An initial and highly successful proposal was launched in 2011, with projects funded for a total of €50 million. Demand from firms was very high and the amount of funding increased further in 2012 to €95 million. This demonstrates the huge interest from industry in funding for innovative products, processes, technologies and business models for improving competitiveness.

Young entrepreneur initiative

Founders are often confronted with obstacles to funding new business ideas against the background of the current economic situation. The domestic venture capital market, which is traditionally poorly developed in Austria, has also been severely affected by the economic and financial crisis. In light of this, an overall package amounting to €110 million was agreed on through the new initiative. This package came into effect from early 2013 and allows company founders access to an amount of annual support during the very difficult initial phase that is, on average, double what had been available to them previously. There are two complementary funds which support this target:

Business start-up fund: Equipped with a budget of €65 million, the business start-up fund is aimed at innovative firms in the first five years of operations and is open to all industries. The investment amount is between €100,000 and a maximum of €1 million. The duration of the investment of a maximum of ten years provides investment and planning security for the firm; at the same time, the objective is to arouse the interest of private investors as early as possible.

Business angel fund: A Business Angel Fund with a total of €45 million increases the supply of venture capital by doubling the investment power of Business Angels. For each euro that private investors put into young companies, there is an additional euro invested from public funds. A leverage effect can be achieved in using public funds by including the European Investment Bank and the private Business Angels. This means that in total €15 million originates from public funds in Austria, €7.5 million from the European Investment Fund and €22.5 million from investments by Business Angels. The fund is also intended for innovative firms in the first five years of operations, with the investment amount being between €150,000 and €300,000 per company. The expected participation period is between three and five years, with a total of between 30 and 50 participating interests per year or approximately 300 participating interests by 2020. In the event of a sale, the public portions are returned to the fund, thereby allowing further investments to be made.

Markt.Start

Public funding of R&D projects is generally limited to technical developments and ends when there is a functional prototype. There is no funding for the route to market, which is associated with low technical but high economic risks. The Markt.Start funding initiative comes into operation here[3], supporting introduction to the market following successful technical completion of an R&D project for experimental development supported by the Austrian Research Promotion Agency (FFG). Markt.Start focuses on supporting young technology-oriented start-ups categorised as small enterprises (SEs). Funding is provided for market launch and implementation for innovative product, procedure and service developments within the framework of corporate funding which is composed exclusively of loans of up to €1 million.

Frontrunner initiative

The Frontrunner Initiative, with a budget of €20 million, is managed by the Austrian Research Promotion Agency (FFG) together with the AWS and is aimed at firms which have their headquarters in Austria and which occupy a top technological position or are on their way to achieving this and wish to bolster their position using an aggressive frontrunner strategy. Frontrunners operate in a competitive market environment and therefore have to develop innovative products or processes on a continuous basis and/or address new markets. The aggressive corporate or business area strategy required for this (frontrunner strategy) is often based on ground-breaking and risky R&D projects, the specific risks of which need to be absorbed through the special funding provided in the form of a grant.

3 www.ffg.at/marktstart

Creative industry cheque

Creative industries voucher become an increasingly important driver for innovations in other business sectors. However, there is empirical evidence that these services are not being used adequately by SMEs, in particular by micro-sized and small enterprises. As a result the "Creative industry voucher" project was launched in February 2013. Its aim is to support the demand side in the creative industries and to offer a financial incentive to small- and medium-sized enterprises to cooperate with companies in the creative sector in future. The innovative activities of SMEs should thereby increase and more creative services will be utilised by SMEs, resulting in the strengthening of the creative industries. The costs of creative industry services for generating ideas, design and development, application, implementation and/or market transfer are funded within the framework of actual innovative entrepreneurial activities of an SME. The maximum funding available is €5,000 (total costs can be funded 100% up to this amount). Based on the huge success of the project, the original budget of €1.5 million was doubled, with €3 million now available for 2013. No further submissions may be made at the present time as the quota is already oversubscribed. However, provided a positive assessment, the programme should be continued from 2014.

Energy Research Initiative (ERI)

The Energy Research Initiative, with a budget of €12 million[4], is a new scheme for funding innovative energy research projects and is implemented within the framework of the on-going funding instruments of the Austrian Research Promotion Agency (FFG) and the AWS. The new Energy Research Initiative is intended to encourage Austrian firms to pursue new methods for energy research and to turn research results and the technological progress associated with these to their competitive advantage as part of the "European Energy Roadmap 2050".

The research initiative supports the use of renewable energy and contributes to an increase in the share of renewable energy sources measured against overall consumption in Austria. Last but not least, the initiative promotes the development of new processes for CO2-free hydrogen production and the use of CO_2 as a primary product in industry for manufacturing economically marketable products and/or for use in industrial processes. The main aim of this initiative is the realisation of anything from prototypes to demo products that may promise potential large-scale industrial utilisation.

Climate Change Centre Austria (CCCA)

The CCCA, set up in summer 2011[5], is the focal point for research, politics, media and the public for all questions related to climate research in Austria, thereby promoting a sustainable climate dialogue and acting as a mechanism for coordinating the promotion of climate research in Austria. The CCCA pursues the following objectives: bolstering the climate research landscape in Austria, promoting young academic talent and supporting knowledge transfer plus advising politicians and society, and thereby addressing one of the major challenges faced by our society. In addition to the *CCCA Office*, the *CCCA Service Centre* was also set up with the objective of developing and providing climate services, i.e. information on climate change as well as its causes and consequences, for research and society.

Preparations for HORIZON 2020

Intensive negotiations took place over recent months on the future EU Framework Programme HORIZON 2020. HORIZON 2020 will facilitate

4 www.ffg.at/efi/initiative
5 www.ccca.boku.ac.at

funding for the entire innovation chain, from basic research through to market launch for new products and services. In addition, investigations into challenges for society (the "Grand Challenges") will also be a priority for the next funding programme.

Austria actively participated in the European negotiations based on its bargaining position decided in the Austrian Council of Ministers on 14 February 2012, with some of the changes obtained being outlined below:

- Austria welcomed the main features of the challenge "Health, Demographic Change and Well-being", but maintained that this programme track (with 16 individual measures at the time) was not designed coherently. In view of this, Austria submitted proposals for a more coherent design. The proposal was successful, and a significant improvement was achieved with the structure reorganised with seven individual measures.

- Over the course of the negotiations on the regulatory text, Austria supported a division of the sixth challenge under the third pillar – with the positive result that there is now one challenge each for the humanities, social sciences, cultural studies and safety research.
- Together with other member states, Austria campaigned intensively for SMEs to receive more funding in the future, and this met with success, as 20% of the funds from the "Industrial Leadership" and "Societal Challenges" pillars will be provided specifically to SMEs.

The negotiation process is scheduled to be completed in autumn 2013, with agreement being sought over the coming months between the Council and European Parliament. The most important thing in this context is the distribution of the budgetary funds to the different areas of HORIZON 2020. In the meantime negotiations are taking place in Austria with the Austrian Research Promotion Agency (FFG) on advising and supporting the Austrian RTI stakeholders in HORIZON 2020.

1.3 Austria's position in an international context

A country's innovation performance is determined by a large number of factors. In addition to the innovative capacity in industry, several other elements play an essential role, including education and science, attitudes in society, the conditions on the factor and goods markets as well as government measures introduced to promote research and innovation, among others. Given this multi-dimensionality, various indicator systems have been developed over recent years for the purpose of providing summary findings on a country's position in terms of international innovative competition.[6] The one thing that they all have in common is the fact that they combine different individual indicators on innovation performance into one overall indicator. As such they not only allow conclusions to be drawn on a country's position in terms of innovative competition, they also reflect current trends and provide an indication of potential starting points for measures related to innovation policy. Austria's position in the European Commission's *Innovation Union Scoreboard* (IUS) 2013 is analysed below. The IUS is of particular interest because the Austrian federal government has set a target for Austria to catch up with the group of *Innovation Leaders* in this ranking in the medium term. An additional ranking is also considered: the "Innovation Indicator" from the Deutsche Telekom Foundation and the Federation of German In-

6 These include the European Commission's Innovation Union Scoreboard, the Global Competitiveness Report of the World Economic Forum, the World Competitiveness Report from the IMD World Competitiveness Centre, the Global Innovation Index from INSEAD along with various individual studies, such as the Cologne Institute for Economic Research (2012), Economist Intelligence Unit (2009), Boston Consulting Group (2009) and Information Technology and Innovation Foundation (2009).

dustries. The priorities set for this ranking differ from those in the IUS, allowing conclusions to be drawn on the significance of methodological differences for a country's positioning in international comparisons.

1.3.1 Austria's position in the Innovation Union Scoreboard (IUS)

The IUS is a further development for the European Innovation Scoreboard, or EIS, which it succeeded in 2010 for the purposes of comparing European innovation. The IUS is implemented on the basis of the European Commission communication on the "*Europe 2020 Flagship Initiative Innovation Union*" to enable the assessment and comparison of innovation development within the EU-27 as well as of the EU vis-à-vis other economies (in particular the US and Japan).[7]

The IUS provides a (quantifiable) representation of performance based on specific indicators that have been further developed over the years for the purpose of creating a realistic and comparable assessment of innovation development.[8] Improvements in the data base and constant development of analytical methods (as well as the increased length of the observation period) are enhancing the comparability of the countries and, thus, the the significance of the IUS/EIS.

Despite these improvements, however, we must keep the limitations of an indicator-based comparison of innovation systems in mind, especially when the individual indicators used in the IUS are combined into a Summary Innovation Index (SII), resulting in the need for a highly cautious interpretation of this number – not all determinants and determining factors can be captured using quantifiable indicators. However, considering these limits, the IUS has proved to be a suitable instrument for tracing developments and providing a basis for comparisons in the areas of R&D and innovation.[9]

The European scoreboard (EIS and IUS) has been subject to change and improvements over time; the list of indicators, for example, was reduced to 25. These indicators cover the relevant areas of research and innovation.[10] They are broken down into three types of indicators (enablers, firm activities and outputs) and eight dimensions. A description of the indicators as well as the methods used can be found in Hollanders and Tarantola (2011).

Tab. 1 provides an overview of the underlying indicators and sources upon which the IUS 2013 is based.

The "innovative potential" of each country is summarised on the basis of these 25 underlying indicators into a *composite indicator* (Summary Innovation Index – SII). The SII values, then, determine the ranking of the 27 member states.

The basic order of EU member states in the IUS/EIS has remained largely unchanged since the benchmark was introduced – the group comprising the "Innovation Leaders" includes four countries: Sweden, Germany, Denmark and Finland. There are ten countries in the "Innovation Followers" group (the Netherlands, Luxembourg, Belgium, the United Kingdom, Austria, Ireland, France, Slovenia, Cyprus and Estonia) that still exceeded (or were just under) the average of the 27 EU member states.

The group of "Moderate Innovators" consists of Italy, Spain, Portugal, the Czech Republic, Greece, Slovakia, Hungary, Malta and Lithuania (positions 15–23). And finally, the group of "Modest Innovators" includes Poland, Latvia, Romania and Bulgaria.

7 European Commission (2010a).
8 The Austrian Research and Technology Report 2008 includes a comprehensive discussion of the EIS (p. 17 et seq.).
9 See Schibany and Streicher for a comprehensive discussion of these aspects (2008).
10 For more details, see the documentation at http://www.proinno-europe.eu/metrics

Table 1: IUS 2013 Indicators

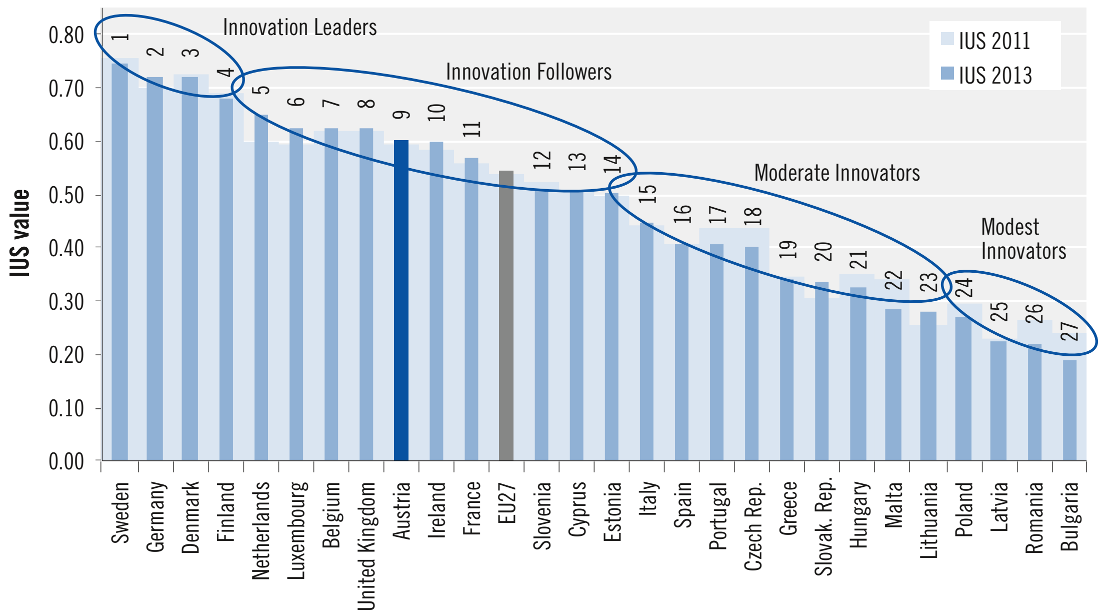
Indicator	Data source	Years covered
ENABLERS		
Human resources		
1.1.1 New doctorate graduates (ISCED 6) per 1000 population aged 25-34	Eurostat	2006 – 2010
1.1.2 Percentage population aged 30–34 having completed tertiary education	Eurostat	2007 – 2011
1.1.3 Percentage youth aged 20–24 having attained at least upper secondary level education	Eurostat	2007 – 2011
Open, excellent and attractive research systems		
1.2.1 International scientific co-publications per million population	Science-Metrix (Scopus)	2007 – 2011
1.2.2 Scientific publications among the top 10% most cited publications worldwide as % of total scientific publications of the country	Science-Metrix (Scopus)	2004 – 2008
1.2.3 Non-EU doctorate students as a % of all doctorate students	Eurostat	2006 – 2010
Finance and support		
1.3.1 R&D expenditure in the public sector as % of GDP	Eurostat	2007 – 2011
1.3.2 Venture capital investment as % of GDP	Eurostat	2007 – 2011
FIRM ACTIVITIES		
Firm investments		
2.1.1 R&D expenditure in the business sector as % of GDP	Eurostat	2007 – 2011
2.1.2 Non-R&D innovation expenditures as % of turnover	Eurostat (CIS)	2006, 2008, 2010
Linkages & entrepreneurship		
2.2.1 SMEs innovating in-house as % of SMEs	Eurostat (CIS)	2006, 2008, 2010
2.2.2 Innovative SMEs collaborating with others as % of SMEs	Eurostat (CIS)	2006, 2008, 2010
2.2.3 Public-private co-publications per million population	CWTS (Thomson Reuters)	2007, 2011
Intellectual assets		
2.3.1 PCT patent applications per billion GDP (in PPS €)	Eurostat	2005, 2009
2.3.2 PCT patent applications in societal challenges per billion GDP (in PPS €) (environment-related technologies; health)	OECD / Eurostat	2005, 2009
2.3.3 Community trademarks per billion GDP (in PPS €)	OHIM2 / Eurostat	2007, 2011
2.3.4 Community designs per billion GDP (in PPS €)	OHIM / Eurostat	2007, 2011
OUTPUTS		
Innovators		
3.1.1 SMEs introducing product or process innovations as % of SMEs	Eurostat (CIS)	2006, 2008, 2010
3.1.2 SMEs introducing marketing or organisational innovations as % of SMEs	Eurostat (CIS)	2006, 2008, 2010
3.1.3 High-growth innovative firms	N/A	N/A
Economic effects		
3.2.1 Employment in knowledge-intensive activities (manufacturing and services) as % of total employment	Eurostat	2007, 2011
3.2.2 Contribution of medium and high-tech product exports to the trade balance	UN	2007, 2011
3.2.3 Knowledge-intensive services exports as % total service exports	UN / Eurostat	2006, 2010
3.2.4 Sales of new to market and new to firm innovations as % of turnover	Eurostat (CIS)	2006, 2008, 2010
3.2.5 License and patent revenues from abroad as % of GDP	Eurostat	2007, 2011

Source: InnoMetrics.

These groups are very stable over time; changes in the relative positioning take place predominantly within these groups. This means the following for Austria's position in the relevant years of publication:

Austria is currently ranked in 9th position and as such, its ranking has nominally worsened continuously over recent years from 6th to 9th position. Compared with last year, Austria was able to increase its SII value slightly, but Luxembourg was able to overtake it (after being in 9th position, it now occupies the 6th spot). However, as previous technology reports have already shown, this must be interpreted with caution, not least because the official ranks in the relevant years of publication are based on the data base available in the relevant year. When an indicator value is not available for a country, the last available value is used as a substitute. This means that the indicators do not (necessarily) all relate to the same data year for all countries – in the event that the indicator does become available at a later point in time, the relative positions of the countries may change. In addition, the fact that the ranking is translated from a continuous variable (the Summary Innovation Index) into a discrete variable (a country's position within the EU-27) must al-

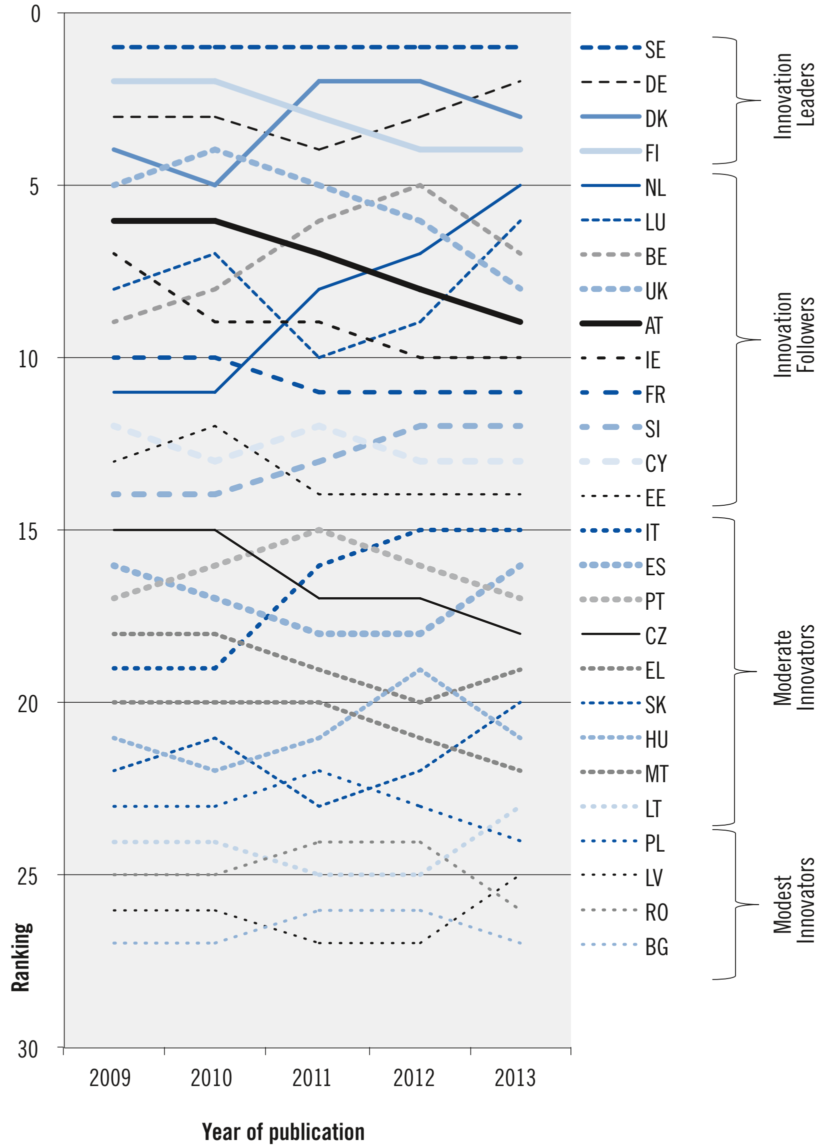
Fig. 4: Country comparison based on IUS 2013 and IUS 2011[11]



Source: InnoMetrics. Presentation by JOANNEUM RESEARCH.

11 Preliminary note on the nomenclature: The new IUS is named "IUS 2013" and therefore relates to publication year t. This is a new feature: previously the IUS (formerly EIS) related to the previous publication year t-1. The last IUS is therefore not IUS 2012 but IUS 2011. This may of course cause some confusion and is not helped by the fact that neither the new nor the old nomenclature relate to the last year of data used for calculating the scoreboard. In the old nomenclature, this was the year t-1 (the last year of data used for the IUS 2011 was therefore 2010); in the new IUS, it is accordingly t-2 (the IUS 2013 therefore relates to 2011 as the latest year of data). In order to ensure a uniform overview here, the years provided below (for instance in presenting the temporal sequences) relate to the IUS/EIS publication year.

Fig. 5: Published rankings of the 27 EU countries over time (publication years 2008–2013)



Source: InnoMetrics. Presentation by JOANNEUM RESEARCH.

so be taken into account, and as such the magnitude of the SII difference is lost.

The current positions and – even more so – slight changes in the country rankings must therefore always be interpreted with extreme caution (and in a sensible, cool headed manner). The group of countries to which Austria belongs is more relevant than the exact position: As can be seen from Fig. 4, Austria is in the top half of the group of "Innovation Followers"; nothing has changed in terms of its membership in this grouping in recent years. This group is characterised by very similar values for the Summary Innovation Index. As a result, even slight changes in the SII lead to noticeable changes in a country's positioning (and this is precisely what happens if old indicator values are used on account of a lack of available data for the publication year). The SII values for the group of countries which occupy places 5-10 differ by only 0.05. The value for rank 4 (Finland) is almost 0.04 higher than the one for rank 5 (the Netherlands). Similarly, the SII difference between Ireland in position 10 and France in position 11 is 0.03. The countries in positions 5–10 can (and should) therefore be seen as being a highly homogeneous group, where even minor changes in the data can (and do) result in noticeable changes in the relative position and, thus, in the IUS ranking.

A look at the individual indicators reveals an image which is practically unchanged compared with the results from recent years (in the figure below, the figures for Austria are shown together with the minimums and maximums of the EU-27, each based on the average for the available EU-27 countries). Austria is more than 10% below the EU-27 average for seven of the individual indicators (in another five indicators, Austria is within +/- 10% of the average). Austria has figures that are significantly above the average in 12 indicators. The strengths and weaknesses are very well-known: Austria remains far below the EU average (-30%) in tertiary degrees in the group of 30- to 34-year-olds, while Austria's position in doctoral degrees and the share of the population with at least a Level II secondary school certificate is above average.

The quality of scientific publications is above average: for the "most quoted publications", Austria is almost exactly at the EU average, while international co-publications are almost four times the EU-27 average. On the other hand, Austria was more than 50% below the average for doctoral students from non-EU countries (this conceals, however, a high proportion of "normal" students from the EU, especially Germany). However, the values for the individual countries in this indicator are distributed very unequally and are dominated by just a few countries – made clear by the fact that Austria is in 10th place in this indicator, despite the value which is significantly below average.

In the group of nine corporate-related indicators, Austria is below average in only one indicator (though significantly so), namely for expenditure on non-R&D-related innovations.

However, Austria's position is weaker when it comes to exports in high-tech services[12], turnover from innovative products, and license revenues from abroad: this represents a certain contradiction to its solid positioning in patents, trademarks and SME innovators.

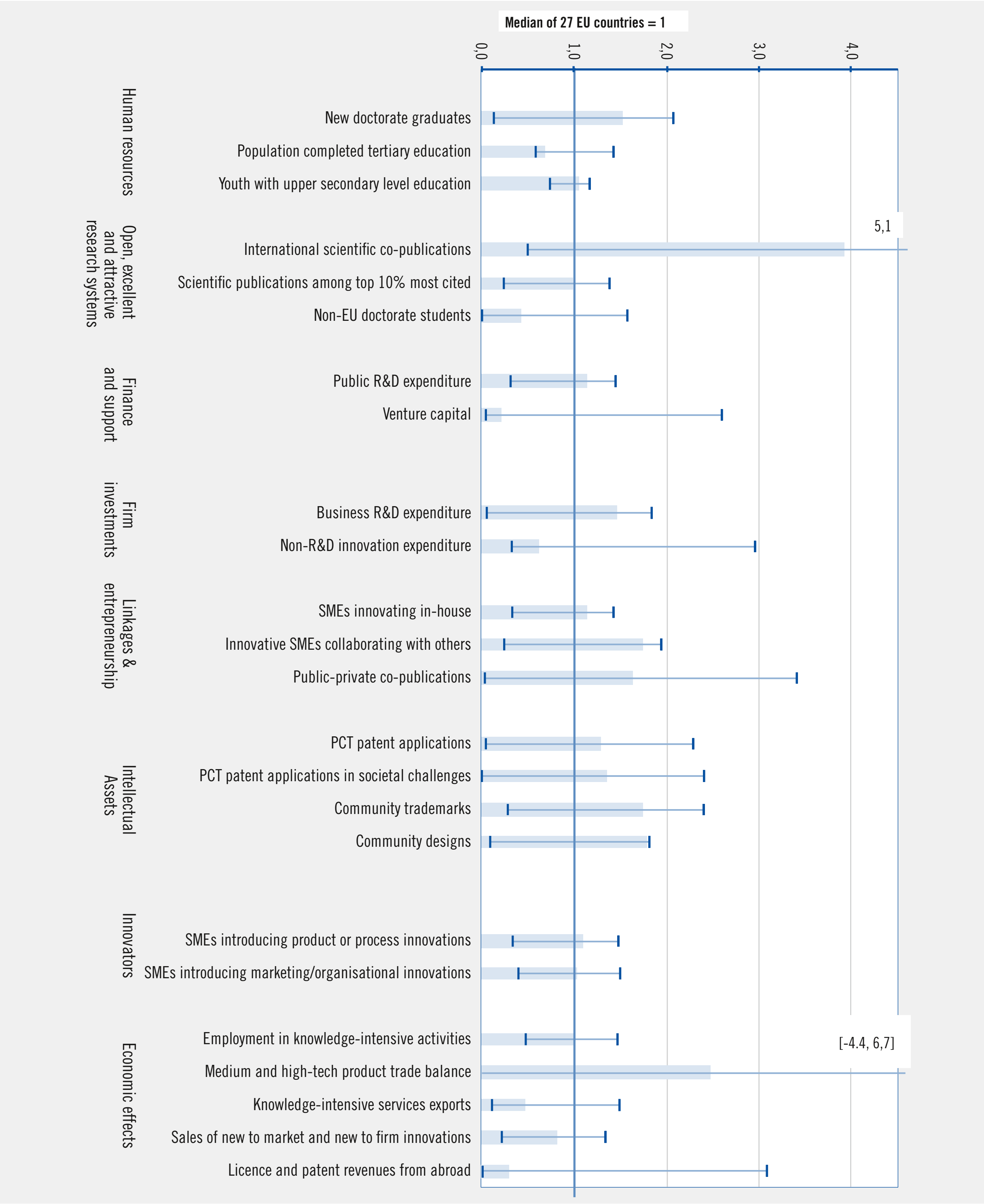
Development of individual indicators over time

The following section compares the chronological development of Austria's individual indicators with those of the Innovation Leaders and Innovation Followers (unweighted mean values). The values are compared based on the original indicator values (values which were missing for certain years were approximated using the last available data point) and presented for the entire available period 2001–2011.

For most indicators, Austria displayed trends similar to those shown by the Innovation Leaders and Followers – this means that Austria's aforementioned relative strength-weakness constellations were very stable in the five to ten years under observation. A certain exception can be found in the group of indicators taken from the Community Innovation Survey (CIS) (these are indicators 2.1.2, 2.2.1, 2.2.2, 3.1.1, 3.1.2 and 3.2.4 – those indicators that have "innovation" in their titles): these show noticeable jumps in the case of Austria. This has to do with changes in survey methodology, which imply that CIS 2006 and CIS 2008 can only be compared to a very limited extent for

12 The IUS does not show Austria's oft-stated weakness in pure high-tech exports because medium to high-tech exports were included here, thereby incorporating Austria's relative strengths in mechanical engineering, machinery equipment and automotive industry.

Fig. 6: Detailed results of IUS 2013 Austria vs. minimum/maximum of the EU-27



Source: InnoMetrics. Presentation by JOANNEUM RESEARCH.

Austria. Statistics Austria addressed this topic as follows in *Innovation 2006–2008 – Results of the Sixth European Innovation Survey (CIS 2008)*:

"... the comparative possibilities have become very limited over the years for various reasons (radically changed questionnaires, a modified random sampling methodology and improved handling of non-response analysis [...], a new industry classification system and, not least, a major expansion in the meaning of the term 'innovation'). The latter two reasons in particular affect the comparability between these results and those of the CIS 2006." [13]

For indicators 1.3.1 and 2.1.1 (R&D expenditure from the public sector and the business enterprise sector respectively), Austria is almost exactly midway between Innovation Leaders und Followers (and also shows very similar dynamics). However, venture capital funding (1.3.2) is very low in comparison: at only 0.02% of GDP, it is below the comparison groups' averages by a factor of 6 according to current figures (although the decrease in recent years has been a little less noticeable).

Indicator 1.1.2, i.e. the share of individuals with a tertiary education in the group of 30- to 34-year-olds, requires particular consideration. At 24% Austria has a significantly lower proportion than the average for both Innovation Leaders and Innovation Followers (over 40% in each case); the EU average is 35%. One of the main reasons for this is a classification issue of some types of degrees in the ISCED 1997, especially of graduates from higher vocational education.[14] If these uncertainties related to classification would be resolved in favour of defining these degrees as tertiary degrees, the tertiary share in Austria would be 36.8%[15] – and as such, above the average for the EU-27, although still significantly below the level among the Innovation Leaders and Followers[16]. Development over time in Austria also displays a very moderate dynamic: between 2001 and 2011 the share in Austria rose from 21% to 24%, whereas the average for the Innovation Followers rose from 29% to 42% (and from 33% to 41% for the Innovation Leaders). On the other hand, the share of 20- to 24-year-olds who have at least a higher secondary-level education (1.1.3) is very high in Austria. In addition to the Scandinavian countries, it is the "new" members from Eastern Europe that have the highest values here.

Austria's performance in the patent indicators is of interest and is extremely welcome news: for both indicators on the PCT[17] patent applications (2.3.1 and 2.3.2), Austria is above the Innovation Followers (even if it is considerably behind the Innovation Leaders). Austria is even above the average level for the Innovation Leaders for the indicators on community designs and community trademarks. However, Austrian license and patent income from abroad is distinctly below average (3.2.5). The value for Austria is not even one-quarter of that for the Innovation Leaders (and is only one-third of the overall EU average).

13 Statistics Austria (2010), p. 15

14 In terms of comparability there is a problem in that the higher professional-education school leaving examination is classified as completion of ISCED level 4a after attending a five-year main course at a technical college, business academy, etc., while the special forms of professional-education schools (graduate schools, advanced training courses, schools for professionals), which offer qualifications which are comparable to the dedicated 5-year main courses, come under the category ISCED 5b and are allocated to tertiary education. This is based on the logic that blocks of education courses - following each other sequentially and in a hierarchical manner - represent the classification principle for the ISCED.

15 See press release 10.485-061/13 from Statistics Austria dated 19/03/2013 on this: *"Despite an increase in the tertiary share, Austria still remains well below the EU average. In addition to higher education, academy and graduate school degrees, master craftsman examinations and foreman courses also come under tertiary degrees in international comparisons. Under this classification, 19.3% of the Austrian population aged between 25 and 64 possessed a tertiary degree in 2010. However, an average 27.6% of this age category had a tertiary degree in those 21 EU countries that are also OECD members at the same time. The gap with the EU-21 average continued to grow wider since the tertiary share in many countries is growing more quickly than in Austria. Yet if the group of 30- to 34-year-olds, which is relevant from the point of view of the Europe 2020 target, is considered, then at 36.8%, the tertiary share with equivalent educational degrees included is just above the EU average and within the range of the target value of 40%."*

16 This problem only has limited effects on Austria's position in the IUS in 2013: applying a tertiary share of 36.9% would bring Austria's SII value very close to the one for the United Kingdom (position 8), but would not be enough for a change of position.

17 Patent Cooperation Treaty (PCT) is a coalition of 16 national/regional patent offices.

The differences for the two indicators "Contribution of medium and high-tech exports to the balance of trade" (3.2.2) and "Proportion of knowledge-intensive service exports" (3.2.3) are significant: while Austria is able to keep up in the first instance (and even has higher contributions than the averages for Innovation Leaders and Followers), in the second, the value for Austria is more than 50% below the relevant average for comparable countries. However, it must be noted here that services that are in demand by foreign tourists in Austria are counted as service exports, and the tourism sector in Austria has an above-average role in the overall economy.

Summary

In the latest Innovation Union Scoreboard (IUS 2013), Austria is in 9th place (8th place in last year's IUS 2011[18] and 7th place in the IUS 2010), and is thereby firmly positioned in the (top half of the) group of *Innovation Followers*. These groupings have been very stable for years, and shifts of positions within these (partial) groups, which occur with every annual comparison, should not be considered to be all too important (this does not only apply to "deteriorations", but should also be considered in the event of any improvements in the rankings). Austria occupies a solid position within the *Innovation Followers* (together with the Netherlands, Belgium, the United Kingdom, and Ireland in places 5 to 10), which as a group, however, lags significantly behind the *Innovation Leaders* (Sweden, Germany, Denmark and Finland).

The individual indicators confirm the strength/weakness pattern familiar from earlier IUS/EIS analyses: certain weaknesses remain in tertiary education, venture capital facilities, license and patent income, and knowledge-intensive service exports. Strengths are evident in the indicators for secondary degrees, scientific publications, R&D expenditure by firms, medium and high-tech material goods exports, as well as intellectual property. Austria saw noticeable fluctuations over time for the indicators derived from the Community Innovation Survey (CIS) (of the six CIS-derived indicators, four affect the innovation behaviour of SMEs), yet these changes are attributable to altered circumstances in this survey's design and execution. For many of the 25 indicators in the IUS, Austria displays trends similar to those exhibited by the Innovation Leaders and Followers – this means that Austria's strength-weakness constellations were very stable over the last five to ten years.

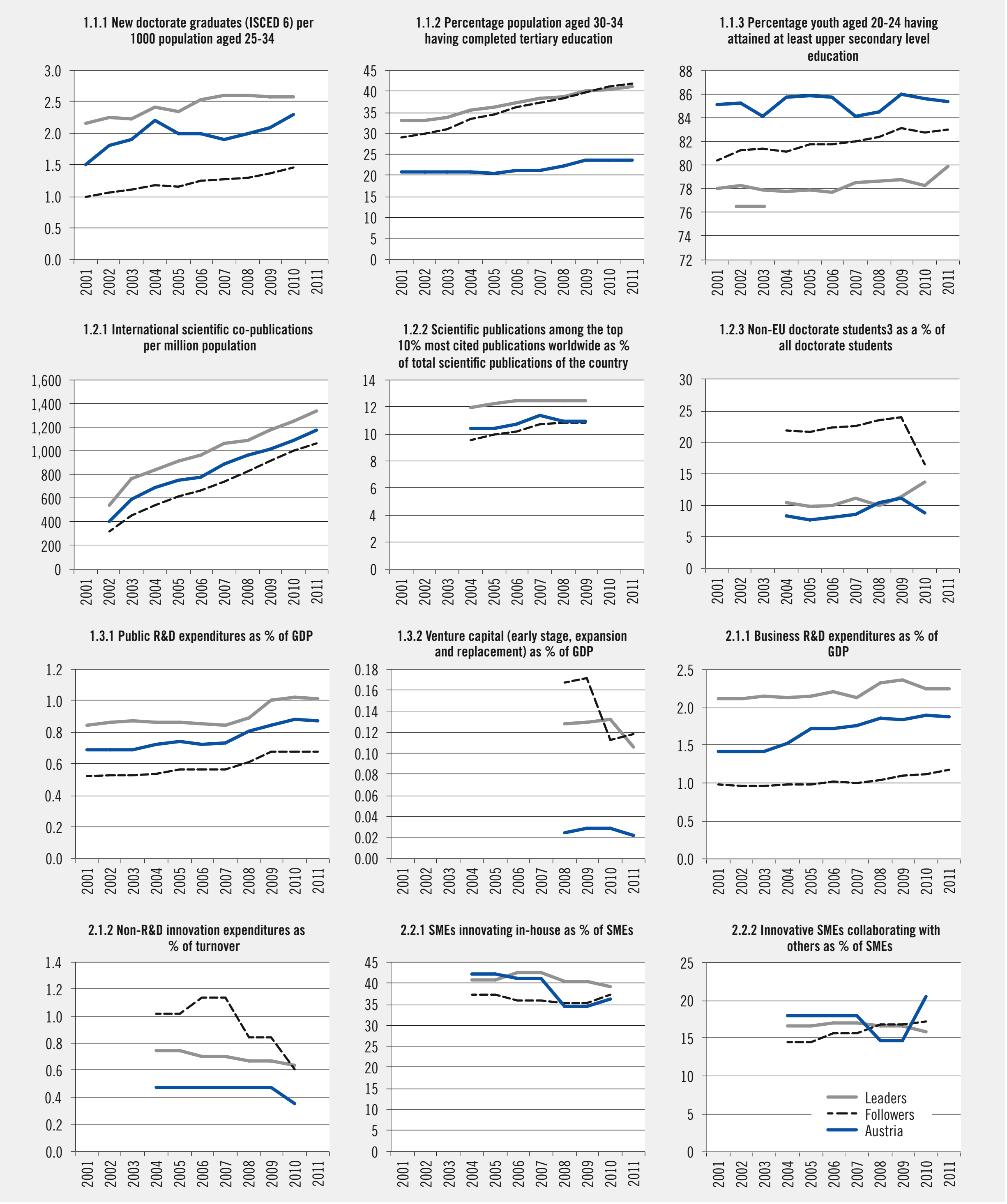
Furthermore, the IUS intends to capture structural aspects in both its conception and execution; accordingly, many indicators are oriented towards a long-term perspective. Immediate reactions to changed political conditions, in the form of short-term substantial improvements in the IUS, are therefore only expected to a limited extent. The IUS (as well as other similar benchmark studies) should instead reveal structural strengths and weaknesses from which long-term opportunities can be derived for the future.

1.3.2 "Innovation Indicator" from the Deutsche Telekom Foundation and the Federation of German Industries

The "Innovation Indicator" from the Deutsche Telekom Foundation and the Federation of German Industries (BDI) was first presented in 2005 and was fundamentally revised in 2011. It compares the innovation performance of 28 industrialised and emerging nations using 38 individual indicators assigned to five fields (industry, science, education, government and society). It has a similar methodological basis as the IUS. However, unlike the IUS, "soft" factors such as expert assessments, society's attitudes towards innovation as well as the networking of innovation

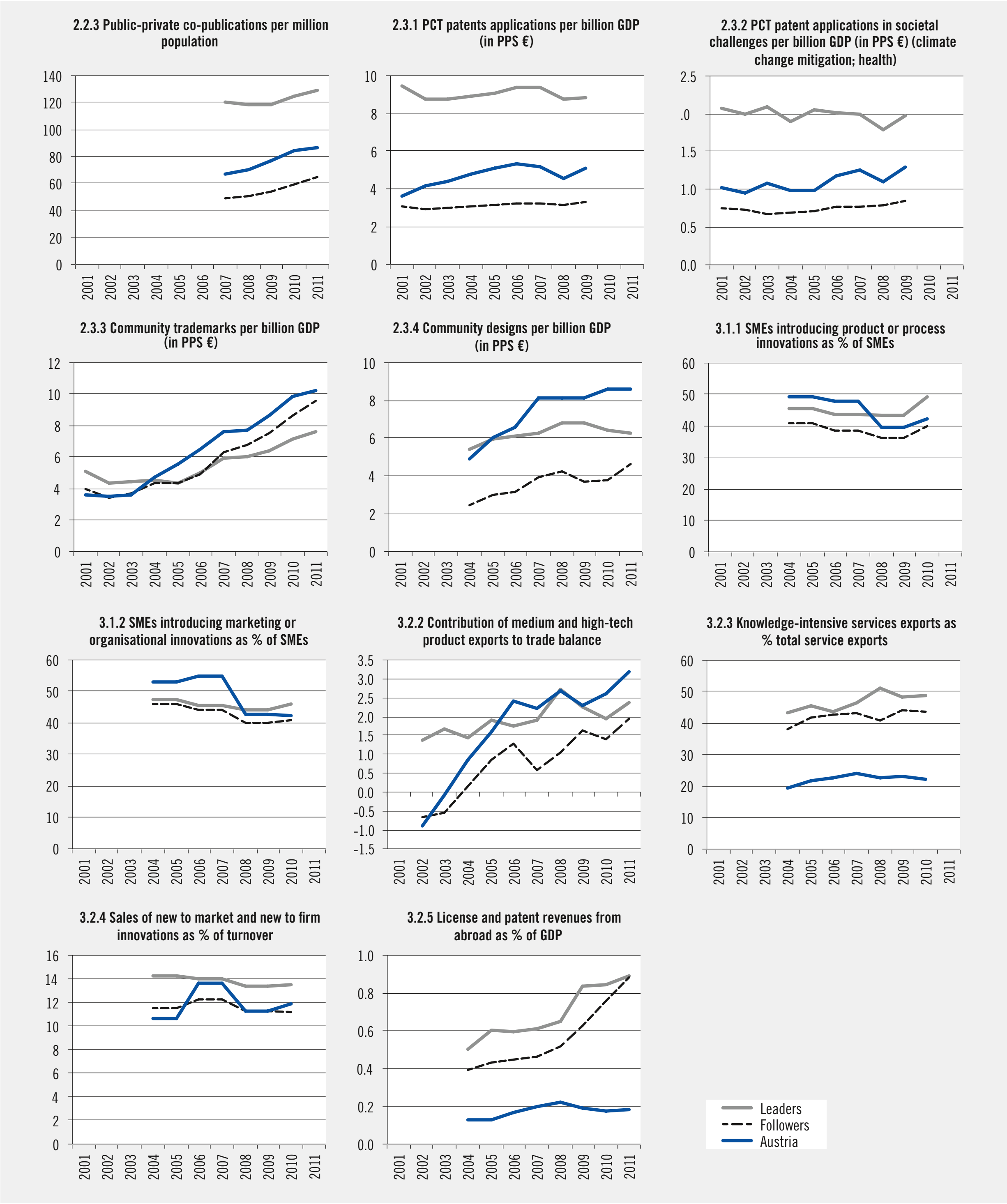
18 Please refer to the change in the nomenclature mentioned in footnote 11 for an explanation as to why the IUS 2011 precedes the IUS 2013

Fig. 7: Temporal development of individual indicators, part 1: Austria vs. Innovation Leaders and Innovation Followers



Source: InnoMetrics. Presentation by JOANNEUM RESEARCH.

Fig. 8: Temporal development of individual indicators, part 2: Austria vs. Innovation Leaders and Innovation Followers



Source: InnoMetrics. Presentation by JOANNEUM RESEARCH.

stakeholders play a greater role, while the innovation performance of SMEs is not given particular consideration and indicators from the community innovation surveys are not included. Furthermore a country's position is not determined in relation to all other countries, but in relation to a group of particularly high-performance and/or larger countries (the US, Japan, Germany, France, the United Kingdom, Italy and Switzerland), i.e. the benchmark applied is a challenging one.

Austria is in 11th place in the latest "Innovation Indicator 2012" (see Fig. 9). Austria dropped three places compared with its ranking in the previous year, since some countries just behind Austria in 2011 (Belgium, the US and Denmark) were able to increase their indicator values while those for Austria remained constant. In comparisons over the longer-term, Austria is one of the countries which was able to improve its position significantly in the "Innovation Indicator". Austria's overall indicator value increased from 44 to 53 points between 2000 and 2011.[19] This is the best improvement in Europe behind the Netherlands, Norway and Ireland. As such, Austria was able to reduce its gap considerably with several countries which were among the Innovation Leaders at the start of the 2000s, such as Sweden, the US and Finland. Nevertheless Austria is also at the bottom of a group of "Innovation Followers" in the "Innovation Indicator". The gap with other countries with the highest indicator values – i.e. Switzerland and Singapore in 2012 – remains considerable and has not been significantly reduced over the last ten years.

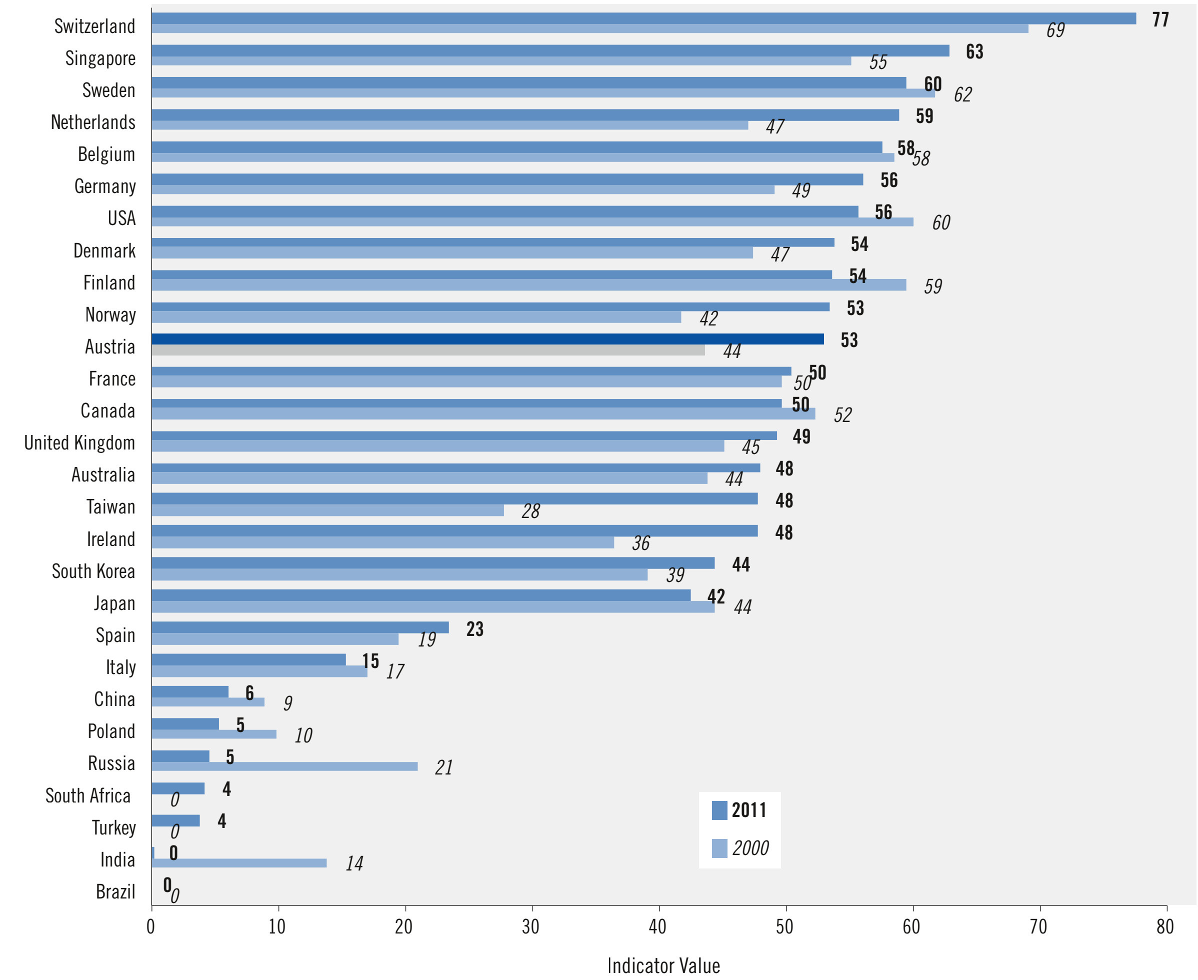
Austria's strengths in the "innovation indicator" are in science (2012: position 10) and in the area of society's attitudes towards innovation (2012: position 7), with this last sub-indicator only being of minor significance for overall performance. Austria has been able to increase its indicator value in science considerably since the mid-1990s on an almost continuous basis. An expansion in patent activities on the part of universities and government research institutions, a rise in the proportion of foreign students, an increase in the number of graduates in natural sciences and engineering as well as the increased citation of publications by Austrian academics are some of the factors behind this development.

Austria also improved in the "industry" sub-indicator, although barely any increase in the indicator value has been discernible here in recent years. In addition to increased R&D expenditure by industry, high productivity growth as well as an improvement in the balance of trade with high-tech goods, R&D tax incentives have also contributed to Austria's positive performance for some time. However, Austria has recently fallen behind in terms of R&D tax incentives, since some other countries from the reference group – namely France and Japan – have become significantly more generous with their system of incentives. As such, the indicator value in the government area has also fallen considerably since 2007, since R&D tax incentives are an essential factor in innovation policy. However, the drop in the indicator value does not mean that government support for R&D has deteriorated in Austria, but rather that other countries have become more appealing here.

A further reason for the decline in the indicator value in the government sub-system are the relative worse positions in the education area. Higher education expenditure per student was less dynamic when compared with other countries, and expert assessments on the quality of state education and research facilities have also worsened. The education sub-indicator is gen-

19 The indicator values are calculated in a similar way to those in the IUS through scaling of the individual indicators to the highest and lowest values of the leading innovation nations and balancing. The value range for the indicators is between 0 and 100. As such, any increase means that a country has improved in relation to the leading innovation nations.

Fig. 9 Country ranking in the 2000 and 2011 "Innovation Indicator"



Note: All indicator values based on the methodological revision completed in 2011.
Source: Deutsche Telekom Foundation/BDI: Innovation Indicator 2012. Calculations by Fraunhofer ISI and ZEW.

erally a weak point for Austria's performance in the innovation indicator. No sustainable improvements in the indicator values have been achieved here over the last 15 years.

The "Innovation Indicator" makes a distinction between input and output indicators[20]. Input indicators represent investments in the innovation system, whereas output indicators reflect the results from research and innovation efforts. Austria stands out through having a particularly favourable ratio between outputs and inputs, which can be interpreted as high productivity of the innovation system. This "system productivity" was increased considerably from very low values in the early 1990s, with the output indicators having increased more strongly than the input indicators. This allowed Austria to move up from 15th position in 1995 to 7th position in 2011.

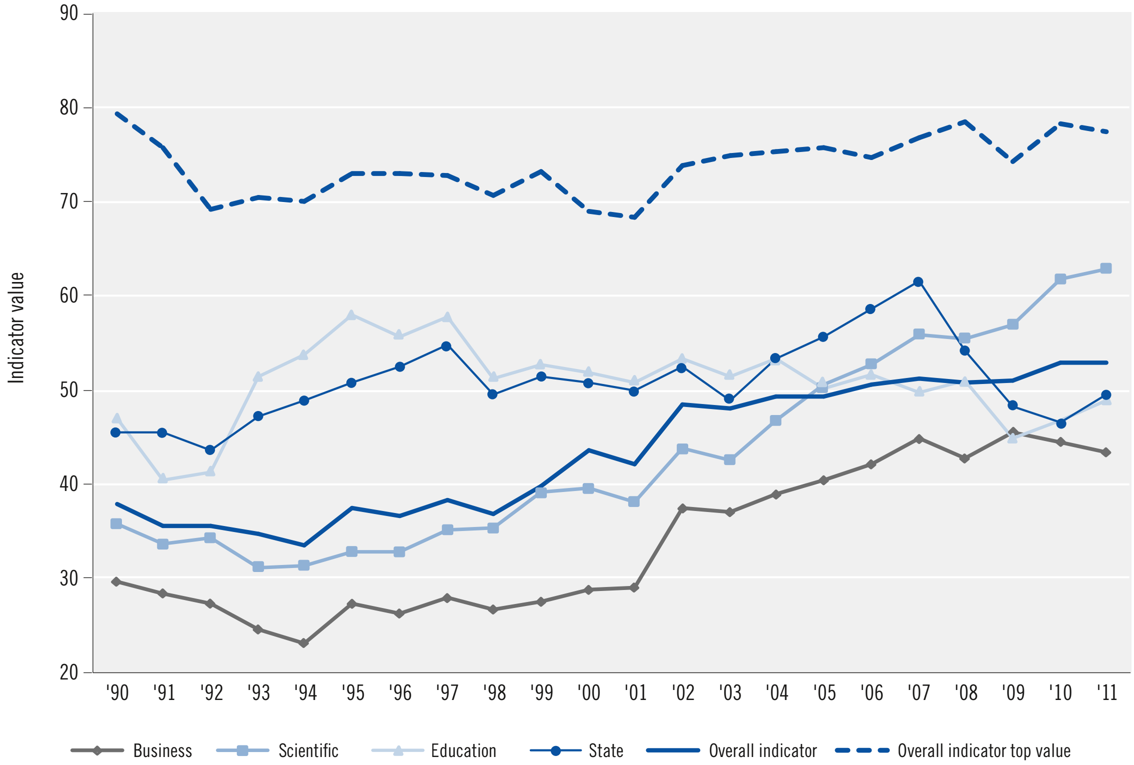
20 The list of individual indicators can be found in Annex I.

1.4 Global trends in R&D expenditure

Global R&D expenditure has risen by more than half over the last ten years, despite the severe economic and financial crisis. At the same time, the breakdown of R&D expenditure has shifted clearly in favour of countries experiencing rapid growth – particularly in Asia. The next section illustrates these changes and examines the changing role for Austria and the European Union (EU-27) in this process.

Various data sources are used in order to cover the global dimension and the maximum period possible (data from UNESCO, OECD, Eurostat and from national statistical offices). An international comparison can at least be made with the data for the EU-27 and OECD member states using the Frascati Manual[21] for data collection. This defines research and experimental development (R&D) as: " … *creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications.*" Overall R&D expenditure is considered (gross expenditure on R&D – GERD) in all sectors of performance (business enterprise sector, higher education sector, government sector and private non-profit sector). Non-OECD members only follow the uniform definitions, standards and methods in the Frascati Manual in part. Any comparison between OECD and non-OECD

Fig. 10: Indicator values for Austria in the 1990–2011 "innovation indicator" according to sub-indicators



Note: All indicator values based on the methodological revision completed in 2011.
Source: Deutsche Telekom Foundation/BDI: Innovation Indicator 2012. Calculations by Fraunhofer ISI and ZEW.

21 OECD (2002), p. 30.

countries must therefore be interpreted with certain caution. In addition, data availability for OECD and EU countries is considerably better than for non-OECD members and also covers longer time periods.

1.4.1 Global changes

The following section looks at the global breakdown in R&D expenditure (and changes to this) in the large global regions between 2002 and 2009. In the seven years from 2002 until 2009[22], global R&D expenditure rose approximately 62%, from 788 billion PPP US $ [23] to 1,277 billion PPP US $.

Looking first of all at the data for 2009 (see Fig. 11), i.e. the most up-to-date year with complete global data, global R&D expenditure is almost split into three equal parts between North America (32.7%), Europe (incl. European countries which do not belong to the EU) (28.5 %) and Asia (33.1%). South America, Africa and Oceania play a comparatively minor role in this with an overall share of 5.7%. Clear absolute growth can be seen for all global regions since 2002. However, the scale of this growth was extremely varied, leading to a shift in the shares of global R&D expenditure for the countries and regions under consideration, primarily away from North America and Europe towards Asia.

Of the larger national economies, China features the highest relative growth with R&D expenditure almost quadrupling; other Asian growth markets such as India and Korea have also seen above-average growth in R&D expenditure. At the same time Japan is also the country in Asia with the lowest relative increase (+27%) in the period under observation. In addition to increased importance for Asia there was also therefore a clear shift within Asia itself. In contrast, at +46%, the relative increase in R&D expenditure in the EU-27 was below the global value, even through it was clearly above that for Japan as well as above the comparison value for North America (40%).

The high relative growth in China is also partly caused by the comparatively low starting level. In terms of absolute increases, these were highest in North America at 120 billion PPP US $, followed by China with 115 billion PPP US $ and the European Union with 94 billion PPP US $. With an overall increase of 127 billion PPP US $, Europe (incl. European countries which are not EU members) is just above the corresponding values for North America and China in absolute terms.

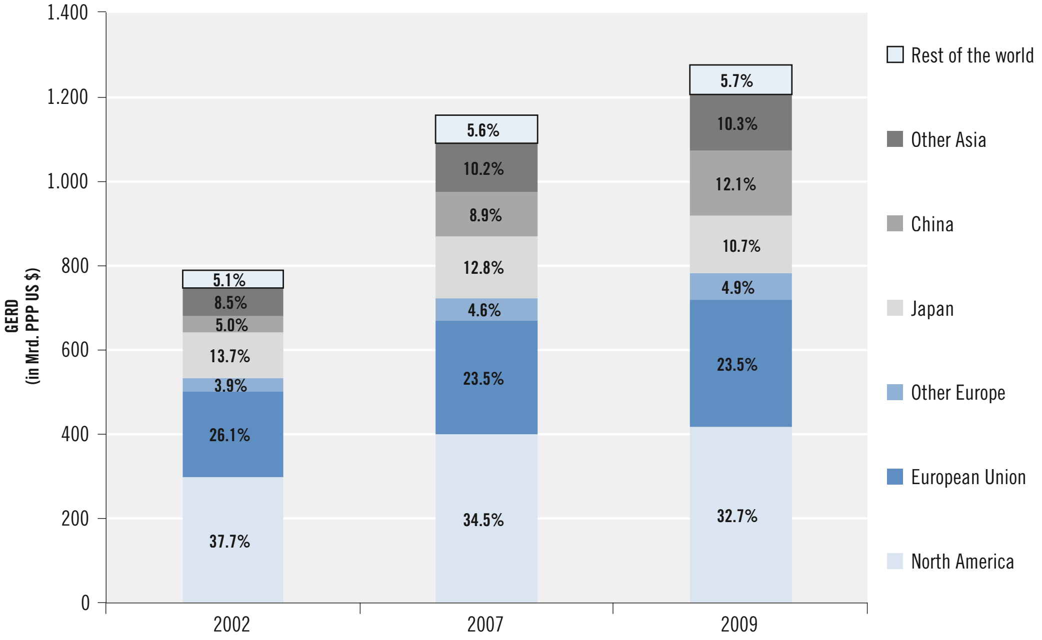
As a result of the high level of growth in Chinese R&D expenditure, China's share of global R&D expenditure rose from 5% in 2002 to 12% in 2009 (Fig. 11). This increased importance of China and other national Asian economies (not incl. Japan) initially led to a drop in the shares of global R&D expenditure between 2002 and 2007 in North America (of 3 percentage points), the EU-27 (3 percentage points) and Japan (1 percentage point). In the following two years until 2009, the share for the EU-27 remained stable, while North America lost a further 2 percentage point share, and Japan also lost a 2 percentage point share of global R&D expenditure. Despite the notable rise of the significance of China in the figures, R&D expenditure in the EU-27 was still around double China's level in 2009 measured in terms of PPP (in US $).

1.4.2 Long-term trends within the OECD

If a distinction is made between OECD and non-OECD member states when considering global R&D expenditure, then the OECD countries had a 75% share of global R&D expenditure in 2009. This represents a clear decline in relation to

22 Complete data on global R&D expenditure by country and region is only available for 2002, 2007 and 2009.
23 PPP US $: Purchasing power parity in US dollars at day-to-day prices.

Fig. 11: R&D expenditure (GERD), 2002, 2007 and 2009



Note: other Asia: Hong Kong, Indonesia, Malaysia, Philippines, South Korea and Singapore.

Source: UNESCO. Calculations by AIT.

2002, when the OECD countries had an 85% total share, and is due to the increased importance of China and other economies outside the OECD experiencing high growth. Analysis of developments in R&D expenditure before 2002 are only possible for the OECD member states due to data availability and improved comparability of the survey methodology (Fig. 12).

The EU-27's share of R&D expenditure in the OECD has remained extremely stable over the entire observation period at between 30% and 35%. While a slight downward trend is discernible in the 1990s, the share rises again slightly from the year 2000, and at 31.5% in the last year of observation of 2010, it was almost exactly at the same level for 1982 of 31.4%.

With a 41.5% share in 2010, the US was the country with by far the largest share of overall R&D expenditure in the OECD area and of overall global R&D expenditure. This share was somewhat higher in the 1980s at 45% and then declined slightly in the 1990s in the same way as in the EU. However, in contrast, the US managed to increase its share again around 2000, although only on a short-term basis, and is now back at the same share as in the early 1990s. Over the entire 30-year period, therefore, the US's share within this relatively narrow range was between 41% and 46% of the R&D expenditure within the OECD.

Bigger changes in significance were recorded for Japan. Japan's share of overall R&D expenditure in the OECD initially rose continuously from 16.0% to 19.7% between 1981 and 1990. This was followed by a phase of equally continuous decline in this share to just 14.5% most recently.

The importance of the other OECD countries has increased significantly over the last 30 years. This group includes the large traditional industrialised nations such as Canada and Australia on the one hand, as well as emerging economies such as Korea and Chile on the other. In some cases these countries had only just joined the OECD observation period and were only considered in the data from this relevant date. A slight overestimation in the growth for the other OECD countries can therefore be assumed.

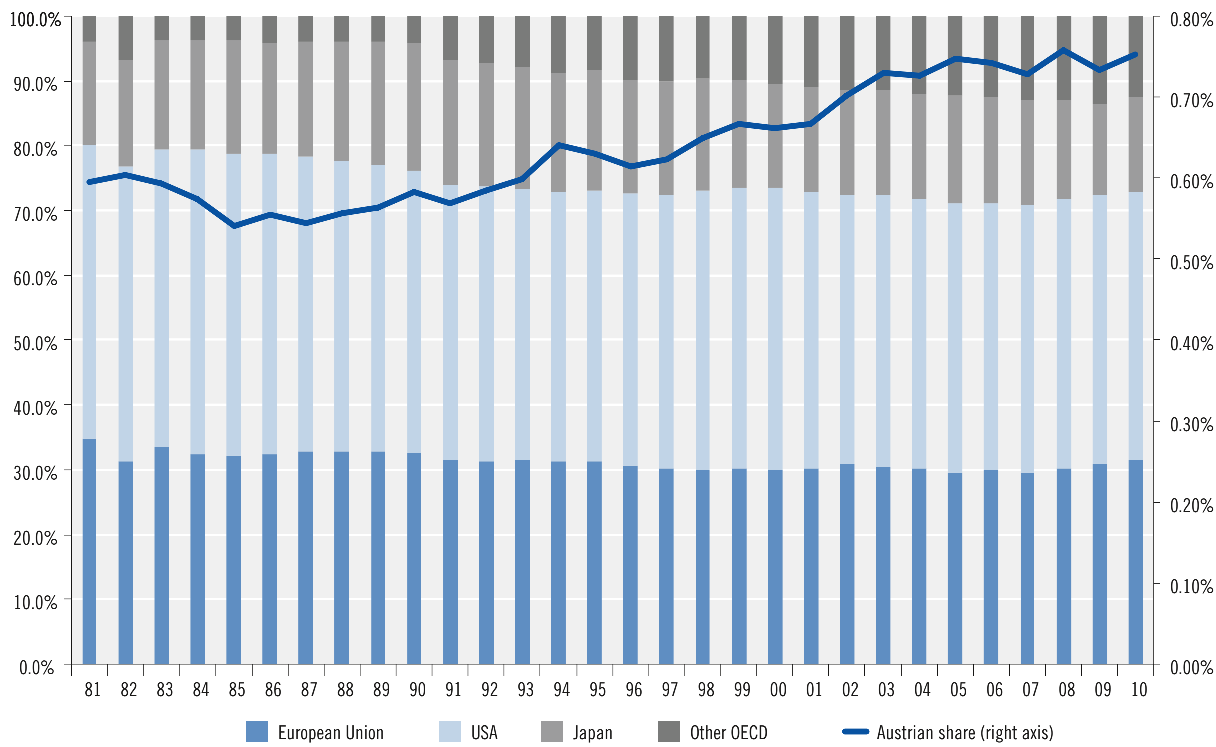
The simultaneous increase in Austria's share is worth noting against the background of the slight decrease in the EU-27's share in R&D expenditure of the OECD countries. While Austria only accounted for around 0.6% of R&D expenditure in the OECD in the 1980s, this share has risen continuously since the 1990s to around 0.75% most recently. In absolute figures, Austrian R&D expenditure grew from 5 billion PPP US $ to almost 8 billion PPP US $. As such, R&D expenditure in Austria grew well above the averages for the OECD or the EU and was therefore able to keep up with the high global growth rates.

1.4.3 Shifts in R&D expenditure within the European Union

Overall R&D expenditure in the EU-27 rose more than double from 138 billion PPP US $ to 305 billion PPP US $ in the 15 years between 1995 to 2010. While all member states increased their absolute R&D expenditure, there were some heavy shifts in country shares for overall R&D expenditure. Tab. 2 shows these shares of the EU countries. A change in percentage points and in positioning of the countries can also be seen from 1995 to 2010 in the *Innovation Union Scoreboard*[24] *(IUS)*.

Austria's share in overall R&D expenditure in

Fig. 12: Proportion of overall R&D expenditure of the OECD (in PPP US $, 1981 to 2010)



Source: OECD. Calculations by AIT.

24 See European Commission (2011a).

Table 2: Proportion of countries in the overall EU-27 R&D expenditure (in PPP US $), 1995, 2000, 2005 and 2010

	IUS Rank	1995	2000	2005	2010	Change 2010 on 1995
Spain	17	3.6%	4.2%	5.8%	6.7%	3.1%
Austria	8	2.1%	2.4%	2.9%	3.0%	0.9%
Finland	4	1.6%	2.4%	2.4%	2.5%	0.9%
Portugal	15	0.5%	0.7%	0.8%	1.4%	0.9%
Denmark	2	1.6%	1.9%	1.9%	2.2%	0.7%
Poland	23	1.3%	1.4%	1.3%	1.8%	0.5%
Ireland	9	0.6%	0.7%	0.9%	1.0%	0.5%
Czech Republic	16	0.9%	1.0%	1.3%	1.4%	0.4%
Hungary	18	0.5%	0.5%	0.7%	0.8%	0.3%
Baltic States	13, 25 and 27	unpublished	0.2%	0.3%	0.4%	0.2%
Belgium and Luxembourg*	5 and 9	2.7%	3.2%	2.9%	2.9%	0.2%
Greece	19	0.5%	0.6%	0.7%	0.6%	0.1%
Slovenia	11	0.3%	0.3%	0.3%	0.4%	0.1%
Malta and Cyprus	20 and 12	unpublished	unpublished	0.1%	0.1%	0.0%
Bulgaria	26	0.2%	0.1%	0.2%	0.2%	0.0%
Slovakia	22	0.3%	0.2%	0.2%	0.3%	0.0%
Romania	24	0.7%	0.3%	0.4%	0.5%	-0.2%
Sweden	1	4.5%	5.1%	4.6%	4.1%	-0.4%
Netherlands	7	4.7%	4.7%	4.7%	4.3%	-0.5%
Italy	14	8.4%	8.3%	7.8%	8.0%	-0.5%
Germany	3	29.0%	28.5%	28.0%	28.3%	-0.8%
United Kingdom	6	15.8%	15.2%	14.8%	12.8%	-3.0%
France	10	19.8%	17.9%	17.1%	16.4%	-3.5%

Note: Positions 1 to 4 Innovation Leaders, positions 5 to 13 Innovation Followers, positions 14 to 23 Moderate Innovators, positions 24 to 27 Modest Innovators.
* 1995 only Belgium

Source: OECD. Calculations by AIT.

the EU-27 rose considerably in recent years, from 2.1% in 1995 to 3% in 2010. This was the second biggest increase in terms of percentage points in the EU-27, with only Spain seeing a significantly larger share increase. Denmark and Finland were able to increase their share to a similar extent from among the group of *Innovation Leaders* (Finland, Denmark, Germany and Sweden). In contrast, the shares for Germany and Sweden fell slightly, although this decline was from a high starting point. From among the group of *Innovation Followers* (IUS ranks 5 to 14), to which Austria belongs, Austria is the only country with a clear increase in its share of R&D expenditure in the EU-27. The two largest national economies in this group, i.e. France and the United Kingdom, were the two countries with the most severe decline.

While large national economies such as Germany, France and the United Kingdom became less significant within the EU, the share for smaller and medium-sized countries experienced an upward trend. In addition to Spain, Austria, Denmark and Finland, it was the twelve new EU member states that primarily gained significance. Despite this increased significance, their total share of 5.7% in 2010 remains comparatively low.

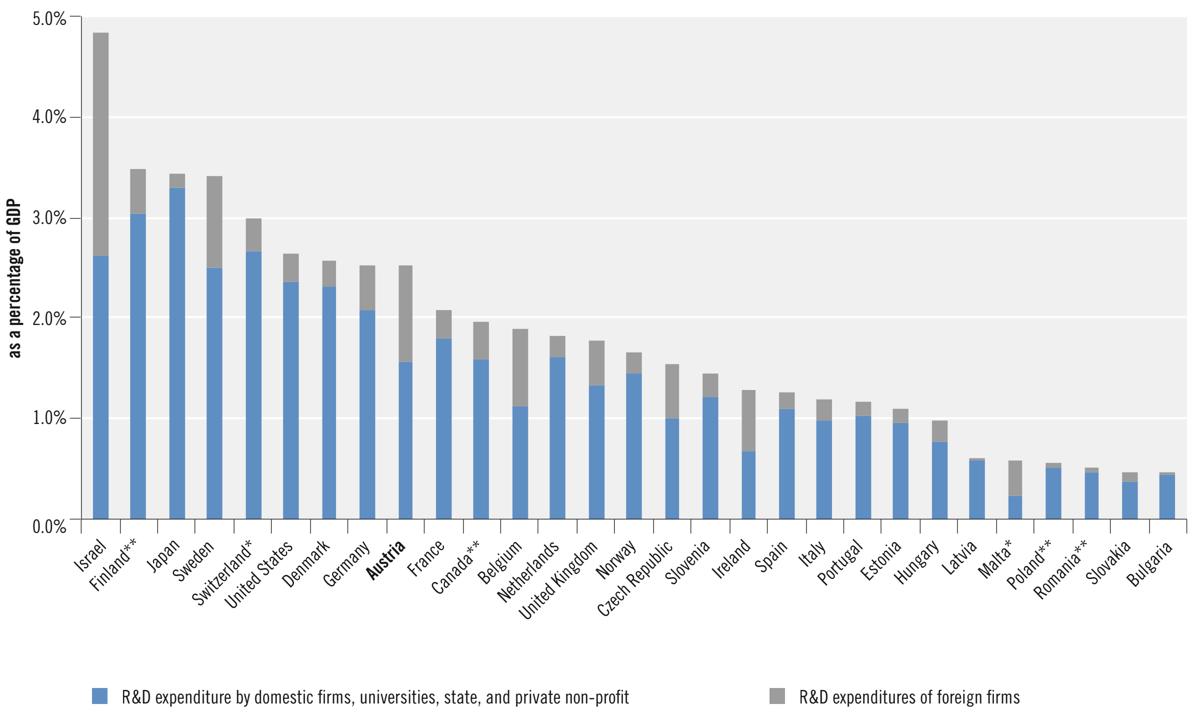
One direct consequence of the growth of smaller countries is a decrease in the concentration of R&D expenditure in the EU-27. The share of the four largest member states – Germany, France, Italy and the United Kingdom – in overall R&D expenditure fell from 73% in 1995 to 65.5 % in 2010. Developments in R&D intensity at the EU level are therefore also increasingly being determined by developments in the small and medium-sized member states.

1.4.4 Globalisation in R&D

Expenditure in the business enterprise sector on R&D has been the driving force behind the increase in R&D expenditure globally. R&D expenditure by firms outside of their respective home countries grew particularly heavily, a phenomenon which is also known as the internationalisation or globalisation of R&D. The question arises here as to the extent to which R&D expenditure by foreign firms has contributed to the huge increases in overall R&D expenditure and to the shifts that have been observed.

Fig. 13 shows the share of R&D expenditure by foreign firms in overall R&D intensity. It is evident that foreign-funded research in some smaller and medium-sized countries is responsible for a significant share of R&D intensity. At the same time, this research by foreign firms plays a less significant role in the large countries such as the US, Japan and Germany, which are responsible for large parts of overall R&D expenditure. There is no complete data available on R&D expenditure by foreign firms for China, but based on data from US firms operating R&D in China, R&D expenditure by foreign firms in China is estimated at between €2.3 and €6.1 billion[25]. This corresponds with a share of less than 10% of overall R&D expenditure in China. The strong

Fig. 13: Contributions by foreign firms to the R&D intensity, 2007



Note: * 2008 instead of 2007, ** 2006 instead of 2007.

Source: OECD, Eurostat, national statistical offices. Calculations by AIT.

25 see Dachs et al. (2012).

increase of R&D in China cannot be explained solely by R&D activities by foreign firms in China, despite China's increasing importance as an R&D location for foreign firms. In addition to the direct contribution of foreign firms in China there are also indirect effects which arise, such as specific forms of knowledge transfer which encourage domestic firms to increase their R&D expenditure.

Foreign firms make a particularly high contribution to R&D intensity in Sweden, Austria, Belgium, the Czech Republic and Ireland. With the exception of Sweden, all of these countries were also able to increase their share in R&D expenditure among the EU-27 within the last 15 years. Sweden did not record any such increase but it does have the second-highest R&D intensity within the EU-27. R&D expenditure by foreign firms therefore has relatively little influence on the global breakdown of R&D expenditure, but it does play a significant and increasing role in developments for R&D intensity, particularly in smaller and medium-sized countries. Around a third of overall R&D expenditure in Austria is now attributable to R&D expenditure by foreign-owned firms – an extraordinarily high number when compared internationally.[25a]

The globalisation of R&D is driven primarily by firms which operate in the area of material goods and is particularly pronounced in some export-intensive medium-high and high-tech sectors.[26] Tab. 3 shows R&D expenditure by foreign firms in Austria by country of origin and compares this with the corresponding expenditure by these countries in the overall EU-27. R&D expenditure by German firms, with a share of over half of overall R&D expenditure by foreign firms, is therefore of particular significance for Austria. However, Austria is also the most important location for German firms within the EU-27, with 38% of this expenditure concentrated in Austria. Beyond this, firms from Switzerland, the United States, Canada and the Netherlands make an essential contribution to R&D expenditure in Austria. Canadian and Swiss firms in particular concentrate their EU-wide research activities on Austria, at a rate of 28% and 11% respectively.

Table 3: Austria as an R&D location for foreign firms (2007, in € million)

Country of origin	R&D foreign firms in		Austrian share in EU-27
	Austria	EU-27	
Germany	1.456	3.786	38%
Switzerland	309	2.941	11%
United States	228	13.535	2%
Canada	180	632	28%
Netherlands	177	4.442	4%
Sweden	40	893	4%
United Kingdom	32	2.365	1%
France	26	3.276	1%
Belgium	18	300	6%
Japan	16	1.133	1%
Italy	14	705	2%
Finland	14	395	4%

Note: Only countries with at least €10 million of R&D expenditure in Austria considered.
Source: OECD, Eurostat, national statistical offices. Calculations by AIT.

25a see footnote 1a, p. 9.
26 at same location.

Summary

While from a global perspective it is the fast-growing Asian national economies, and in particular China, that have been able to increase their shares in overall global R&D expenditure at the expense of the US, Japan and the EU-27, Austria was one of the few EU countries that was able to keep its share at a stable level. The stability of Austria's share meant a considerable absolute increase in expenditure, since this occurred in an environment where global R&D expenditure increased hugely. Austria's share in R&D expenditure of the EU-27 and of the OECD increased significantly as a result.

Europe and North America were still responsible for over 60% of global R&D expenditure in 2009, despite the shifts in the global breakdown of R&D expenditure towards Asia. A decline in the share of the four largest national economies was evident within the EU-27, but over 65% of EU-27 R&D expenditure was attributable to these four countries in 2010. Several other countries besides Austria were able to increase their importance. Aside from Spain, this primarily involved a number of smaller and medium-sized EU countries, including the two *Innovation Leaders* Denmark and Finland, and also Belgium, Ireland and the Czech Republic.

While increased R&D expenditure in China can only partly be explained by foreign firms, its importance in smaller and medium-sized EU countries is significantly higher. In the case of Austria, foreign firms already contribute around one-third of overall R&D expenditure, and are therefore a crucial driver of the strong rise in R&D expenditure that has been established. Its neighbour Germany is particularly significant here. After the US, Austria is the second most important destination country for cross-border R&D expenditure by German firms. The share of R&D investments in Austria attributable to German firms is more than 50%.

2 Major federal funding agencies in Austria

2.1 The Austrian Science Fund (FWF)

The Austrian Science Fund (Fonds zur Förderung der wissenschaftlichen Forschung – FWF) amounts to funding for basic research, in that projects funded by the Austrian Science Fund define their "value" on the basis of their significance for the development of science and the expansion of scientific and basic knowledge. The Austrian Science Fund's work rests accordingly on three pillars:

- Strengthening Austria's scientific performance in international comparison and its attractiveness as a research location, above all by funding top research by individuals and teams, as well as contributing to the improvement of competitiveness of research institutions and Austria's science system;
- Qualitative and quantitative expansion of research potential according to the principle of "educating through research";
- Strengthening communication and enhancement of the interactions between science and all other areas of cultural, economic and social life, with systematic public relations work aimed, above all, at strengthening the acceptance given to science.

In all of its fields of activity, the Austrian Science Fund uses the international scientific community as its benchmark of quality. An integrated peer review system ensures the quality of research supported by the Austrian Science Fund: the peer review process for funding applications submitted to the Austrian Science Fund is made up soleley of experts from abroad whose impartiality has been checked. Over 5,000 of these international expert opinions are obtained each year.

Tab. 4 and Tab. 5 provide an overview of the Austrian Science Fund's funding in 2012. Application volume reached € 676.7 million in 2012, which is a new record high. Approval volume at the Science Fund for 2012 was just under the € 200 million mark at € 196.4 million. This was also a record approval volume, although the rate of increase in comparison to 2011 was a mere 0.6%. The number of decided applications remained practically unchanged in 2012 at 2,216 and the number of approved projects fell slightly at 684. Overall the approval rate at the Austrian Science Fund only changed marginally in 2012. Measured against the number of new approved applications the rate dropped from 30.6% (2011) to 30.2%. The ratio of new approval totals to requested funds fell from 24.8% in 2011 to 24.2% in 2012.

The amounts requested for funding have risen continuously over the years: a comparison with 2000 shows that the number of projects submitted has more than doubled, and the amount of funding requested has multiplied by a factor of around five. Approvals could not meet this demand: in the same period of time, the number of approved projects rose by 30%, and approved funding merely doubled. The gap between demand and potential approvals therefore continues to widen.

Funds for stand-alone projects were the largest category, measured in terms of proportion of funding. Stand-alone projects received funding of € 319.7 million in 2012, which constitutes 47.2% of the Austrian Science Fund's total funding. The next two largest funding categories are international programmes at € 71.8 million (10.6%) and START at € 57.8 million (8.5%).

Table 4: Number of funding grants in 2012

Funding programme	Applications decided		New approvals		Approval rate in %		
	2012		2012		2012		
	Number	% Women	Number	% Women	Rate	Women	Men
Stand-alone projects	1,080	25.6%	334	26.0%	30.9%	31.5%	30.7%
International programmes	311	15.4%	83	15.7%	26.7%	27.1%	26.6%
SRAs (special research areas)	65	16.9%	27	11.1%	12.5%	0.0%	15.0%
SRA (special research area) extensions	42	16.7%	35	11.4%	83.3%	57.1%	88.6%
NRN (national research network) extensions	6	16.7%	4	25.0%	66.7%	100.0%	60.0%
START	53	20.8%	7	28.6%	13.2%	18.2%	11.9%
START extensions	6	16.7%	6	16.7%	100.0%	100.0%	100.0%
Wittgenstein	21	9.5%	2	0.0%	9.5%	0.0%	10.5%
Doctoral programmes (DPs)	5	20.0%	2	0.0%	12.5%	0.0%	15.4%
DP extensions	3	0.0%	2	0.0%	66.7%	0.0%	66.7%
Schrödinger	135	33.3%	68	30.9%	50.4%	46.7%	52.2%
Meitner	123	39.0%	40	40.0%	32.5%	33.3%	32.0%
Firnberg	52	100.0%	15	100.0%	28.8%	28.8%	-
Richter	57	100.0%	15	100.0%	26.3%	26.3%	-
Translational research	78	14.1%	21	9.5%	26.9%	18.2%	28.4%
Clinical research (KLIF)	123	30.1%	17	52.9%	13.8%	24.3%	9.3%
Programme for the Development and Inclusion of the Arts (PEEK)	56	48.2%	6	66.7%	10.7%	14.8%	6.9%
Total	2,216	28.7%	684	28.2%	30.2%	30.2%	30.2%
Concept applications for SRAs (special research areas)	24	16.7%	6	16.7%			
Concept applications for DPs	16	18.8%	5	20.0%			

Source: Austrian Science Fund.

The largest share of the Austrian Science Fund's funding goes towards the financing of scientific staff. This suggests that the Austrian Science Fund is making a significant contribution to the development of scientific human potential. In comparison with 2000, the number of research staff financed through Austrian Science Fund projects has almost doubled: 3,852 people were on the Austrian Science Fund payroll in 2012. This is a significant potential if articulated in terms of the total scientific and artistic staff at universities – which according to Unidata stood at 20,104.9 FTEs on 31 December 2012 (see Tab. 6).

The number of Austrian Science Fund fellows has seen a particularly strong increase. Fellows are researchers who lead an Austrian Science Fund project and finance their own salary from their project. Without an Austrian Science Fund project these individuals, who are almost exclusively young researchers, would have major problems conducting their research projects because research locations typically cannot offer them career opportunities. Their share of project leader positions in stand-alone projects has risen in terms of approvals from 16% (2007) to 20% (2012) in the last five years. The Austrian Science Fund also believes that another challenge in the realm of scientific staff is that there are still not enough women among the applicants, with only around 30% of applicants being female. One positive development is that the share of women

Table 5: Funding totals by programme in 2012

Funding programme	Applications decided		New approvals		Approval rate in %		
	2012		2012		2012		
	Total	% Women	Total	% Women	Rate	Women	Men
Stand-alone projects	€ 319.7	25.9%	€ 97.6	26.2%	29.8%	30.4%	29.6%
International programmes	€ 71.8	13.4%	€ 16.2	15.2%	21.9%	24.8%	21.4%
SRAs (special research areas)	€ 25.9	17.9%	€ 12.0	8.0%	10.2%	4.6%	11.6%
SRA (special research area) extensions	€ 18.2	15.5%	€ 14.0	13.0%	77.0%	64.5%	79.2%
NRN (national research network) extensions	€ 3.7	24.6%	€ 2.6	32.0%	54.0%	68.7%	49.2%
START	€ 57.8	19.8%	€ 4.4	27.5%	7.4%	10.3%	6.7%
START extensions	€ 3.3	18.1%	€ 3.3	18.1%	99.8%	100.0%	99.7%
Wittgenstein	€ 31.5	9.5%	€ 3.0	0.0%	9.5%	0.0%	10.5%
DPs	€ 11.9	18.0%	€ 6.5	1.3%	14.4%	0.0%	17.7%
DP extensions	€ 7.1	0.0%	€ 4.1	0.0%	58.6%	0.0%	58.6%
Schrödinger	€ 13.3	33.5%	€ 7.3	30.0%	52.9%	46.6%	56.0%
Meitner	€ 15.1	39.8%	€ 5.9	39.2%	33.6%	33.5%	33.6%
Firnberg	€ 11.0	100.0%	€ 3.3	100.0%	28.9%	28.9%	-
Richter	€ 15.6	100.0%	€ 4.7	100.0%	26.7%	26.7%	-
Translational research	€ 25.9	13.3%	€ 6.1	7.8%	23.0%	13.2%	24.5%
Clinical research (KLIF)	€ 28.4	27.1%	€ 3.3	52.8%	11.5%	22.5%	7.4%
Programme for the Development and Inclusion of the Arts (PEEK)	€ 16.4	52.4%	€ 2.0	69.3%	12.2%	16.3%	7.8%
Total	€ 676.7	25.8%	€ 196.4	25.3%	24.2%	24.5%	24.0%
Concept applications for SRAs (special research areas)	€ 104.9	18.9%	€ 24.6	13.1%			
Concept applications for DPs	€ 35.5	18.7%	€ 12.1	17.8%			

Source: Austrian Science Fund.

Table 6: Research personnel funded by the Austrian Science Fund (Austrian Science Fund) in 2012

		2010	2011	2012
Postdocs	**All**	**1,197**	**1,229**	**1288**
	Women	554	575	517
	Men	643	654	771
Doctoral candidates	**All**	**1,683**	**1,771**	**1935**
	Women	710	745	819
	Men	973	1,026	1116
Technical staff	**All**	**122**	**137**	**173**
	Women	82	98	118
	Men	40	39	55
Other staff	**All**	**403**	**405**	**456**
	Women	193	213	215
	Men	210	192	241
Total	**All**	**3,405**	**3,542**	**3852**
	Women	1,539	1,631	1669
	Men	1,866	1,911	2183

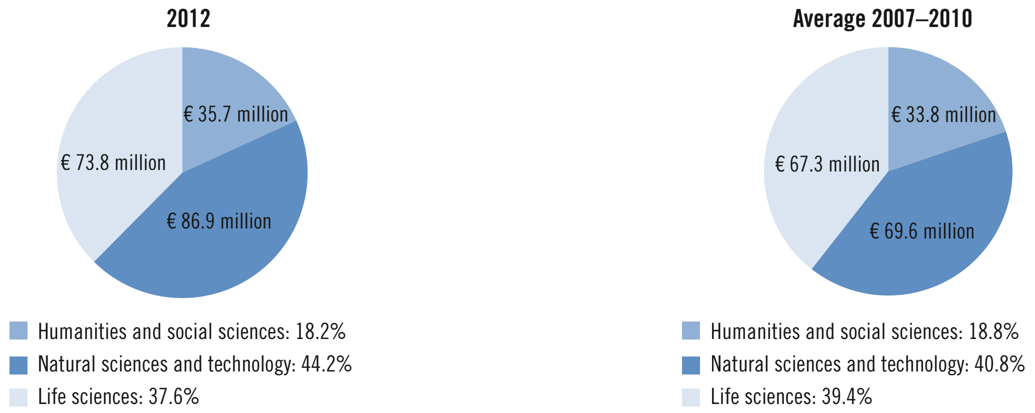
Source: Austrian Science Fund.

among new approvals rose from 25.9% in 2011 to 28.2% in 2012. The goal in Doctoral Programmes and in the Special Research Areas is to increase the proportion of women who are project leaders, with a target of 30% set for women in the faculty and in sub-project leadership.

In terms of the spread of Austrian Science Fund funding across scientific disciplines, structures at the higher aggregate levels have remained comparatively stable over the years. Broadly speaking, there are three areas here: life sciences, natural science and engineering, and the humanities and social sciences. In the 2012 reporting year, total approved funding of € 73.8 million went towards life sciences, € 86.9 million towards natural science and engineering and € 35.7 million towards the humanities and social sciences.

This breakdown is based on the applications

Fig. 14: Approvals by scientific discipline (total overview of all Austrian Science Fund programmes)



Source: Austrian Science Fund.

submitted and not on Austrian Science Fund quotas. However, there are two areas with circumstances for which the Austrian Science Fund's general procedural mechanisms are evidently inadequate in reality and which the Austrian Science Fund accommodated by making its own proposals: the fourth proposal in the area of artistic development (PEEK) and the second in clinical research (KLIF) were successfully completed in 2012. In both cases the Austrian Science Fund assembled an international jury in order to provide the required expertise. In the case of clinical research, however, it turned out that this was no longer necessary, meaning that the special procedural steps required for this area can be covered in the context of the Austrian Science Fund's conventional procedures. So, following one last proposal in 2012/13, the clinical research (KLIF) projects will be dealt with in a process similar to the one in place for Austrian Science Fund single project funding.

Another positive development was the payment of overhead costs since their reintroduction in 2011 for stand-alone projects and the Programme for the Development and Inclusion of the Arts (PEEK): the Austrian Science Fund paid out € 5.6 million in overheads to Austrian research locations in 2012, which is € 4.3 million more than in the previous year. This amount is not part of Austrian Science Fund grant volume but rather is provided as an additional amount. Given the strict Austrian Science Fund budget, it has not been possible to date to extend overhead payments to all programmes at the Austrian Science Fund. This results in unwanted distortions in programmes, such as in the international projects, SRAs (special research areas), DPs (doctoral programmes) and women's programmes, in which researchers are put at a competitive disadvantage if their overhead costs are not covered.

2.2 The Austrian Research Promotion Agency (FFG)

The Austrian Research Promotion Agency (Forschungsfördungsgesellschaft – FFG) offers a diverse portfolio of instruments for funding research projects at firms and research institutions. The broad range of instruments extends from low-threshold entry-level formats to funding for top research. There were a few organisational changes at the Austrian Research Promotion Agency (FFG) in 2012, allowing the concept of thematic and portfolio management that had been introduced earlier to be implemented to a large extent. The Austrian Research Promotion Agency (FFG) now has a standardised set of funding instruments, comprehensive monitoring by topic that presents real-time allocation of funding divided into topics, as well as cross-programme topic teams which ensure that experiences are exchanged on a constant basis between programmes and that instruments are coordinated along policy-issue lines. A new instrument-level initiative, Markt.Start, was introduced in 2012. With this initiative, the Austrian Research Promotion Agency (FFG) is working on behalf of the Federal Ministry of Transport, Innovation and Technology (BMVIT) in order to address a bottleneck spot in the Austrian innovation system: implementing successfully concluded R&D projects on the market. This instrument enables the Austrian Research Promotion Agency (FFG) to offer loan financing for the subsequent market penetration phase to new firms which have successfully completed a development project in the general programmes. Financing volume can go up to € 1 million. It should also be mentioned that on 1 January 2013 the Austrian Research Promotion Agency (FFG) was entrusted with the task of assessing the R&D expenditures that apply for the research premiums.

Tab. 7 provides an overview of the number of projects, participations, integrated stakeholders, and funds secured contractually for 2012. Total secured funding volume (including liabilities and loans) in 2012 was € 483.3 million, which corresponds to a cash value of € 361 million. In comparison with 2011 this was an increase of 3.4% in cash-value funding (2011: € 349 million cash value). This funding supported research proposals for a total amount of € 979.3 million (increase of 8.4% compared with 2011). The total number of funded projects stood at 2,913, which encompassed 5,125 participations and 2,876 different stakeholders. The number of stakeholders funded by the Austrian Research Promotion Agency (FFG) rose 4.3% over the previous year (2,758 stakeholders), which suggests an ongoing expansion of Austria's research base.

Measured in cash value as well as the number of projects and the total costs induced by research projects, the greatest importance within the comprehensive Austrian Research Promotion Agency (FFG) portfolio is attributable to the general programme category. The general funding programme, which is the core programme for bottom-up enterprise-oriented research funding for the Austrian Research Promotion Agency (FFG), stands out within this area with about 42% of cash value (and 43% of projects). The number of projects funded in the general funding programme rose by 4.4% from 607 funded projects in 2011 to 634 in 2012. The Innovation Voucher has proven its value in the meantime. This programme line, which seeks to make it easier for small and medium-size firms to commence continuous R&D activity, supported a total of 486 projects.

The second largest programme area (measured in terms of secured cash value funding) of the Austrian Research Promotion Agency (FFG) includes various structural programmes that constitute a total cash value of € 111.4 million. The COMET programme for competence centres is particularly worth noting here. This programme accounted for € 79.9 million in 2012. This high sum was the result of contractual extensions at several existing competence centres during 2012. The COMET programme is the successor to the K programmes (K-plus, K-ind, K-net) and pursues the aim of further strengthening a culture of cooperation between manufacturing and science and promoting the development and utilisation of shared research expertise. The programme focuses in particular on excellence, the integration of international research expertise and the development and safeguarding of technology leadership among firms in order to strengthen Austria's position as a research location.

The topical programmes form the third significant programme area in the funding portfolio of the Austrian Research Promotion Agency (FFG) in terms of quantity. This programme seeks to establish focal points in selected topics in order to attain internationally visible critical mass in strategic fields of future research. A total of € 96.2 million in cash value is attributable to the topical programmes. These topics are specifically focused on such fields as energy, ICT, production

Table 7: Austrian Research Promotion Agency (FFG) funding statistics in 2012 [in € 1,000]

	Programme	Projects	Participation	Stakeholders	Total costs	Funding incl. loans and liabilities	Cash value
ALR	ASAP	6	11	9	1,574	934	934
		6	**11**	**9**	**1,574**	**934**	**934**
BP	General programme line	634	656	515	382,757	208,798	98,060
	Service innovations funding line	36	38	37	12,427	6,567	5,397
	Headquarter programme line	20	22	22	56,113	24,963	17,883
	High-tech start-up programme line	19	19	19	14,265	9,979	6,650
	BRIDGE	59	197	183	21,997	14,662	14,662
	EUROSTARS	12	12	11	6,713	3,906	3,906
	Innovation Voucher	486	971	730	3,048	2,840	2,840
		1,266	**1,915**	**1,427**	**497,319**	**271,714**	**149,398**
EIP	TOP.EU	20	20	9	1,838	1,378	1,378
		20	**20**	**9**	**1,838**	**1,378**	**1,378**
SP	AplusB	5	5	5	39,216	12,900	12,900
	COIN	16	97	90	8,848	5,169	5,169
	COMET	7	488	439	248,213	79,850	79,850
	FoKo	14	203	189	5,432	4,336	4,336
	Strategic Impulse Centres	18	33	31	2,767	2,171	2,171
	Talents	1,191	1,243	671	11,329	7,006	7,006
		1,251	**2,069**	**1,301**	**315,805**	**111,431**	**111,431**
TP	AT:net	4	4	4	1,138	284	284
	benefit	31	61	54	10,945	6,656	6,656
	ENERGIE DER ZUKUNFT	45	142	110	17,773	8,902	8,902
	FIT-IT	36	60	41	29,435	10,979	10,979
	GEN-AU	3	3	3	27	27	27
	IEA	13	20	11	1,054	1,054	1,054
	Intelligent Production	34	98	84	14,768	10,569	10,569
	IV2Splus	92	272	185	22,762	15,821	15,821
	KIRAS	19	107	70	12,058	8,229	8,229
	Beacons for eMobility	2	26	25	13,205	5,567	5,567
	NANO	10	23	17	2,071	1,698	1,698
	NANO-EHS	4	9	7	588	573	573
	Neue Energien 2020	74	279	209	36,544	25,415	25,415
	TAKE OFF	3	6	6	430	430	430
		370	**1,110**	**675**	**162,798**	**96,204**	**96,204**
Austrian Research Promotion Agency (FFG) funding and expenses		**2,913**	**5,125**	**2,876**	**979,335**	**481,661**	**359,345**
Austrian Research Promotion Agency (FFG) authorisations					1,654	1,654	1,654
Austrian Research Promotion Agency (FFG) total operational funds 2012					**483,315**	**483,315**	**360,999**

Note: Quantitative figures refer to secured funds in 2012.

Source: Austrian Research Promotion Agency (FFG)

and security research. Some of these topics are therefore particularly compatible with the "Grand Challenges" and "Key Enabling Technologies" (KETs) defined by the EU in its HORIZON 2020 programme. The topical programme lines are therefore part of a new mission orientation[27] in Austrian research and technology policy that was also supported by the RTI strategy launched by the Austrian federal government in 2011.

The "Production of the future" RTI initiative promotes new technological developments in the area of material and product technologies. The "ICT of the future" programme supports innovations in various areas of information and communication technologies, including micro- and nano-electronics. Finally, key technology developments in important fields of application are addressed in funding programmes in the energy and mobility areas as well, such as the research and demonstration programme "Technological beacons in electromobility", the "Energy-efficient vehicle technology" funding programme of the climate and energy fund, the Austrian aerospace technology research programme TAKE OFF and the "Smart cities" programme.

Given Austria's good positioning in key technologies (see Chapter 4.5), we can expect that the country will profit from the European Commission's intensified efforts in the area of research and technology policy, including the HORIZON 2020 programme. National funding should supplement European funding on a few specific points. Firstly, this includes further strengthening of the connection between industrial and public research in the individual key technologies, since scarcely any other area is as dependent on new scientific research results as the development of new technologies. Bilateral research projects between science and business should also be supported with sufficient time horizons in addition to cooperative research institutions such as the competence centres. Secondly, potentials located at the intersection of two or more key technologies should be exploited more effectively. Thirdly, the links between key technologies and future fields of application should be expanded through the Smart Cities and Electromobility programmes to include other application areas such as medicine and health care, sustainable energy, and new production and logistics concepts.

The broad range of Austrian Research Promotion Agency (FFG) funding can also be seen when we consider funding by type of organisation (Tab. 8). Firms account for 52% of secured funds in 2012. The number of participations by firms increased by 10% in 2012 (2011: 2,688 participations). The number of different stakeholders among firms rose in 2012 by 2.9% to 1,991 (2011: 1,934 stakeholders). This increase can be seen as an additional indication of the lasting dynamism of research activities in the Austrian economy and the continuous expansion of the corporate research base.

In terms of the share of secured cash value funding, research institutions came in at second place with 31%, followed by universities with a share of 11%. The shift in percentage of research institutions (which was 21% in the previous year) is due to contract extensions for the COMET programme for competence centres in 2012. After corresponding interim evaluations, there were extensions and therefore funding allocations in 2012 that did not exist in 2011 due to the multi-year cycle of these contract extensions.

Austrian Research Promotion Agency (FFG) funding in 2012 by different fields of technology is shown in Fig. 15 based on the definition of technology fields enumerated in the "CORDIS Subject Index Classification Codes".[28] A few of the fields of technology are summarised here for the sake of clarity (e.g. all ICT-oriented technology fields, as well as three biotechnology fields, namely agricultural, industrial and medical

27 For more on the "new mission orientation" in technology policy, see Gassler et al. (2006).
28 See http://cordis.europa.eu/guidance/sic-codes_en.html

fields, as well as a few small, closely related fields). It should be kept in mind that the "breadth" of these technology fields is very different; the individual sequence of technology fields does not indicate that a technology is more or less important in terms of Austrian Research Promotion Agency (FFG) funding. Nevertheless, an analysis of the flow of funds in each of these technology fields is interesting: it shows that materials engineering (including steel and metal working, plastic and rubber industry, etc.) and industrial production (production technology, tool manufacturing, industrial processes, etc.), which are two central fields of technology for manufacturing, are also two major fields of strength for Austria's industrial structure that appear prominently in the funding landscape of the Austrian Research Promotion Agency (FFG). One-fourth of all secured Austrian Research Promotion Agency (FFG) funds, or € 88.7 million, go to these two fields of technology.

Additional significant fields of technology in terms of quantity are energy, information and communication technologies (ICT), and electronics and microelectronics. The last two fields are also two central focal points at EU level (in HORIZON 2020) and receive special coverage in the Austrian Research Promotion Agency (FFG) funding portfolio. The technology fields of energy (which also includes renewable energy technologies) and environment & sustainability are also central "missions" of Austrian RTI strategy and/or part of the "grand challenges" of HORIZON 2020, which means that they are represented to a corresponding extent.

2.3 Austria Wirtschaftsservice (aws)

Austria Wirtschaftsservice GmbH (aws) was founded in 2002 for the purpose of contributing to the growth of the Austrian economy: its owner representatives are the Federal Ministry for Transport, Innovation and Technology (BMVIT) and the Federal Ministry of Economy, Family and Youth (BMWFJ). As a special federal funding bank, the aws offers all forms of business financing, from guarantees and loans to grants and equity capital instruments. Depending on the phase in which the firm finds itself and the reason for financing, a mix of financial products is developed that takes into consideration the distribution of public and private risk. In addition to monetary payments, coaching services are also on offer which range from specific training for high-tech entrepreneurs to IP consultancy and applications, as well as technology and market research. The funding approach is heavily oriented towards growth and innovation, thereby covering a broad spectrum of issues from preparing to found a company and the market introduction phase to larger leaps in growth, such as internationalisation in later phases.

Table 8: Austrian Research Promotion Agency (FFG) funding by organisation type 2012 [in € 1,000]

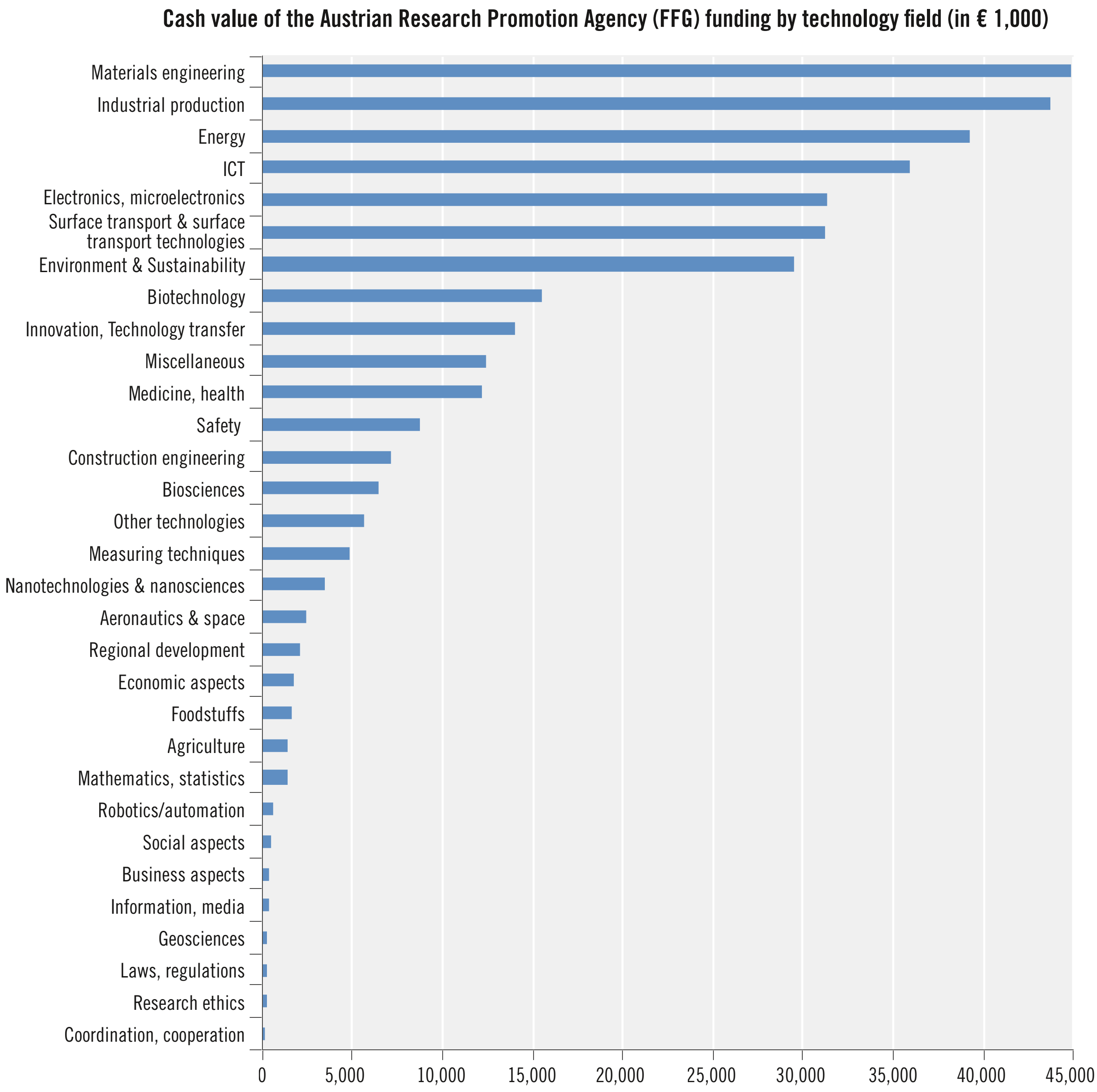
Organisation type	Stakeholders	Participations	Total funding	Cash value	Percentage of cash value
Firms	1991	2,959	310,378	188,308	52%
Research institutions	151	771	112,157	111,910	31%
Universities	473	1,046	39,709	39,709	11%
Intermediaries	52	77	16,286	16,286	5%
Other	209	272	3,132	3,132	1%
Total	2876	5,125	481,661	359,345	100%

Source: Austrian Research Promotion Agency (FFG)

Tab. 9 provides an overview of funding in 2012 in the area of financial instruments. Monetary instruments alone support about 4,000 firms each year in their growth and innovation projects with a total volume of more than € 2.6 billion. Total funding provided through financial instruments in 2012 amounted to more than € 872 million, which is an increase of about 3.2% over the previous year. Furthermore, aws provides coaching and awareness initiatives which support implementation of the federal government's RTI policy goal of creating value by utilising technology in the markets.

More than one quarter of total aws funding,

Fig. 15: Austrian Research Promotion Agency (FFG) funding by technology fields 2012



Source: Austrian Research Promotion Agency (FFG)

Table 9: AWS funding 2012

	Secured funding [number]		Total project volume [€ millions]		Funding [€ millions]	
	2012	2011	2012	2011	2012	2011
Guarantees	759	672	458.0	863.0	199.9	195.3
Loans	1,068	1,044	1,454.2	445.0	558.2	530.4
Grants	2,567	2,305	1,643.2	1,066.0	103.5	101.5
Equity capital	5	7	20.8	35.0	11.2	19.2
Total result	4,399	4,028	*2,609.1	2,409.0	872.8	846.4

Note: * Total result adjusted for multiple counts.

Source: AWS

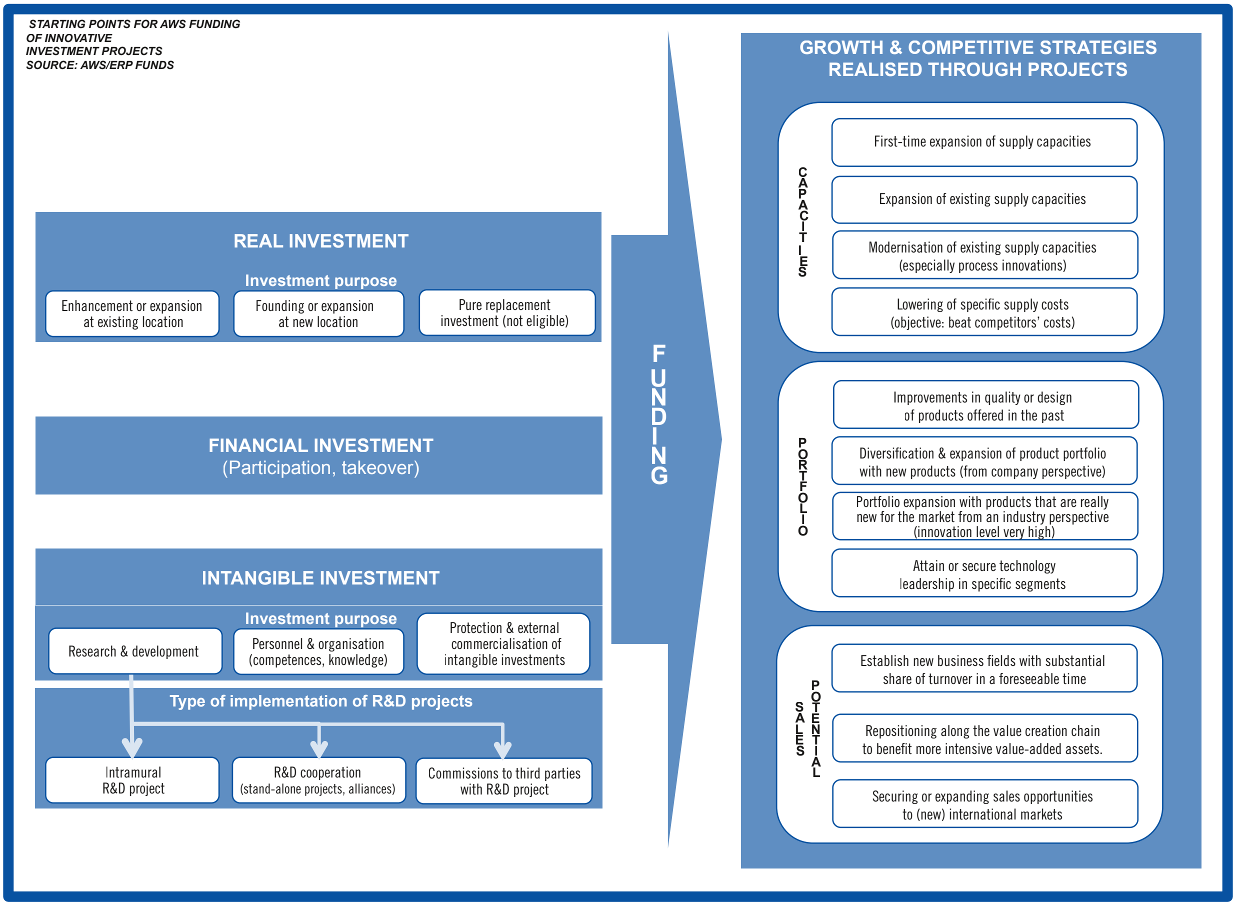
i.e. around € 200 million, was attributed to granting guarantees in 2012, with the focus placed on the internationalisation of innovative Austrian firms. An increase in demands for loans of more than 5% of the credit volume of € 558 million suggests that Austrian firms are becoming more willing to invest again. There is also a trend towards larger projects (more than € 5 million total investment volume per firm). The equity capital instruments offered by aws are becoming increasingly important, especially for knowledge-intensive companies, due to a lack of private venture capital in Austria. Three participations in (international) funds began in 2012 under the auspices of the Venture Capital Initiative: these are dedicated to investment in high-tech and clean-tech firms in Austria. In the end, aws also posted a slight increase in the grants sector.

aws acts primarily as a "financing partner" for innovation projects that are comparatively large from the perspective of and in relation to the financing power of the funded firm. Substantial financial contributions are based on the one hand on support that takes the form of loans and grants. On the other hand they arise through the leverage effects from equity and guarantee instruments used, in that these open up additional sources of private financing, such as commercial loans or additional private equity.

When selecting projects in these programmes that it considers worthy of funding, the aws has displayed a strong orientation towards innovation, with real investments in pure R&D activities forming a significant starting point (see Fig. 16). Consequently, the projects implemented deliver measurable contributions to knowledge transfer and to the utilisation and diffusion of commercially viable innovations in a business context. The implementation of innovative projects in turn makes a substantial contribution to those corporate strategies that facilitate capitalisation on economic opportunities and an improvement in competitive positioning for the funding recipient.

The significance of aws tools for RTI policy is based both on a broad approach to financial support for innovative projects as well as programmes that provide solutions for a specific set of problems that face select target groups. The heart of aws activities is comprised of funding offers – especially PreSeed, Seedfinancing, Impulse and the Venture Capital Initiative – which increase the likelihood of a successful market introduction in early phases of a company's life cycle (see Tab. 10).

Fig. 16: Starting points for funding innovative investment projects



Source: AWS

Table 10: Overview of monetary aws programmes for promoting knowledge-intensive start-ups in 2012

2012	Projects [number]	Total project volume [€ millions]	Funding [€ millions]
PreSeed	27	6.1	4.1
Seed financing	18	124.9	12.3
Temporary management	3	12.0	0.1
Creative industries (impulse)	75	9.8	4.6
Venture Capital Initiative (VCI)	5	32.6	16.3
Total	128	185.4	37.4

Source: AWS

Instruments that increase effectiveness were also developed in connection with offers that focus on specific target groups: monetary support measures are augmented by coaching and intermediary services which support funding recipients from idea development to conceptualisation, planning and implementation through to the utilisation of project results (see Tab. 11).

Table 11: Overview of awareness, coaching and intermediary services, as well as training measures, 2012

2012	Projects [number]
Awareness and coaching services	
Jugend Innovativ – (youth innovation competition)	539
Government Innovation Prize	627
Business plan competition – Best of Biotech (BOB)	80
Intellectual Property (IP) – consultancy and exploitation	237
aws creditworthiness analysis	6
Total	1,489
Intermediary services	
Business Angels – stock exchange (I²)	178
Participants in training and education	
Life sciences	310
Creative industries	855
Total	1,165

Source: AWS

The intensity of the support provided is particularly high in the pre start-up and start-up phases, and decreases the more a company becomes established. The awareness and coaching services provided by aws are targeted at precisely this area. Non-monetary measures are aimed primarily at the start-up phase for knowledge-intensive firms, beginning with measures to increase "entrepreneurial spirit", such as Jugend Innovativ, a competition among pupils to which 539 project ideas were submitted in 2012, or the business plan competition BOB (Best of Biotech), which had 80 participating projects in 2012, and not least the state prize for innovation. Specific educational modules have been fine-tuned for start-ups in the growth fields of the life sciences and the creative industries; a total of 1,165 people took part in 2012.

For start-ups and SMEs, coaching also extends to the development, utilisation and exploitation of intellectual property (IP). Together with the Austrian Patent Office, aws offers SMEs its "discover.IP" service in order to support and intensify knowledge among Austria's small to medium-size firms about how to use their intellectual property with optimum results. Together with IP exploitation consulting services from aws, 237 firms made use of these services in 2012.

Relevant measures were also implemented in 2012 to orient services towards those seeking funding. This reduced the amount of time between submission to the signing of the contract by one-third.

3 Scientific research and tertiary education

No sector is as exposed to so many diverse transformations on a constant basis as the higher education sector. The creation of the Austrian University Plan and the Austrian Higher Education Conference established important new governance instruments for the coordination and management of the entire Austrian Higher Education area. Performance agreements have been created for the universities for the period from 2013 to 2015, structural funds have been introduced and the ongoing implementation of the new collective agreement for university employees has been evaluated. Furthermore, an inter-sectoral body was established with AQ Austria (Agency for Quality Assurance and Accreditation Austria) and the Austrian Academy of Sciences was repositioned. The topic of Open Access has attracted significant attention at the national and international level and affects all scientific and academic institutions with its goal of making scientific publications publicly accessible on the Internet, unleashing a variety of approaches to measures and initiatives among university policy stakeholders.

3.1 The Austrian University Plan and the Austrian Higher Education Conference as new governance instruments for the Austrian Higher Education Area

The development of the Austrian University Plan, which began in 2011, is an important scientific and educational policy project that aims to ensure the highest quality of research and teaching through coordinated cooperation, priority-setting and bundling of resources. Increased differentiation among stakeholders, internationalisation of research, changes in funding systems, initiatives and policies at the European level and ambitious research policy targets require coordination between university partners and policymakers that will sharpen and develop profiles through bundling resources. The first Austrian University Plan – which is understood as a rolling planning instrument subject to further development – was presented in December 2011. It was the result of projects and coordination between Universities Austria, the Austrian Association of Universities of Applied Sciences, the university senates, the Austrian Science Board, an international group of experts and the Federal Ministry of Science and Research (BMWF). The Austrian University Plan builds on the results of the Federal Ministry of Science and Research's dialogue with universities and an expert report from three internationally renowned university researchers.

The Austrian Higher Education Conference was constituted in spring 2012 to support the targets articulated in the Austrian University Plan and to carry out coordinating activities. The Conference is a body that provides coordination and consultancy services, prepares positions on important topics related to science policy, prioritises problem areas and submits recommendations and proposals as input for the Austrian University Plan and the Federal Minister. The Austrian Higher Education Conference consists of members of the Federal Ministry of Science and Research, Universities Austria, the Association of Universities of Applied Sciences, the Austrian Science Board, the university senates, and the Students' Union. The Conference was founded on 3 May 2012, and its various working groups have been working continuously since then on questions related to reaching shared positions among all stakeholders. The Austrian Higher Education Conference follows the principle of a cooperative debate between the universities and interest groups. Coordination between the Austrian Higher Education Conference's working groups is handled by the General Secretary of the Ministry and a special office established for this purpose. In the context of broader communication and coordination with other interest groups, the plan is to invite other stakeholders such as ministries, research promotion funds, research societies, university lecturer associations and the Austrian Provincial Governors' Conference to submit position papers on important topics. The Austrian Higher Education Conference is not a formal legal institution, yet it does assume an important position in the governance of Austria's universities. The Conference puts into practice ideas about modern governance concepts that postulate that the options for central policy management of the higher education system are limited against the background of greater autonomy yet increasing competition among higher education institutions, and that coordination among the individual stakeholders is necessary. An important guiding maxim of the Austrian University Plan, and thereby the Austrian Higher Education Conference, is the support for differentiation and priority-setting, as well as cooperation that preserves the autonomy of stakeholders at the same time. The establishment of the Austrian Higher Education Conference as a coordinating body can therefore be seen as an important further development in Austria's science and university systems.

In the course of preparing the Austrian University Plan, various working groups were formed and four major topics were addressed:

- Coordination measures
- University place funding
- Development plan
- Research infrastructure plan

As stated above the coordinating body of the Austrian Higher Education Conference was established to implement the goal of improving coordination in national university policy. Central problems in higher education development have been discussed since 2011 with important stakeholders from the Higher Education Area. The primary challenge here is coordination in the area of priority-setting, teaching and research. Both research prioritisation and the planning of subjects on offer require coordination and comparison among the universities and especially between the locations.

The introduction of "university place" funding is a high-priority goal in national higher education policy and an important project in the current government programme. The first basic points of this kind of model were defined in the context of the Austrian University Plan by a working group created by Universities Austria and the Federal Ministry of Science and Research (BMWF). The Austrian legislature's proposal for capacity-oriented student-related university funding, published at the end of 2012 after a one-year phase of negotiations, provided the government with the first specifications for the model and is now ushering in its implementation. The target is a transparent model of university funding that focuses more on quality and capacity than was the case previously. Universities may therefore in future be funded on the basis of three separate financing channels: the global budget will consist of a partial amount for teaching, a partial amount for research and a partial amount for infrastructure and clinical overheads. This means that Austria is following the international trend of separating the funding for teaching and research. According to a model that was developed especially for Austria, the number of supervised university admission placements on offer weighted by subject groups represents the essential criterion for financing teaching and is also an indicator for financing research. In this system, any research that is required to uphold the quality of research-led teaching is measured by the number of student places and is designated as a research supplement. This kind of model is also being implemented at the international level, as in Switzerland for instance. There are also strategic components for both teaching and research. A sub-amount based on competition-based research indicators will also be endowed to finance university research.

Under the plans full implementation is currently divided into multiple phases which extend to 2021 in accordance with legal and budgetary circumstances. The first step is gradual optimisation of study conditions which includes the possibility of admission rules in five particularly high-demand subjects and the creation of 95 additional professor posts in these fields of study.

The development plan prioritises important construction projects for three planning regions in the east, south and west. The development plan stipulates the sequence of construction activity in the 22 national public universities and the Austrian Academy of Sciences. This coordinated overall planning was also used as the template for the performance agreements.

The research infrastructure plan should help with the planning and coordination of investments in major research infrastructure. This includes setting priorities for the financing and development of the cost-intensive research infrastructure. In this context, the systematic survey of the entire Austrian university research infrastructure with a value of more than € 100,000 conducted in 2011 and 2012 can also provide an important basic reference for the development of a research infrastructure roadmap.

Promoting internationalisation is another important goal of the Austrian University Plan and is understood as a cross-cutting theme. The Austrian University Plan defines the development of internationalisation strategies at all universities as an important measure. Such strategies must reconcile international, national and regional developments and bring together strategic partnerships between universities, non-university research institutions and industry. Coordination among national stakeholders is mandatory for successful participation in international and European initiatives, programmes and networks. In this context the Austrian University Plan also recommends the formulation of regional specialisation strategies, which are also called "Smart Specialisation" at the international level. The stated goal of such programmes is for higher education and non-university research institutions to develop specialisation strategies with a view to the future direction of EU research agendas in close cooperation with their respective regional contacts at funding agencies. Furthermore, the Austrian University Plan encourages the intensified expansion of research service points for the purposes of taking over and professionalising project management activities from third-party funding projects (international and European).

The need for enhanced coordination at the regional level is also evidenced by the Austrian Higher Education Conferences created by the regional governments (in Tyrol, Styria, Burgenland and Salzburg), whose goals correspond with those of the federal Austrian Higher Education Conference, such as coordinating content-related positions and promoting cooperation while retaining independent profiles. In Styria, for example, resource allocation is being optimised for joint research and teaching and infrastructure utilisation is also being improved. There should also be increased cooperation in the area of intellectual property rights and research services.

The Austrian University Plan and the Austrian Higher Education Conference set out important policy targets and positions for the responsible departments in 2011 and 2012. Coordination in profile development and priority setting in the area of research, the creation of a research infrastructure plan and measures for the introduction of new university financing are considered to be particularly relevant in terms of developing Austria as a location for research and innovation. The goals and strategies developed in the Austrian University Plan provided an important foundation for working out performance agreements for the period from 2013 to 2015. The performance agreements are one of the central instruments for implementing higher education and science policy goals on the basis of budgetary stimulus mechanisms. The following section outlines the performance agreements concluded in 2012 between the Federal Ministry of Science and Research (BMWF) and the universities.

3.2 Financing for universities from 2013 to 2015

Financing for universities from 2013 to 2015 is characterised by two essential features. Firstly the universities are entering a new three-year performance agreement period and secondly, the formula-bound budget is being replaced by the new instrument of Higher Education Area structural funds. The following describes the essential priorities and research policy strategies that were defined in the performance agreements. The discussion focuses primarily on the creation of critical mass through national cooperative ventures, setting priorities in research and development of the major research infrastructure. Even though the supply of qualified graduates undoubtedly makes an important contribution to Austria functioning as a research, innovation and industry location, the Research and Technology Report does not go into a more detailed discussion of developments in teaching and higher education. Using the performance agreements of public universities as a foundation, we pursue the following questions: i) how advanced are Austrian universities in terms of building up their profiles; ii) which fundamental strategies are being pursued; and iii) in what scope are research priorities being defined.

3.2.1 Completion of the performance agreements for 2013 to 2015

Performance agreements were introduced with the Austrian University Act of 2002 and they are a central instrument used in the financing and management of Austria's public universities. The performance agreements help to allocate global budgets for universities over a period of three years at levels which are tied to targets and performance. Negotiations for the third performance agreement period from 2013 to 2015 took place in 2012. By the end of April as the universities had submitted their proposals, there was an initial round of negotiations and a written position paper from the ministries responsible for the programme. To this end, the Federal Ministry of Science and Research (BMWF) conducted quantitative analyses and evaluations for the projects and targets formulated by the universities. Negotiations were successfully completed with all of the universities by the end of December. Completion of the new performance agreements built on the experience of the first two performance agreements, incorporated recommendations from the Court of Auditors and the Austrian Science Board and it was implemented on the basis of an adapted set of negotiation guidelines.

The Austrian University Plan and the Austrian government's RTI strategy provide the central strategic framework for the Federal Ministry of Science and Research (BMWF) in managing the universities. The most important targets and themes for the Ministry were: i) continuing topic and priority setting, ii) intensification of cooperation, iii) expanding internationalisation, iv) strategic development of research infrastructure and v) further (qualitative or qualitative) development of third-party funding acquisition. Additional higher education policy guidelines included an increased focus on coordination and capacity, which in view of the Austrian University Plan and the future study-related governance and financing requires additional coordination among stakeholders. Nearly all universities refer explicitly to the Austrian University Plan in formulating their targets and measures.

The universities' formulation of performance agreements was accompanied by the preparation and adaptation of development plans. These form the foundation for the preparation of performance agreement proposals by the universities.

Priorities and strategies in research

Pooling and aligning research activities towards research priorities is an important long-term goal for higher education and research agendas. Developing priorities and profiles is therefore aimed at strengthening the special competences of Austrian universities and faculties. Universities should assess their resources and determine where their particular strengths lie and how they can expand existing capacities so that they can succeed over the long term in the scientific community and research market and/or be viewed as unique. Universities began formulating research priorities as they prepared their first development plans and performance agreements in 2004 and 2005. At the beginning of 2006, all public universities had drafted research priorities at the faculty and department level, and a majority of higher education institutions had already defined research topics that were assigned shared priority at the overall university level. Universities describe overall university "research priorities" explicitly as such (e.g., the University of Innsbruck), yet they also call them research clusters (e.g., Medical University of Vienna), research fields (Medical University of Graz), fields of expertise (Graz University of Technology), competence fields (University of Natural Resources and Applied Life Sciences), profile lines (the University of Veterinary Medicine Vienna) and profile priorities (University of Art and Design Linz). In addition, a few universities have also defined research platforms or research centres where several faculties work together. Overall it can be seen that research topics described as research priorities are often defined more narrowly, while competence fields, research clusters and research fields have a broader definition. See Annex III for the complete list of all research priorities pursued by universities at the overall university level.

The priority-setting process was and is a challenging and somewhat difficult process for the universities, yet they were able to define shared topics across institutional, faculty and disciplinary boundaries, thereby striking out into new territory. The areas of emphasis and thematic fields are generally almost always interdisciplinary in character. The universities are thereby attempting to find the optimum combination of successful individual research, faculty research priorities, inter-faculty research priorities and university-level priorities. Universities are therefore caught in the middle: on the one hand they want to and have to concentrate on selected research topics, yet on the other they want to retain the latitude required for innovative developments. The breadth of subjects is necessary above all for smaller universities so that they can offer research-led teaching, as the University of Linz for instance affirms. At the same time they realise that diversity also means strength, and that new innovative fields of research arise first and foremost through providing linkage between disciplines. In this context for example the University of Graz has committed itself to diversity in methodology and themes, yet at the same time defines research priorities in the core areas of its scientific disciplines. The University of Vienna also views interdisciplinary research based on disciplinary excellence as a particularly salient way to develop a research profile. Interdisciplinary research is understood in this context as research that is always based on highly qualified disciplinary research and takes place within a faculty, between faculties or centres, or in cooperation between universities and non-university research institutions. This is illustrated by the general challenge for universities in finding the appropriate balance between focus and differentiation. In this regard a few universities refer to their unique subject combinations, such as the University of Natural Resources and Applied Life Sciences with its conglomeration of natural sciences, engineering, social sciences and economics, or the University of Linz with its combination of natural sciences, engineering, social sciences, economics and jurisprudence.

Ongoing development planning and the newly negotiated performance agreements indicate that nearly all Austrian universities have defined explicit university-wide "research priorities" which, along with other strategic research goals at the university, ought to be developed first. The Vienna University of Economics and Business Administration and the University of Klagenfurt for example successfully completed their priority-setting process in 2012; the latter has defined plans for "priority setting through inter-faculty research topics" in its performance agreement and wants to establish coordination mechanisms for this purpose.

However, priority-setting and topic selection as a whole are a continuous process. In recent years for instance a few universities have striven to reduce their number of research priorities in an attempt to meet expectations that in some part were articulated by the universities themselves. Graz University of Technology for example pared down its number of research priorities, which they call Fields of Expertise, from seven to five in recent years; they are marketing this as the university's "fingerprint". The University of Linz has reduced the number of what it terms Priorities for Excellence from eight to six. In some cases this process entails increased bundling of topics that are related in terms of content. Some universities (for example the Medical University of Graz) explicitly state that they have not combined any research priorities, and that they do not plan to do so in future. At the same time there are some universities that have defined new and promising topics as future research priorities. The University of Leoben for example wants to expand its energy technology department significantly in the coming years and to establish the "Centre on the Mountain", a research, security and education centre under actual operating conditions for subject areas such as geotechnology, raw material extraction, mining and tunnel construction and petroleum engineering. The University of Economics and Business Administration wants to establish and develop a new subject called "Global Transformations and Sustainability: People, Businesses and Policies", which is designated here as an expansion area. The Medical University of Innsbruck is planning to promote a new research priority in "Genetics, epigenetics, genomics", and claims that successful GEN-AU projects have contributed to the development of this topic. The University of Veterinary Medicine Vienna wants to establish the research priority "Animal behaviour and human-animal relations". At the Medical University of Innsbruck for instance, research priorities of this type are defined in accordance with especially stringent criteria, such as the number of existing publications in a topic area, the scientists working on the topic and the opportunities for successfully acquiring third-party funding.

The universities are also making major efforts aimed at establishing and developing university-wide priorities on a sustainable basis. This includes appointing coordinators, additional financing from university funds, filling vacant professorships and creating new posts in the research priority subjects, establishing a Doctoral Programme, expanding post-doctoral programmes and promoting a targeted international publication strategy. At the early stages a few universities have further specified very generally defined topics and brought them into line with the strategies of participating institutions or faculties. Vienna University of Technology has specified the "TU Research Matrix" for example in this regard. Further development of the university-wide priority-setting process is therefore often defined explicitly as a project within the performance agreements.

The universities have completed several initial analyses, assessments and evaluations of their research priorities. The Medical Universities for example evaluated the number of publications and even citations at the level of individual research priorities. Third-party funding (such as the Austrian Science Fund, Special Research Areas, EU projects, COMET) and the establishment of doctoral programmes and schools are considered important. The acquisition of third-party funding for research priorities is evaluated as a factor for the success of a research priority. A few universities are pursuing a strategy whereby successful medium-term priorities or platforms are institutionalised over the longer term, as in the form of research centres.

At the same time, universities want to promote new and bolder topics outside of defined research priorities. The University of Graz for example contends that university research profiles should be developed on existing strengths, thereby creating critical mass. However, there is an argument in favour of the idea that it is indispensable for universities to have the latitude to support research that goes down completely new roads and that develops outside of the range of established knowledge. The goal at the University of Graz is therefore to promote the development of "radical (in the sense of unorthodox) innovative approaches to research", above all by forming interdisciplinary teams from different scientific cultures.

In addition to explicit promotion of profile development, raising the share of third-party funding, increasing the number of publications, developing doctoral programmes and additional internationalisation are further important projects defined in the performance agreements. The performance agreements also set specific target values for these areas. Universities have formulated third-party strategies for the further development of third-party funding both in terms of quantity and quality, including in relation to internationalisation and the reference to the importance of the EU Research Framework Programme and HORIZON 2020. The Vienna University of Economics and Business Administration wants to create its own EU office for further professionalisation of research services and to provide funding (matching grants) to support the launch and completion of major EU projects.

Furthermore, analysis of the new development plans and performance agreements shows that orienting research toward the issue of solving social challenges is gaining in importance. The EU defines this phenomenon with its "Grand Challenges" terminology, which is already being seen in the new strategy documents from the universities. The University of Vienna for example has stated that: "*In the upcoming "Horizon 2020" framework programme, the European Commission will focus its attention on the funding of research activities that address major societal challenges. This is why the University of Vienna is also encouraging its scientists to become more involved in projects in these subject areas, and significant preparatory work has already been done in these areas*." The focus on social problems is viewed as characteristic of these developments. In order to address social challenges, the University of Natural Resources and Applied Life Sciences in Vienna has created a "Three Pillar Model" consisting of life sciences, engineering, and social studies and economics in teaching and research, which is aimed at facilitating more comprehensive work on socially relevant problems.

Strategies for cooperation, research infrastructure and internationalisation

In addition to setting priorities at the university level, the Federal Ministry of Science and Research (BMWF) believes that an important research policy goal is to promote cooperation and coordination of research activities among universities. An additional core point for the Ministry's negotiations was more intense strategic governance in the planning of research infrastructure investments and corresponding coordination between the universities. In the 2013–2015 performance agreement, universities had to plan their investments in national and international major research infrastructure and present the relationship with research strategy in a new sub-section dedicated to this topic in the research chapter. Both goals are central guidelines and recommendations in the Austrian University Plan, as mentioned above.

Research cooperation among domestic universities has been expanded consistently in recent years, partially driven by the need for joint use of a research infrastructure that is becoming ever more investment and cost-intensive. Infrastructures are being used in a more cooperative way; universities report faculty, inter-faculty and inter-university shared use of research infrastructures. The University of Vienna for example has named the mass spectrometry centre as an example of a resource that is used collectively by all institutions in the chemistry faculty, the NMR spectroscopy centre which is used cooperatively by the chemistry and life sciences faculties and the faculty centre for nanostructural research which is used by both the physics and chemistry faculties as well as the Technical University of Vienna and the University of Natural Resources and Applied Life Sciences. Successful cooperative programmes such as the Max Perutz Laboratories in Vienna (University of Vienna und Medical University of Vienna), the NAWI Graz (University of Graz und Graz University of Technology) or High Performance Computing in Vienna (University of Vienna, Vienna University of Technology and the University of Natural Resources and Applied Life Sciences) should all be expanded further according to the performance agreement. There are additional examples of new projects, such as the Water Cluster Lunz (University of Vienna, University of Natural Resources and Applied Life Sciences, and the Danube University at Krems), the Vienna Center for Computational Materials Science (University of Vienna and the Vienna University of Technology), the Regenerative Biology research area (University of Salzburg and the Paracelsus Medical University) and cooperation in the area of biobanking (medical universities). Along with cooperation between universities, the performance agreements also envision cooperative arrangements with non-university research institutions. Projects related to participation in major international research infrastructures are also cited. The Technical University of Vienna for example is involved in CERN, the Medical University at INSTRUCT and an initiative for structural biologists in Europe, all of which require appropriate financial support from the universities and are considered in the performance agreements.

Universities often pursue a "Smart Specialisation" strategy to encourage more closely coordinated planning between universities and other research stakeholders at individual locations. Such strategies are currently underway in many regional governments, often in combination with an internationalisation strategy that is being developed at the same time. In Graz for example research on lipids will be expanded at the three universities located there. The University of Veterinary Medicine Vienna has for instance defined "biomed" and "biomedtech" as areas within the Vienna Life Science Cluster that are suited to integration in the Smart Specialisation strategy.

Incorporation of institutes from the Academy of Sciences is also an important project at a few Austrian universities (for more information, also see Chapter 3.5) and is therefore designated as a project in the performance agreement. This requires the implementation of integrative measures at many locations and the definition of new research strategies.

Another focus is on cooperation in the area of research services. The aforementioned cooperative programmes in Styria (NAWI Graz, BioTechMed and the Styrian Higher Education Conference) are also planning increased service coordination related to research and technology at the state's five universities. Cooperation is due to be intensified further in the area of patent activities and commercialisation.

The Austrian University Plan described the development of "internationalisation strategies" at all universities as an essential measure for establishing European and international directions in research. The international research focus at universities is also evident through the HORIZON 2020 programme and the aforementioned planned development of research services for international projects and programmes at many of the universities. Some universities, such as the medical universities in Vienna and Graz, also wish to participate in Joint Programming Initiatives (JPIs) and have defined this as an explicit goal.

A total of 291 projects and 101 goals were articulated in the "Research" area. The Federal Ministry of Science and Research (BMWF) and the universities are increasingly using indicators that enable the quantification and measurement of target attainment and allow an assessment of whether project implementation has been successful. Furthermore, milestones related to project implementation have been defined to a greater extent than in the last performance agreements. The negotiated target values have been set with thoroughly conservative figures. No one wants to agree to potentially ambitious and ostensibly unrealistic targets in the current difficult environment pertaining to financing and increasing competition. Typical formulations include "remain constant", "stabilisation" or "moderate increase", all of which presumably follow the goal of a "more robust" foundation for the agreement.

In summary, the priority-setting process at the public universities demonstrates a high level of continuity for the research priorities that have been defined and pursued over the years. There is also a strong developmental trend towards greater combination of resources and the use of shared infrastructures in the context of collectively defined research topics and research centres. All universities are committed to continuing their strategic activities in the area of cooperation, taking into account the recommendations enumerated in the Austrian University Plan. The universities also want to strengthen cooperation in the area of shared applications for financing from structural funds from the higher education area as soon as calls for proposals are published.

3.2.2 Structural funds for Higher Education Areas

An amendment to the University Act introduced the instrument of Higher Education Area structural funds in summer 2012. This replaced performance-oriented financing in the form of formula budgets with a new allocation mechanism and supplemented the total amount of university financing available with the Higher Education Area structural funds. The University Act of 2002 introduced the formula budget, which was applied for financing some individual budget components from 2004 to 2012. The basic budget and formula budget together constitute the global budget, which is determined in advance in each case for the three-year periods of the performance agreements. These budget components made up around 20% of the global budget for universities. A total of eleven indicators were used in the formula budget, and these are weighted differently. Teaching was measured by four indicators and weighted at 45%; incorporation and development of the arts and research were measured by two indicators that were also weighted at a total of 45%. Promotion of women (two indicators) was included at 7% and student mobility (two indicators) at 3% within the overall formula. Three indicators used in the formula budget are the number of students making satisfactory progress in their studies, the number of graduating students and the income from R&D projects; these are also used in an adapted form in the model for distributing Higher Education Area structural funds.

The purpose of the new guidelines is to use less indicators, thereby making calculation of financing less complicated than the previous complex indicator-driven formula budget. The total amount available to universities for the PA period from 2013 to 2015 is made up of a partial amount for the basic budget and a partial amount for the Higher Education Area structural funds. For the PA period from 2013 to 2015, Higher Education Area structural funds in the amount of € 450 million are being disbursed along with the basic budget, which will continue to be based on performance agreements. The total sum is divided into five partial amounts in the following proportions: 1. partial amount for students making satisfactory progress in their studies (60%), 2. partial amount for university graduates (10%), 3. partial amount for knowledge transfer (14%), 4. partial amount for private donations (2%), and 5. partial amount for cooperative arrangements (14%). The corresponding indicators are defined as follows: Indicator 1: "Number of students making satisfactory progress towards bachelor's, diploma, and master's degrees, weighted by subject groups," Indicator 2: "Number of students completing their bachelor's, diploma, and master's studies, weighted by subject groups," Indicator 3: "Revenues from R&D projects and from projects in the development and inclusion of the arts, in €", and Indicator 4: Revenues from private donations in € (according to the Intellectual Capital Statements Ordinance 2010). The partial amount for cooperation is distributed on the basis of qualitative criteria in calls for proposals.

Indicators 1 and 2 are both weighted by disciplinary group. All courses of study offered at Austrian universities were classified into seven disciplinary groups, each of which was weighted with a factor from 1 to a maximum of 5. There was also a weighting scheme in the previous formula model, although subject groups were only divided up into three groups depending on the courses of study. The fact that the Higher Education Area structural funds model differentiates between seven groups is relevant because its logic is associated with the planned introduction of university place financing. There were numerous consultations with the universities regarding the determination of these weights in order to reflect as much as possible the different costs that the universities incur for offering teaching in different subjects. In 2011, the working group created between the Ministry and Universities Austria to address capacity-oriented university place financing completed comprehensive cost estimates for teaching in different subjects, taking into account the target values for advising relationships, which were an important foundation for definition of the seven disciplinary groups.

Both the guidelines for distributing Higher Education Area structural funds and for university place financing pursue a strategy of separating out financing of research and teaching in order to create a transparent framework for calculations, budgeting and controlling. Against the backdrop of the aforementioned structure, Higher Education Area structural funds in the amount of € 315 million (indicators 1 and 2) will be disbursed for the PA period from 2013 to 2015. A total of € 72 million (indicators 3 and 4) is available for the knowledge transfer components and € 63 million is available for the "cooperation" components. The "Revenues from R&D projects and from projects for the development and inclusion of the arts in €", is based on index I.C.2 from the Intellectual Capital Statements Ordinance (WBV 2010), which is also entitled "Revenues from R&D projects and from projects for the development and inclusion of the arts, in €". However, this category only includes those revenues that are received as grants or commissions from the Austrian Science Fund, the Jubilee Fund of the Austrian National Bank, the EU, states (incl. their foundations and institutions), municipalities and municipal associations (except Vienna), and firms and private institutions (foundations, associations, etc.).

As described above, an additional share of Higher Education Area structural funds is awarded in a proposal process for cooperation projects. The cooperation projects are then meant to cover the following three areas of the university's entire spectrum of services: teaching, research and development including developing the arts, and also administration. Projects from all three areas should be supported in any case, whereby cooperation projects that promote excellence and develop structures (especially cluster and school formation) should be prioritised in accordance with regulatory guidelines. Up to one-third of the costs for individual projects are covered with a partial amount for cooperation. Project funds are used to cover start-up financing. A commission handles the proposal and award process. Cooperation projects are being submitted in 2013. A few universities have already defined possible projects in their current performance agreements that should be submitted as project proposals.

As in the past, the global budget allotted by the Federal Ministry of Science and Research (BMWF) can be freely disbursed for the PA period from 2013 to 2015. Austrian universities then typically define internal target agreements between the rector's office and the faculties or departments, and a few universities use systems similar to the formula budget or the indicator-driven model of the Higher Education Area structural funds to allocate financial resources internally.

The Higher Education Area structural funds are a new, transparent and performance-oriented financing model that offer incentives with regard to research for universities to acquire third-party funding and undertake appropriate co-financing.

3.3 Implementation of the new collective agreement for university employees

Several years of negotiations between the National University Federation and the Public Service Union resulted in the first collective agreement (CA) for universities. The CA applies to all university employees who entered into an employment relationship with a university after 31 December 2003. Several years have elapsed since the CA went into effect on 1 October 2009, and a study by the University of Klagenfurt's Faculty of Interdisciplinary Education and Research assessed in greater detail the extent to which the agreement has been implemented.[29] The study shows that the migration to the collective agreement at domestic universities is very advanced. In the winter semester 2011, more than three-quarters of all scientific and artistic employees are employed on the basis of the CA. However, it must be remembered that the CA is based on different personnel structures at universities and types of universities[30], and that the different proportions of existing (permanent) "non-CA employment relationships" are a factor which codetermines the "latitude" that universities have in implementing the agreement and play a part in accounting for university-specific differences.

According to the CA, university assistants – as illustrated in Fig. 17 – represented at around one-third the largest share of scientific-artistic core staff at Austrian universities in the winter semester 2011, followed by university lecturers and professors. The technical and natural science universities have a share of 41.4% of university assistants among core staff according to the CA, followed by full universities, which have a share of 37.1%, and both have largely migrated new assistants' contracts. The new categories of Senior Lecturers and Senior Scientists have relatively low numbers with the exception of the arts universities, where the share of Senior Lecturers (20.4%) among core staff is above average in comparison with other universities. One reason for this is that the importance of teaching (especially in the form of one-on-one artistic instruction) is particularly high at arts universities, which is why teachers are more tightly integrated into the core staff. The situation is different at the medical universities, where the share of university lecturers – permanent employees who have completed their post-doctoral dissertation, and are employed under older contracts – is above average at 37.5%. Moreover, medical universities have long been the best at establishing tenure track positions (7.4% of core staff), followed by full universities (5.6%).

Tenure track positions and the instrument of qualification agreements form the heart of the collective agreement. The motivation for this approach is to establish a career model at Austrian universities that resembles the *tenure track* model in the United States, which results in a permanent position as "associate professor" once the candidate fulfils their tenure requirements (typically within a period of six years). The major difference with the U.S. model is that applications for tenure track positions in Austria are completely open to the university's own employees as well, while the U.S. system exclusively recruits external candidates on a competitive basis. Furthermore, the U.S. *tenure track* system leads directly to the position of university professor, while in Austria professorships (shaped by the employment regulations of the Universities

29 See Pechar et al. (2012).

30 Types of universities include: "full universities", which include the Universities of Vienna, Graz, Innsbruck, Salzburg, Linz and Klagenfurt; "technical - natural science universities", which include the Vienna and Graz Universities of Technology, as well as the University of Natural Resources and Applied Life Sciences Vienna and the University of Leoben; "medical universities,", which include the human medicine universities in Vienna, Graz and Innsbruck, as well as the University of Veterinary Medicine Vienna; "arts universities", including the Academy of Fine Arts, the Vienna University for Applied Arts, the University of Music and Performing Arts Vienna, the Mozarteum University of Salzburg, the Graz University of Music and Performing Arts, and the Linz University of Art and Industrial Design. The Vienna University of Economics and Business Administration does not fall under any of these categories and is therefore included in the "all universities" category.

Act) continue to be awarded on the basis of appointments under the Universities Act of 2002.

The pattern of awarding positions in recent years demonstrates that Austrian universities also have the option of awarding tenure track positions internally: 68% of the new tenure track positions created in the winter semester 2010 were awarded to former internal university assistants. Universities justify this by arguing that they did not want to lose highly qualified inhouse employees in the context of providing support for young talent, therefore they offered them a tenure-track position; in the future, however, such positions should increasingly be awarded on a competitive basis in accordance with international standards. The Medical University of Vienna has established the largest number of tenure track positions by far (152 tenure track positions in the winter semester 2011), followed by the University of Innsbruck (78 tenure track positions) and the University of Graz (57 tenure track positions). Tenure track positions that require a scientific qualification such as the post-doctoral thesis, or second dissertation, do not have the same status however at every type of university. At arts universities, for example, temporary employment contracts are preferred over tenure track contracts.[31] This is also reflected in the results in Fig. 17. A few universities are establishing tenure track positions that specifically promote women, such as the TU Graz, which created two tenure track positions each year in the performance agreement period from 2010 to 2012 for highly qualified female scientists.

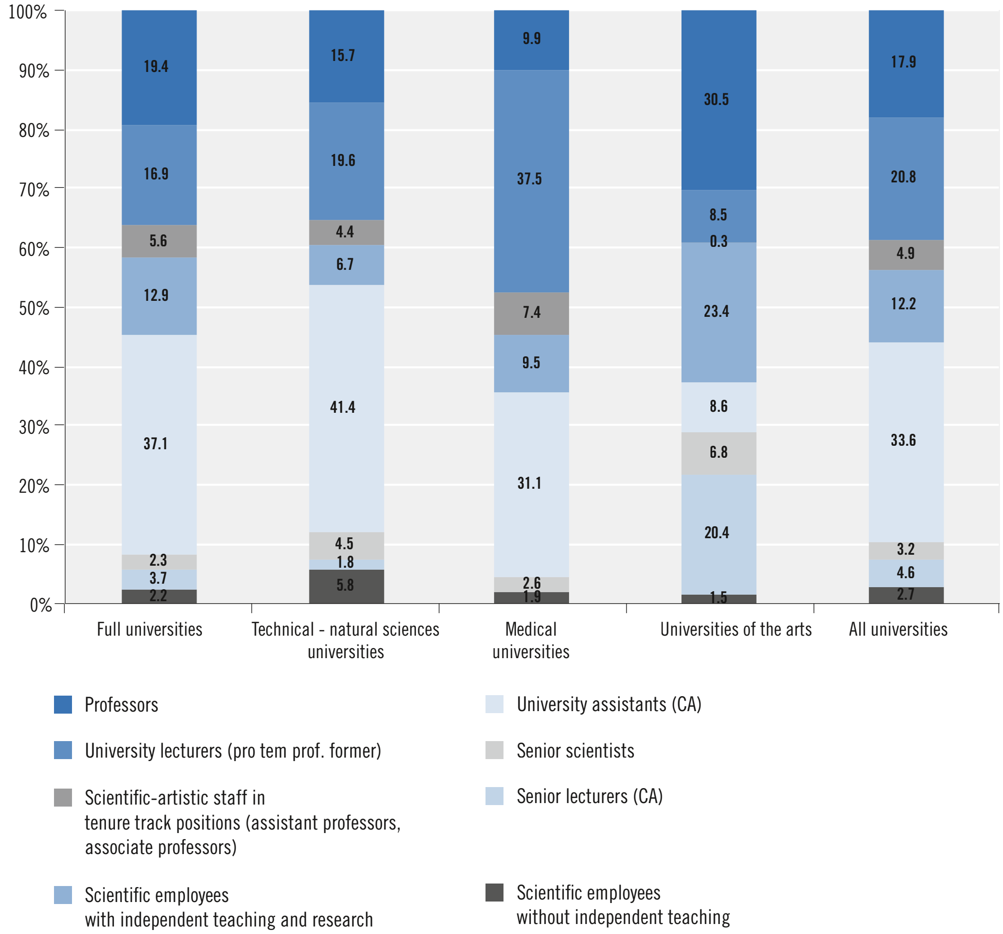
Another noteworthy change relates to the development of permanent employment contracts at Austria's universities. As Fig. 18 illustrates, the proportion of permanent employees among the total number of scientific staff (including employees hired with third-party funds) has declined continuously in recent years, a development which has also been caused in part by the transition period between the Universities Act and the implementation of the collective agreement.[32] In the winter semester 2011, an average of 24.4% of scientific staff employed at all universities were employed on a permanent basis. The universities that have the lowest proportion of permanently employed scientific staffers are the full universities (19.4% in the winter semester 2011) and the technical and natural science universities (21.5% in the winter semester 2011).

Among limited employment contracts it is noticeable that the share of pre-doc positions at all universities in particular has trended upwards. These employment arrangements, which serve to deepen and expand the disciplinary, scientific and artistic education of university assistants in accordance with the CA, primarily fulfil an educational function and lead to a larger number of doctoral candidates being integrated at the institutional level. In contrast, post-doc positions, which are limited to four to six years without any opportunity for tenure qualification, are losing their appeal; at the University of Salzburg, for example, these positions are no longer offered at all. This is also due among other things to the fact that third-party funded positions have increased enormously in recent years. Project employees at the technical and natural sciences universities financed externally in particular constitute an important and in some cases the largest staff group. A large proportion of the third-party funded positions are set up as pre-doc posts that

31 See also the University Report (2011), p. 87.

32 Since the introduction of the University Act, all new hires of scientific or artistic employees up to the point at which the CA came into effect and in the context of the legal transition have almost exclusively been temporary contracts (the universities had to comply with the Contract Staff Act when preparing work contracts for scientific and artistic employees).

Fig. 17: Structure of scientific-artistic core staff (headcounts) as a percentage, winter semester 2011



Source: Pechar et al. (2012), adapted.

function as an educational position. A seamless transition from pre to post-doc positions is no longer possible today at some Austrian universities, such as the University of Vienna, the University of Graz and the Technical University of Graz, meaning that a switch of institutions is required after completing a doctorate, and such changes are generally encouraged today for the development of a scientific career.

The CA career model causes universities to differentiate between rotation and fluctuation positions and tenure track positions in their staff planning. This offers the universities latitude for conceptualisation and action, yet it also opens up a problem that they have to deal with: on the one hand there should be enough rotation positions to ensure the education of the next generation of qualified scientists; on the other, enough tenure track positions should be available to offer career opportunities to highly qualified young talent.[33]

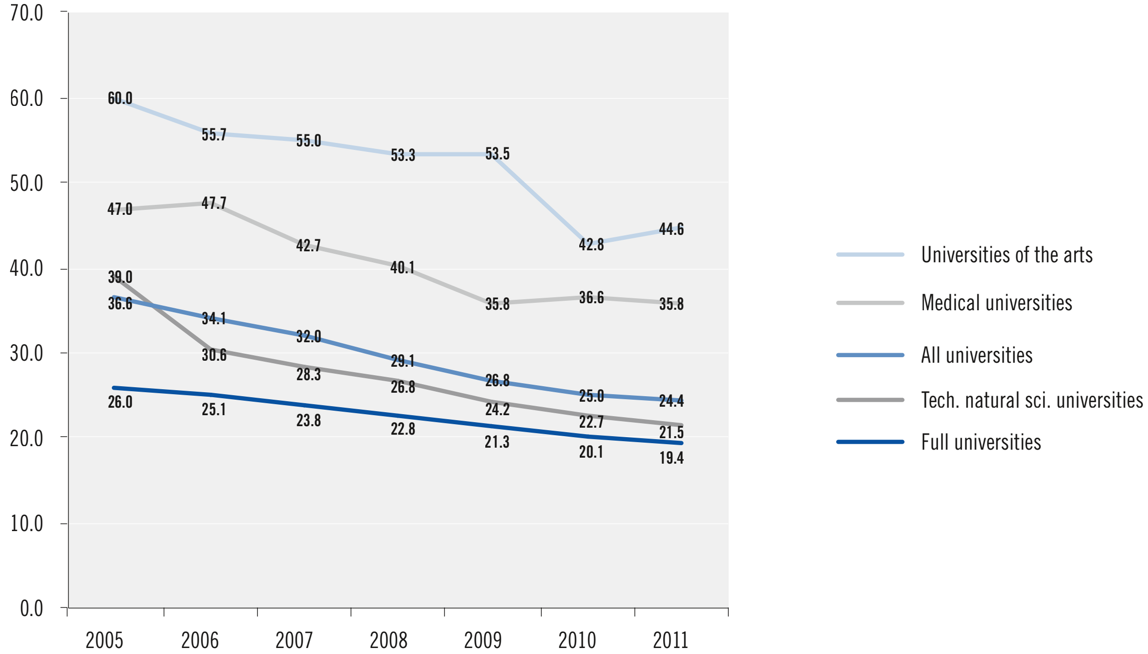
33 See also the University Report (2011), p. 87.

There are certainly differences among Austria's universities with regard to ideas about the proper ratio of tenure track positions to rotational posts.

3.4 External quality assurance and the Agency for Quality Assurance and Accreditation Austria

The external quality assurance system for the higher education sector in Austria was previously governed on a sector-specific basis for historical reasons. Given the developments in quality assurance at the national and European level (such as the issuance of the European Standards and Guidelines), Austria commenced with further development of the external quality assurance system in the government programme for the 24th legislative period (2008 to 2013). The goal was to create an inter-sectoral system and to integrate the three quality organisations acting separately, i.e. the Austrian Council of University of Applied Sciences (FHR), the Austrian Accreditation Council for Private Universities (ÖAR) and the Austrian Quality Assurance Agency (AQA), into one central institution. The High-

Fig. 18: Percentage of permanently employed scientific employees among scientific staff[34] (head counts) by type of university, winter semester 2005–2011



Source: Pechar et al. (2012), adapted.

34 The category of "scientific staff" includes all members of scientific core staff, student employees, third-party financed project employees and lecturers.

er Education Quality Assurance Act (HS-QSG) which came into force on 1 March 2013 provides the legal foundation for this new system and a new cross-sectoral quality assurance institution.

The new quality assurance organisation – the Agency for Quality Assurance and Accreditation Austria (AQ Austria)[35] – began operations in March 2012 and acts as an independent institution with full legal capacity, with the state responsible for its oversight and financing. AQ Austria, which consists of four bodies: the board of trustees, the general assembly, the board and the appeals commission, is thereby the central agency for all external quality assurance agendas at public and private universities, as well as universities of applied sciences.

Along with the rules governing the organisation and tasks of AQ Austria, the HS-QSG also includes quality assurance procedures and their framework conditions. The explicit goal of external quality assurance is not only to record quality assurance structures and processes in the areas of study and teaching, but also to consider all areas of responsibility at institutions of higher education (such as research, staff development, etc.) External quality assurance is therefore intended to fulfil a dual purpose: firstly it should be used as a steering instrument by the state, and secondly, it should provide higher education institutions with an aid for their own further development.

The Agency's central tasks include two quality assurance procedures: audits and accreditations. Audits meet the obligation at public universities of conducting an external evaluation of internal quality management systems with the objective that certification is used to confirm the establishment of a quality management system as contemplated in Section 14 of the Universities Act of 2002. Audits must also be conducted at existing universities of applied sciences that have already undergone an institutional evaluation according to the precepts of the Universities of Applied Sciences Studies Act. Institutional accreditations must be used for new universities of applied sciences, and programme accreditations must be applied for new courses of study. Institutional accreditation procedures are applied to private universities. New courses of study are also in turn subject to programme accreditation.

A major new feature of the HS-QSG is that higher education institutions have freedom of choice with regard to quality assurance agencies in the context of audit proceedings. This means that public universities are able to hire the national agency (AQ Austria) or an international quality assurance agency to conduct audits. Foreign quality assurance agencies must be registered members of the *European Quality Assurance Register for Higher Education (EQAR)* or another internationally recognised and independent quality agency. This is meant to ensure that audits correspond to audit areas in accordance with the HS-QSG and conventional standards for processes and professionalisation. However, at the same time this also signals a certain degree of openness in the system.

The openness of this system is expressed in the enhanced integration of students in external quality assurance. As such the HS-QSG provides for the first time that students will be represented in the uppermost governing body of AQ Austria, i.e. on the Board. Furthermore, students will act as part of evaluator groups and will benefit from the new regulations regarding transparency (such as the obligation to publish the process results). Moreover, an independent "Ombudsman for students" was established in the Federal Ministry of Science and Research (BMWF) as an ombudsman, information and service institution that incorporates the previous "Student Ombudsman Office". Another new development is the obligation to register interdisciplinary studies. International providers of study programmes must register with the Federal Ministry of Science and Research (BMWF) in future to guarantee

35 www.aq.ac.at

not just an adequate overview of educational offers available in Austria, but also to be able to provide corresponding background information on such offers.[36]

3.5 Repositioning the Austrian Academy of Sciences

The Austrian Academy of Sciences (ÖAW) has a long tradition. Founded in 1847, the Academy consists today of a scholarly society, a research management institution and an institution that supports young talent and provides services. The Austrian Academy of Sciences looks after the handling of research programmes for the Federal Ministry of Science and Research (BMWF). The Academy's role is to develop grant programmes and administer and award grants from public funds set aside for this purpose, from third-party funding and those supported by private sponsors.

The research management organisation has grown significantly since 2000. Today it includes numerous highly successful scientific research institutions that are performing work in areas such as molecular biology, biomedicine, physics, applied mathematics, space research, materials sciences, the humanities and social and cultural studies. Some of the most renowned research societies and institutions are the Institute of Molecular Biotechnology (IMBA), the Gregor Mendel Institute for Molecular Plant Biology (GMI), the Research Centre for Molecular Medicine (CeMM), the Johann Radon Institute for Computational and Applied Mathematics (RICAM), the Institute for Quantum Optics and Quantum Information (IQOQI), the Institute for Demography, the Institute of Medieval Research and the Institute for Iranian Studies.

Performance indicators from recent years document the academic success of the Austrian Academy of Sciences: 1,103 scientific publications were published in the MINT disciplines in 2012 (46 articles of which appeared in prestigious professional journals such as "Nature", "Science" or "Cell" and their sister journals) and 1,106 were published in the humanities, social sciences and cultural studies area.

A total of 75 prizes and awards were bestowed upon Austrian Academy of Sciences employees in 2012. One highlight was the presentation of the "Innovator Award", endowed with $ 7.4 million, with which the United States Department of Defense is supporting research at the Academy's own IMBA. In addition to START prizes awarded to two Academy fellows in 2012, there are 16 ERC grants (nine Starting Grants, six Advanced Grants, and a Proof of Concept Grant) with a total funding volume of more than € 24.3 million that are ongoing at Academy institutions. The ratio of third-party funds acquired by Academy research institutions in 2012 to the basic budget (almost € 96.59 million) yields a third-party funding ratio of 45.39% (MINT 47.76%, humanities, social sciences and cultural studies 38.68%). Numerous Academy research results quickly made their way to market – 39 patents were filed in 2012 – and to science-based consulting, as in demographic studies, and to the public through symposia, lectures and exhibitions.

In terms of support for young talent, the first call for submissions went out for the "New Frontiers Groups" programme, which was developed by the Austrian Science Fund in cooperation with the National Foundation and funded for five years with € 8 million, establishing independent junior research groups that focus on scientific topics that they have selected at Academy institutions, thereby bringing new incentives and ideas into Academy of Sciences research. All of this reflects the high (national and international) competitiveness of the Austrian Academy of Sciences (ÖAW), an organisation whose appeal for top scientists should continue to grow in future with the creation of a tenure track option,

36 This chapter is based on the special edition of Austria Innovativ (6a/2012) as well as Erlinger-Schacherbauer (2012).

i.e. a transparent, performance-guided scientific career path at the Academy that follows international standards.

The huge expansion in highly successful Academy research managers made it necessary to modernise and adapt the Academy's management structures. New statutes and rules of procedure came into effect in 2011, thereby implementing modern and transparent structures at the management level:

- Expansion of competences of the executive board,
- Establishment of an Academy Council with a supervisory function,
- Establishment of a Director for Finance and Administration, and
- Expansion of the powers of the directors of research institutions.

For the first time in the history of the Academy a crucial step was taken with the signing of a performance agreement in November 2011 between the Federal Ministry of Science and Research (BMWF) and the Academy for the period covering 2012 to 2014. The Academy presented its plans for 2012 to 2014 in the agreement, and in return it received three years of financial planning security from the federal government in the form of a global budget of € 223.8 million. The Austrian Academy of Sciences is the largest non-university research management body in Austria, with over 1,100 employees (FTEs). The Academy is pursuing the goal of expanding its leading role in application-oriented basic research, both in Austria and abroad, and in setting priorities. The Academy has therefore gone through a prioritisation process in its research portfolio in order to concentrate on proven disciplinary and interdisciplinary strengths and to further specify its research areas on the basis of six priorities: (1) European identities and the preservation and interpretation of cultural heritage, (2) demographic change, migration and integration of people in heterogeneous, innovative societies, (3) biomedical basic research, (4) molecular plant biology, (5) applied mathematics, including modelling and bioinformatics and (6) quantum optics and quantum information.

Furthermore, the performance agreement for 2012 to 2014 specifies the following aims for the Academy in its function as a research management institution:

- Exclusive operation of research units with critical mass in their disciplinary fields,
- Continuation of highly specialised and/or long-term research projects on the preservation and interpretation of cultural heritage,
- Contribution to priority-setting and strategic positioning within the Austrian research landscape in cooperation with universities and non-university institutions, and
- Participation in regional, European and international research infrastructures within the *European Roadmap for Research Infrastructures*.

The overarching goal is to elevate elite research at Academy research institutions to an internationally competitive level. This development is also being supported by the Austrian University Plan, which explicitly refers to attention being focused on areas of research excellence as part of establishing Austria as a research location in future. The Plan also contemplates priority-setting at universities and research institutions. In this context, the Austrian Academy of Sciences has implemented an important measure for future focus and priority-setting by transferring individual Academy institutions and research groups to Austrian universities. The following transfers have already been implemented:

Transfer to the University of Innsbruck

- Institute for Limnology (ILIM)
- Research Institute for Biomedical Aging Research (IBA)

Transfer to the University of Salzburg

- Geographic Information Science (GIS)
- Corpus Scriptorum Ecclesiasticorum Latinorum (CSEL)
- Institute for Realia of the Middle Ages and Early Modern Period (IMAREAL)

Transfer to the Krems University for Continuing Education
- Institute for Integrated Sensor Systems (IISS) (retroactive to 1 January 2013)

Transfer to the Medical University of Graz, Graz University of Technology and the University of Graz
- Institute for Biophysics and Nanosystems Research (IBN)

Transfer to the University of Graz
- Institute for European Tort Law (ESR) (research group)

Transfer to the University of Leoben
- Erich Schmid Institute of Materials Science (ESI) (research group)

Transfer to the University of Vienna
- Commission for the Legal History of Austria
- Institute for European Integration Research
- Commission for Linguistics and Communications Research (research group)

Transfer to the University of Klagenfurt
- Institute for Comparative Media and Communication Studies (research group)

The focus on the priority fields was supported by transfers from research institutions to universities and was also driven forward within the Academy through research units being consolidated or incorporated into existing institutions following relevant assessments. As of the beginning of 2012 there are now 28 institutes under the aegis of the Austrian Academy of Sciences instead of 63 research units. The budget freed up by these transfers and consolidations is now available to the Academy for the purposes of investing in its priority fields, thereby assuring the continuity of scientific excellence into the future.

3.6 Open Access

Scientists are tasked with creating and sharing knowledge and information. In most disciplines, publications represent the most important medium for sharing scientific findings. An external (anonymous) evaluation procedure is typically used to guarantee adherence with quality standards. Publishers decide on the basis of such evaluations whether to publish manuscripts and, if the evaluation is positive, these texts are then offered commercially.

The distribution structure for scientific knowledge has tended toward a concentration of providers and towards significant price increases at the publishing houses in recent years. In some scientific disciplines (such as medicine, the natural sciences and engineering), prices have quadrupled in the last 20 years, meaning that budgets at scientific libraries have scarcely been able to keep pace with the price increases at the large publishing houses.[37] The possible and hoped-for effects of digital media distribution via the Internet, however, have not yet materialised in this sector. This is precisely why calls have become increasingly urgent for new methods and structures for distributing scientific knowledge. The central concept in this debate is Open Access (OA), "*…free access to scientific results (publications and research data) on the Internet*".[38]

According to the Open Access paradigm, knowledge and information should be freely accessed in order to contribute to improved transparency, sustainability and interactivity in a knowledge-based society.

37 See also http://open-access.net/at_de/general_information/gruende_und_vorbehalte/gruende_F&Er_oa/

38 Reckling (2013), p. 1. The following chapter is based primarily on a publication composed by Falk Reckling in February 2013 entitled, "Open Access – Aktuelle internationale und nationale Entwicklungen" (Open Access - Current international and national developments). We would also like to thank Falk Reckling for his comprehensive support of this chapter.

Proponents of Open Access offer several reasons for this paradigm shift:

- The Internet creates the technical prerequisites for making scientific results accessible anywhere and at any time;
- Publishers typically receive scientific publications at no cost from authors who often receive public financing;
- External evaluators also offer their quality assurance services free of charge in most cases;
- Finally, the huge increase in costs for journal subscriptions and licences (driven by the pricing policies of large well-known publishing firms) has led to a situation in which only a few libraries are in a position to acquire all of the publications that they want or need.

Along with the financial argument there is also a theory that the findings from publicly financed research should be freely accessible, not only to ensure the exchange of knowledge within the scientific community but also to create added value for society. The Finch Report recently published in the United Kingdom in order to create a foundation for a national OA strategy, identifies the following arguments for a OA policy that is oriented towards the future:

- Improved transparency and accessibility, more awareness of responsibility and a heightened public interest in research,
- Improved knowledge transfer, especially between research and innovation, and therefore more economic growth and prosperity,
- Higher efficiency in relation to the research process itself through expanded and easier access to knowledge, less time required for searching for knowledge and wider and improved use of analytical methods, as well as
- Improved legitimation as regards the public, especially when research is financed by public funds.[39]

The *Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities* (2004) is the authoritative document for disseminating the Open Access paradigm; it attracted 249 institutional signatories from all over the world (including three Austrian institutions: the Austrian Science Fund (FWF), the Austrian Rectors' Conference and the University of Vienna).[40] There are now almost 400 institutional signatories.[41] This document states that Open Access publications must fulfil two basic requirements:

1. The author(s) and right holder(s) grant(s) "*…to all users a free, irrevocable, worldwide, right of access to, …*" and "*…a license to copy, use, distribute, transmit and display the work publicly and to make and distribute derivative works, in any digital medium for any responsible purpose, subject to proper attribution of authorship*"; and
2. That "*a complete version of the work and all supplemental materials, including a copy of the permission as stated above, in an appropriate standard electronic format is deposited (and thus published) in at least one online repository…*".[42]

Open Access does not mean, however, that publishing in *Open Access* will be 'free' in future. On the contrary, the costs for scientific publishing will climb in the transition phase, whereby two paths, which still require financing, can lead toward the implementation of OA: *Green Road* and *Gold Road*.

3.6.1 Green Road

The basic principles of *Green Road* are that every scientific article is archived by its author(s) in a freely accessible database – a repository – in parallel with its publication in a journal. *Preprints* and *Postprints* can be archived.[43] *Preprints* are

39 See Finch (2012).
40 In addition to the Berlin Declaration, the *Budapest Open Access Initiative* (2002), which was supported by both individuals and institutions, and the Vienna Declaration (2005) should be mentioned as proactive initiatives addressed to the international community.
41 See the list of signatories at: http://oa.mpg.de/lang/de/berlin-prozess/signatoren/
42 Berlin Declaration, p. 3.

manuscripts of scientific articles that were submitted to journals but that have not yet undergone the quality assurance process. The authors typically therefore do not have the usage rights, so there are generally no legal guidelines that prevent self-archiving. *Postprints* represent the opposite situation: the articles have already been subject to the review process and have been accepted for publication. This can give rise to legal problems because the publishers have different ways of handling this kind of second publication. Many scientific publishers specify what they call embargo periods, meaning that they allow the publication of *Postprints* after a certain amount of time has passed. Since embargo periods are between 6 and 36 months, this massively restricts the ability to cite the publication and impacts its current nature.

The scientists for their part often find the policies at individual publishing firms (such as different rules for embargo periods, formats, archiving locations) to be obscure, complicated and therefore too time intensive. In a few disciplines, however, such as mathematics, physics and economics, self-archiving by scientists is already practised on a very broad basis, even if this is mostly in the form of *Preprints.*

3.6.2 Gold Road

The term *Gold Road* is used to describe a method in which the original scientific work is published directly in an OA publication. This process generally includes a peer review, and the authors typically sign a contract with the publisher which governs the rights and terms of use. The *Directory of Open Access Journals* Internet platform already lists over 8,700 OA journals for which a peer review process is mandatory for publication.[44] Financing can be implemented in one of two ways:

- The first form of financing involves the authors paying fees per article, thereby assuming publication costs through *Article Processing Charges (APC),*. This model has become widespread in the life sciences. To promote this model, funding organisations, among them the Austrian Science Fund (FWF) since 2004, have begun to assume the costs of publication for their funding recipients.
- The second form of financing envisions funding organisations, research facilities, professional societies and libraries increasingly committing themselves to scientific publishing in addition to the commercial publishing firms; this means that scientists are provided with the technical and financial resources that enable the publication of journals or series of books without forcing the authors themselves to bear the costs. This approach has found favour especially in the smaller disciplines and the humanities and social sciences.[45]

Both forms of financing shift the costs from the readers to the authors of scientific articles and/or members of scientific organisations. The *Gold Road* is therefore in no way less costly than the conventional system, yet it could create efficiency gains if total costs are reduced through increased competition.

According to the latest estimates, *Gold Road* accounts for between 10 and 16% of published articles. Obviously this approach also presents difficulties for scientists seeking to publish. One disadvantage is that OA publications have only established themselves systematically in the last ten years, and only comparatively few OA publications have earned a reputation which is going to attract scientists to submit their manuscripts for publication. In addition, only a few research locations and funds have offered financial support for the *Gold Road*, whether as administra-

43 Along with Preprints and Postprints, there is also a distinction made between institutional and subject-specific repositories. The scientific activities of individual institutions are combined in institutional repositories, while scientific articles are collected in an interdisciplinary way in the disciplinary repositories.

44 http://www.doaj.org/doaj?func=browse&uiLanguage=en

45 See Reckling et al. (2012).

tors of OA publications or as providers of funds for APCs for scientists. There is also the fact that the new market has brought forth providers that offer low quality at relatively high costs.

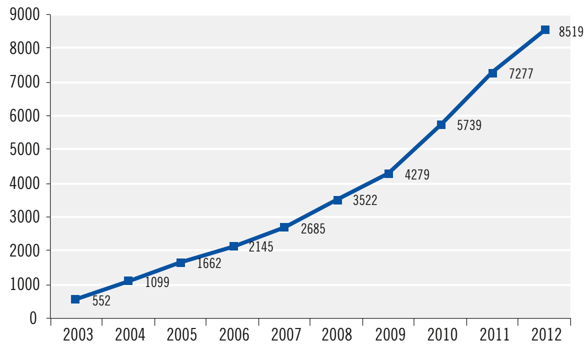
Numerous publishers are offering *hybrid models* alongside publication in OA journals. These are hybrid journals that are not Open Access, yet offer scientists the option of "buying" their article and thereby publishing it in Open Access. In fact, the authors or funding organisations assume the costs of making these publications available free of charge to readers. In terms of the publishers, major internationally active publishing houses generally offer the option of publishing in hybrid journals today. However, this has garnered criticism because these publishers are demanding increased Open Access fees from conventional journals, yet they have not reduced their subscription costs, meaning that the publishers are using OA developments for their own profit and benefit.[46]

3.6.3 The development of Open Access journals

The first Open Access Journals (OAJs) were founded in 1989 and, as illustrated in Fig. 19, the number of OAJs has grown exponentially in the last ten years. Overall, out of more than 30,000 reported scientific journals, we can assume that around a quarter of them are OAJs.

Open Access journals are registered in the *Directory of OA Journals (DOAJ)*, which currently lists journals from 121 countries. The USA is the worldwide leader with a total of 1,270 registered OAJs, followed by countries such as Brazil (801), the United Kingdom (575), India (463), Spain (442), Egypt (350), Germany (259) and Canada (255). Measured in terms of population, Switzerland (125) is currently the largest producer of OAJs. Nations with strong science systems therefore tend to invest in this new market, although up-and-coming scientific countries such

Fig. 19: Development of Open Access Journals (OAJ), 2003–2012



Source: Falk (2013), from: www.doaj.org.

as Brazil, India and Egypt are evidently using cost-efficient options for market entry. Viewed by discipline, life sciences have the highest share of the market at around 35%, followed by social sciences (25%), humanities (15%), natural sciences (12%) and engineering sciences (10%). There were a total of 40 Online Access Journals published in Austria at the end of 2012, with the most renowned journals being *Living Reviews in European Governance*, *European Integration Online Papers*, *Myrmecological News* and *Vienna Yearbook of Population Research*.

The OAJ market was driven primarily by the technical possibilities of the Internet, which makes market entry significantly more affordable and provides a set of free software solutions – especially the Open Journal System which is financed by a consortium of American and Canadian universities. Other drivers of the rapid development of OAJs were the non-commercial *Public Library of Science* (PLoS) and the commercial *BioMedCentral Verlag*.

The *Public Library of Science* took an additional step by establishing a publication model called PLoSOne, a so-called megajournal that within a few years has become the largest profes-

46 See Bauer, Stieg (2010). An overview of the publishing firms that work with hybrid models can be found in the sub-directory of the SHERPA/RoMEO site, "*Publishers with Paid Options for Open Access*" (http://www.sherpa.ac.uk/romeo/PaidOA.html).

sional journal in the world. With almost 24,000 articles in 2012, *PLoSOne* follows three principles: (1) to publish promptly, (2) to accept articles from all natural sciences disciplines and (3) to refuse to engage in editorial selection, for instance with regard to the scientific significance of articles. This means that around 70% of all submitted articles are accepted, that editorial overhead is very low and that APC per article is kept low at about € 1,000. Numerous imitators among commercial publishers have also emulated this model, such as *SageOpen, Forum of Mathematics, OpenBiology, GigaScience* or the recently launched *Open Library of Humanities* initiative.

3.6.4 International developments

On 14 February 2013, the bipartisan *Fair Access to Science and Technology Research Act* (FASTR) was introduced in the United States Senate and House of Representatives. The Act dictates that, in accordance with the Green Road, scientific publications funded by public funding sources (with an annual budget of more than $ 100 million) should be archived in OA with a maximum embargo period of six months. At the European level, the European Commission began an Open Access pilot project in August 2008 which is based on parts of the 7th European Framework Programme (FP7) and the European Research Council (ERC). Open Access is being promoted in selected areas such as energy, environment, health and ICT by encouraging all funding recipients to store their (*peer-reviewed*) publications in a repository and to make them freely accessible after an embargo period of six months to one year. The Gold Road funds all publication costs, including author fees. This pilot project is accompanied by a monitoring project called *OpenAIRE*, which has taken over the constant exchange with the European Parliament, the Member States and stakeholders.[47] The European Research Council (ERC) also proactively supports OA. The ERC joined the world's largest full-text database for scientific publications in the life sciences, the *Europe PubMedCentral* repository. With over 2.6 million papers, *Europe PubMedCentral* is by far the most significant Postprint repository and has received essential support from **funding organisations such as the NIH, Wellcome Trust, MRC, BBSRC, Austrian Science Fund** and **ERC**. All of the aforementioned funding organisations require that their project participants archive their work in *Europe PubMedCentral*.

Publishing in OA should continue to be promoted in future. All publications that arise in the context of EU funding should be made accessible in Open Access. For HORIZON 2020 this means that all funded publications (including research data) should be required to publish in OA under the *Green Road* or *Gold Road* approach.[48] Furthermore, the European Commission is communicating its target of having all Member States publish at least 60% of their scientific publications in OA by implementing relevant actions by 2016. With this the funding organisations are considered to be responsible in particular for long-term archiving of scientific data. In order to accelerate this development, the European Commission recommended that as of 1 February 2013 its Member States initiate OA measures for publicly financed research at the national level and define a clear policy with regard to a more rapid implementation of Open Access and Open Data in accordance with European targets.[49]

Up to now the EU member states have adopted completely different approaches to implementing Open Access, with the United Kingdom certainly counting as one of the absolute pioneers in this regard. The United Kingdom was the first country in the world to announce that it will convert the entire economy of its scientific pub-

47 See "Open Access in FP7", http://ec.europa.eu/research/science-society/index.cfm?fuseaction=public.topic&id=1300&lang=1
48 In the *Green Road* approach, scientific publications are supposed to be made freely accessible after an embargo period of six months, with an embargo period of twelve months before free access is provided for the humanities and social sciences.
49 See Council of the European Union (2013).

lication system to OA over the next few years. The *Finch Report* is leading the way in this regard; all interest groups were involved in the preparation of the report and scenarios for the changeover were developed as part of the process. The UK Research Councils are providing approximately 3 billion pounds sterling to finance the changeover in the next few years, and they are also changing their policies. As of 1 April 2013, all scientific publications that are funded by Research Councils must be accessible in OA. *Article Processing Charges (APCs)* are meant to be financed by funds allocated specifically for this purpose. Furthermore, it is expected that the universities and institutions of higher education will establish funds themselves for the purpose of supporting OA publishing.[50]

Among the Nordic countries, Denmark has taken steps toward OA in recent years. Denmark developed and set up a national OA strategy after a process of coordination with all relevant stakeholders. Sweden created its own OA programme, which is coordinated by the *National Library's Department for National Cooperation*. Moreover, universities are legally obliged to provide public access to their research results, including "*research results for commercial exploitation*". Publishing in OA has also become a standard practice in Finland, accompanied by numerous obligations and guidelines from the universities. The same applies in Norway, where OA is being established at the national level as a higher-level goal by the *White Paper on Research*. According to this document, all publicly financed scientific publications must be freely accessible. In the Netherlands, both the scientific community as well as the libraries certainly appear to be active in implementing OA, even if drastic budget cuts mean there will not be any additional investments in this area in future.[51]

Germany is one of the countries that is not pursuing a national OA strategy. Germany is following a bottom-up approach, which means that individual stakeholder initiatives are particularly crucial in determining the further development of OA. Research organisations such as the Deutsche Forschungsgemeinschaft (DFG; German Research Foundation) have already defined their own OA policy. The strategic plan in Switzerland is similar. The Swiss National Fund has required its funding recipients to publish in OA since 2007. Switzerland has launched a dialogue between science and society to generate further support for Open Access. Both the association of the four Swiss Academies of Arts and Sciences and the Conference of University Libraries have recommended providing free access to scientific publications or have started OA projects. There are pilot projects for instance, such as the one at the main library of the University of Zurich, which has supported Open Access publications in both the humanities and the social sciences since 2012 with a publication fund.

3.6.5 The status quo in Austria

As in other European countries, Austria does not have a national coordinated OA policy or initiatives organised centrally. There are individual institutions and scientists who are proactively promoting Open Access publishing. The Austrian Rectors' Conference signed the *Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities* in 2004, and an Open Access working group was formed after the publication of the *Recommendations from the EUA Working Group on Open Access* in 2008. The results from this working group form the January 2010 recommendations from Universities Austria (uniko) regarding Open Access policies at universities. The working group recommended active support for a transition to the Open Access paradigm by means of a *Green Road* strategy – aware that use of existing repositories or the creation of new ones would require additional funding resources (including third-party ones).

50 See Osborn (2013).
51 See European Commission (2011b).

Furthermore, the university administrations are being encouraged to enact an Open Access policy.[52]

Open Access was enshrined as a topic of the future at the national level as the Austrian Council for Research and Technology Development (RFTE) articulated Open Access in Strategy 2020 as follows: "*The Council considers it incumbent upon science and RTI – above all for such activities that are financed with public funds – to keep society widely and comprehensively informed about their actions as well as their findings and developments. Among other obligations this includes the fact that all public research results in Austria (especially publications, primary research data, etc.) shall be freely accessible on the Internet by 2020; the key term here: Open Access.*"[53] Accordingly there are different stakeholders taking action to implement and disseminate OA in Austria, and there are already numerous measures being implemented by funding organisations, research societies and universities.

Support measures by the Austrian Science Fund (FWF)

The Austrian Science Fund (FWF), one of the first signatories to the Berlin Declaration, has had a consistent OA policy since 2003 which currently includes the following measures:

- Since 2003, the Austrian Science Fund provides financing for publications under the *Gold Road* approach. This amounted to almost 900 journal and book publications in 2012, with a total volume of € 1.6 million. Measured in terms of its overall budget, this sum, along with the Wellcome Trust[54], is one of the world's highest figures for a funding organisation.
- All grant recipients have undertaken since 2006 to make their publications freely accessible under the *Gold Road* or *Green Road* models whenever legally possible.
- Since March 2010, the Austrian Science Fund has participated in *PubMedCentral* through *UKPubMedCentral*; this means that all project managers in the field of life sciences receive a project account at *UKPubMedCentral for the purposes of archiving their publications there. Almost 3,000 publications from Austrian Science Fund publications from the field of life sciences have been made freely accessible thanks to this initiative.*
- *The Austrian Science Fund has also expanded funding for Open Access publications of books: The establishment of the* FWF *E-Book-Library creates a repository that is technically supported by the PHAIDRA Team at the University of Vienna in which all publications funded by the Austrian Science Fund since December 2011 are made freely accessible at the same time that the book, e-book or similar document is published. The Austrian Science Fund also offers to digitise all FWF-funded books that have appeared since 2000 and to publish them in the FWF E-Book Library*.
- Together with the Federal Ministry of Science and Research (BMWF), in October 2012 the Austrian Science Fund expressed an interest in start-up financing for OAJs in the humanities and social sciences. This is intended to fund five to ten premium international OAJs in 2013.
- Internationally through *Science Europe* (an umbrella organisation for European research funders and research management organisations) the Austrian Science Fund is working towards shared European standards for OA, which are supposed to be published in the spring of 2013.

52 See uniko (2010).
53 RFTE (2009): Strategie 2020, p. 31.
54 The Wellcome Trust in London is the world's second wealthiest foundation that funds medical research.

- In Austria, the Austrian Science Fund very recently began a discussion about a *University/Academic Press* . The idea is that research locations and publishing firms create a shared publication platform that establishes the technical criteria for international standards for internationally visible publications with quality assurance processes (such as peer review, expert editing) and OA.

Measures by the Austrian Academy of Sciences (ÖAW) and IST Austria

The Austrian Academy of Sciences has been pursuing an implicit Open Access policy since 2005, and this policy was formally enacted in the summer of 2011. The Academy recommends that ÖAW scientists make their research results freely accessible by archiving them as soon as possible to the publication date and in a form which is appropriate for their disciplinary subject, insofar as this is contractually permissible, thereby following the *Green Road* strategy. Authors at the Austrian Academy of Sciences have the right to make a digital copy of their scientific publication accessible to the public in a repository. The institutional repository EPUB.OEAW established in 2006 offers an archiving service that functions as the electronic platform for the Austrian Academy of Sciences publishing firm and provides other subject-specific services. The Austrian Academy of Sciences publishing house is a so-called *Green Publisher*; this means that journal articles can be posted online as a manuscript (yet not in the publishing layout) on the scientist's homepage or in a research institution repository before the publisher issues the publication. The Austrian Academy of Sciences only retains a non-exclusive right to publication, which for the author means that they can continue using their scientific work without additional restrictions. This rule applies to journals, but not to books and databases. Furthermore, in its *Author's Choice* programme, the Austrian Academy of Sciences offers the option of making journal articles or anthology chapters freely accessible on the Internet at the time of publication, upon payment of an OA fee. This option should be viewed as a *Gold Road* option, even if the Austrian Academy of Sciences typically recommends following the *Green Road* (primarily for cost reasons); for the *Gold Road*, the Academy principally recommends third-party funding (for example, from the Austrian Science Fund). The 2012–2014 performance agreement between the Austrian Academy of Sciences and the Federal Ministry of Science and Research (BMWF) stipulates that the ÖAW will continue to promote its OA offers in future. The ÖAW is also supposed to expand its OA publications in future this way.[55]

The Institute of Science and Technology Austria (IST Austria) has also constructed its own repository under Open Access principles. The evaluation of IST Austria which among other things was supposed to be a response to all of the Institute's publications was crucial for this. One main aspect during the development phase was that data entry effort should be kept to the lowest minimum possible. The goal was to be able to transfer data and files simply from the publication database to the repository. The effort for scientists was supposed to be very low; they would load their content into the system once and library services would take care of all the other necessary steps. Overall OA policy at IST Austria – which uses a repository based on EPrints – is therefore promoting the *Green Road*. However, IST Austria has also recently established a publication fund for financing the *Gold Road*.[56]

3.6.6 Measures at Austrian universities

Austria's universities have already begun implementing measures and initiatives to implement OA. The Open Access activities at the University of Vienna have flourished the most, offering

55 See Nentwich et al. (2012).
56 See Rossini (2012).

services and infrastructure for self-archiving (Green Road) of scientific publications and primary research data, while also supporting scientists in their publication projects with technical, financial and bibliometric aid.[57] The University of Vienna established the university-wide Digital Asset Management System Phaidra (Permanent Hosting, Archiving and Indexing of Digital Resources and Assets) in 2008. Phaidra, a repository for administration, research and teaching offers long-term management of digital contents in different formats so that valuable digital inventories can be secured over the long term and made accessible worldwide. Phaidra's user group quickly spread beyond the University of Vienna once the system began operations. A series of institutions use Phaidra today, either as a stand-alone installation or in a hosting arrangement, such as the Arts Universities in Graz and Linz, the University for Applied Arts in Vienna, the Austrian Science Board, the Austrian Research Society, the Forum for Austrian University Libraries and the Science Fund (FWF).[58] The Vienna University of Economics and Business Administration also has an institutional repository. The ePub^WU^ Open Access publication server has been in operation now for ten years, offering free and permanent online access to scientific works. There are currently about 1,300 documents that can be retrieved and copied, printed and cited within the framework of the copyright provisions governing academic and private use.

Other universities such as the Graz University of Technology or the University of Graz are also planning repositories to implement the *Green Road*. The University of Graz has a target to install a publication server in which publications such as (1) diploma theses, doctoral and post-doctoral theses, (2) essays, proceedings, research papers, reports and special editions, as well as (3) digital objects of all kinds, such as images (e.g. manuscripts), video clips, audio files, CD-ROMs, auxiliary materials, etc. can be collected and made available to the public over a single online platform. The Mozarteum University of Salzburg is also due to establish a similar hybrid library. The Graz University of Technology, the University of Vienna and the University of Natural Resources and Applied Life Sciences have also established publication funds for promoting the *Gold Road*.

The overwhelming majority of Austrian universities are working very actively on the introduction and development of Open Access strategies and further development of Open Access initiatives. The universities have also enshrined their commitments to OA in their 2013–2015 performance agreements. Further development of OA will gain special relevance in the university network in the future. There are Open Access cooperation and coordination activities in collaboration with the Austrian Science Fund (FWF) and the österreichischen Bibliothekenverbund- und Service GmbH (Austrian Library Association and Service company) of which all Austrian universities are a part. The goal is to develop an Austria-wide solution for Open Access and to establish an Institutional Repository for Preprints. There are also cooperative projects emerging at the regional level, such as the joint Styrian Open Access platform. The University of Graz, the Graz University of Technology, the Medical University of Graz, the University of Leoben and the Arts University of Graz are all participating in this platform with the goal of creating a university repository, including electronic long-term archiving and a representative research information system by 2015.

Another initiative is the financing of the Austrian share of the $SCOAP^3$ international initiative (Sponsoring Consortium for Open Access Publishing in Particle Physics). Its aim is for all relevant high-energy physics journals to appear in OA starting in 2014. This effort is being organised together by the University of Vienna, the Vienna University of Technology, the University of

57 See http://openaccess.univie.ac.at
58 The website set up in 2012 offers an overview of cooperative projects: http://phaidra.org

Graz, the University of Innsbruck, the Austrian Academy of Sciences (ÖAW), the Austrian Science Fund (FWF), the Federal Ministry of Science and Research (BMWF) and the Österreichische Bibliothekenverbund- und Service GmbH (OBVSG). At the end of November 2012, the OA Network Austria (OANA) was established at the initiative of the UNIKO and the Austrian Science Fund. The network will strive in future to (1) coordinate OA measures among Austrian research locations, funding providers and research agendas, (2) formulate uniform positions in relation to information providers (including publishers), and (3) be a point of contact and source of information for (research) policy.

3.6.7 Further developments in the Open Access paradigm

The Internet has permanently changed the way in which scientists work and publish and how communities perform research and communicate. Access to information has changed. Science without access to electronic publications, databases or the Internet is inconceivable today. This is also accompanied by increasing transparency in research. The "ivory tower" of the sciences has been dismantled – through access to publications and also access to research data and integrative databases, such as STAR METRICS in the USA. Such databases make essential contributions to progress in OA with their links to publications, data, patents, research institutions, third-party funding providers, etc.

Open Data

Like OA, free access to research data also includes demands for more internal transparency in research, however, Open Data is more difficult to implement because, unlike for publications, the technical requirements and standards vary widely between the disciplines, and these can often only be resolved at the national level and for each discipline. The discussion about Open Data is therefore in its infancy, even though we can identify a few general principles: there is consensus in the community that free access to publicly funded research data is an essential element of science because this facilitates the reproducibility of scientific findings. Data should therefore be used and re-used with as few restrictions as possible in future – within ethical and legal limits – and archiving should permit long-term usability.

There are already various approaches at the national level for presenting data to the public that are relevant for research. A whole series of research-related data and materials is administered by publicly financed institutions such as museums, libraries, statistical offices and meteorological institutes that publish on their own portals. However, access (e.g. to the microdata) is often very limited or must be purchased. Access to public administration data, also known as Open Government Data, is even more advanced. Open Government Data relates to "*public sector data holdings that are rendered freely accessible by the state and administration in the common interest without any limitation with regard to usage, further distribution and further application.*"[59] Given the increased interest in Open Access, we have seen renewed activity recently in Austria promoting initiatives to make public administration data freely accessible.[60]

STAR METRICS

Open Access has also become very relevant in public research funding, especially as this relates to processing by funding organisations. The pioneering country here is once again the USA. STAR METRICS (*Science and Technology in America's Reinvestment – Measuring the Effects of Research on Innovation, Competitiveness and Science*) was launched in 2009 as a cooperative venture between the U.S. Office of Science and

59 von Lucke, Geiger (2010).
60 See Open Government Data Austria (http://data.gv.at/).

Technology Policy, the National Science Foundation and the National Institutes for Health. STAR METRICS aims to develop a uniform data infrastructure as the foundation for standardised evaluation methods for the analysis of research projects. The STAR METRICS programme structure is divided into two levels: the first level concerns the determination of direct effects from public research investments on the employment situation in the science sector; the second level focuses on reporting scientific, social and economic effects from research investments. Belgium and Brazil have already developed similarly coherent data infrastructures. Developing databases for documenting public research funding and for making scientific results and effects from public research transparent is also an essential challenge for other European countries. In reference to STAR METRICS the German Expert Commission on Research and Innovation 2012 e.g. also recommended launching similar projects in Germany.[61]

Summary: Open Access as an active paradigm for the future

Some experts have examined the upward trends and come to the conclusion that Open Access will become the dominant model for publication in the next 10-15 years.[62] We will have to wait and see whether this is the case. Nevertheless, OA has already ushered in a transformation in the way we understand the roles of those involved in the research process:

- Funding organisations will integrate costs into their budget for the publications that result from their financial support.
- On the one hand research locations and libraries will transfer publication funds to scientists, at least partially. On the other, they will take on a more active role in the publication process by intensifying support for scientists by means of publishing infrastructures and repositories.[63]
- Scientists will increasingly be expected to consider the costs for publications in their strategic plans.
- Publishing firms must be aware that they are no longer operating in a "normal" market where private investments and services generate legitimate profits. Their business is based more and more on publicly financed services. Pricing must therefore take into account the service and quality provided by the corresponding publication organ.
- (Research) policy will have to create the framework conditions (e.g., Austrian Science Fund policy, anchoring OA policy among the universities in their performance agreements, creating repositories) which allow public goods produced by science to generate added public value through free access.

As is the case with every reform, a paradigm shift towards OA publications will probably involve higher costs in the transition phase before efficiency gains set in. Costs will be borne by the authors and no longer by their readers. In the humanities, this paradigm shift will not be quite as noticeable because authors up to now have always participated in the publication costs by means of printing cost contributions; the situation is different in the natural sciences (where articles rather than monographs are the primary vehicle of publishing), where OA will largely lead to a reduction in costs for industry covered by the public purse. However, in the medium term freely available science may open up inestimable innovation potential.

61 See EFI (2012).
62 See Lewis (2012).
63 The recently introduced EpiSciences concept even proceeds on the assumption that the scientific community could work solely on the basis of Preprint servers without commercial providers.

4 The role of manufacturing in the innovation system

This chapter describes manufacturing's role in the innovation system, with manufacturing being defined basically as the segment that manufactures products (Section C of the ÖNACE classification). While the employment function of manufacturing is still important, though in decline, its contribution to innovation and therefore to long-term growth of the national economy is crucial.[64] We will first provide a brief overview of the causes of the industrial policy renaissance. Then a presentation of structural change in the world and in Austria will set the framework within which we must interpret developments in manufacturing. Finally, we will show the many diverse contributions that manufacturing has made to technological progress, explicitly adopting a broad perspective. The presentation and interpretation of indicators related to innovation is therefore accompanied by an analysis of productivity figures that are the result of innovation processes and are of outstanding importance for the development of national economic prosperity. We then present the performance of Austrian manufacturing in key enabling technologies (KETs) and in the export of goods that can potentially protect the environment. These two topics are of central importance for the future development and international competitiveness of Austrian manufacturing.

Every empirical analysis of manufacturing and comparison with the overall economy or the services sector has had to consider a few changes in these sectors.[65] The association with the services sector is closer than ever before, and there is an increase in the share of service activities within the manufacturing sector. The outsourcing of service activities by manufacturing firms creates growth in the services sector at the cost of manufacturing without fundamentally changing the activities. Many manufacturing goods are sold today as bundles of goods that contain service components in addition to the physical ware. The organising of processes and the integration of systems throughout the international value-creation chain are central tasks for modern industry that require the services of highly skilled engineers. All of this suggests that the division between the manufacturing and services sectors, as is commonly found in industry statistics, is becoming less meaningful. Furthermore, we must consider that neither the manufacturing nor the services sector are homogeneous entities; instead, differences within each sector are greater than the differences between them. However, empirical analyses continue to show that there are significant differences between these two sectors. At the same time, we must exercise caution when interpreting the data, though many comparisons are necessarily short and to the point.

4.1 The renaissance in industrial policy

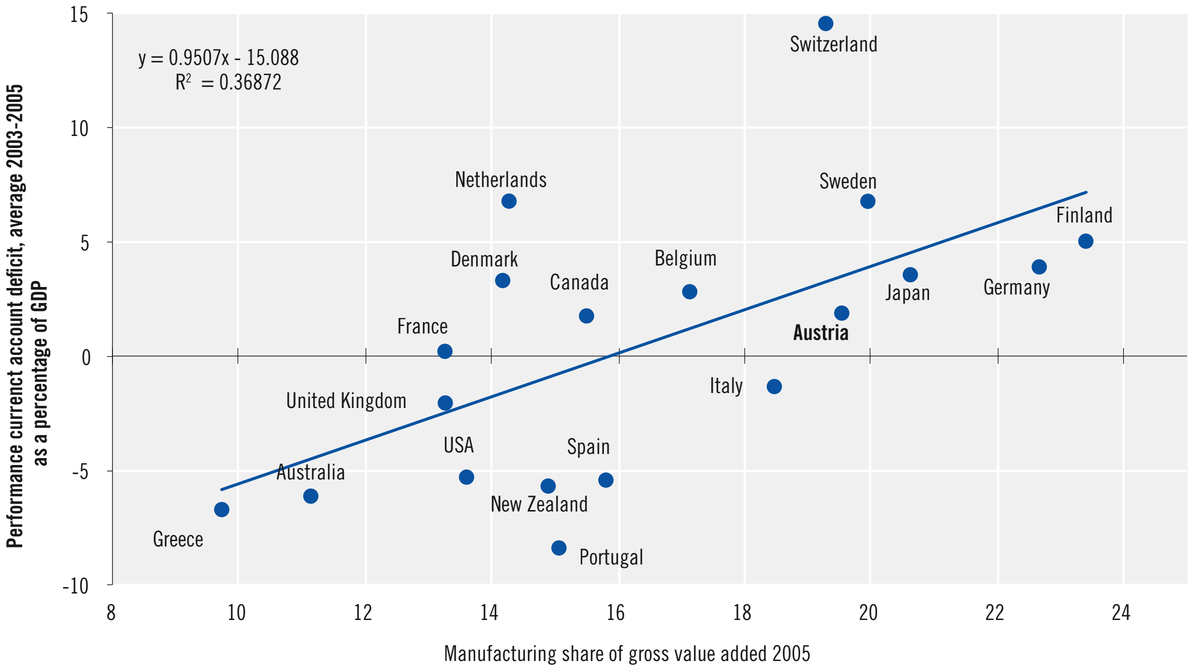
The global economic and financial crisis led to a reassessment of economic policy options and structural change. The manufacturing sector was at the heart of this global reorientation. Manu-

64 See Helper et al. (2012).
65 See Pilat et al. (2006), Mc Kinsey (2012).

facturing was long considered obsolescent, with a large manufacturing sector seen as a sign of sluggish structural reform; this judgement has turned completely around. The renaissance in industrial policy is accompanied by a parallel industrial paradigm shift in manufacturing that some authors have described as the "third industrial revolution".[66] This "revolution" is defined primarily by a convergence of various technologies such as material technologies, the Internet, 3D printing, and technologies associated with renewable energies. As a consequence of these developments and also because of increasing production costs in China, there may be a partial return of industrial production processes to the OECD countries.[67]

What are the causes for this new interest in economic policy in manufacturing? First, there was already an increase in the popularity of industrial policy before the crisis, associated with the rise of China and the Lisbon Strategy.[68] The crisis itself revealed the contrast between the Anglo-Saxon model of growth driven by the financial markets, which appears to have reached its limits, and the astonishingly robust, industry-driven German model, resulting in a reorientation of economic policy.[69] The United Kingdom, the USA, and France all went through a period of intense de-industrialisation in the years before the crisis.[70] There is a fear that the off-shoring and shrinkage of manufacturing will lead to an erosion of innovative potential for these national economies.[71] U.S. President Obama has declared the renewal and expansion

Fig. 20: Share of manufacturing and performance currenct account



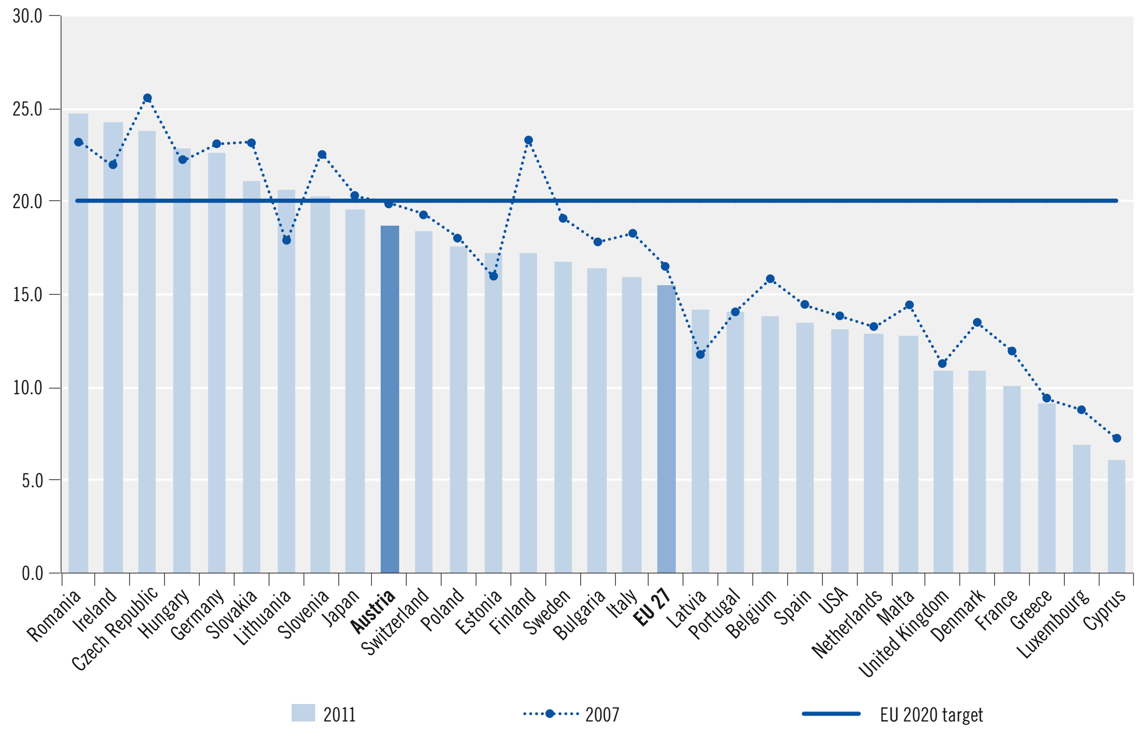
Source: OECD, World Bank. Calculated by JOANNEUM RESEARCH.

66 See Rifkin (2011), Reiner (2012), Marsh (2012).
67 See Fishman (2012), The Economist (2012).
68 See Aiginger (2006), Riess, Välilä (2006).
69 See Rattner (2011), Rürup, Heilmann (2012).
70 See Shanmugalingam et al. (2010), Spence, Hlatshwayo (2011).
71 See Pisano, Shih (2009), Tassey (2010).

of manufacturing to be an important goal of his administration.[72] In Europe, the southern European countries are attempting to get a handle on their current account deficits, which also requires a redirection of national economic resources towards the manufacturing sector. Yet the United Kingdom and the USA have very negative trade and account balances and are also finding themselves confronted with the challenge of boosting exports. Fig. 20 Illustrates that a high share of manufacturing goes along with an positive current account, while the loss of industrial export capacity apparently cannot be automatically replaced by increasing service exports.

The paradigm shift in national economic policies is also on display at the level of supranational organisations. The OECD for example long assumed a dismissive attitude towards manufacturing under the liberal motto, "deregulate and wait". A recent edition of the OECD Observer contained an argument, however, that "industrial policy can be made to work".[73] The EU has also established new industrial policy focuses with its "integrated manufacturing policy" strategy, which appeared in 2010 as part of the Europe 2020 Strategy.[74] This strategy was overhauled and reoriented with the publication of an "update" just two years later.[75] In this "update", the EU set itself the target for manu-

Fig. 21: Manufacturing's share of value added in the EU-27 and Switzerland, Japan and the USA



Source: AMECO, EU Commission, COM(2012) 582.

72 See The White House (2012).
73 See Pilat (2012).
74 See European Commission (2010b).
75 See European Commission (2012a).

facturing to reach 20% of the value added. The primary motivation for this shift was the important role of manufacturing for innovation and exports, as well as competition with the USA and Asia in terms of offering locations deemed attractive to industries with a promising future. As Fig. 21 shows, manufacturing currently accounts for about 16% of value added in the EU-27. This means – no more and no less – that Europe is striving for substantial re-industrialisation after several years of structural change that focused on de-industrialisation. At 18.7% (2011), Austria belongs to the group of countries with a high proportion of manufacturing. Before the crisis, this figure stood at 19.9% (2007). If we only look at countries with a similar level of development then Austria, after Germany, has the highest proportion of manufacturing in the EU.

In general, the simultaneous advent of new manufacturing policy initiatives may further increase competition for industrial investments. The same applies to the competition for locations in the rapidly growing environmental industry. Economic policy is particularly challenged to find a clever way to negotiate between industrial policy initiatives and an attitude that leaves the markets to their own devices.

4.2 Global shifts in industrial production capacity

The past few decades were defined by a profound upheaval in the geographical organisation of global industrial production. Never before in economic history have there been so many countries that demonstrate industrial capacities and abilities and that compete as locations for investments and production orders. The reorganisation of manufacturing in particular along continental and global value chains has led to a dramatic increase in manufacturing in some emerging countries.

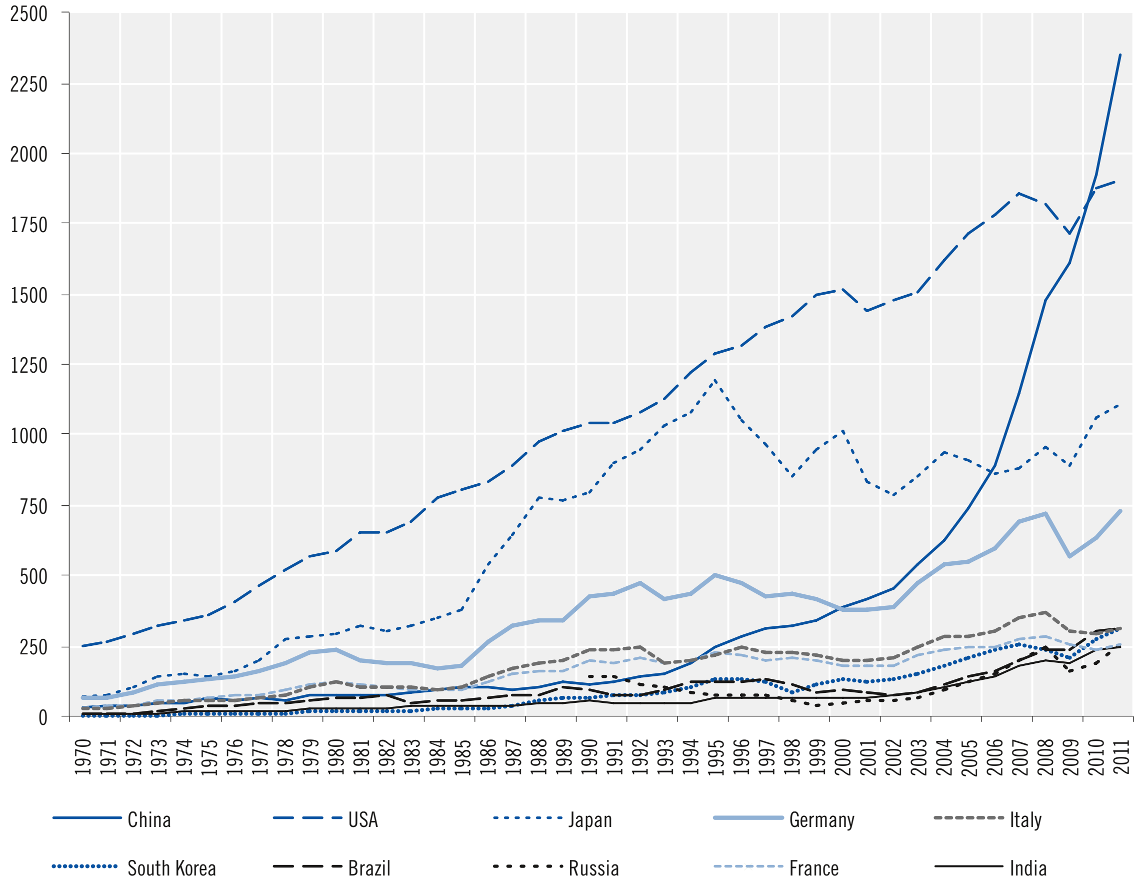
The shifts in manufacturing structures worldwide can be seen in the transformation in production shares and absolute magnitudes of value added. Viewed proportionally, the share of global manufacturing value added held by developing countries stood at 24% in 1990 and climbed from 27% in 2000 to 42% in 2012.[76] Fig. 22 shows the development of manufacturing value added among the ten most significant producing countries worldwide in 2011 in billions of dollars. The most important development in the period observed from 1970 to 2011 is without a doubt China's impressive performance, and it surpassed the USA in 2010 as the nation with the highest manufacturing revenues; China is also the only country to reach over 2 billion U.S. dollars in annual manufacturing revenue. Japan's development in contrast has stagnated significantly as it continues to struggle with unsolved macroeconomic problems that began in 1990. Germany's development is striking: after a long phase of zero or negative growth since 2002, its economy is gaining significant steam. The high concentration of manufacturing revenue in the four most important producing countries – China, the USA, Japan and Germany – is shown particularly clearly in Fig. 22. These four countries stand far apart from the next six most important manufacturing locations; Brazil, Russia and India are of subordinate importance in comparison to China.

Fig. 23 depicts manufacturing revenue data for the 25 most important manufacturing locations worldwide in 2011 in billions of dollars. About 87% of global manufacturing revenue is produced in these countries. China, the USA, Japan and Germany, which account for 54% of revenues, are responsible for more than half of global manufacturing output. Austria is positioned 24th and is therefore barely among the 25 most important manufacturing producers.

While Fig. 22 and Fig. 23 clearly show the im-

76 See Marsh (2012).

Fig.22: Gross value added in the manufacturing sector in the top 10 producing nations, in billions of U.S. dollars, 1970–2011



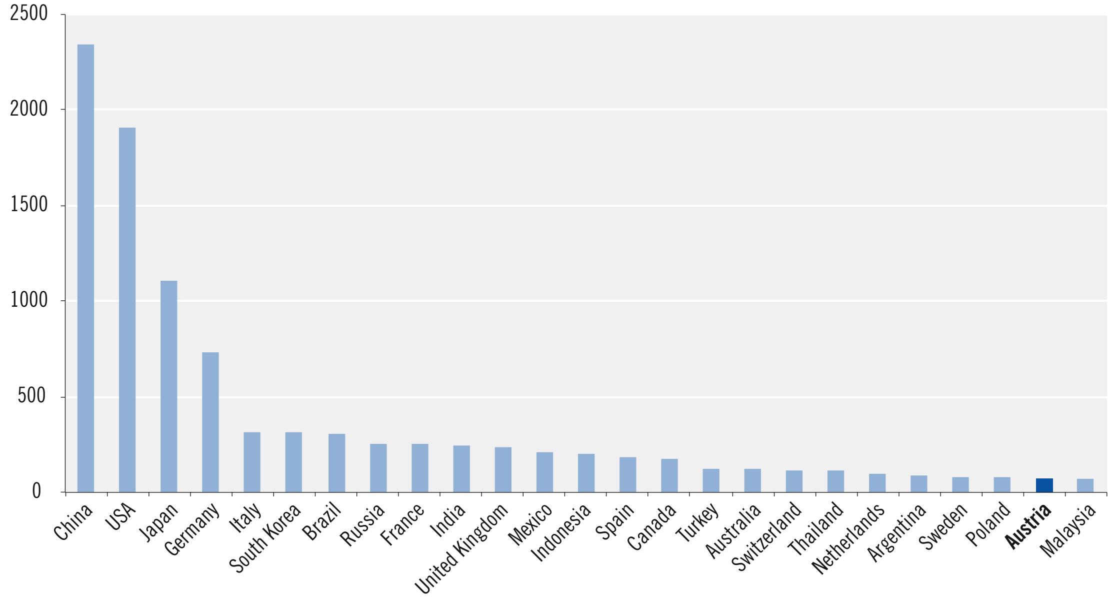
Source: UN National Accounts. Calculated by JOANNEUM RESEARCH.

portance of China and other emerging countries, a completely different view results if we include a society's manufacturing intensity in the sense of manufacturing value created per capita. Fig. 24 portrays this for the same countries as Fig. 23. China, along with India, Brazil and Russia, are all countries that (still) have very low manufacturing intensity. For example, manufacturing value per capita in China, "the world's factory", stands at $ 1,700, or less than half as much as in the de-industrialised United Kingdom, where the comparable figure is $ 3,700. Switzerland has by far the highest manufacturing intensity in the world, followed by Germany, Japan, Austria and Sweden. The essential explanatory factor for this distribution of industrial intensity is the difference in productivity between the manufacturing sectors in the OECD countries and in the emerging countries.

4.3 Transformation and structure of Austrian manufacturing in international comparison

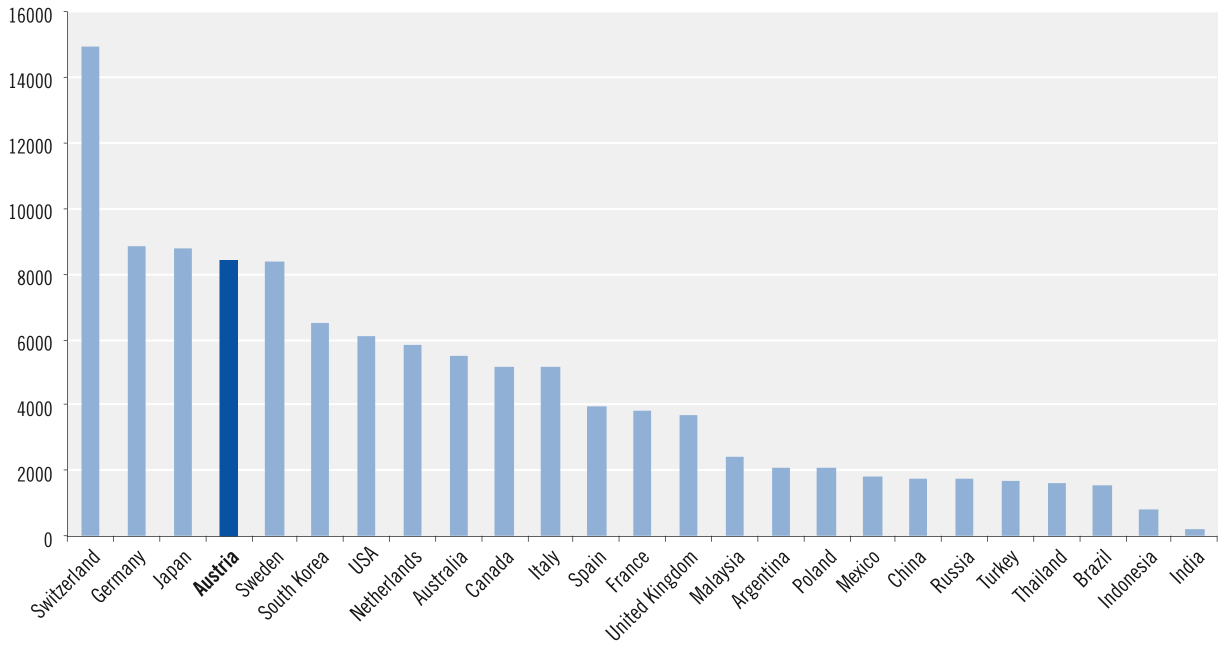
Austria, like all developed economies, has gone through a long-term process of de-industrialisation. A more precise analysis, however, reveals that the progression of this structural change is in no way uniform and that the de-industrialisa-

Fig. 23: Gross value added from manufacturing from the 25 largest manufacturing producers, in billions of U.S. dollars, 2011



Source: UN National Accounts, World Bank. Calculated by JOANNEUM RESEARCH.

Fig. 24: Gross value added from manufacturing per capita in the 25 largest manufacturing producers, 2011

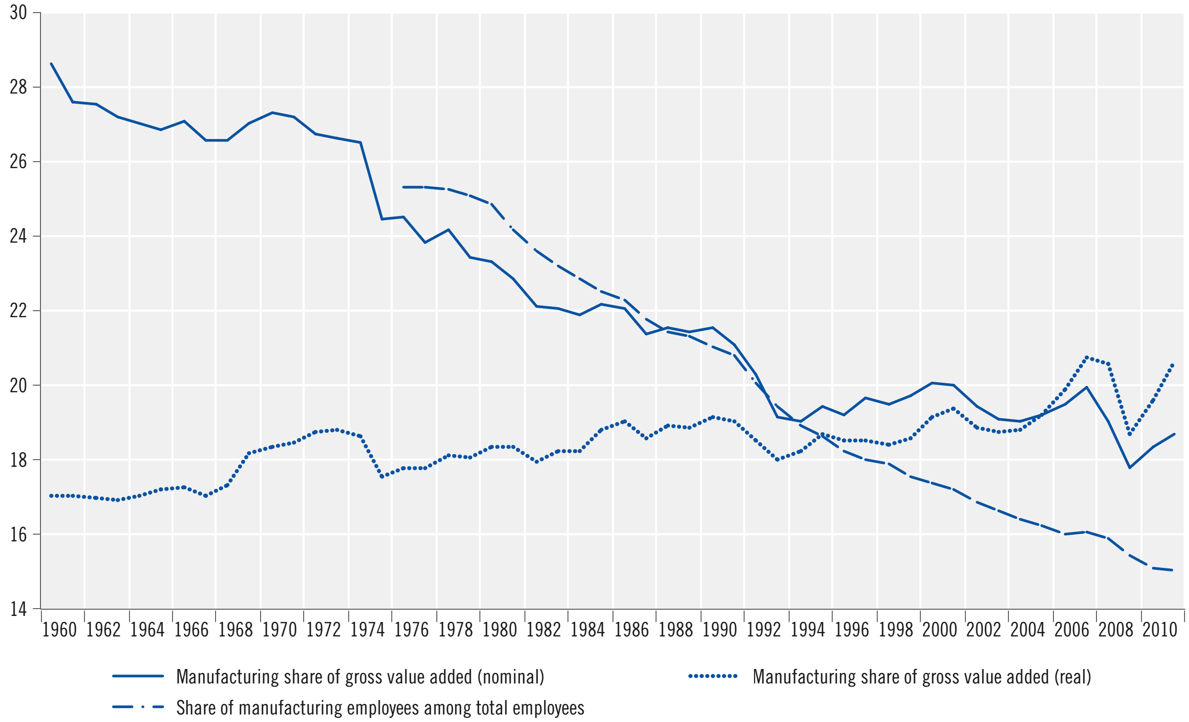


Source: UN National Accounts, World Bank. Calculated by JOANNEUM RESEARCH.

tion of individual national economies is not a law of nature.[77] The last 10 to 15 years have shown more than ever that individual wealthy national economies can have a high proportion of manufacturing while other countries such as the United Kingdom and France underwent de-industrialisation at a sometimes rapid pace.

Fig. 25 shows the long-term development of manufacturing in Austria. It makes clear the typical features of structural change in manufacturing. First, there was a decrease in manufacturing's share of nominal value added from 1960 to 2011 from approximately 29% to 19%. However, the pace of decline in manufacturing has slowed considerably, and there has basically been a stabilisation of the manufacturing share since the early 1990s. It is worth noting that this is precisely the time at which there was a significant increase in competition resulting from the reduction of market segmentations (opening up of Eastern Europe, EU accession). The employment rate fell consistently from 25% (1976) to 15% (2011). The rising curve in Fig. 25 represents the share of real manufacturing value added in total real value added. The real share increased due to relatively high productivity growth in manufacturing. This is a consequence of high competition intensity in the markets for manufactured goods, which forces firms to pass on gains in productivity to consumers in the form of lower prices. The low rate of price increases in the manufacturing sector necessarily lead – under otherwise identical circumstances – to a fall in the share of value added measured in nominal prices. High growth in

Fig. 25: Austria: Manufacturing share of gross value added (nominal, real) and employment, 1960–2011



Source: AMECO, national accounts. Calculated by JOANNEUM RESEARCH.

77 See Rürup and Heilmann (2012).

manufacturing productivity also explains the sharp fall in employment in comparison to nominal value added.

Tab. 12 depicts an international comparison of developments in Austria using indicators for absolute and relative de-industrialisation. The table uses aggregated country groups that represent different paths of sectoral development. Tab. 12 distinguishes on one hand between value added and employment indicators (columns 2 and 3), and on the other hand between volumes and value (lines 2 and 4). The latter permits us to draw conclusions about whether we are dealing with absolute or relative de-industrialisation. *Absolute de-industrialisation* is when indicators decrease in absolute terms (volumes), and *relative de-industrialisation* is when proportions fall. The volumes of manufacturing production, measured in change in real value added, increased in all country groups, including Austria. The highest increases occurred in the Scandinavian national economies, and the lowest increases were in the countries of Southern Europe. Accordingly, there is no absolute de-industrialisation with value added. The opposite is the case for employment volumes, which are falling in all country groups including Austria, whereby the decline in Austria is the weakest in comparison to the country groups. Between 2000 and 2007, employment only fell very slightly in Austria. The sharpest fall in employment took place in the Anglo-Saxon countries between 1995 and 2007/2010.

The special role played by the continental countries of Germany, Switzerland and Austria in value added shares in manufacturing is clear. There was even a slight increase in the manufacturing share of value added between 1995 and 2007. The Anglo-Saxon and Southern European countries exhibit rapid de-industrialisation, with the manufacturing share of value added standing at about 14%. This provides an uneven picture of relative de-industrialisation measured in manufacturing share of value added, and there was a significant differentiation among the country groups for the years 2007 and 2010. Employment proportions on the other hand confirmed relatively constant de-industrialisation for all country groups. The continental European countries again had the highest manufacturing share at about 15%, and the Anglo-Saxon countries the lowest at about 10%.

The differences in manufacturing dynamics are the result of a complex interaction of various factors.[78] Along with supply-side causes such as productivity advances and manufacturing's outsourcing of service activities, demand-side factors also play a role, such as increased use of income for services. The latter incidentally does not exhibit a saturation effect; instead, it is the result of consumer reactions to changes in relative prices between manufacturing and service goods.[79] Increasing attention is being paid to the influence of imports from low-wage countries and the off-shoring of manufacturing from OECD countries to emerging countries.[80] In general, these factors have very different levels of importance for the different branches of manufacturing. Nevertheless, empirical studies show very clearly that the most important quantitative effects are internal factors, whereby growth in productivity may have the most decisive importance. Manufacturing is therefore shrinking not least because it has been so successful in increasing efficiency. Still, the influence of import competition has become a more significant factor in explaining de-industrialisation in recent years.[81]

The question remains though as to why some countries, despite high gains in manufacturing productivity, can still maintain a relatively high

78 See Nickel et al. (2008), Schettkat (2006).
79 See Debande (2006).
80 See Debande (2006), Dachs et al. (2006).
81 See Rowthorn, Ramaswamy (1998), Rowthorn, Coutts (2004).

Table 12: Absolute and relative deindustrialisation: Volume and shares of industrial value added and employment (1995=100)

	Volume of industrial value added				Volume of industrial employment			
	1995	2000	2007	2010	1995	2000	2007	2010
Austria	100	120	153	144	100	97	96	92
Continental European countries	100	111	137	126	100	96	90	88
Nordic countries	100	131	171	157	100	102	94	83
Anglo-Saxon countries	100	128	156	146	100	99	82	75
Southern European countries	100	113	121	108	100	103	98	86
	Share of industrial value added				Share of industrial employment			
	1995	2000	2007	2010	1995	2000	2007	2010
Austria	19.4	20.1	19.9	18.4	18.7	17.4	16.0	15.1
Continental European countries	21.5	21.6	22.4	20.8	20.8	19.2	17.7	16.9
Nordic countries	20.6	20.5	18.4	15.4	17.8	17.1	14.9	13.4
Anglo-Saxon countries	18.0	15.9	13.4	12.8	16.0	14.7	11.3	10.2
Southern European countries	18.0	17.3	14.4	12.8	18.4	17.3	14.7	13.5

Note: Because there was not sufficient data available for the Anglo-Saxon countries for 2010 the average values of 2008 and 2009 were used.
Continental European countries: Germany, Austria and Switzerland; Nordic countries: Sweden, Finland and Denmark; Anglo-Saxon countries: USA and Great Britain; Southern European countries: Greece, Spain, France, Italy and Portugal.

Source: AMECO. Calculated by JOANNEUM RESEARCH.

share of manufacturing. Apparently these manufacturing locations have managed to compensate, at least partially, for productivity gains with a strong expansion in sales. In other words, high competitiveness in pricing, as well as advantageous specialisation and positioning in international value added chains of manufacturing locations, are important for retaining a strong manufacturing core. This may also explain the success of German and Austrian manufacturing, where supply structures that focus on highly specialised investment goods in niche markets facilitate a premium for quality and that are ideal for the recent cycle of globalisation and the concomitant demand for these goods in emerging countries.[82] Unlike U.S. manufacturing, which shrivelled due to massive outsourcing to Asia, Germany and Austria enhanced their competitiveness of domestic production by expanding European value added chains to take advantage of low wage costs in Eastern Europe while retaining a manufacturing sector that is significantly larger than those in other countries.[83] In the years before the financial crisis, Austrian manufacturing was able to profit from wage restraint, which – even if to a lesser extent – increased price competitiveness as in Germany.[84] In sum, increases in productivity and technical progress may be more significant in terms of explaining the high competitiveness and dynamism of Austrian manufacturing.[85] Furthermore, the Eastern European countries also serve as dynamic export markets for Austrian manufacturing.[86] More recent studies show however that there is a trend toward outsourcing

82 See Rürup, Heilmann (2012).
83 See Wolfmayr et al. (2007).
84 See Tichy (2010).
85 See Ragacs et al. (2011)
86 See Wolfmayr et al. (2007).

skill-intensive activities to Eastern Europe due to human resources bottlenecks in Germany and Austria.[87]

The structure of Austrian manufacturing has traditionally been characterised by a low proportion of technology- and skill-intensive manufacturing segments. In 2007, for example, both the share of high-tech manufacturing and of skill-intensive sectors (including some services segments) stood below the EU-25 average (excluding Romania and Bulgaria), while the opposite was the case for the share of low-tech and low-skill manufacturing: in this area, Austria has a higher share than the EU-25 (European Commission (2011c). A similar picture emerges in export structure (Reinstaller and Sieber 2012). These findings about economic structure, with good macroeconomic performance in parallel, are often viewed in a negative light, and have provoked much discussion.[88] Tab. 13 shows the share of manufacturing sectors by R&D intensities over time (see Annex I). In sum, there was a significant technological upgrade in Austrian industry during the period from 1980 to 2007. The two less technology-intensive segments declined, while medium-high and high technology increased. The main winner however of structural change is medium-high technology, not high technology, with the share of medium-low technology remaining virtually unchanged. Mechanical engineering and manufacture of transport equipment are examples of the medium-high technology segment (see Annex I). The share of medium-technology manufacturers increased the most in terms of manufacturing value added, from about 51% in 1980 to about 61% today.

Given low-wage competition from Eastern Europe and Asia, this raises the question of how Austria, despite this apparently low intensity of skill and technology, still has a relatively large and competitive manufacturing sector. Tab. 14 contains a few clues. The table shows the share of manufacturing in the medium technology segment and then the R&D intensity of these industries in international comparison. Austria ranks second only after Germany in the medium-high technology segment. Germany's proportion is still much higher at 45%, a reflection of German manufacturing's extraordinarily strong specialisation in mechanical engineering and manufacture of transport equipment. Austria's share of medium-low technology manufacturing is much higher than Germany's at 28% and equivalent to countries such as Italy and Spain.

The lower part of Tab. 14 portrays the distinctiveness of Austrian manufacturing in the medium technology segment. It shows that Austria's medium-technology manufacturing has above-average R&D intensity. While the

Table 13: Intersectoral structural change: Share of value added of Austrian manufacturing by technology intensity as a % of the total manufacturing value

	1980	1985	1990	1995	2000	2007	Change 1980/2007 (in percentage points)
High technology manufacturing	7.3	8.6	10.1	10.2	10.9	9.6	2.3
Medium-high technology manufacturing	21.9	22.8	24.6	24.3	26.7	32.9	11.0
Medium-low technology manufacturing	29.5	30.6	27.8	27.9	28.1	28.2	-1.3
Low technology manufacturing	41.2	38.0	37.4	37.6	34.2	29.2	-12.0

Source: STAN database OECD. Calculated by JOANNEUM RESEARCH.

87 See Marin (2008), (2010).
88 See Peneder (2008), Dachs (2009), Janger (2012).

Austrian manufacturing sector has a much lower R&D intensity in general than Germany, Finland and the USA, Austria's medium-high technology sector is particularly dynamic and more R&D intensive than its counterparts in the aforementioned countries. Only Sweden and Italy are more R&D intensive than Austria in this manufacturing segment. There was a similar finding for medium-low technology. This Austrian manufacturing sector has above-average R&D intensity at 2.8%. Italy also has a higher R&D intensity here. In comparison to Italy, however, it is clear that R&D only constitutes part of manufacturing performance. While Austrian manufacturing attained high gains in productivity from 1995 to 2007, there was a decline in productivity in Italian manufacturing.[89] A comparison of R&D intensities with Spain and Slovenia makes it clear that in reality there are major differences between the countries in the industries combined in the OECD classification: Austrian, Germany and Swiss mechanical engineering sectors seem to be quite different from their Spanish or Slovenian counterparts.

In summary, the picture that emerges for Austria is one of a mature yet dynamic industrial nation that is apparently very successful in niches in the medium-technology segment. Perhaps medium-technology industries do not require extraordinarily high R&D intensities and numbers of scientists to be internationally competitive.[90] The cumulative development of implicit practical knowledge in production, the availability of well-educated skilled workers, and a flexible and intelligent search for market niches may also play an important role.[91] Furthermore, it is also clear that Austria's medium-technology manufacturing segment is more R&D intensive than in other important reference countries. This effect is confirmed by the finding that Austria has a higher R&D ratio than would be expected in such an economic structure.[92] Perhaps these medium-technology industries, with a high share of cumulative practical development and implicit knowledge, are more resistant to imitation than some high-technology industries.[93] This could prove to be an advantage in the increasing competition among locations for manufacturing capaci-

Table 14: International performance comparison of industries in medium-technology segments, 2007

	Share in manufacturing value added								
	Austria	Germany	Finland	Sweden	USA	United Kingdom	Italy	Spain	Slovenia
Medium-high technology manufacturing	32.9	45.1	23.0	31.8	22.9	24.2	27.0	26.6	26.9
Medium-low technology manufacturing	28.2	22.8	24.0	23.3	25.3	21.9	30.9	32.9	29.2
	R&D intensity								
	Austria	Germany	Finland	Sweden	USA	United Kingdom	Italy	Spain	Slovenia
Medium-high technology manufacturing	11.2	9.8	7.4	15.0	9.8	7.2	11.8	4.1	4.1
Medium-low technology manufacturing	2.9	1.9	3.1	2.7	N/A	2.1	3.7	1.3	1.5

Source: STAN database OECD. Calculated by JOANNEUM RESEARCH.

89 See Reiner (2012).
90 See Tidd et al. (1997), Janger (2012).
91 See Malerba (2005), von Tunzelmann, Acha (2005).
92 See Reinstaller, Unterlass (2012).
93 See Tichy (2010).

ty. The prerequisite here, however, is an ongoing search for further improvements and flexible responses to changing global market structures. Naturally, this includes an additional increase in R&D intensity as one strategy among many to continue to improve competitiveness.

4.4 Manufacturing, growth and innovation

Manufacturing's role in the innovation system is interesting primarily for reasons related to growth policy. From an economic perspective, innovation and R&D are means to the end of improving growth and increasing prosperity. We must therefore first find out what the general contribution is that manufacturing makes to growth. The development of productivity and the contributions of various sectors is of crucial importance in this context. The Nobel Prize-winning economist Paul Krugman (1994, 13) put it this way: "*Productivity isn't everything, but in the long run it is almost everything*." Krugman's statement is based on the theoretical insight that an increase in prosperity can only be attained through growth in productivity.

Productivity, and therefore the growth and prosperity of an economy, are profoundly shaped by the structure of the industry and the business enterprise sector, among other factors. Various industries and sectors exhibit different potential in terms of their contribution to increasing the economic performance of a national economy. The segments of industry that must be viewed as instrumental for growth are those that contribute to the development of knowledge and thereby generate positive externalities through the diffusion of this knowledge, have dynamic economies of scale, and offer potential for product differentiation.[94] These features may apply to a special extent for the manufacturing sector when viewed at an aggregate level.

From a theoretical perspective there are two approaches to analysing manufacturing's role in growth processes. The first approach originated from Nicholas Kaldor (1967, 1972). Industry has sinking average costs due to high fixed costs and effects from learning and specialisation in production. Both together contribute to a disproportionate increase in productivity in the manufacturing sector, which makes industry the engine of growth for a national economy, so to speak. This relationship is also described as Kaldor's growth laws and has been confirmed by empirical studies.[95]

The second theory was developed by William Baumol (1967) in his article on the "cost disease of services". Under certain conditions, lower increases in productivity at services firms cause the services sector to steadily increase its share of value added and employment, and is therefore ultimately a "growth disease": total growth in economic productivity stagnates and prosperity gains fail to materialise. This development has also been proven in empirical investigations.[96] However, it must also be acknowledged that a few studies have come to the conclusion that the tertiarisation of industry does not entail a slowdown in growth.[97]

4.4.1 Manufacturing and growth in productivity

Manufacturing exhibits higher growth than the services sector. This is the extremely robust result of numerous empirical studies.[98] However, there are also services segments that have above-average productivity growth, and different manufacturing areas also develop in completely different ways.[99] In sum, however, it is accepted

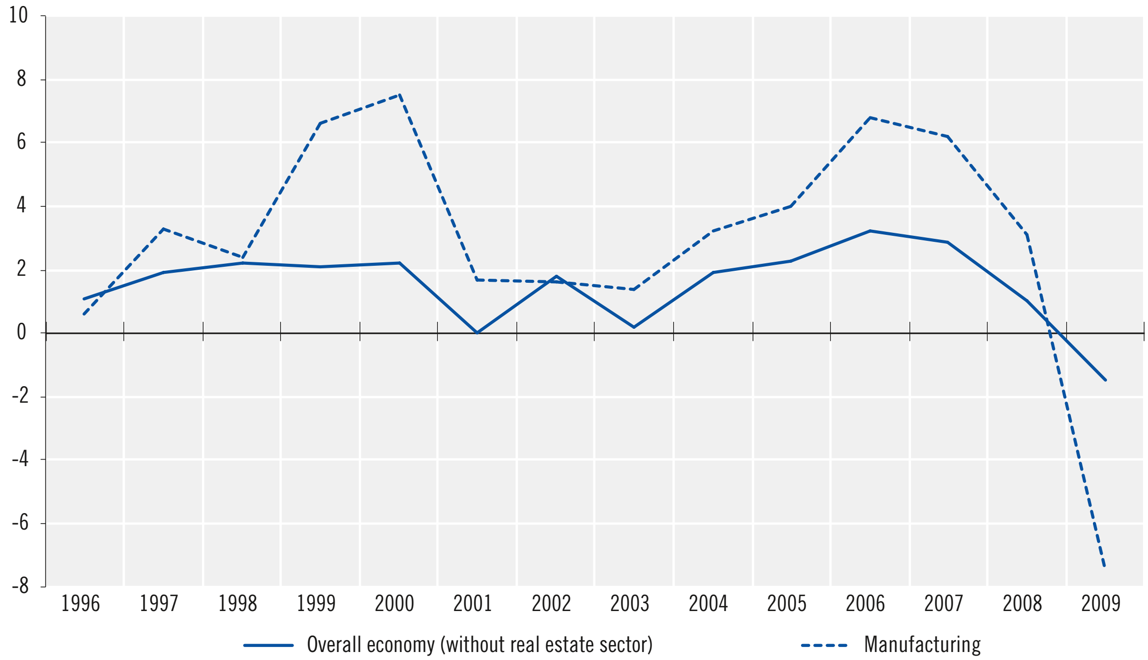
94 See Janger (2012).
95 See Necmi (1999), Wienert (2009), McCasland, Theodossiou (2012), Oh et al. (2012).
96 See Peneder (2003), Hartwig (2012).
97 See Maroto-Sanchez, Cuadrado-Roura (2009).
98 See OECD (2005), Pilat et al. (2006).
99 See Jorgensen, Timmer (2011).

that structural change towards a services industry is connected with a fall on the productivity ladder (structural change burden), while conversely the transformation from an agricultural economy to an industrial society entails an ascent on the productivity ladder (structural change bonus).

Rodrik (2011) vividly describes the negative growth effects caused by de-industrialisation in the USA and in the United Kingdom. The USA have recorded the highest increases in employment in the personal and social services since 1990, with manufacturing shrinking rapidly. Due to the positive productivity differential favouring manufacturing, another consequence was a 0.3 percentage point drop in annual productivity growth for the entire U.S. economy, due to the fact that the relative weight of manufacturing declined. This corresponds to about one-sixth of actual realised productivity gains in the USA. The effect is even more significant in the United Kingdom. Between 1990 and 2005, structural change in the direction of less productive services had a negative effect of 0.5 percentage points on annual growth in productivity, which corresponds to one-fourth of total productivity gains.

Fig. 26 portrays the development of Austrian labour productivity in manufacturing and the overall economy for the period from 1996 to 2009. The graph shows that there was higher productivity growth in manufacturing than in the overall economy, which is in line with the theory and the results for other countries. Manufacturing grew at an average annual rate of about 2.9% in the period under observation, which is nearly twice as fast on average than the overall economy, which expanded productivity at a rate of 1.5%. The higher volatility of growth in manufacturing productivity is striking in Fig. 26. There was a drastic fall in labour productivity in the crisis year of 2009, as was the case in Germany as well. This drop was due to the retention of em-

Fig. 26: Annual growth in Austrian labour productivity in manufacturing and the overall economy in %



Source: OECD Productivity Database. Calculated by JOANNEUM RESEARCH.

ployees despite low utilisation.[100] At the same time, however, it created the basis for a rapid recovery in the following year, when international demand for manufacturing goods increased again.

The relative importance of sectors can be represented by splitting up their contributions to the overall productivity growth of the economy. The productivity analyses of the OECD show that Austrian manufacturing was responsible for about 40-50% of growth in overall economic productivity in the last two decades. While this figure is even higher for countries such as Sweden and Finland, Greece and the United Kingdom tend to have growth in productivity that is driven by services.[101] Austrian manufacturing's contribution to growth in the gross national product averaged around 30% in the years from 1995 to 2010.[102]

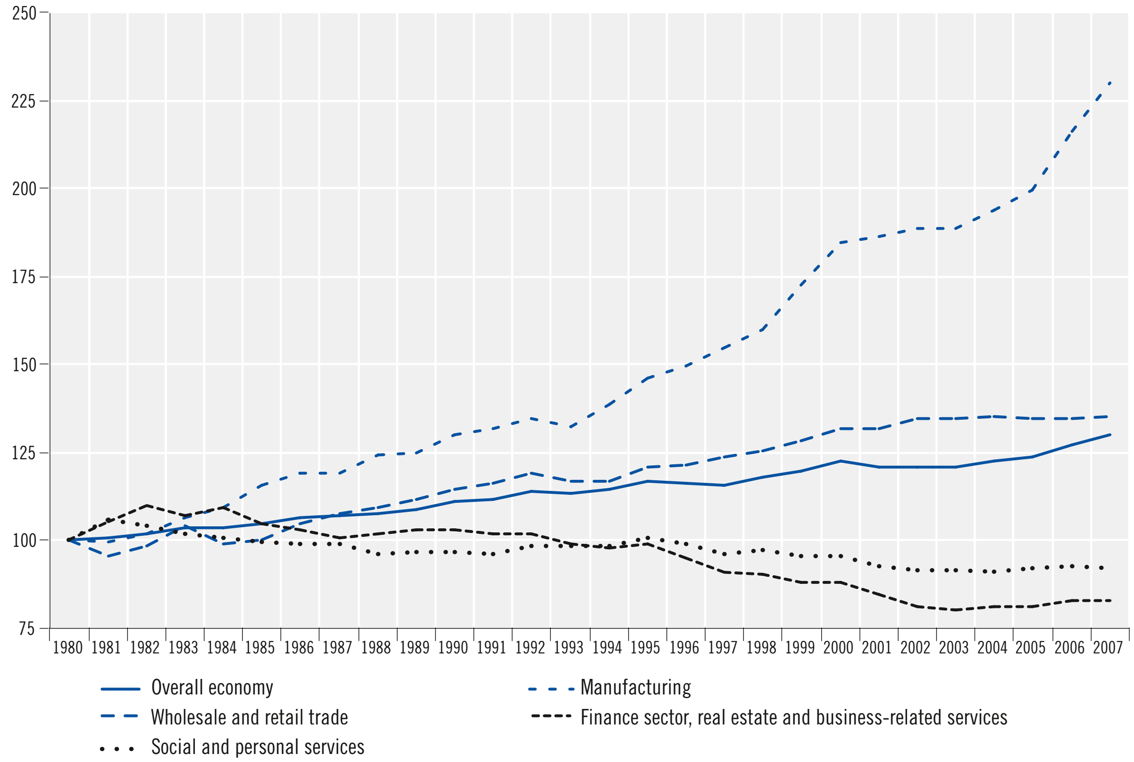
Labour productivity is shaped in crucial ways by the amount of the factors labour and capital that are input. To assess production efficiency and its change over time, isolated from these influences, we calculate multi-factor productivity.[103] This can be understood as a metric that reports the efficiency with which inputs are transformed into outputs. For example, two firms with the same amount of capital and employees can have very different levels of productivity. The cause for this lies in their different levels of multi-factor productivity. This concept brings together disparate aspects such as technology, innovation, incentive systems, and organisational effects. Multi-factor productivity therefore depicts technological and non-technological innovations in a very comprehensive sense and in one number.

Growth analyses for Austria show that the increase in multi-factor productivity makes by far the most important contribution to GDP growth. In short, Austria will not become more wealthy just because more capital is invested, but rather because resources are used in increasingly intelligent and efficient ways.[104] The same applies to just about all OECD countries.[105] Fig. 27 depicts growth in multi-factor productivity, differentiated by sector.[106] The manufacturing sector and selected large services segments are shown. First, we can see that the multi-factor productivity of the overall economy increased by more than 25% between 1980 and 2007. In contrast, the efficiency of manufacturing grew at 125%, or more than five times as fast. If we take a look at the services segments, efficiency in wholesale and retail trade also increased faster than the overall economy, but at a significantly slower rate than manufacturing. Multi-factor productivity in the large services segments of social and personal services decreased just as in company-oriented services and the financial industry. Thus this indicator shows in an even more impressive way that manufacturing is a higher dynamism and makes a disproportionate contribution to growth in overall economic productivity.

In discussions about the growth in productivity argued here, references are often made to problems in measurement and reporting for the services sector. According to this line of argument, productivity increases could be higher in the services sector than the available data show. There are suggestions, however, that productivity developments in the manufacturing sector are underestimated. One cause for this may be insufficient reporting of quality improvements and price developments for innovative products, especially in the ICT area.[107] In contrast, there may be an overestimation of productivity devel-

100 See Rattner (2011).
101 See Pilat et al. (2006), OECD (2008).
102 See Ragacs et al. (2011).
103 See Syverson (2011).
104 See Gnan et al. (2004).
105 See Blanchard, Illing (2010).
106 See O'Mahony, Timmer (2009).
107 See Blanchard, Illing (2010).

Fig. 27: Development of multi-factor productivity of the overall economy, manufacturing, and selected services segments (1980=100)



Source: EU KLEMS database. Calculated by JOANNEUM RESEARCH.

opment in the services sector, especially with regard to the financial sector, one of the most dynamic sectors in the years before the financial crisis.[108] Furthermore, the increasing importance of upstream and downstream service activities in the manufacturing sector are leading to the same reporting problems as in the services sector. In short, scholarly literature on economics has not yet answered the question of whether measurement problems in the manufacturing and services sector are more serious.[109] By using growth volumes instead of comparing levels, in any case, we do reduce possible distortions.[110]

4.4.2 High manufacturing intensity among the Innovation Leaders

The role and importance of industry for a national economy's innovation system can be approached by analysing the relationship between manufacturing intensity and innovation performance. The latter should be defined in very broad terms by using synthetic indicators from two innovation ranking schemes.

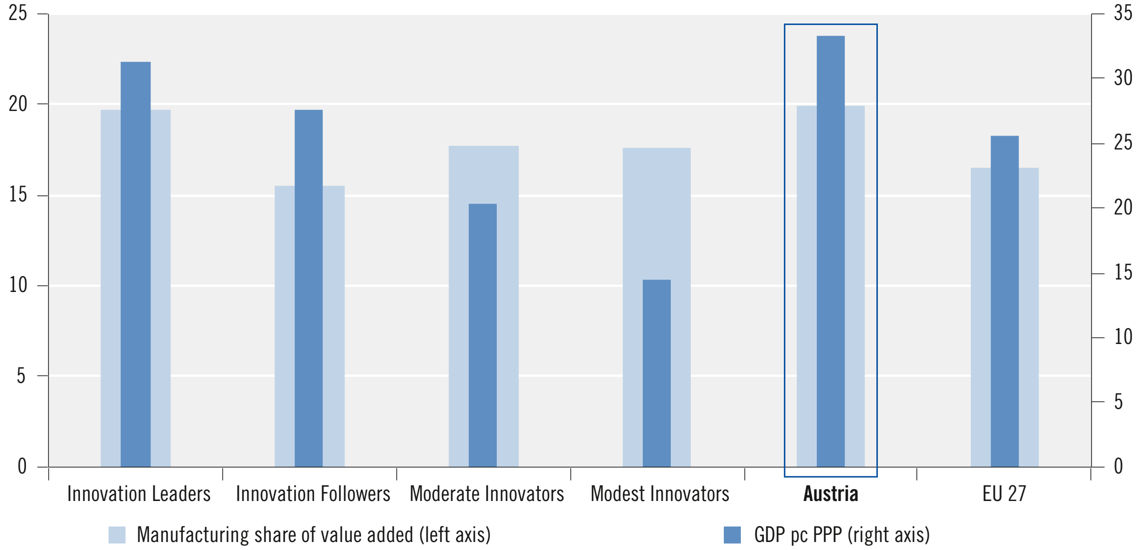
Fig. 28 shows the average values for the EU-27 countries by different innovation classes in accordance with the Innovation Union Scoreboard (2011). The average values for manufac-

108 See den Haan (2011).
109 See Schettkat (2006).
110 See Schettkat (2010).

turing share and GDP per capita were calculated for the four Innovation Leaders: Sweden, Germany, Finland and Denmark. If we first assess manufacturing's share in value added, we see that the Innovation Leaders report the highest manufacturing share of value added at almost 20%, while the Innovation Followers (excepting Luxembourg) show a significantly lower degree of manufacturing at 15.5%.[111] The Moderate Innovators and Modest Innovators again reported somewhat higher manufacturing shares of approximately 17.5%, yet these are also lower than for the group of Innovation Leaders. The fact that the Innovation Leaders have the highest average level of manufacturing share is all the more remarkable because an assessment of differing levels of development leads us to expect precisely the opposite result. The negative correlation typically assumed for the level of gross domestic product and manufacturing share does not apply here. According to Fig. 28 Austria has the same high share of manufacturing as the Innovation Leaders and a somewhat higher GDP per capita; both values are far above the EU-27 average.

Along with the EU's Innovation Union Scoreboard, Germany's Innovation Indicator[112] is also an oft-cited synthetic indicator for estimating the relative innovation performance of economies. The latest ranking in 2012 awarded the first five places to the following countries: Switzerland, Singapore, Sweden, Germany and Finland. All of these countries have a high share of manufacturing, with an average value of 18.5% (2007). If all of the rest of the countries in the ranking are grouped together, with the exception of the BRICS countries, these countries exhibit an average share of manufacturing in value added of 16.8%. This results once more in the finding that the most innovative national economies

Fig. 28: Average manufacturing share of value added (2007) and GDP per capita (2012) in the innovative country groups under IUS 2011



Source: AMECO, IUS. Calculated by JOANNEUM RESEARCH.

111 An analysis of Luxembourg would yield an average manufacturing share of about 14.8% and a much higher GDP per capita at 31,689.
112 See the Innovation Indicator (2012).

have on average a higher share of manufacturing than less innovative economies.

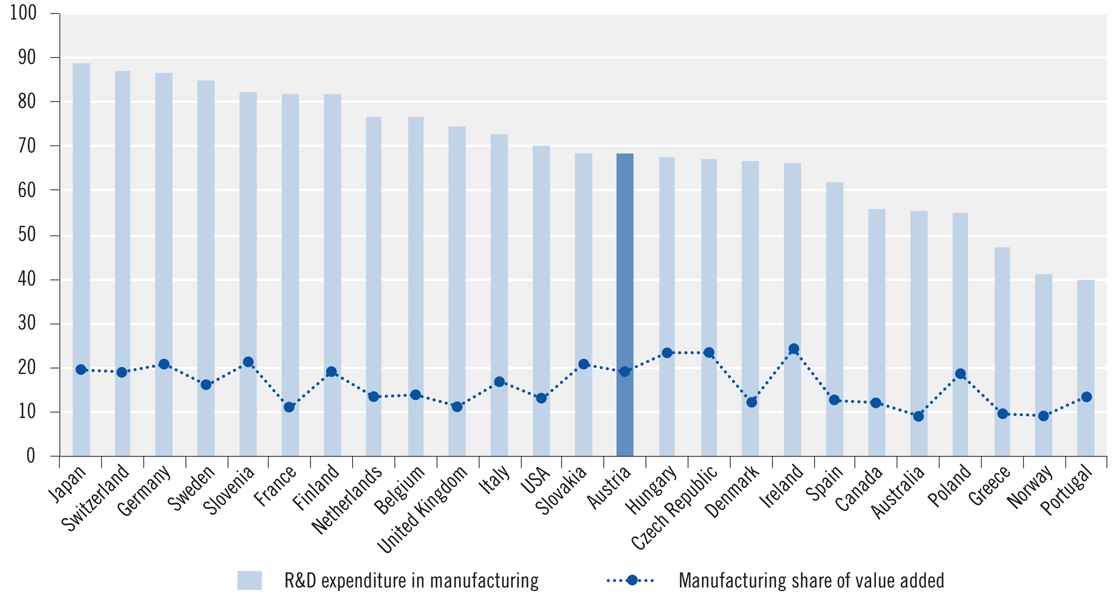
Taken together these results support the notion that manufacturing has a positive influence on innovation performance. The reverse direction of causality must also be considered: strong innovation performance also enables the preservation of a substantial manufacturing core in high-wage countries, despite competition from low-wage countries.

4.4.3 Manufacturing and research & development (R&D)

R&D investments and R&D intensity in the business enterprise sector are important determinants of economic growth and the competitiveness of a national economy.[113] An analysis of R&D expenditure by sectors reveals that manufacturing is by far the most significant investor in R&D. Fig. 29 shows manufacturing's share of total expenditures in the business enterprise sector for R&D and manufacturing's share of value added for the EU and OECD countries. Manufacturing share in Austria lies somewhat below 20%, although manufacturing is also responsible for 70% of R&D expenditures in the business enterprise sector. Even in the United Kingdom and the USA, which are considered classical service economies whose share of manufacturing is low, manufacturing's share of R&D expenditure exceeds Austria's. The Innovation Leaders Germany, Sweden and Finland exhibit manufacturing shares of R&D expenditures of over 80%.

R&D intensity by sectors is also interesting along with the share of expenditures. This is shown in inter-sectoral and international comparison in Fig. 30. R&D intensity is calculated here as a share of R&D expenditure in sectoral

Fig.29: Share of R&D expenditure in manufacturing of total R&D expenditure in the business enterprise sector (2010) in % and manufacturing share of value added (2010)*

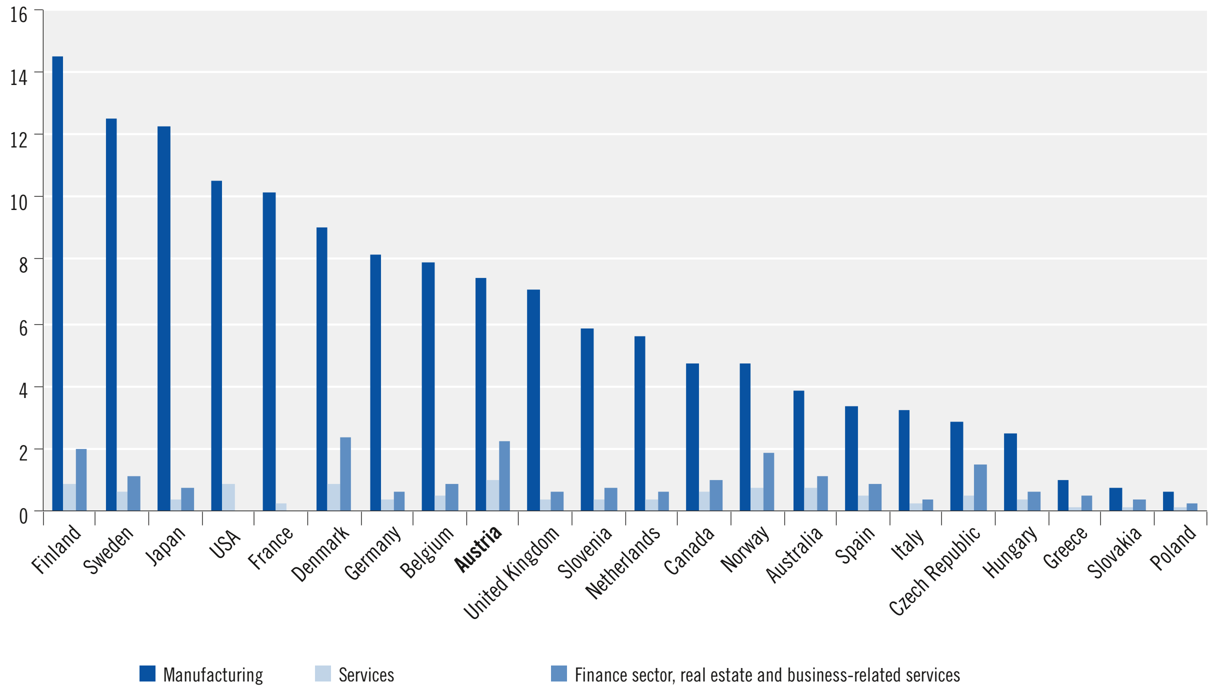


Note: *The calculation of R&D expenditure in manufacturing is done indirectly through the share of R&D service expenditures. This may result in small uncertainties because for example the construction industry also has R&D expenditures, even if these are minimal.

Source: OECD STAN database, AMECO.

113 See Aiginger, Falk (2005).

Fig. 30: R&D intensity (R&D expenditure as % of value added) by segments (2009 or latest available data)

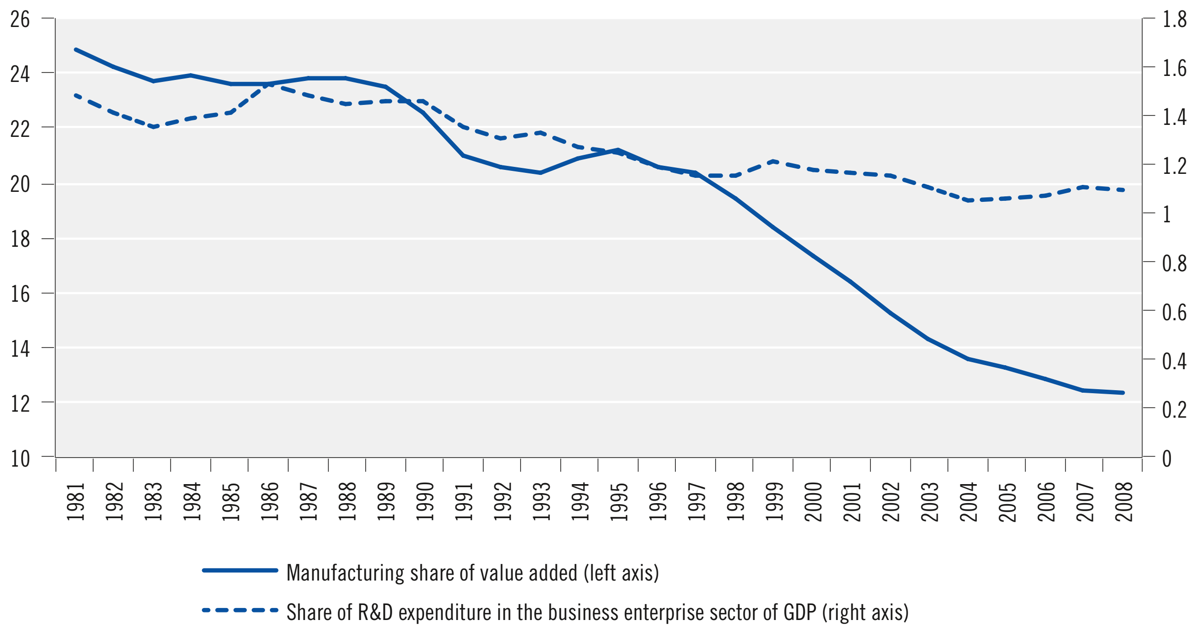


Source: OECD STAN database. Calculated by Joanneum Research

value added. The overall services sector, as well as company-related services, are shown along with the manufacturing sector. First of all, the graph show significantly more R&D intensive manufacturing sector in all included countries. The manufacturing sector, which includes such low-technology industries as clothing and textiles, continues to be significantly more R&D intensive than the group of high-quality services. Austria's R&D intensity in manufacturing stands at 7.4%, in the services sector at 0.9%, and in company-related services at about 2.2%. In international comparison, Austrian manufacturing has an overall significantly lower R&D intensity than the Innovation Leaders. This finding, however, does not apply to Austrian manufacturing in the medium technology segment (see above). Denmark and Germany, which have comparable manufacturing structures, spend relatively more on R&D, with respective R&D intensities of 9.0% and 8.1%. The manufacturing sector in Finland and Sweden are much more technology-intensive than manufacturing in the USA.

The major importance of manufacturing for R&D and the relatively low R&D intensity of the services sector leads to the supposition that tertiarisation could be associated with a drop in R&D intensity and the R&D ratio. In fact, empirical analyses show that structural change has a negative effect on the R&D ratio (structural effect) for numerous countries (Dachs 2009). On the other hand, however, there is an increase in R&D intensity in industries (intensity effect). It is this increase in R&D activities within existing industries that overcompensates for the negative effects of structural change on the R&D ratio. This compensatory mechanism however is not a law of nature, and the United Kingdom is an example of how de-industrialisation can also be linked to a decline in R&D expenditures in the business enterprise sector (Fig. 31).

Fig. 31: The example of the United Kingdom: de-industrialisation and decline of business enterprise R&D expenditure in GDP



Source: OECD, AMECO. Calculated by JOANNEUM RESEARCH.

4.4.4 Innovation and innovation cooperation in the manufacturing and services sectors

For all of their heterogeneity, services firms exhibit different, technology-driven patterns of innovation than their manufacturing counterparts. It is typically assumed that services engage in innovations that are primarily not technological in nature (marketing innovation, organisational innovation), while manufacturing is more heavily involved in technological innovations (product innovation, process innovation). Even if this description is appropriate in the sense of characterising the relative specialisations of the two sectors, it nevertheless conceals the fact that manufacturing has higher innovation expenditures intensity in all innovation categories.[114] The result is interesting because it confirms and does not contradict the results of the comparison of R&D intensity.

Tab. 15 shows the results of the most current innovation survey for Austria. In the manufacturing sector, about 61% of all firms engaged in innovative activities from 2008 to 2010, while the corresponding value for the services sector stood at 53%. The share of innovative firms in the knowledge-intensive area was somewhat higher at 64% than in the medium-low technology manufacturing segment (61%), yet significantly below the proportions for high-technology and medium-high technology.

In terms of technological innovation, a predictable picture emerged of a significantly higher share of technologically innovative manufacturing firms in comparison to the services sector. However, more than half of the firms in the

114 See Miles (2005).

Table 15: Innovation in the manufacturing and services sectors

	Firms with innovation activities as a % of all firms	Firms with innovation activities based on technological innovations as a % of all firms	Firms with innovation activities based on non-technological innovations as a % of all firms
Manufacture of goods	60.6	50.4	45.1
High tech	95.9	89.3	79.9
Medium-high tech	80.4	73.8	57.8
Medium-low tech	61.1	50.4	43.7
Low tech	51.1	39.6	39.1
Services	53.4	38.9	43.6
Knowledge-intensive services	63.9	51.6	51.6
Less knowledge-intensive services	48.2	32.5	39.7

Source: CIS 2010. Calculated by JOANNEUM RESEARCH.

knowledge-intensive services sector reported that they were innovative in a technological context from 2008 to 2010.

The last column of Tab. 15 shows the share of firms with non-technological innovations in the respective sectors. In an aggregated comparison, there was a slightly higher share for manufacturing than for the services sector. We should note however that the latest innovation survey of the services sector resulted in a higher share of non-technological innovative firms.[115] The significantly higher share of non-technological innovations in the high-tech industry remains clear though. The current data also present the medium-high tech segment as more innovative than services in a non-technological sense. These results may primarily be the result of the complementarity of technological and non-technological innovations. The introduction of new products may bring about a marketing innovation with it, and a new process is rarely introduced without being accompanied by new organisational developments.

This therefore roughly confirms the image of an innovative manufacturing sector. The result is further supported if we consider that an important part of services innovations take part via the acquisition of manufactured goods. According to the adapted taxonomy of innovation by Pavitt (Tidd et al. 1997), broad segments of the services economy belong to what are called supplier-dominated segments in which innovation processes primarily occur through the purchase of external technologies. The financial and trade sectors, which are classified among the information-intensive sectors, depend on the acquisition of technologies from other sectors. One example here is the automated teller machine, which radically changed the business model for customer service at banks. However, the financial industry is a good example of a services industry with a high percentage of endogenous innovations, even if their benefit seems questionable in retrospect. This tendency in the services sector to purchase industrial technology also shows up in innovation expenditures. The proportional expenditures for the acquisition of machinery and equipment for innovation are stable in the services sector and are significantly above the figures for manufacturing. Manufacturing on the other hand invests more in internal R&D.[116] The manufacturing sector therefore makes essential indirect contributions to innovation and productivity improvements in the services sector.

115 See CIS (2008), Statistics Austria (2010).
116 See Statistics Austria (2012), (2010).

Of course we must keep in mind the reverse as well: a high-performing services sector is an essential prerequisite for dynamic industrial development. Studies show however that manufacturing makes crucial contributions to the genesis and competitiveness of company-related services through intermediary demand.[117] This may be one of the reasons why there is no shortcut from an agricultural economy to a high-performance services economy in the developmental process of national economies.[118]

The performance of an innovation system is influenced by the cooperative behaviour of its stakeholders, among other factors. There is typically an assumption that more intensive patterns of cooperation, based on the associated utilisation of complementarities and the diffusion of knowledge, are more advantageous than fragmented innovation systems. In order for innovation capacity to remain high on a long-term basis, the openness of regional and national innovation systems must be guaranteed. Tab. 16 shows the average innovation cooperation behaviour of manufacturing and services companies. While 25% of manufacturing firms participate in innovation cooperation, services firms report a figure of 20%. The difference becomes greater when we look at cooperative innovation activities work with scientific institutions. This means that manufacturing firms provide a disproportionate amount of diffusion of scientific knowledge in the business enterprise sector, and its subsequent commercialisation. The last two columns in Tab. 16 refer to the more intensive networking of manufacturing firms in the innovation system, because such firms have a higher degree of innovative relationships among their various different cooperation partners.

The innovation performance of manufacturing described in this chapter enables important insights into the causes of different performance levels with regard to productivity in manufacturing and services. Both aforementioned theories regarding manufacturing as an engine of growth[119] and the cost disease of services[120] emphasise that manufacturing has a higher potential for productivity improvements. Furthermore, from the perspective of the economics of innovation, it must be emphasised that manufacturing also has higher R&D intensity and innovation expenditures intensity. This in turn promotes sector-based technological progress and thereby growth in productivity.

Yet why do manufacturing firms invest more in R&D than services firms, and why are they – at least according to available statistics – more

Table 16: Innovation cooperation in manufacturing and services compared

	Share of firms with innovation cooperation in % of all firms	Share of firms with ... of all firms with innovation cooperation in %		
		... cooperation with scientific institution (university, university of applied sciences)	... four types of cooperation partners	... five and more types of cooperation partners
Overall economy	22.4	42.6	12.1	23.1
Manufacture of goods	25.5	48.7	13.3	26.5
Services	19.8	35.7	10.5	19.4

Source: CIS 2010. Calculated by JOANNEUM RESEARCH.

117 See Guerri, Maliciai (2005).
118 See Paque (2009).
119 Kaldor (1967).
120 See Baumol (1967).

innovative on average? There are two basic answers to these questions: first, R&D investments and innovation activities may result in higher profit for manufacturing firms than for services firms. This is, in the final analysis, a consequence of differences between the sectors in terms of production technology. Second, the competitive pressure in manufacturing is much higher than in many services segments because of the tradability of their goods and there is less market segmentation due to regulation. This in turn forces manufacturing to search constantly for ways to differentiate their goods from those of the competition, typically by means of innovation activities and R&D investments.[121] All in all, technology and competition are the two central factors that explain sectoral differences in innovation between manufacturing and services.

4.5 Austria's position with key enabling technologies

New technologies are a crucial driving force for innovations. They make essential contributions to competitive advantages and improvements in productivity. Among the multitude of new technological developments, there are some that are particularly interesting because they can be used in many different fields and can therefore broadly influence the innovation capacity of a national economy. Such broadly applicable new technologies are called *key enabling technologies* because they open the path to completely new products, services and business opportunities.

In its report entitled "*A European Strategy for Key Enabling Technologies – A bridge to growth and jobs*", the European Commission (2012b) recently emphasised the importance of key enabling technologies for industrial development. Key enabling technologies can make decisive contributions to innovation breakthroughs, especially in contemporary challenges such as energy supply, environmental protection, and health. With the aid of new materials, new procedures, and new components, major progress can be made in increasing energy efficiency, climate protection, and securing a high standard of health for an ageing population. The use of key enabling technologies qualifies at the same time as a prerequisite for preserving Europe as a manufacturing location in a globalised world. This is because such technologies facilitate the modernisation of the production basis while also contributing to the creation of new, more competitive products and manufacturing segments.

The EU Commission defines Key Enabling Technologies (KETs) as "*knowledge and capital-intensive technologies associated with high research and development intensity, rapid and integrated innovation cycles, high capital expenditure and highly-skilled employment [...] of systemic relevance, multidisciplinary and trans-sectorial, cutting across many technology areas with a trend towards convergence, technology integration and the potential to induce structural change*"[122] and has identified six such technologies:[123]

- Advanced materials
- Industrial ("white") biotechnology
- Photonics
- Nanotechnology
- Micro- and nanoelectronics
- Advanced manufacturing technologies[124]

121 See Schumpeter (2005), Syverson (2011).
122 See European Commission (2009a).
123 A definition and description of the six key enabling technologies can be found in European Commission (2009b) and Aschhoff et al. (2010). See also the report of the High-level Expert Group on Key Enabling Technologies (2011) and the EU Competitiveness Report 2010 (European Commission 2010).
124 The latest EU communication from 2012 (European Commission 2012) limited production technologies to advanced production techniques that are used in one of the five other key enabling technologies. In this year's Research and Technology Report, the original, more expansive definition of manufacturing technology was used, which includes all advanced manufacturing techniques, regardless of the sectors in which they are used.

The EU Commission believes that key enabling technologies have great potential for strengthening Europe as a manufacturing location. This is because Europe leads the world in many key enabling technology fields in science and technical inventions. On the other hand, the EU Commission has also identified major deficits in turning R&D results into new products. This is why the EU Commission recommends funding key enabling technologies throughout the innovation chain, from basic research to pilot projects and large-dimension demonstration projects. Support for key enabling technologies comes from the HORIZON 2020 programme (over € 6.6 billion for industrial applications of key enabling technologies alone), the European Investment Bank, the EIT KICs and structural funds, as well as through the initiation of new public-private partnerships.

The question for RTI policy in Austria is which role Austria is currently assuming in the area of key enabling technologies, both in R&D and in production, and how national RTI measures (that have direct and indirect connections to key enabling technologies) are positioned in comparison to (planned) EU activities to support KETs. The Austrian federal government's aim of establishing Austria as an Innovation Leader imbues the topic of key enabling technologies with a new significance. This is because, in order to be a leader in innovation, it is not enough for a country to be in a position to pick up on current technological trends; an Innovation Leader must also be able to set such trends in motion. We are therefore investigating which position Austria currently holds in the development and marketing of key enabling technologies, and how Austria's performance in this regard has changed in the last ten years.

4.5.1 The importance of key enabling technologies for innovation in manufacturing

Key enabling technologies (KETs) are one kind of cross-cutting technology,[125] which form an essential foundation for technical innovations. As cornerstones for innovative integrated solutions, KETs open up a range of opportunities for product and process innovation in a large number of industries and fields of application. In contrast to other cross-cutting technologies such as information and communication technologies[126], the direct effects on innovation from key enabling technologies are essentially limited to the production sector. This is because new materials, biotechnological and nanotechnological processes, optical and microelectronic components are primarily of use for innovations in materials and manufacturing processes. Nevertheless, there are also indirect innovation potentials in services from the use of products that are based on key enabling technologies, especially in the health area (medical engineering), in the transport industry (energy-efficient and quieter vehicles), and in information and communications services (more powerful information and communication technology).

What makes the difference in the effect of key enabling technologies – and cross-cutting technologies in general – on innovation and competitiveness is not only the development of fundamental technologies, but above all their utilisation in complex products and solutions. The important factors are both the speed of diffusion of new technologies and the development of new fields of application. It is a major challenge to reconcile the technological possibilities offered by these new technologies with the requirements of users, the market, regulatory guidelines, the

125 See Helpman (1998).
126 See Ark, Piatkowski (2004).

capabilities of downstream processing firms, and cost-efficient production. These sorts of coordination processes can provide essential support for direct collaboration among stakeholders at different levels of innovation processes and value creation chains, especially between technology producers and users of basic technologies.[127] In this context, it is quite important where new key enabling technologies are created. A strong domestic foundation in technology makes it easier for manufacturing to develop innovative solutions through the use of key enabling technologies.

Against this background, many measures that support key enabling technologies and seek to exploit their innovation potential aim not just at research funding, but also at cooperative ventures between key enabling technologies-based industries and the sciences, user industries, and end users. Austria is pursuing this path with such programmes as its competence centres (COMET) and through funding of application fields for new technologies in the areas of Smart Cities and electromobility.

Expectations for the short-term effects of key enabling technologies on innovation should not be set too high, though, because many innovative ideas are in the earliest stages of implementation. And the higher the claim of innovativeness is, the longer the periods of time are until innovative ideas are translated into products that are suitable for everyday use, and the higher the investments as well as barriers that must be overcome. Broad diffusion typically sets in when a technical standard has established itself and the advantage versus existing products and solutions is clearly visible and assessable. Only then will demand be sufficiently high to lower production costs through scaling effects and thereby enable lower product prices. Many of the expectations regarding the high short-term profitability for new key enabling technologies have proven to be too optimistic, as was the case for nanotechnological and biotechnological applications.[128] However, other areas of key enabling technologies that have already advanced farther down their technological path of development, such as micro- and nanoelectronics, photonics, and different fields of materials technology, do show how great the spillover effects of key enabling technologies can be on innovation in the widest possible range of manufacturing segments over a long-term period of time.

4.5.2 Austria's position in patent applications for key enabling technologies

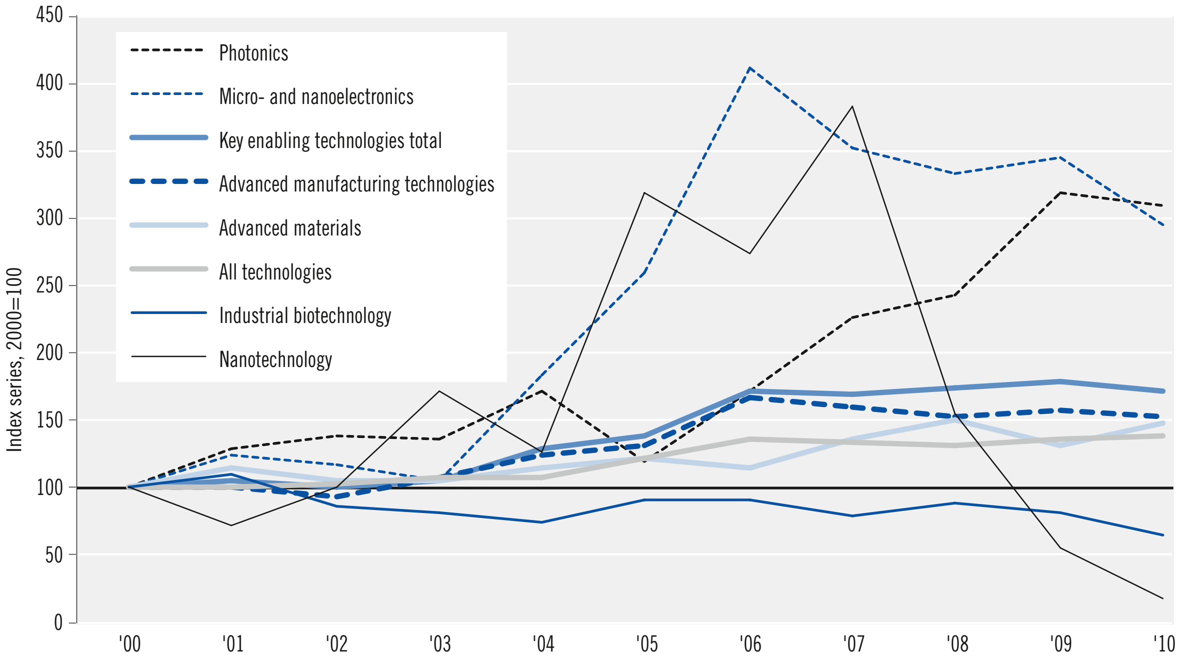
Austria's position in the development of new technologies in the individual fields of key enabling technologies can be ascertained on the basis of patent statistics. This assessment relies on the assignment of International Patent Classification (IPC) numbers for the six key enabling technology fields that were developed for a monitoring system by the EU Commission[129].[130] To examine technological development in these six fields, all patent applications by Austrian applicants or inventors since 2000 were considered and aggregated into patent families (i.e. patents that were registered both at Austrian and foreign or international offices are only counted once). To determine Austria's international position, only patent applications to the European Patent Office (EPO) and via the World Intellectual Property Organisation's Patent Cooperation Treaty (PCT) procedure were considered, thereby attaining a higher degree of comparability between different countries. The analyses are based on the

127 See Fagerberg (1995), Porter (1990).
128 See European Commission (2010).
129 See van de Velde et al. (2013).
130 The restriction proposed in this study for advanced manufacturing technologies is not used here because this would only include advanced manufacturing technologies that have a direct relation to one of the five other key enabling technologies. Instead, a definition was applied from an earlier European Commission study that offers a broader view of production technologies (see Aschhoff et al., 2010).

Patstat database of the European Patent Office (November 2012 edition). Due to the 18-month time lag between patent application and patent publication, complete application data is only available up to 2010. For EPO/PCT applications, the time lag is much longer due to the interval between the first application and the application to additional patent offices, so that figures for international comparison are only available in complete form up to 2009.

From 2000 to 2010, organisations and private persons resident in Austria[131] filed a total of 32,838 patents (in the sense of patent families). Of these, 7,101 patents (21.6%) are classified as key enabling technologies. This percentage climbed from a solid 18% at the beginning of the 2000s to over 24% at the end of the decade. Patent dynamism was therefore significantly higher in key enabling technologies than in the average of all fields of technology. While the number of patent applications increased overall from 2000 to 2010 by 38%, growth in key enabling technologies was 72%. The highest dynamism within the key enabling technologies was in photonics and micro- and nanoelectronics; the number of patents filed per year tripled in both fields over the last decade (see Fig. 32). In light of the small number of patent applications in nanotechnology each year, this field experienced very erratic growth. After stronger patent activity from 2005 to 2007, there have only been a few recent patent applications in this field of technology. Patent growth for advanced manufactoring technologies stood slightly above the

Fig. 32: Development of share of patent applications in KETs in Austria, 2000–2010



Source: Patstat. – Key enabling technology definition from van de Velde et al. (2013). – Calculations by ZEW.

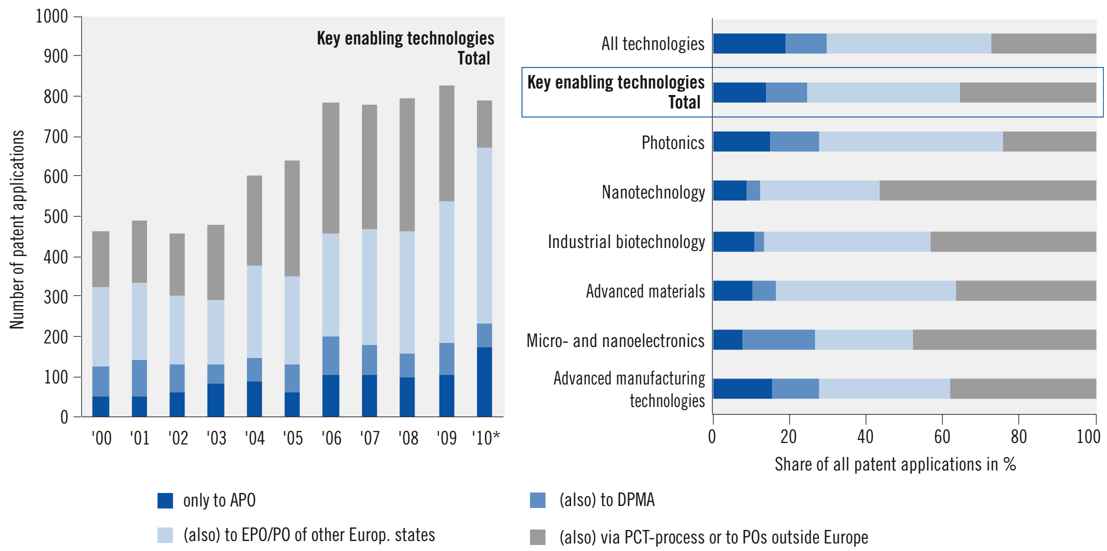
131 A patent application is considered to have come from Austria whenever at least one of the applying organisations or private persons are residing in Austria. This procedure is preferred to a classification by the residence of the inventor(s), firstly because it allows a better recording of where decisions are made about the commercialisation of patented inventions. Second, classification by the residence of the inventor(s) in adjacent regions that have many people who commute across borders produces unclear results. It should be noted in this context that patent applications by firms in Austria that are subsidiaries of international firms typically appear with the Austrian subsidiary as the (co-)applicant. An evaluation on the basis of inventor residence generates very similar results, with an overall slightly higher number of patent applications.

average for all technology fields; in material technologies, growth corresponded to the average rate of change for patent applications in Austria. The only area in key enabling technologies that had below-average growth during the last decade was industrial biotechnology.

Most patents for key enabling technologies are filed internationally. From 2000 to 2010, over 85% of all key enabling technology patents were (also) filed at patent offices outside of Austria (Fig. 33). Proprietary rights were filed for regions outside of Europe in 36% of patent applications, and an additional 40% did so for European countries outside of Austria and Germany. At the international level, 11% of patents were only filed in Germany. 14% of all key enabling technology patents applied for protection in Austria only. In comparison to all patent applications by Austrian applicants, key enabling technology patents have a much stronger international orientation. This suggests a strong export orientation among firms that are creating inventions in the area of key enabling technologies. Applications in countries outside of Europe have gained in importance over time. This is attributable in part to increasing utilisation of the PCT process as an application method.

Of key manufacturing technology patents, 70%were filed by firms, 4% by institutions of higher education, public or cooperative research institutions, and 26% by individual inventors.[132] The importance of business enterprises as patent filers is higher for the key enabling technologies than the average of all technology fields (Fig. 34).

Fig. 33: Patent applications in KETs in Austria, 2000–2010 by reporting offices

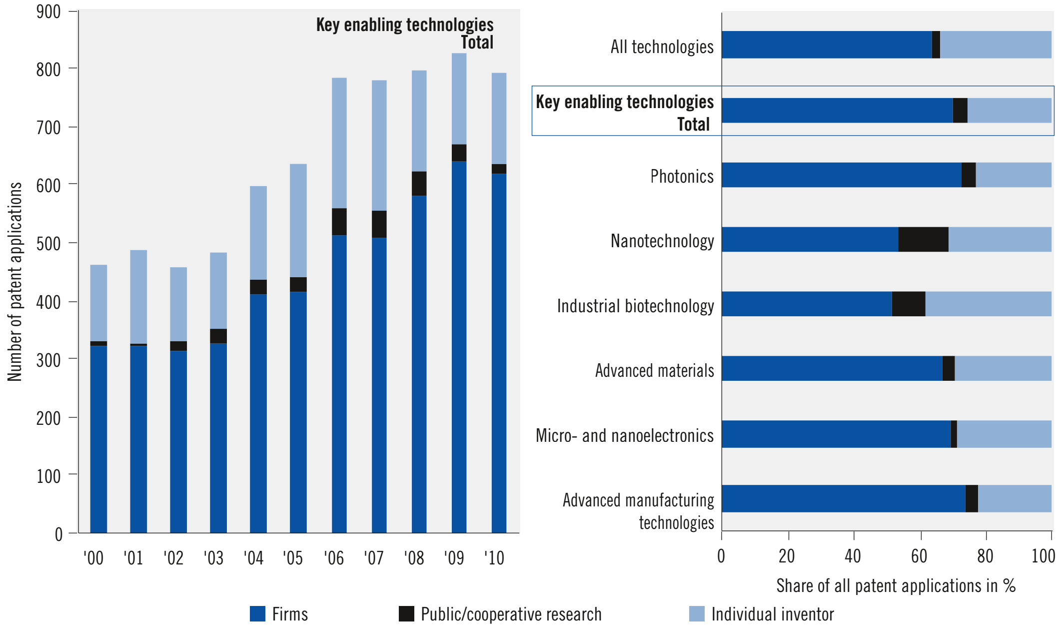


Note: * 2010 Under-coverage of patent applications via the PCT process and to patent offices outside of Europe, and over-coverage of the three other application methods due to often late filing of patents at offices outside of Europe.
APO: Austrian Patent Office, DPMA: Deutsches Patent- und Markenamt (German Patent and Trademark Office), EPO: European Patent Office, PO: Patent Offices, PCT: Patent Cooperation Treaty.

Source: Patstat. – Key enabling technology definition from van de Velde et al. (2013). – Calculations by ZEW.

132 For patent applications in which both firms, universities, public or cooperative research institutions on one hand, and individual inventors on the other, are involved, the individual inventors were not counted because such persons are almost always owners or employees or a firm or research organisation. The proportion of patent applications by individual inventors therefore refers to patents that were filed exclusively by individual inventors. Individual inventors can be freelancers, owners of firms, or employees.

Fig. 34: Patent applications in KETs in Austria, 2000–2010 by sector affiliation of applicants



Source: Patstat. – Key enabling technology definition from van de Velde et al. (2013). – Calculations by ZEW.

Firms file a particularly high share of the patents in photonics and advanced manufacturing technologies. Public research plays a comparatively major role in nanotechnology and industrial biotechnology. The rise in patent applications in the area of key enabling technologies over the last decade comes primarily from firms, yet public research has also increased its patent activities noticeably, although from a very low starting level.

A classification of applicants from the business sector and cooperative research by industry shows that the greatest portion of key enabling technology patents comes from electronics/measurement technology/optics (28.6% of patent applications from 2000 to 2010), mechanical engineering (15.0%), electrical engineering (11.8%), chemicals/petroleum products (9.8%), research and development (7.9%), and metal production (4.2%) (Tab. 17). The electronics/measurement technology/optics industry is the largest filer of patents in nanotechnology, micro- and nanoelectronics, and advanced manufacturing technologies. In industrial biotechnology, over 45% of patent applications come from firms in the pharmaceutical and chemical industries. In advanced materials, the chemicals and metal production industries dominate; and over one-fourth of patents in photonics come from electrical engineering and electronics/measurement technology/optics.

If we compare a sector's share of patent applications in all technology fields with its share of key enabling technology patents, then electronics/measurement technology/optics, chemical and petroleum, metal production and electrical engineering have all proven to be particularly close to key enabling technologies. Their patent portfolio is oriented at an above-average level towards key enabling technologies. Firms in the R&D sector (including cooperative research), in contrast, file patents with disproportionate frequency in fields outside of key enabling technologies.

Of the key enabling technology patents filed by businesses from 2000 to 2010, 75.8% came from large firms (with 250 or more employees) and

Table 17: Patent applications in the business enterprise sector (incl. cooperative research) in KETs in Austria, 2000–2010 by industry

Industry	ÖNACE	All	KET	PH	NT	IB	AM	ME	AMT	R&D
Food and beverage	10-12	0.6	0.2	0.0	0.0	2.3	0.2	0.0	0.1	0.6
Textiles/clothing/leather	13-15	1.0	0.4	0.3	0.0	2.7	0.5	0.0	0.4	0.3
Wood/furniture	16, 31	2.5	1.3	0.9	0.0	1.0	2.2	0.1	1.2	0.7
Paper/printing	17-18	1.3	0.7	0.6	1.1	0.5	1.7	0.0	0.4	0.7
Chemicals/petroleum	19-20	4.3	9.8	0.0	6.9	15.0	35.2	0.2	2.7	3.7
Pharmaceuticals	21	8.4	3.7	1.8	7.6	35.5	5.7	0.0	1.5	3.8
Rubber/plastics	22	3.3	1.6	0.4	0.0	0.6	4.1	0.4	1.0	2.2
Glass/ceramics/stone products	23	2.2	2.2	1.7	0.0	0.0	6.3	0.4	1.1	1.4
Metal production	24	2.0	4.2	0.4	1.1	0.0	12.8	1.6	4.9	2.6
Metal products	25	7.1	3.6	1.9	1.6	1.6	7.2	0.6	3.6	2.5
Electronics/precision engineering/optics	26	14.3	28.6	33.8	45.7	4.2	2.7	77.4	33.2	10.4
Electrical devices – electrical engineering	27	7.5	11.8	42.4	15.2	2.1	2.6	9.9	5.4	16.2
Mechanical engineering/repairs	28, 33	19.0	15.0	4.7	3.3	3.1	9.3	3.0	22.6	11.1
Automobile manufacturing	29	4.8	2.4	1.2	0.0	0.0	1.0	1.6	3.3	7.2
Rail/aircraft manufacturing	30	1.6	0.5	0.5	0.0	0.0	0.3	0.2	0.7	2.1
Medical engineering/sporting goods	32	3.2	0.9	0.4	1.1	0.0	0.7	0.2	1.2	1.8
Mining/provisioning/waste disposal	5-9, 35-39	0.5	0.4	0.9	0.0	1.0	0.2	0.1	0.4	0.3
Construction/real estate	41-43, 68	0.9	0.5	0.0	0.0	2.1	0.4	0.0	0.7	0.6
Trade/transport/logistics	45-53	1.6	0.8	0.6	0.0	0.5	1.1	0.0	0.9	5.2
Software/telecommunications	61-63	1.5	0.9	1.5	0.0	0.4	0.2	0.3	1.0	4.1
Architecture and engineering	71	2.5	1.9	0.9	1.1	4.8	0.8	0.1	2.8	7.5
R&D	72	8.8	7.9	4.1	15.3	20.1	4.2	3.6	9.9	12.6
Other industries	1-3, 55-60, 64-66, 69-70, 73-96	1.3	0.8	1.0	0.0	2.3	0.6	0.2	0.9	2.2

Note: All: All technology fields; KET: Total key enabling technologies, PH: photonics; NT: nanotechnology; IB: industrial biotechnology; AM: advanced materials; ME: micro/nanoelectronics; AMT: advanced manufactoring technologies; R&D: R&D expenditure in 2009.

Source: Patstat. – Statistics Austria. – Key enabling technology definition from van de Velde et al. (2013). – Calculations by ZEW.

24.2% from SMEs. SMEs are underrepresented in the field of key enabling technology patents insofar as their share of all patent applications by firms stands at 30.4% and their share of total R&D expenditures by firms at 28.7%. The SME share of patent applications is comparatively high in nanotechnology at 41.4% and 32.2% in industrial biotechnology, and is very low in advanced materials and micro- and nanoelectronics.

Regional distribution of applicants for key enabling technology patents (without individual inventors) deviates significantly from the regional distribution of R&D capacities (firms incl. cooperative research, universities, the state, private non-profit institutions).[133] While an average of 34% of total R&D expenditures from 2000 to 2009 fell to Vienna, only 11.4% of key enabling technology patents came from Vienna. This dif-

133 Patents from applicants with multiple locations in Austria were classified to the location at which the overwhelming portion of the applicant's R&D activities take place.

Table 18: Development of share of patent applications in the business enterprise sector in key enabling technologies in Austria, 2000–2010 by firm size

Size category	All	KET	PH	NT	IB	AM	ME	AMT	R&D
SME (under 250 employees)	30.4	24.2	29.6	41.4	32.2	15.4	18.6	26.6	28.7
Large companies (250 and more employees)	69.6	75.8	70.4	58.6	67.8	84.6	81.4	73.4	71.3

All: All technology fields; KET: Total key enabling technologies, PH: photonics; NT: nanotechnology; IB: industrial biotechnology; AM: advanced materials; ME: micro/nanoelectronics; AMT: advanced manufactoring technologies; R&D: R&D expenditure in 2009.

Source: Patstat. – Statistics Austria. – Key enabling technology definition from van de Velde et al. (2013). – Calculations by ZEW.

Table 19: Development of share of patent applications in the business enterprise sector and public and cooperative research in key enabling technologies in Austria, 2000–2010 by regional government

State	All	KET	PH	NT	IB	AM	ME	AMT	R&D
Burgenland	0.6	0.7	0.8	0.0	0.7	0.3	1.3	0.6	0.6
Carinthia	4.9	11.3	2.9	0.9	0.4	4.7	44.3	14.0	2.7
Lower Austria	10.9	14.0	13.1	20.1	8.8	31.6	5.7	8.8	8.9
Upper Austria	19.1	18.7	6.1	20.9	13.8	21.5	7.3	23.2	16.0
Salzburg	5.7	3.5	2.0	0.0	2.9	3.8	1.1	4.9	3.7
Styria	18.5	21.2	11.8	11.1	15.1	17.4	27.0	24.5	19.9
Tyrol	13.6	8.2	8.4	4.5	28.4	14.7	3.3	5.3	9.1
Vorarlberg	10.6	11.0	41.2	2.7	0.0	1.5	3.7	6.7	2.7
Vienna	16.0	11.4	13.9	39.6	30.0	4.5	6.3	12.1	34.0

All: All technology fields; KET: Total key enabling technologies, PH: photonics; NT: nanotechnologies; IB: industrial biotechnology; AM: advanced materials; ME: micro/nanoelectronics; AMT: advanced manufactoring technologies; R&D: R&D expenditure in 2009.

Source: Patstat. – Statistics Austria. – Key enabling technology definition from van de Velde et al. (2013). – Calculations by ZEW.

ference can be explained primarily by the fact that industrial R&D activities in the Viennese economy are oriented primarily at areas outside of key enabling technologies (such as pharmaceuticals/red biotechnology, telecommunication equipment) and that patent activities in public research (universities, state), which constitute the greatest part of Vienna's R&D capacities, are generally low because scientific publications represent the main marker of value in the sciences. The two countries with the greatest shares of overall patent applications in the area of key enabling technologies are Styria (21.2%) and Upper Austria (18.7%). Lower Austria (14.0%), Carinthia (11.3%) and Vorarlberg (11.0%) also have relatively high shares. The regional distribution of patent applications is sometimes very concentrated within specific key enabling technology fields. Over 71% of the patents filed in micro- and nanoelectronics between 2000 and 2010 came from Carinthia and Styria; over 80% of nanotechnology patents came from firms or institutions in Vienna, Lower Austria and Upper Austria; and over 58% of industrial biotechnology patents came from Vienna and Tyrol. The Austrian state with the highest share of patents in photonics is Vorarlberg. Lower Austria and Upper Austria dominate in advanced materials, and Upper Austria and Styria dominate in advanced manufactoring technologies. Regional distribution is determined overall by the activities of a few large firms.

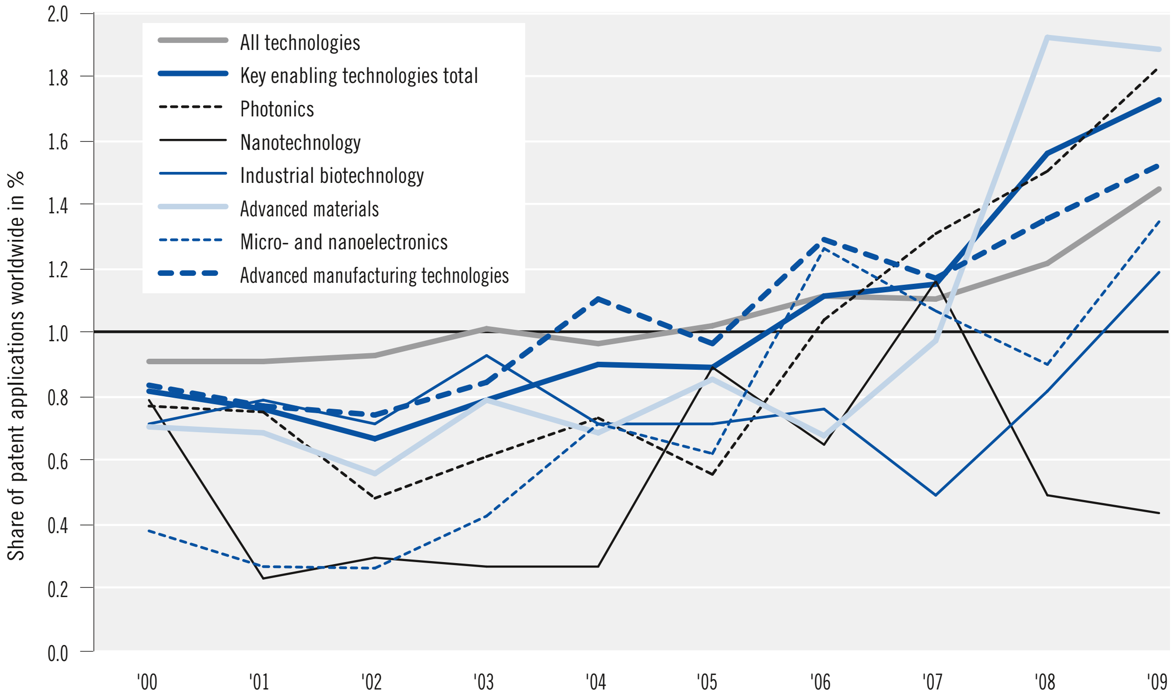
"International patent applications" are used to assess the development of key enabling technology patent applications in Austria in international comparison. These are applications to the EPO and to the WIPO through the PCT process. These methods of application are usually used when a patent must be protected in many countries and marketed internationally. Due to the higher expense associated with EPO and PCT applications, these patents are also considered more valuable. Austria's share of international patent applications worldwide has climbed significantly since the mid-2000s. This applies to patent applications across all fields of technology and even more for patents in key enabling technologies. While 0.66% of international patent applications worldwide for key enabling technologies came from Austrian applicants in 2002, this percentage rose to 1.73% by 2009 (Fig. 35). Austria's gains in key enabling technologies were significantly higher than the average for all technologies.

Austria's gain in share of worldwide patent activity was particularly strong in advanced materials, photonics, advanced manufactoring technologies, and micro- and nanoelectronics. In industrial biothechnology, Austria's share rose only in 2008 and 2009, a time when worldwide patent activity in this field declined. Austria's contribution to the number of international nanotechnology patent applications worldwide is nearly always below average.

Austria shows higher dynamics in terms of patents than many European reference countries in almost all key enabling technologies (Fig. 36). With a 50% increase in the number of international patent applications in key enabling technologies between the 2000–2003 and 2006–2009 periods, Austria is far ahead of Belgium, Finland, Denmark, Sweden and Switzerland, which had growth rates of 6-19%. The number of key enabling technology patent applications in Germany and the EU-27 remained constant between the two periods, while it dropped by 14% in the Netherlands.

Austria's patent growth, which is high in international comparison, is clear in five of the six key enabling technologies. Patent application figures declined only in one technology, namely industrial biotechnology, and this was also the case in almost all of the other coun-

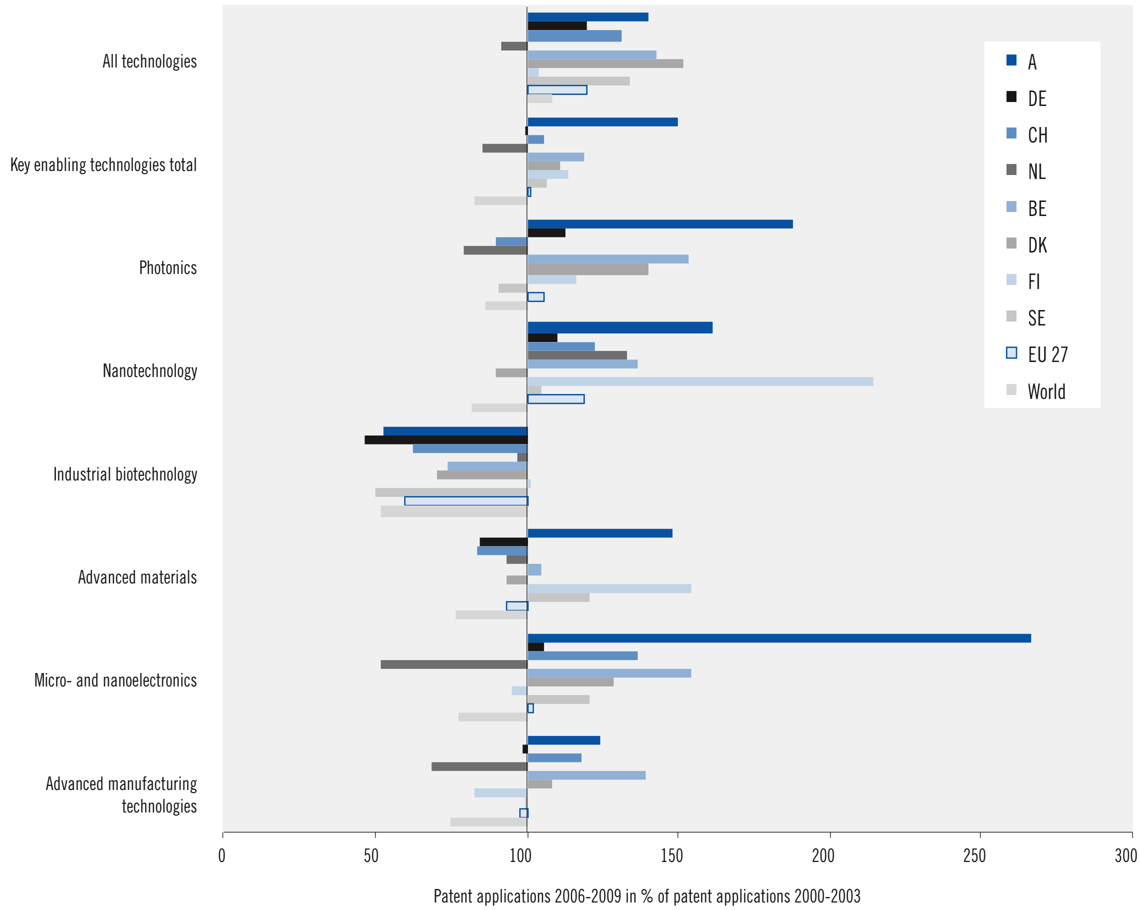
Fig. 35: Austria's share of international patent applications worldwide in KETs, 2000–2009



Note: International patent applications: applications to the EPO or via the PCT process.

Source: Patstat. – Key enabling technology definition from van de Velde et al. (2013). – Calculations by ZEW.

Fig. 36: Dynamics in international patent applications in KETs in the 2000s in selected countries



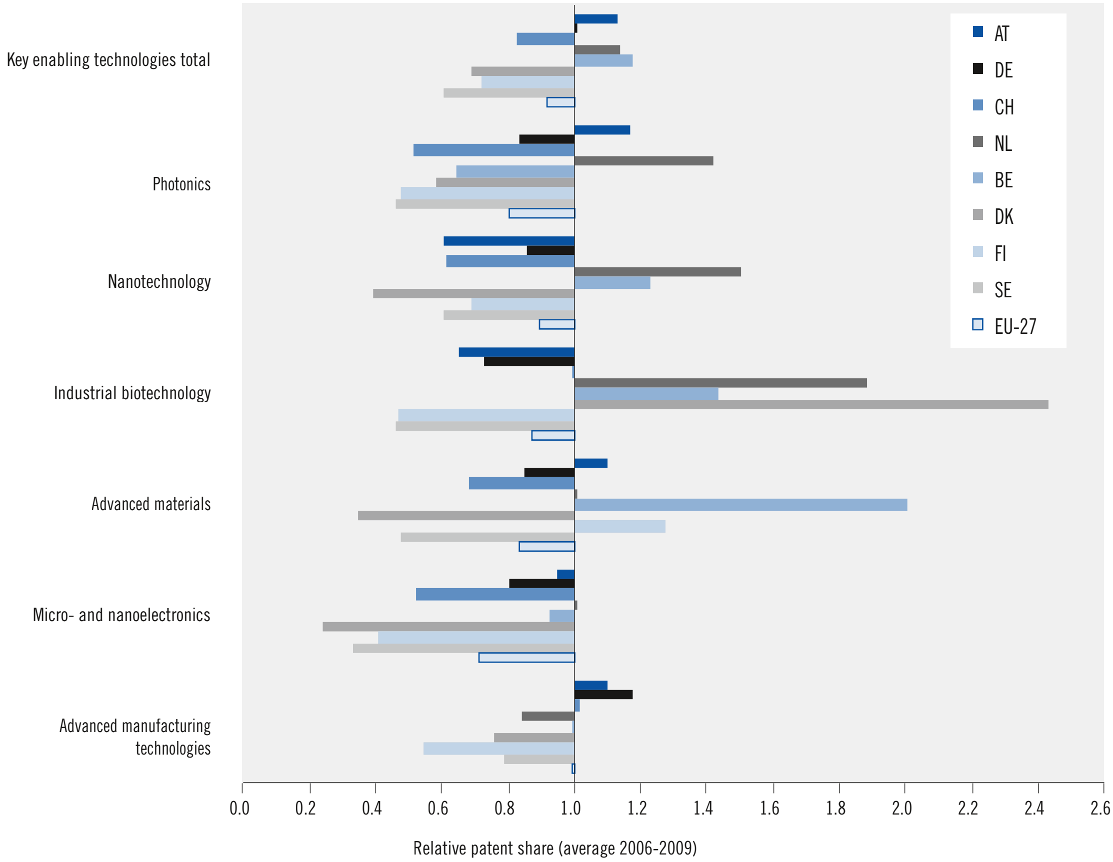
Note: International patent applications: applications to the EPO or via the PCT process.

Source: Patstat. – Key enabling technology definition from van de Velde et al. (2013). – Calculations by ZEW.

tries. No other country in the group of reference countries attained as high a level of growth as Austria in the area of photonics and micro- and nanoelectronics. The increase in micro- and nanoelectronics is particularly impressive; Austrian applicants increased their submission of international patent applications by 166%. Austria is second only to Finland with regard to patent dynamics in advanced materials and nanotechnology. Austria is also in second place behind Belgium in advanced manufactoring technologies.

The strong increase in patent application figures throughout the 2000s has led to Austria having a positive specialisation in key enabling technologies at the end of the decade. At the beginning of the decade, the proportion of patent applications in key enabling technologies in Austria was still lower than the average of all countries. This positive specialisation results from disproportionate patent activity in photonics, advanced materials, and advanced manufactoring technologies (Fig. 37). Despite a high patent dynamic in micro- and nanotechnology, this specialisation still remains slightly below average. Patent activity in industrial biotechnology and nanotechnology remains comparatively low. Overall, Austria exhibits very bal-

Fig. 37: Specialisation in international patent applications in KETs, 2006–2009: relative patent share for selected countries



Note: Relative patent share: share of patent applications 2006–2009 in the respective field of technology in total patent applications 2006–2009 for a country, divided by the share of patent applications 2006–2009 in the respective field of technology worldwide in total patent applications 2006–2009. A value greater than 1.0 indicates that the country in question has an above-average number of patents in this field.

Source: Patstat. – Key enabling technology definition from van de Velde et al. (2013). – Calculations by ZEW.

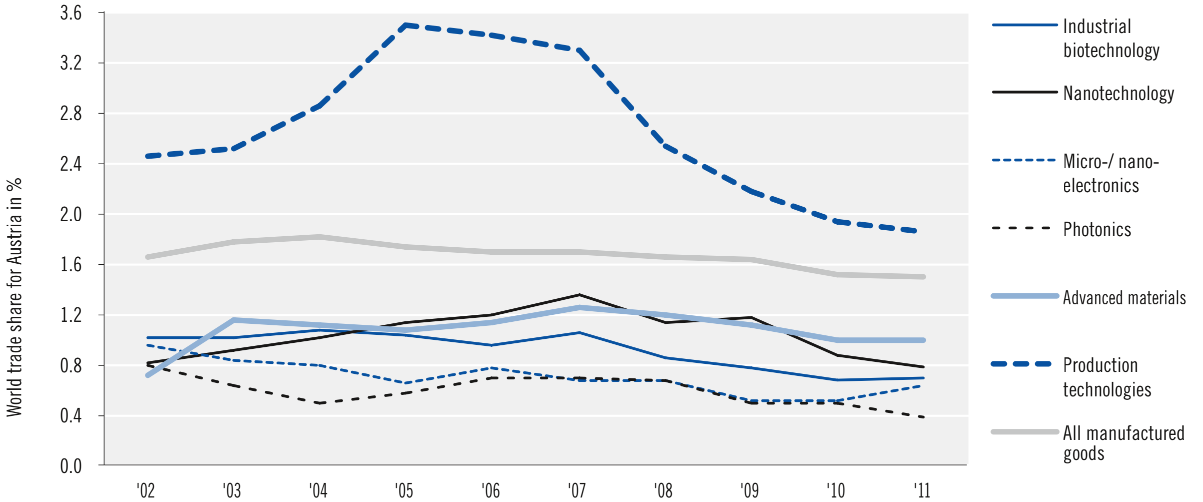
anced patent activity in the six key enabling technologies. Other countries of a similar size have a significantly stronger focus on individual fields of technology. Denmark has a pronounced specialisation in industrial biotechnology, yet is barely active in most of the other fields. Austria's "flat" profile is similar to that of larger countries such as Germany. Due to the circumstance that there is high spillover potential among the six key enabling technologies and many overlapping areas for technological developments that can build on one another, a broad and balanced key enabling technology portfolio can be considered as advantageous.

4.5.3 Austria's position in foreign trade with products based on key enabling technologies

An assessment of a country's economic performance in key enabling technologies is much more complex than determining technological performance. This is because production and foreign trade statistics, unlike patent statistics, do not permit a clear attribution of produced and traded goods to specific fields of technology, because these statistics classify goods by their usage or by their material composition, but not by technologies used in production or specific technological components. An EU Commission project[134] attempted to identify those products in the conventional classification of goods[135] that could be considered to be based primarily on key enabling technologies. The development of foreign trade in the six key enabling technology fields can be compared internationally on the basis of this classification.[136] Evaluations of production statistics are not possible because of non-disclosure agreements at the level of individual goods in the underlying statistics.

Austria's share of worldwide[137] exports of products based on key enabling technologies is below average in all technology fields, with the exception of advanced manufactoring technologies (Fig. 38). While Austria reached a percentage of 1.5% in global trade in 2011, the percentages of the five key enabling technologies were significantly lower, from 0.4% (photonics) to 1.0% (advanced materials). Austria attained an above average percentage of 1.8% of global trade in advanced manufactoring technologies in 2011. In the mid-2000s this was sometimes twice as high due to single large orders in metallurgy technology and for semiconductor technology plants. Austria's share of global trade in industrial biotechnology, photonics, micro- and nanoelectronics, and advanced manufactoring technologies has shown a downward trend in the last ten years, which also corresponds to the trend for all manufactured goods. Austria held its position in global trade, however, in nanotechnology and advanced materials. This stability is actually a significant achievement because the global integra-

Fig. 38: Austria's share in global trade in KETs, 2002–2011



Note: Share in global trade: share of Austrian exports in total exports by the 39 countries that dominate world trade (the EU-27 countries, Switzerland, Norway, Iceland, Croatia, Macedonia, the USA, Japan, South Korea, Canada, China, Russia and Israel).

Source: Comtrade. – Key enabling technology definition from van de Velde et al. (2013). – Calculations by NIW and ZEW.

134 See van de Velde et al. (2013).

135 This is the CPA (Classification of Products by Activity) and the European Commission's ProdCom classification in production statistics, as well as HS (Harmonised Commodity Description and Coding System) and the CN (Combined Nomenclature) that is derived from the HS by the EU Commission in foreign trade statistics.

136 A limited list validated by experts was used for this purpose that only covers the core area of the individual fields of technology and only includes those groups of goods for which classification to a key enabling technology field is clearly feasible. Due to shifts in the classification of goods in 2002, we were only able to use the values from 2002 onwards.

137 "Worldwide" here is limited to a group of 39 countries that are particularly important in trade with key enabling technology products: the EU-27 countries, Switzerland, Norway, Iceland, Croatia, Macedonia, the USA, Japan, South Korea, Canada, China, Russia and Israel.

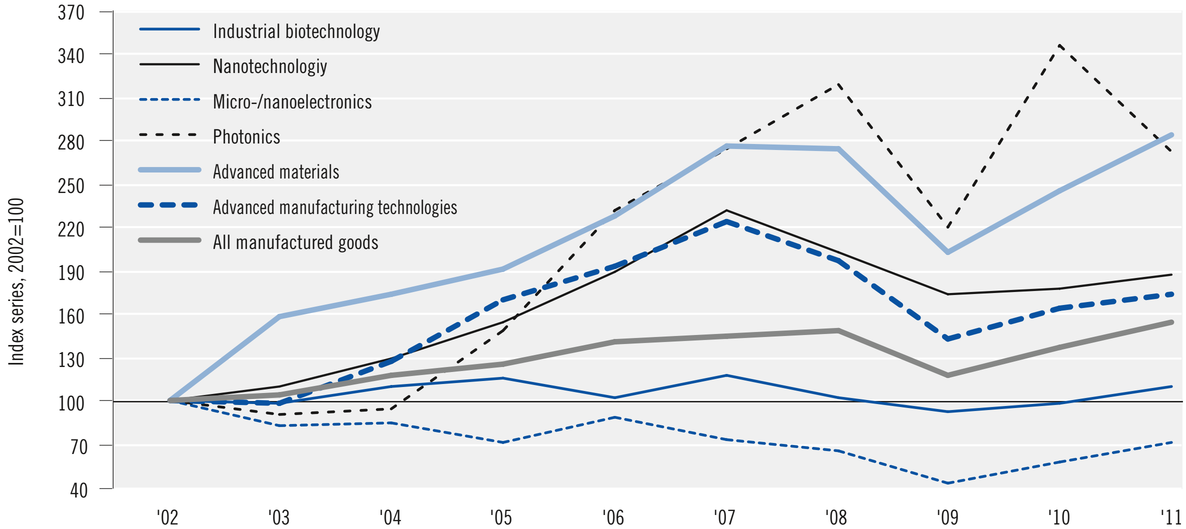
tion of emerging countries increased competition on the world markets at the same time.

Austria's exports climbed in four key enabling technologies at much faster pace than the average for all groups of goods (Fig. 39). Nominal exports in photonics and advanced materials in 2011 were 2.5 times higher than in 2002; in nanotechnology and advanced manufactoring technologies, exports for 2011 exceeded the level of 2002 by 87% (and 74%) (calculated at current prices). In industrial biotechnology, however, there was no significant climb in export volumes in the 2000s. Exports for micro- and nanoelectronics in 2011 were even significantly under the figure for 2002.

Austria's export dynamism in the area of key enabling technologies is quite distinctive in comparison to global foreign trade dynamics, and it often deviates from the average export dynamism of the EU-27. If we compare the volume of exports in the period from 2007 to 2011 with that of the period from 2002 to 2006, Austria has a particularly strong increase in advanced materials that stands above both the global and EU values and exceeds export growth in all of the reference countries (Fig. 40). There were also comparatively high rates of growth in photonics and nanotechnology. Export growth was below average in advanced manufactoring technologies and industrial biotechnology. There was a significant expansion in international trade for all five key enabling technologies during the 2000s. Trade expansion was significantly above the average for all manufactured goods in nanotechnology, photonics, advanced materials, and advanced manufactoring technologies. Export volumes for industrial biotechnology increased at approximately the same pace as the overall expansion in trade.

Micro- and nanoelectronics are the exception here. World trade in this segment of electronics increased only slightly in the past decade, and it decreased in some industrialised countries, in some cases severely. Austria is ranked in this group with a 12% decrease in exports between 2002/06 and 2007/11. EU-27 exports fell by 17% between these two periods, while global exports climbed by 14%. The context of this development in foreign trade is the increasing off-shoring of microelectronic component production to re-

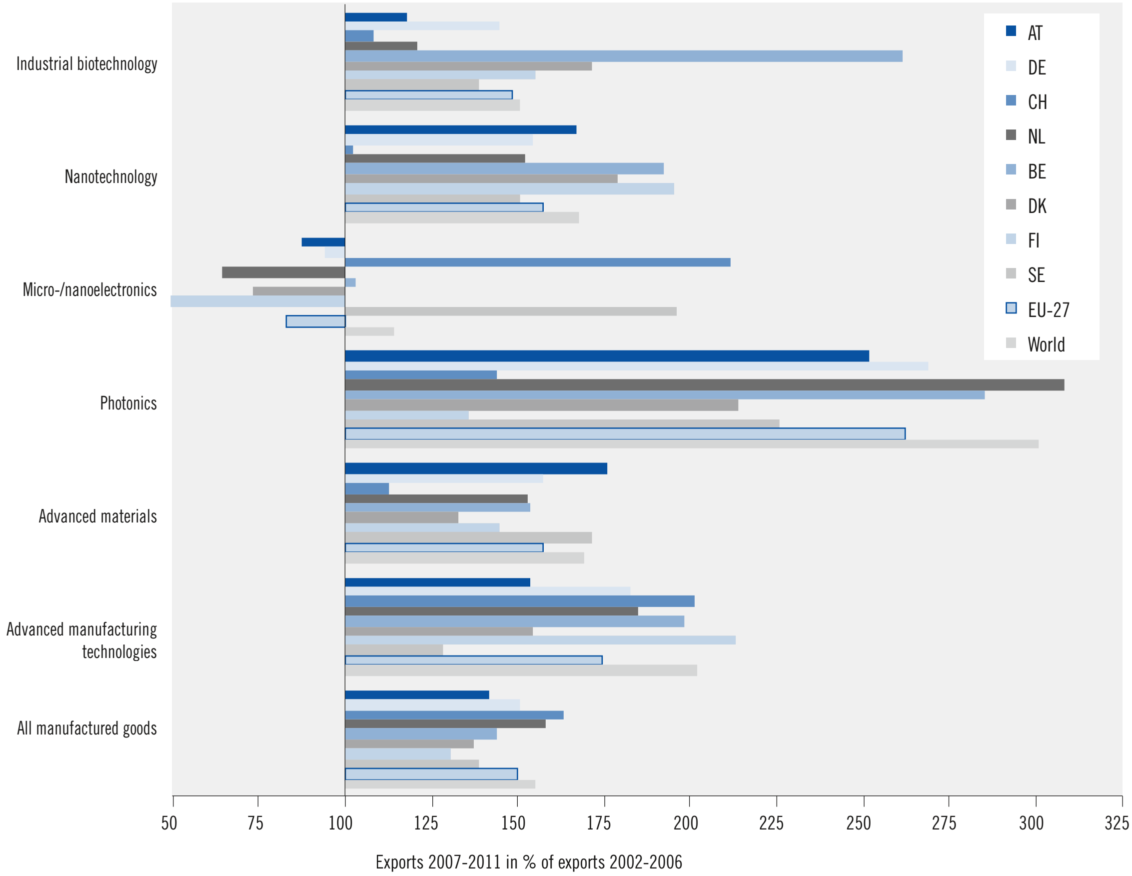
Fig. 39: Dynamics of Austrian exports in KETs, 2002–2011



Note: Index series based on export volumes in €.

Source: Comtrade. – Key enabling technology definition from van de Velde et al. (2013). – Calculations by NIW and ZEW.

Fig.40: Export dynamics in KETs 2002–2011 in selected countries



Note: Exports in U.S. $ in current prices.
* the EU-27 countries, Switzerland, Norway, Iceland, Croatia, Macedonia, the USA, Japan, South Korea, Canada, China, Russia and Israel.

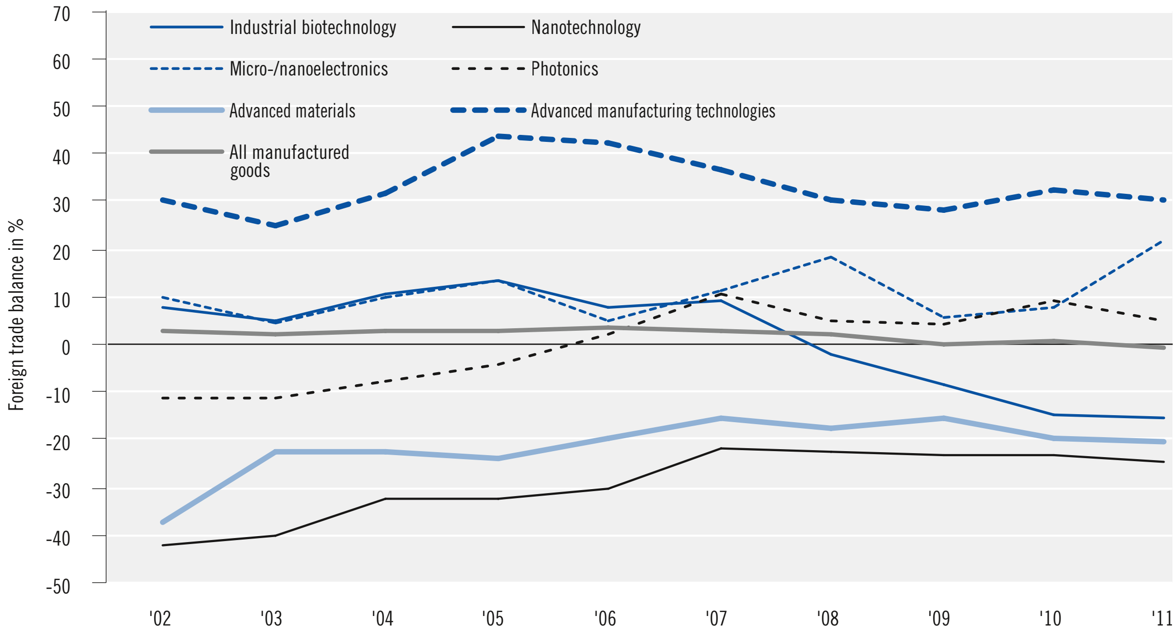
Source: Comtrade. – Key enabling technology definition from van de Velde et al. (2013). – Calculations by NIW and ZEW.

gions in which these parts are used in further processing steps. This caused exports in the former main export countries of Japan, the USA, the United Kingdom and Germany to fall. Eastern and southeast Asian countries, including South Korea, Taiwan and China, report strongly growing exports.

Along with export dynamics, the foreign trade balance is a second important indicator for evaluating economic performance in key enabling technologies. Austria has posted a positive trade balance every year since 2002 in two fields – advanced manufactoring technologies and micro/nanoelectronics – whereby surpluses are especially high in advanced manufactoring technologies (Fig. 41). There were surplus exports in industrial biotechnology up to 2007; since then, imports have outweighed exports. The opposite development was the case for photonics, where there have been slight export surpluses since 2006. Advanced materials and nanotechnology had a negative foreign trade balance, whereby the deficit at the end of the 2000s was much less significant than at the beginning of the decade.

The current positive trade balance in advanced manufactoring technologies, micro- and nanotechnology, and photonics, in an otherwise overall balanced trade situation, means that Austria

Fig. 41: Austria's foreign trade balance in KETs, 2002–2011



Note: Foreign trade balance: exports minus imports in % of total foreign trade volume (exports plus imports).

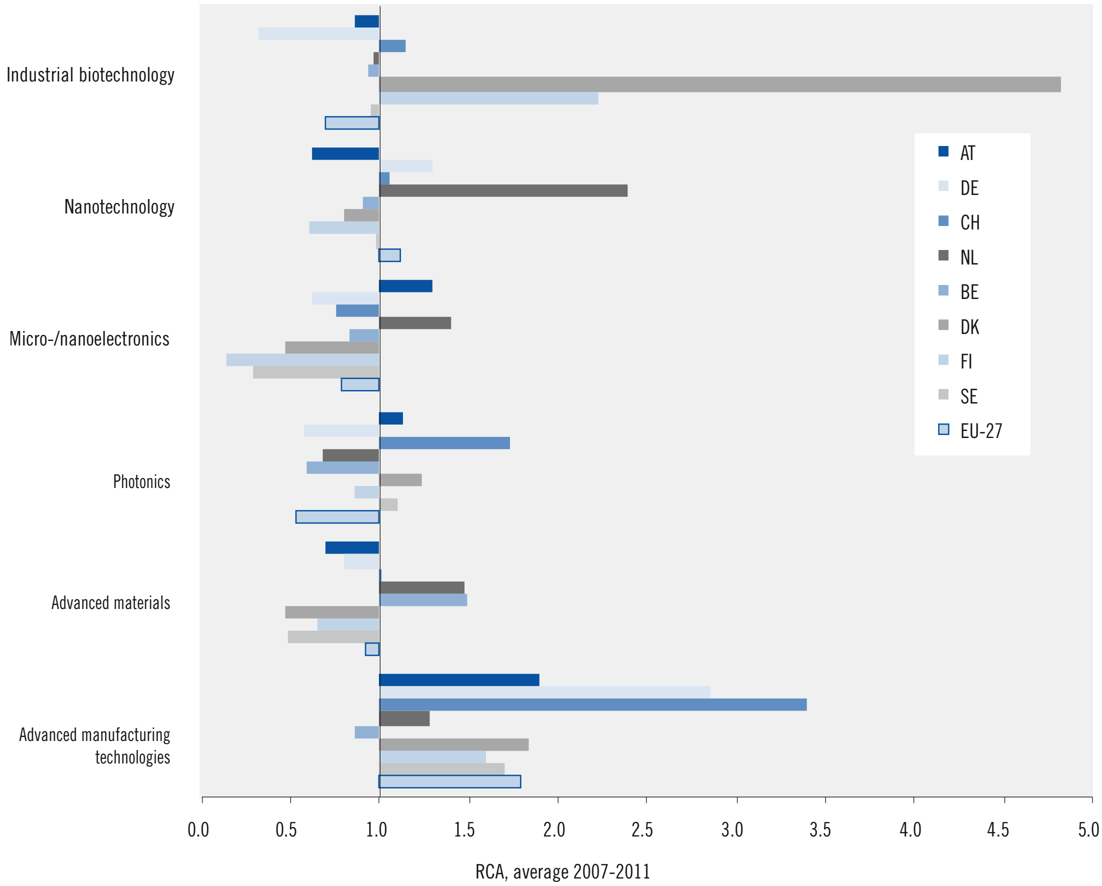
Source: Comtrade. – Key enabling technology definition from van de Velde et al. (2013). – Calculations by NIW and ZEW.

is specialised in the trade with these three key enabling technologies. The highest specialisation is in advanced manufactoring technologies (Fig. 42). The trade balance is slightly positive for micro- and nanoelectronics, which nevertheless represents a special situation in comparison to other highly-developed industrialised European countries, as only the Netherlands and Austria have positive specialisations in this key enabling technology. In photonics, Switzerland, Sweden and Denmark, along with Austria, have positive specialisation values. Austria's strongest negative specialisation is in nanotechnology.

In international comparison, Austria's pattern of specialisation looks relatively flat, meaning that Austria is well-represented in all six key enabling technologies and is not focused on individual fields. Other countries of comparable size have much higher specialisation figures for individual key enabling technologies. Denmark and Finland have a very strong orientation towards industrial biotechnology, the Netherlands towards nanotechnology, Switzerland towards photonics, and Switzerland and Germany towards advanced manufactoring technologies.

In summary, we can state that Austria is well positioned in key enabling technologies, in terms of its R&D, production and marketing capacities. Austria has significantly expanded its patent activities in key enabling technologies in the last ten years and shifted its patent portfolio in the direction of key enabling technologies. This has given Austria greater weight in the global production of new technological expertise in these fields of technology, which are particularly important for future competitiveness. Austria's strengths lie above all in advanced manufactoring technologies, advanced materials and photonics. In contrast to many other small, highly developed economies, Austria has significant R&D capacities in all six fields of key enabling technology. The strengthening of its position in patent applications also brings along a powerful expansion of Austrian

Fig. 42: Foreign trade specialisation in KETs 2007–2011 in selected countries



Note: RCA: Revealed Comparative Advantage: export-import relation in the respective key enabling technology in relation to the export-import relation for all manufactured goods.

Source: Comtrade. – Key enabling technology definition from van de Velde et al. (2013). – Calculations by NIW and ZEW.

exports of key enabling technology-based products. Photonics, advanced materials, nanotechnology and advanced manufactoring technologies all posted especially high rates of growth. Austria's share of global trade in key enabling technologies, however, remains below average, with the exception of advanced manufactoring technologies. This means that potential for growth still exists. Foreign trade also confirms that Austria is well-represented in all six fields of key enabling technology. These positive developments were borne by Austrian manufacturing firms and supported by RTI policy.

4.6 Green manufacturing as a growth factor

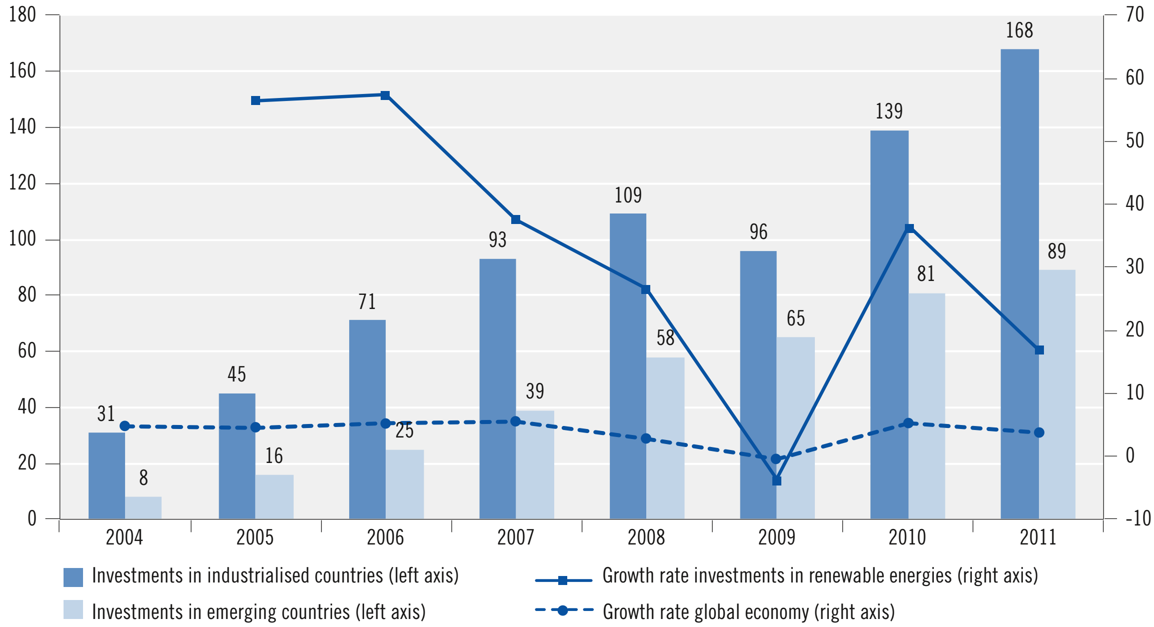
Economic growth is a prerequisite for employment, financing the social security systems, and therefore increasing prosperity. The economic and financial crisis clearly illustrate the negative effects of a lack of growth, particularly in such crisis countries as Greece and Spain. Nonetheless, growth at any price is not a reasonable economic policy option. Rising raw materials prices, environmental limitations and potential dangers (climate change), as well as impairments in use caused by environmental degradation all underscore the relevance of strategies that pursue intelligent, and above all sustainable, growth.[138]

4.6.1 Market development and market potential for environmentally friendly goods

Manufacturing plays a central role in realising intelligent growth because the shift towards an environmentally friendly and sustainable economy is associated with a massive need for investment. This transformation is about rebuilding the material world, replacing conventional, non-sustainable technologies with investment goods that ensure an environmentally sustainable economy and way of life according to the dictum, "low energy – low carbon – low distance"[139]. This phase of transformation is anticipated to unleash a significant global investment cycle that brings about a shift in demand for those manufacturing goods that are in a position to fulfil corresponding technological requirements.[140] This change, however, is not a vision that can be attained by market forces alone. The powerful networking effects of conventional technologies prevent the change to alternative systems of energy supply or mobility in many ways.[141] It also seems that the question remains open as to which countries can profit from the transformation that will be caused by the growth of "green" industries. At the moment, however, there is intense locational competition seeking to reap "first mover advantages" and agglomeration advantages. In general, it seems that the distribution of focal points in manufacturing remains undecided. An intelligent industrial policy can establish positive stimuli here and thereby promote growth opportunities that firms must, however, take advantage of.

The expected dynamic is already recognisably

Fig. 43: Level and growth in global investments in renewable energies in industrialised and emerging countries in billions of U.S. dollars and percentages



Source: Bloomberg 2012, IMF World Economic Outlook Database. Calculated by JOANNEUM RESEARCH.

138 See Aghion et al. (2009).
139 Kletzan-Slamanig, Köppl (2009).
140 See Rifkin (2011).
141 See OECD (2011b).

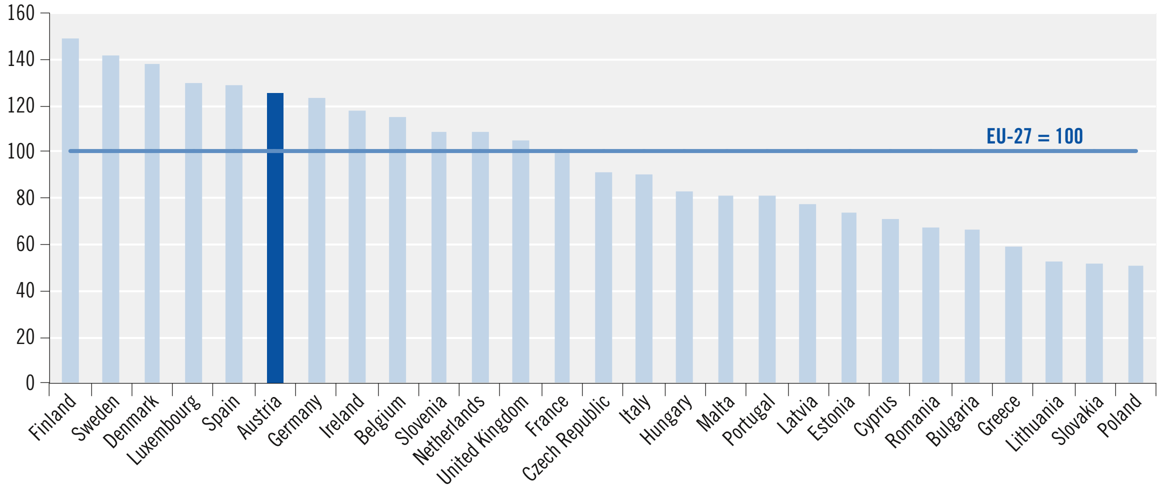
present in a few segments of the environmental technology industry. Fig. 43 shows global investments in renewable technologies, which amounted to about USD 206 billion in 2011. What is remarkable above all is the high dynamism of investments, both in industrialised and emerging countries. This dynamic becomes clear when we compare growth rates in investment in renewable energies with the growth rate of the global economy. Fig. 43 shows that, with the exception of the crisis year of 2009, investments constantly grew much faster than the global economy. This may continue in the foreseeable future offering new opportunities for expansion to innovative manufacturing firms.[142]

4.6.2 *The competitiveness of green manufacturing in Austria*

Previous analyses of the structure and dynamism of Austria's green manufacturing industry depict positive performance and competitiveness. This is expressed in rising exports and a high intensity of technology and innovation performance. Numerous firms in this sector can be classified in the high technology segment.[143]

If we observe Austria's starting position in the sector of environmental innovation in international comparison, we see that Austria has a generally high level of competitiveness as well as dynamic development. Fig. 44 shows this with the example of the overall index of the Eco Innovation Scoreboards, which assesses 16 variables that focus primarily on inputs and outputs of environmental innovations. These indicators include for example state expenditures for environmental and energy research, resource productivity, and revenues in environmental industries. According to these indicators, Austria is ranked sixth in the EU-27. Countries such as Germany, the United Kingdom, the Netherlands and Belgium, which are ranked above Austria on the general European Innovation Scoreboard, exhibit worse performance than Austria in environmental innovations. The Austrian economy apparently offers solid pre-

Fig. 44: Austria's Eco-Innovation Performance in international comparison (overall index of Eco-Innovation Scoreboard 2011)



Source: http://www.eco-innovation.eu/

142 Ibid.
143 See Kletzan-Slamanig, Köppl (2009).

Table 20: Shows the development in Austrian exports of potential environmental protection goods in € billions 2002–2011

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Waste	0.4	0.4	0.5	0.6	0.7	0.8	0.8	0.7	0.7	0.8
Water	0.8	0.9	1.0	1.2	1.3	1.6	1.7	1.2	1.3	1.6
Air	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2
Precision instruments	0.2	0.2	0.3	0.3	0.3	0.5	0.4	0.3	0.4	0.5
Noise	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.2	0.2	0.2
Climate protection	1.1	1.3	1.5	1.7	1.9	2.2	2.6	2.3	2.5	2.7
Rational use of energy	0.5	0.6	0.6	0.6	0.6	0.8	0.8	0.8	0.8	0.9
Rational energy conversion	0.3	0.3	0.3	0.4	0.3	0.3	0.4	0.4	0.3	0.5
Renewable energy sources	0.4	0.5	0.6	0.7	1.0	1.1	1.3	1.1	1.3	1.3
Total exports of potential environmental protection goods	2.7	3.0	3.4	3.8	4.4	5.2	5.8	4.6	5.1	5.7
Total imports of potential environmental protections goods	2.6	2.8	3.1	3.5	3.9	4.2	4.3	3.6	4.1	4.6
Balance of exports-imports of pot. environmental protection goods (in € billions)	0.1	0.2	0.3	0.4	0.5	1.0	1.5	1.0	1.0	1.1
Share of environmental goods exports of industrial goods exports (in %)	4.0	4.3	4.3	4.7	4.8	5.2	5.6	5.7	5.4	5.4

Note:[1]Adjusted to account for double counting.

Source: OECD, ITCS – International Trade By Commodities, Rev. 3 (different years). – COMTRADE database, Statistics Austria. Calculations by NIW.

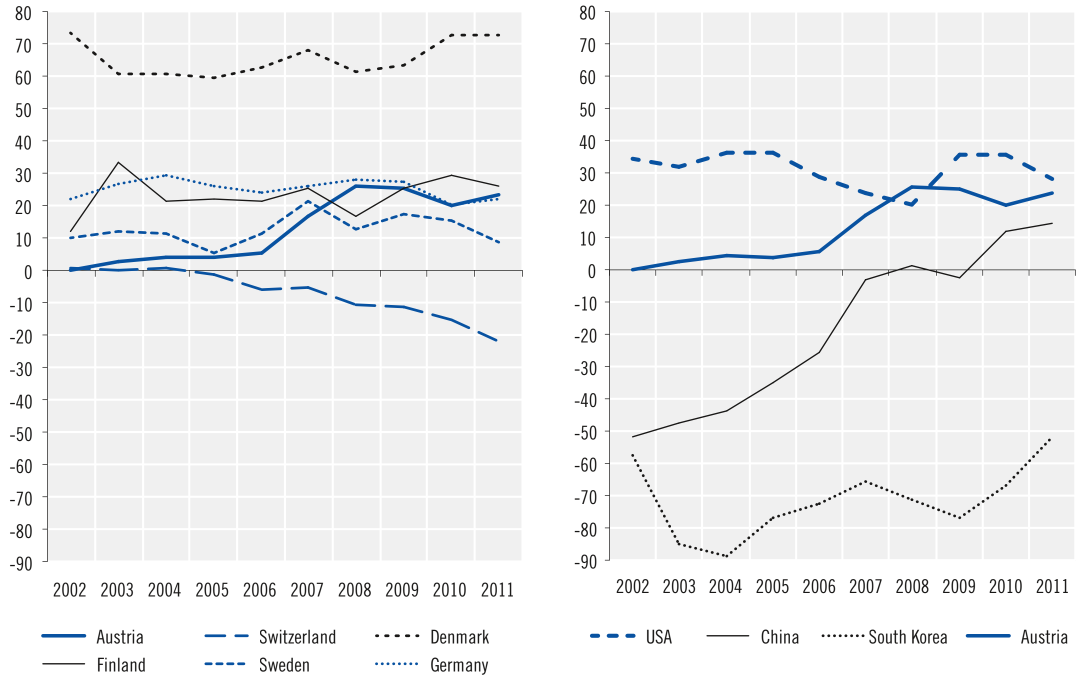
requisites for the realisation and marketing of environmental innovations.

The development of exports is one of the central indicators for the competitiveness of sectors and is of central importance for small open economies such as Austria's. The following discussion presents Austria's export performance and specialisation on the basis of classifications by Germany's Institute for Economic Research in Lower Saxony on potential environmentally friendly goods (see Annex: Klassifikation von potenziellen Umweltschutzgütern (Gehrke et al. 2012)). Potential environmental protection goods are exclusively those material goods that can be classified by the context of their usage, such as waste disposal and climate protection.

Tab. 20 shows the development in exports of potential environmental protection goods in € billions. It is clear that all groups of goods have increasing export figures for the period from 2002 to 2011. Potential climate protection goods was already the most significant group of goods in 2002 and delivered export revenues of € 2.7 billion in 2011, half of which came from renewable energy sources. An analysis of export growth rates shows that goods for renewable energy sources have the most dynamic growth; from 2002 to 2011, these exports grew by 230%, while climate protection goods also rose overall by an impressive 140%. There were lower growth rates for merchandise having to do with air and noise, even if these goods already started at a low level in 2002. Total exports of potential environmental protection goods rose from € 2.7 billion by 109% to € 5.7 billion in 2011. For the sake of comparison, total exports of manufacturing wares increased by approximately 53% during the same period. As a consequence of this growth, the percentage of potential environmental protection goods in manufacturing exports rose from 4% to 5.4%. Moreover,Tab. 20 shows that trade in environmental goods makes a positive contribution to the activation of the trade in goods balance, posting a positive sectoral trade balance of € 1.1 billion in 2011.

This solid performance is also discernible in an analysis of Austria's advantages compared to other economies. Such a comparison uses the typical index value of the Revealed Comparative Advantage (RCA), which considers import competition in addition to exports. This method standardises the import/export relation of a spe-

Fig. 45: Specialisation of selected countries (RCA values) for potential environmental protection goods



Note: RCA: a positive figure means that the export/import ratio for this product group is higher than for manufacturing wares overall.

Source: OECD, ITCS – International Trade By Commodities, Rev. 3 (different years). – COMTRADE database. Calculations by NIW.

cific group of goods with the import/export relation for all manufacturing goods. Positive values denote a comparative advantage, while negative values indicate a comparative disadvantage in foreign trade for a specific group of goods.[144] Fig. 45 presents the development of Austria's specialisation and its comparative advantages in the export of potential environmental protection goods. The RCA values are positive for the entire period from 2002 to 2011, meaning that these data demonstrate that Austria has a comparative advantage in potential environmental protection goods. It is also clear that this advantage increased significantly in the years before the crisis. In comparison to other countries, such as Germany and Finland, this growth led to a catching-up process, while Denmark, due to its position as a global leader in such areas as wind power, had even stronger specialisation advantages. Switzerland has an increasing comparative disadvantage. The right side of Fig. 45 presents Austria in comparison with the USA, China and South Korea. These two Asian countries are making massive investments in measures to promote environmental technology industries. In fact, in the case of China in particular, there is extraordinarily dynamic development, even if this only recently turned the corner from a comparative disadvantage to a comparative advantage. In any case, however, this dynamism in Chinese exports of potential environmental protection goods may continue over the medium term.

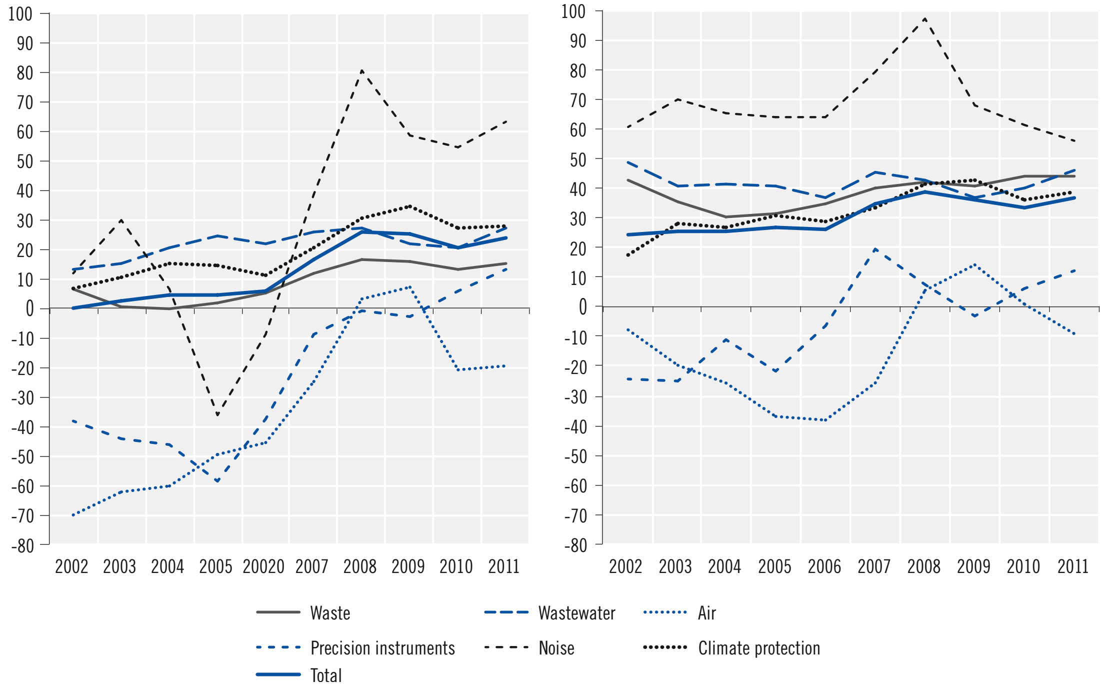
While Fig. 45 shows the comparative advantages in trade in potential environmental protection goods in comparison to other countries, Fig. 46 presents the revealed comparative advantages

144 See Siebert, Lorz (2007).

(RCA) (right side) as well as the relative share of global trade (RXA) (left side) for the individual sub-groups of potential environmental protection goods from Austria. A positive RXA value indicates that Austria has a higher export share of overall Austrian exports in the respective group of goods than the export share of this group of goods in global exports. In contrast, the RCA only assesses the national export sector. The RXA measures deviations in the Austrian export structure from the average global export structure and is therefore a measure of export specialisation. A positive RXA value indicates an export specialisation. Fig. 46 shows both indicators for potential environmental protection goods have comparative advantages and a positive export specialisation; these advantages and this specialisation increased over the period from 2001 to 2011. There is a clear split in potential environmental protection goods into waste, wastewater, noise and climate protection on one hand, and precision instruments and air on the other. Austria has comparative advantages and a positive export specialisation for the first group, but not for the second.

Even if trade is not a zero-sum game, the shift in global trade shares is another important indicator of the competitiveness of sectors. The development of global trade shares of potential environmental protection goods is depicted in Tab. 21, with countries organised in descending order according to the changes in their market shares. The last column shows that China and to a lesser degree South Korea were able to gain market shares. Austria is the only highly developed economy that did not suffer any losses in global

Fig. 46: Austria's foreign trade specialisation for potential environmental protection goods, RCA (left) and RXA (right)



Note: RXA: a positive figure means that the share of world trade in this product group is higher than for manufacturing wares overall.
RCA: a positive figure means that the export/import ratio for this product group is higher than for manufacturing wares overall.
MSR: Precision instruments.

Source: OECD, ITCS – International Trade By Commodity Statistics, Rev. 3 (different years). – COMTRADE database, Calculations and estimates by NIW.

Table 21: Global trade shares of potential environmental protection goods and their changes

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Change 2002–2011 in percentage points
China	4	4.7	5.7	7	8.3	9.7	10.9	11.5	14	14.5	10.5
Korea	1.7	1.3	1.4	1.6	1.7	1.7	1.7	2.1	2.1	2.4	0.7
Austria	1.7	1.8	1.9	1.8	1.8	2	2	1.9	1.7	1.7	0
Finland	1.2	1.4	1.1	1.1	1.1	1.2	1.1	0.8	0.9	0.9	-0.3
Germany	15.5	15.5	15.5	15.7	15.8	15.6	16.1	15.7	15	15.2	-0.3
Sweden	2	2.1	2.1	1.8	1.8	1.9	1.9	1.7	1.6	1.6	-0.4
Switzerland	1.9	1.8	1.8	1.7	1.5	1.6	1.6	1.7	1.5	1.4	-0.5
Denmark	2.1	2	1.8	1.8	1.8	1.9	1.9	1.9	1.7	1.5	-0.6
USA	14.4	12.4	11.8	12	11.3	10.6	10.4	11.3	11	10.8	-3.6

Note:Share of a country's exports in the world's total exports in %. Global exports are calculated from the exports of the OECD countries, China and Hong Kong plus the imports from the country groups not mentioned.

Source: OECD, ITCS – International Trade By Commodities, Rev. 3 (different years). – COMTRADE database, Calculations by NIW.

Table 22: Regional structure of exports of potential environmental protection goods

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
EU 27	74.1	73.2	72.1	69.0	69.8	68.0	68.3	64.9	66.5	63.8
USA	4.5	3.4	3.1	3.5	3.8	3.5	3.7	3.5	4.5	6.1
BRIC	2.6	3.2	3.9	6.1	5.5	6.4	6.6	7.0	7.0	7.0
Other regions	18.8	20.2	20.8	21.4	20.8	22.1	21.4	24.6	22.0	23.1
World	100	100	100	100	100	100	100	100	100	100

Source: OECD, ITCS – International Trade By Commodities, Rev. 3 (different years). – COMTRADE database. Calculations by NIW.

trade share; instead, Austria was able to stabilise its share at about 1.7%. The USA in particular is consistently losing global market share.

A regional distribution of exports of potential environmental protection goods is shown in Tab. 22. Developments in this regard correspond broadly to the economic policy goal of diversifying export markets and increasing presence in the BRIC countries in order to participate in their growth edge. The EU-27's dominant 74% share in 2002 fell by about 10 percentage points to about 64% in 2011. In comparison, the share of total exported goods to the EU-27 countries was about 70% in 2011. The situation is precisely the reverse with regard to the BRIC countries: the export of potential environmental protection goods in these countries is higher at 7% than overall goods exports (6.3%).[145]

To conclude, the Austrian green manufacturing sector has a positive outlook for competitiveness. There are increasing comparative advantages and positive export specialisations, as well as above-average growth in exports with a very positive sectoral trade balance. Austria was able to hold its position on the global markets, despite massive catching-up processes in China and other upwardly mobile economies, and Austria was able to diversify its export structure for potential environmental protection goods in an advantageous way. Austria's solid position on the Eco-Innovation Scoreboard points to attractive framework circumstances. This means that Austria

145 See BMWFJ (Federal Ministry of Economy, Family and Youth) (2012).

has an outstanding initial competitive position in terms of green manufacturing capacities. These must be taken advantage of and turned into value creation and successful exports.

4.7 Summary

The role of manufacturing and its contribution to innovation, exports and employment is once again at the centre of economic policy debates. Numerous countries and the European Commission are pursuing a strategy of re-industrialisation.

The global shift in manufacturing production capacities in recent years has resulted in China having extraordinarily dynamic growth in manufacturing. At the same time, manufacturing output per capita remains significantly higher in the OECD countries than in China, India or Brazil.

Austria belongs to the group of countries with the highest proportion of manufacturing in international comparisons. Nevertheless, the share of manufacturing has fallen over the long term, even though manufacturing's share of value added has stabilised over the last fifteen years – aside from the crisis – similar to Germany or Switzerland. Employment in manufacturing, however, has fallen, both in absolute numbers and as a percentage of overall employment. There has been a strong increase of manufacturers in the medium technology segment in the course of technological change within manufacturing. Although the share of high technology is still low, medium technology manufacturing in Austria has been relatively more R&D intensive than in relevant reference countries. In general, manufacturing in Austria has undergone a successful process of internationalisation since 1990, an expression of its solid competitiveness that has prevented a further unravelling of the industrial core.

Manufacturing drives the technological evolution of an economy to a degree far exceeding its relative size in the economy. Most R&D and innovation activity is carried out by the manufacturing sector – often, of course, in close cooperation with the service sector. Different technologies and competitive intensities may be the crucial explanatory factors for this. This superior innovation performance continues to the degree that manufacturing is a motor of growth in productivity. The same case also applies to the export sector. The role of manufacturing for R&D and innovation is also underscored by the fact that the innovation leaders are considerably more industrialised than the innovation followers, moderate innovators, and modest innovators, although they are characterised by a lower level of development.

Austria is well positioned in key enabling technologies in terms of its R&D, production and marketing capacities. In the past decade, the Austrian manufacturing sector has greatly expanded its patent activities in the area of key enabling technologies. This has given Austria greater weight in the global production of new technological expertise in these fields of technology, which are particularly important for future competitiveness. The strengthening of its position in patent applications also brings along a powerful expansion of Austrian exports of key technology-based products.

An empirical study of Austria's green manufacturing shows positive dynamics and ever greater competitiveness in these sectors. High growth expectations for environmentally friendly merchandise on global markets opens up realistic options for a significant expansion of state-of-the-art, ecologically sustainable manufacturing.

Manufacturing will continue to play an important role in the future performance of innovation systems in highly developed countries such as Austria. This theory rests above all on the argument that product and process innovations are often complementary, especially in technologically progressive sectors. This creates a necessity for spatial proximity between R&D and design activities as well as production locations.[146] To

146 See Tassey (2010), Aghion et al. (2011), Psiano, Shih (2012).

put it another way, an outward migration of production can also mean a loss of R&D units in the medium term.[147]

Austrian manufacturing is a success story. Its success is based mainly on motivated, competent entrepreneurs and skilled workers who are ready to perform. There are also circumstances in Austria that are shaped in a particularly auspicious way with regard to social partnerships and European integration.[148] The opening of Eastern European markets and the domestic market, and the rising competitive pressure resulting from it, have contributed to a reinvigoration of domestic manufacturing firms. Further improvements to the human capital pool will be critical going forward. Special attention must be given to schools and internships as well as the education of scientists and engineers at universities and universities of applied sciences. Industrial policy – which in Austria is primarily innovation policy, and quite rightly so – can set the tone and provide incentives for further improvement of international competitiveness. The necessary instruments and institutions are already in place. Above all, it is necessary to continue the successful course of recent years and take a flexible, collaborative approach to meeting the challenges facing the manufacturing sector in Austria.

147 See Kattinger (2012).
148 See Butschek (2012).

5 Innovation at the business enterprise level

A continuous implementation of innovations is the driving force behind lasting corporate success, which in turn leads to economic growth and employment. In this context, we will investigate the effects of R&D expenditure on employment growth and the export orientation of firms in Austria. Furthermore, the European innovation survey (Community Innovation Survey – CIS) provides a data source that lets us analyse and compare corporate innovation behaviour in Austria. This chapter focuses initially on the innovation performance of Austrian firms in international comparison before entering into a deeper analysis of differences in innovation behaviour among various sectors and especially in relation to company size. Finally, we take a look at fast-growing new companies in Austria and Germany with regard to the sustainability of their growth trajectory. The background here is that observers often ascribe an essential role to these companies in terms of structural change and the generation of employment. This is why the EU Commission is also focusing renewed attention on the topic of "fast-growing companies" in the context of "Europe 2020" by introducing an indicator dedicated to this feature starting in 2013.

5.1 The effect of R&D on employment

By the early 1990s at the latest it had become clear that research, technological development, and innovation are associated with growth. At the European level, it is *common sense* that innovations are viewed as an important engine of growth for Europe as a business location: "*Europe's competitiveness, our capacity to create millions of new jobs to replace those lost in the crisis and overall, our future standard of living depends on our ability to drive innovation in products, services, business and social processes and models*."[149]

Although the positive correlation between R&D, innovation, growth and employment is proclaimed again and again, the empirical evidence can be difficult to interpret. It is particularly evident at the macroeconomic level that the causal connections between inputs (research) and outputs (growth and employment) are complex and multi-dimensional.[150] Along with the question of how economic developments influence R&D expenditure, such spending is certainly more dependent on future expectations than all other investments and therefore exhibits a pattern that is not necessarily parallel to economic cycles. This is because the effects of research, technological development and innovation (RTI) on the creation of new jobs depends in particular on the period that is selected for analysis, on the new technologies in the respective fields, on the competitive situation in the relevant market, and the potential structural adaptability of the employment market. It is therefore scarcely possible to speak of a direct, linear connection between RTI and new jobs in the overall economy. Nevertheless, most macroeconomic models identify a positive correlation of the effects of RTI on employment, because technological progress works to strengthen growth, which in turn affects employment and the relationship between output growth and employment – despite

149 European Commission (2010a), p. 2.
150 See Schibany, Gassler (2010).

the complex chains of causality within a small open economy.[151]

Similar to the evaluation of RTI in terms of employment and growth at the overall economic level, there are also theoretical assumptions underpinning the models that associate RTI and employment at the business enterprise level. However, at the company level it is only possible to a limited degree to evaluate crowding-out effects. It is difficult to differentiate whether the positive developments in revenue and employment at an innovating company that performs R&D can be attributed to pure market expansion, or whether this development stems from a crowding-out effect.[152]

Nonetheless, the causal connections between RTI and employment at the business enterprise level can be assessed in a much clearer way, both in theoretical and empirical terms. The decision at the business enterprise level to invest in R&D depends, of course, on many influencing factors, such as the development of demand and markets, economic circumstances, and whether such investments actually bring about the desired profits. The tone of most studies, however, indicates that RTI benefits firms in any case, and that this has a positive effect on employment.

A recently published study by Falk et al. (2013) assessed the effects of R&D expenditure on employment development and export orientation in Austria. With its focus on the company level, this study numbers among the most profound studies of economic growth at companies that conduct R&D, and it delves into developments before and after the economic and financial crisis in particular.

Data base

The data base is comprised of company data from the Austrian Research Promotion Agency (FFG), which recorded data on about 700 companies performing R&D during the period from 2009 to 2011. This data, which comes from funding requests to the general programmes, contains information about revenue, employment, R&D expenditure, R&D personnel, the age of the company, export ratio, cash flow, and regional affiliation. This high-quality data also includes small firms with fewer than ten employees as well as service firms.

5.1.1 R&D intensity and employment growth before and after the crisis

Falk et al. (2013) initially pursue the question of whether firms with high R&D intensity have higher employment growth. The study measures R&D activities as the proportion of R&D expenditure in terms of revenues and classifies business enterprises into three groups: (i) less than 3%, (ii) three to 15%, and (iii) more than 15%. The following Fig. 47 provides a clear picture. Employment growth climbs continuously with R&D intensity.

Between 2006 and 2008, firms with lower R&D intensity posted an average annual employment growth rate of 2.9%. In the same period, firms with medium R&D expenditure had more than double that rate in employment growth at 6.1%. Firms with an R&D intensity of more than 15% had an even higher figure. Although the financial and economic crisis slowed down employment growth significantly, firms with a high R&D intensity suffered less of a dampening effect than others.

5.1.2 R&D intensity and employment growth according to company size

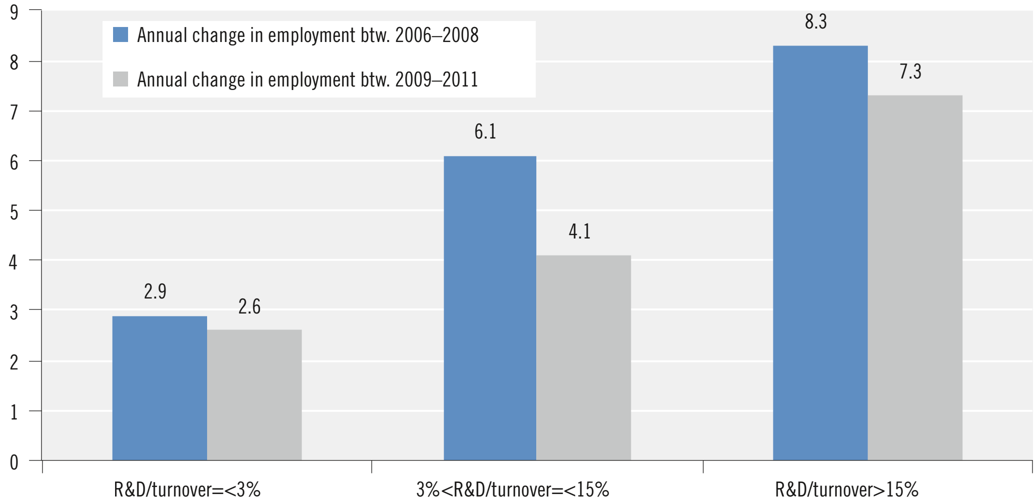
Falk et al. (2013) also evaluated the data by company size classes in order to get a more detailed look at the association between R&D expenditure and employment effects. Companies were subdivided

151 "The long-run economic impact of innovation on employment is clearly not negative; many decades, and even centuries, of innovation in advanced economies have been accompanied by employment growth instead of the ever-decreasing levels of jobs that many predicted." (Harrison 2008, p. 2).

152 See Harrison (2008).

into three groups on the basis of their size: (i) fewer than 50 employees, (ii) between 50 and 249 employees, and (iii) 250 or more employees. Start-ups and young companies that were founded in 2006 or later are not included in the analysis because these firms often exhibit rapid employment growth and therefore are not comparable with established companies. Descriptive statistics also

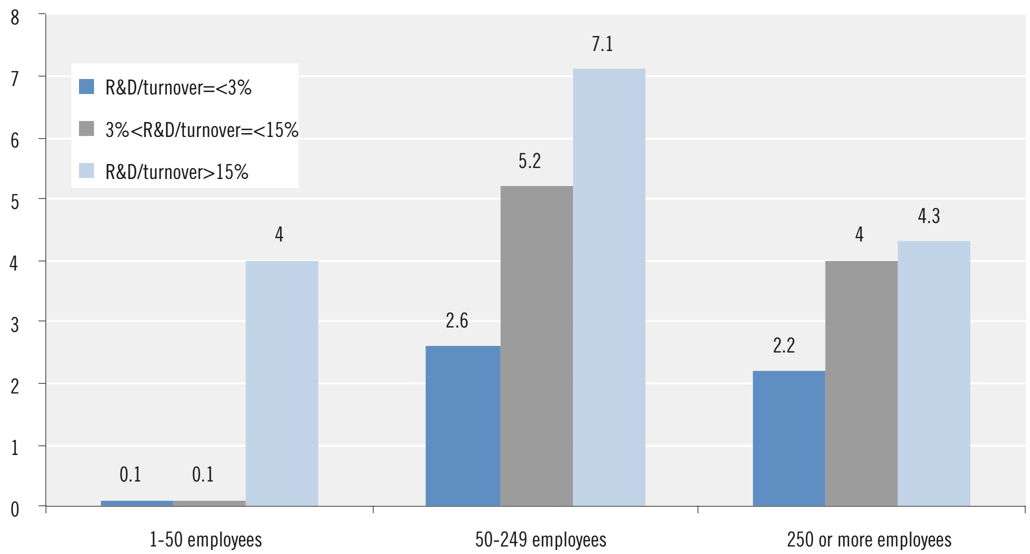
Fig. 47: Annual growth in employment by R&D intensity in %, 2006–2011



Note: Evaluation based on 1,752 (2006–2008) and 752 (2009–2011) firm assessments.

Source: Core data from the Austrian Research Promotion Agency (FFG). Calculations by the Austrian Institute of Economic Research (WIFO), Falk et al. (2013).

Fig. 48: Annual growth in employment by R&D intensity and company size in %, 2009–2011



Note: Number of assessments: 615. The sample does not contain any new companies (founding year 2006 or later). The average is the median measured across all firms.

Source: Core data from the Austrian Research Promotion Agency (FFG). Calculations by the Austrian Institute of Economic Research (WIFO), Falk et al. (2013).

confirm a positive correlation between R&D intensity and employment development in all company size classes for this selection criterion.

The results show that between 2009 and 2011, firms with medium and high R&D intensity, regardless of the number of employees, had significantly higher employment growth than companies with lower R&D intensity. The largest gain in employment took place in research-intensive firms with 50 to 249 employees. Companies in this size class that invested either between 3 and 15% or more than 15% of their revenue in R&D activities in 2009 experienced the highest average annual gains in employment from 2009 to 2011 at 5.2% and 7.1% respectively. The comparison between small firms with lower R&D intensity and those with an R&D intensity of more than 15% was especially remarkable. Employment growth within this group was borne exclusively by the most innovative, fastest-growing firms ("gazelles").

Falk et al. (2013) then conducted a regression analysis on the basis of cross-sectional data as a supplement to the descriptive results. The empirical results on the basis of median regression show that R&D personnel intensity (defined as the proportion of R&D employees among all employees) of firms at the beginning of the period under investigation (2006 and 2009) had a positive and significant influence on employment growth in subsequent years. According to Falk et al. (2013), this means that R&D intensive companies of comparable size and comparable age grew faster than companies that were not R&D intensive. For the latest period from 2009 to 2011, the results demonstrate that firms with an R&D personnel intensity that was ten percentage points higher exhibit 0.9 percentage points higher growth rates.

5.1.3 R&D intensity and employment growth according to company age

This positive correlation was confirmed at an even higher level with regard to the question of how a firm's age influences employment. This is because very research-intensive young companies (founded in 2006 or later) have annual employment rates of 22.5%, which is twice as high compared to young firms with medium R&D expenditure. Even young companies with lower R&D expenditure delivered surprisingly strong employment growth at a rate of +4.5%, while employment sank on average in all company age classes by -0.3% each year. This result of course reflects a natural course of events because young and newly founded companies create jobs at first, and they cannot shed jobs if they do not have any employees. This is of course different for large and established firms.

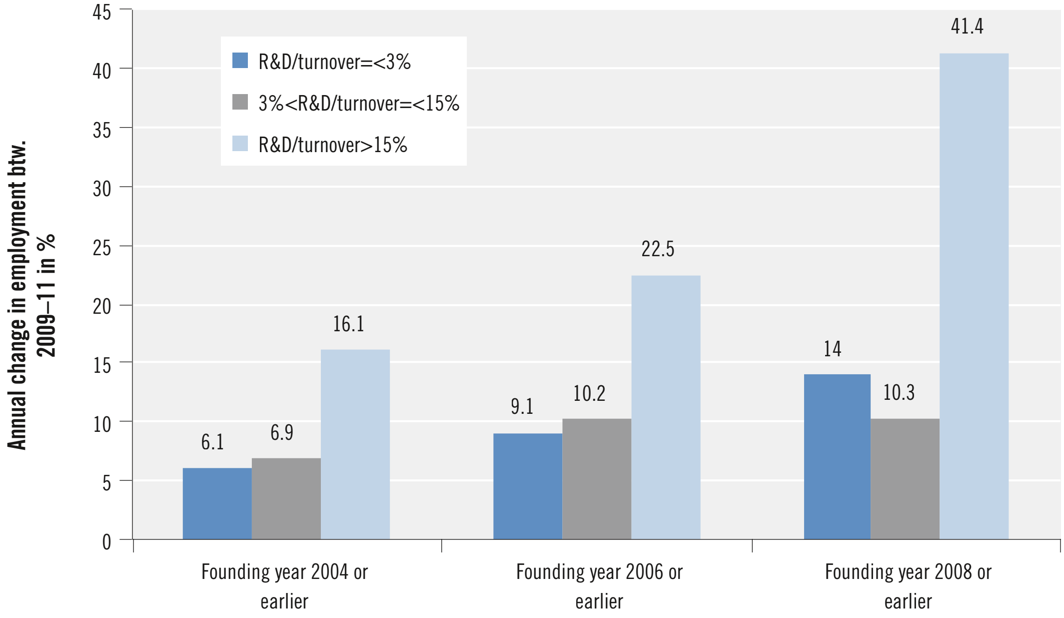
If young companies are further differentiated on the basis of their founding date, the increasing importance of R&D intensity among young firms in particular becomes clear. At the same time, this suggests that the Austrian economy is going through a process of becoming younger, as Falk et al. (2013) emphasise (see Fig. 49).

Firms that were founded in 2008 or later exhibited a higher employment dynamic throughout the period from 2009 to 2011 than did companies that were founded two to four years earlier. This effect proved to be particularly pronounced among young companies with R&D expenditures of more than 15%. They attained an average employment growth rate of 41.4%, almost twice as high as firms that were just two years older and that had similar R&D intensity. It shows that young, research-intensive business enterprises in particular increased their employment numbers substantially, thereby assuming an important position in the structural transformation of the Austrian economy.

5.1.4 R&D intensity and export ratio according to company size

The following Fig. 50 also shows a close relationship between R&D intensity and the propensity to export. The calculations by Falk et al. (2013) reveal, on one hand, a positive association between research intensity and the propensity to export, while on the other hand, company size was a decisive factor when it came to exports. Medi-

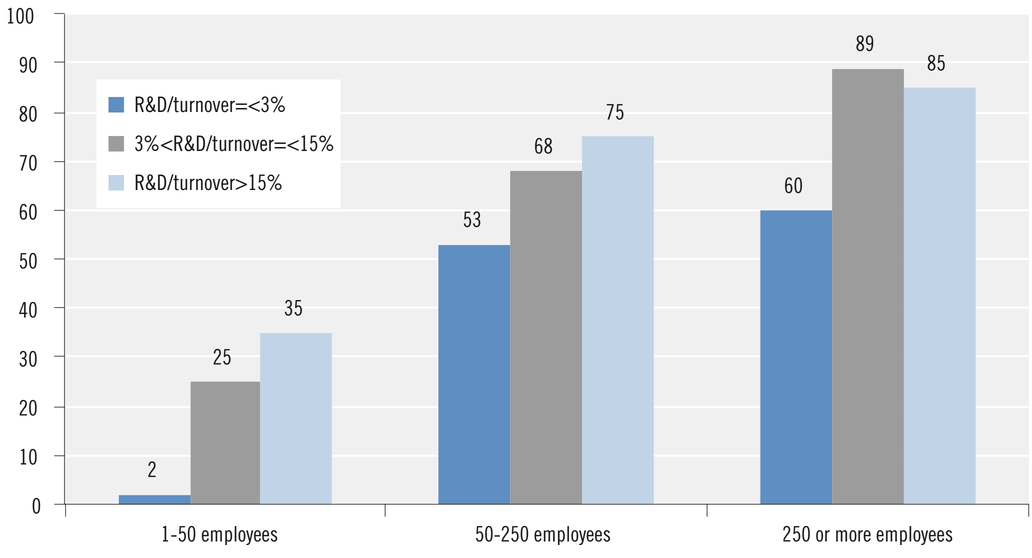
Fig. 49: Annual growth in employment by R&D intensity and firm age, 2009–2011



Note: The average is the median measured across all firms. Number of firms: 227 (founding year 2004 or later), 161 (founding year 2006 or later) and 87 (founding year 2008 or later).

Source: Balance data from the Austrian Research Promotion Agency (FFG). Calculations by the Austrian Institute of Economic Research (WIFO), Falk et al. (2013).

Fig. 50: Export rate and R&D intensity 2009–2011



Source: Balance data from the Austrian Research Promotion Agency (FFG). Calculations by the Austrian Institute of Economic Research (WIFO), Falk et al. (2013).

um-sized companies, even with a low R&D intensity of less than 3%, attained a significantly higher export rate of 53% from 2009 to 2011, which was more than one-and-a-half times the rate of the most research-intensive small firms. Those firms with an R&D intensity between 3% and 15% are finding 68% of their demand abroad. The same applies to large companies with 250 or more employees. In this size category, firms with medium R&D intensity export 89% of their goods abroad.

Falk et al. (2013) use a quadratic regression model to show a non-linear correlation between export rates and R&D personnel intensity. This means that the export rate rises continuously at first along with R&D personnel intensity, and then the positive effect of R&D employees on the export rate weakens as personnel intensity increases. Starting at an R&D personnel intensity of 45%, companies cannot get beyond the saturation point of 52% for average export rates; the curve plateaus at that point. Even firms that work almost exclusively on research, with three out of four employees working on R&D, cannot reach a higher figure on average.

Falk et al. (2013) examine the limiting factors in their analyses. The data base only includes a certain part of Austrian businesses, which means only those kinds of R&D companies for which the Austrian Research Promotion Agency (FFG) records and retains data. The analysis focuses on the factors of company size, founding date and period under observation to gain a statistical view of the effects of R&D intensity on employment growth and export rates. This is why other influencing factors are excluded. The general finding that technological change is one of the most important engines of growth in a developed economy is nonetheless sufficiently documented by an analysis of this kind.

5.2 Innovation activities in the business enterprise sector and the role of SMEs

The results of the seventh Innovation Survey (CIS 2010) were published in November 2012. The results provide the data base for this chapter, which on the one hand positions the innovation performance of Austrian firms in European comparison (i.e. with selected countries), and on the other, presents specifically Austrian detailed results for a series of indicators (e.g. at the industry level).

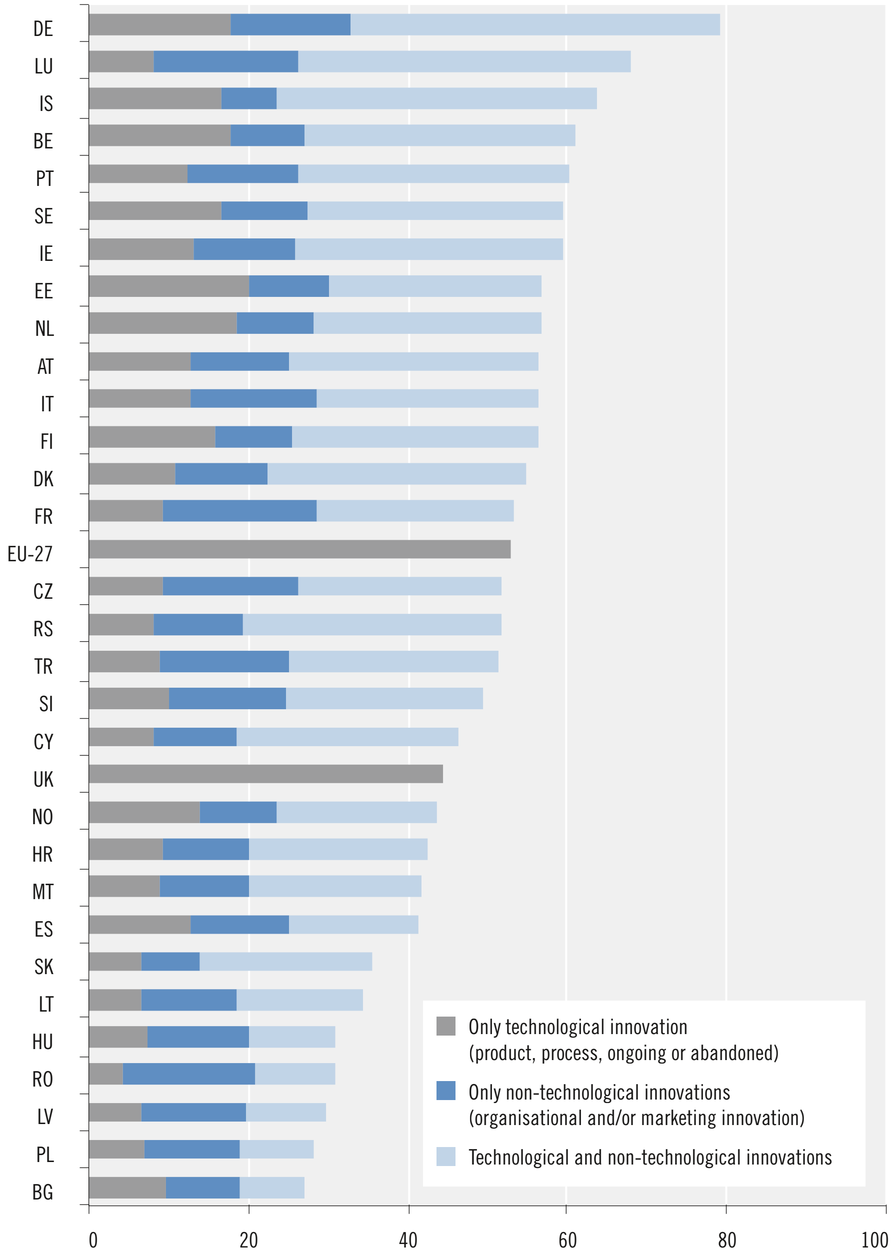
It should be noted that the European Community Innovation Survey uses a subjective definition of innovation, meaning that a surveyed company decided from its own (subjective) perspective whether and to what extent innovation activities were in place. This also captures those innovations that are new, at least for the firm, even if these innovations are not new to the market. In addition, a broad understanding of innovation is used, as has become customary in innovation surveys. Non-technological innovations such as organisational and marketing innovations were recorded along with technological innovations.

5.2.1 Innovation performance in European comparison

Fig. 51 shows the innovator ratio (proportion of innovating firms among all companies) for the participating countries, whereby a distinction is made among different types of innovation (and combinations thereof, as firms were able to perform innovation activities in a broad range of areas during the period under observation). In European comparison, there were decidedly large disparities with regard to the innovator ratio, with the span ranging from an 80% ratio of innovating firms in category leader Germany to just under 25% for last-place Bulgaria, with the European average standing at 53%. Austria has an innovator ratio of 56%, which puts it above the European average.

If we take a look at the different types of innovation, then we can see that in practically all countries there is a solid proportion of firms that perform both technological and non-technological innovation activities at the same time. Their share of all innovating firms moves between 30% and 60%. In Austria, 55% of all innovating firms

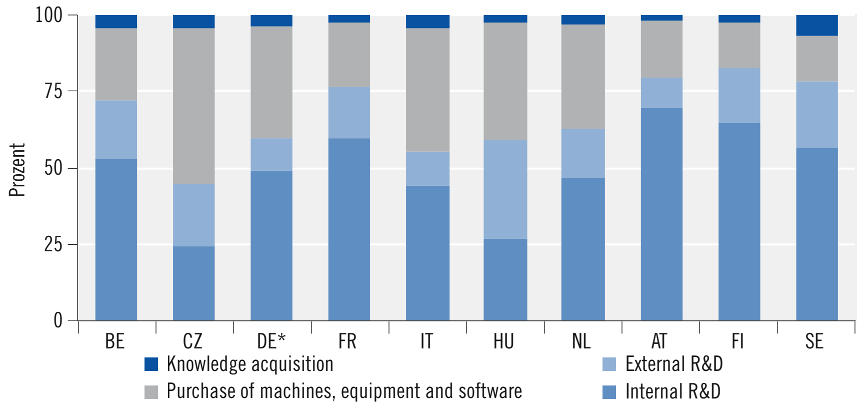
Fig. 51: Firms with innovation activities (as a % of all firms) in 2010



Note: It is not possible to differentiate between innovation types for the United Kingdom or for the EU-27.

Source: Eurostat CIS 2010. Calculated by JOANNEUM RESEARCH.

Fig.52: Distribution of innovation expenditures by activity types (as a % of firms with technological innovation activities) in 2010



Source: Eurostat CIS 2010; except * CIS 2008, as Eurostat did not publish any differentiation for innovation expenditures for Germany in the CIS 2010. Calculated by JOANNEUM RESEARCH.

are ranked in the group that performs both technological and non-technological innovation activities. This demonstrates that innovation processes are multi-dimensional, while technological and organisational changes are closely linked with one another. This is a circumstance that has been emphasised repeatedly in the innovation research of recent years and has also been expressed in diverse innovation policy measures that no longer aim exclusively at "hard" technologies.

A comparison to the sixth Innovation Survey[153] shows that these structures have remained robust over time. This applies for Austria as well. Only a few countries posted major deviations: the innovator ratio in the Netherlands, for example, climbed from 45% to 57%, and in Sweden from 54% to 60%, while it sank in the Czech Republic from 56% to 52%.

For innovation activities for product and process innovations (meaning for technological innovation processes), distinctions can be made between different types of activities, with weighting assigned by monetary expenditures for individual activities. Specifically, there are distinctions made between (i) internal corporate research and experimental development (intramural R&D), (ii) awarding of R&D contracts to third parties (extramural R&D), (iii) acquisition of machines, equipment, and software, and (iv) acquisition of external knowledge.[154] The results for selected countries are displayed in Fig. 52 . The majority of the reference countries shown here (including Austria) assign the greatest weight in the context of technological innovation activities to intramural R&D. About half of innovation expenditures are allocated to intramural R&D; in Austria, this figure reaches 69%. The second most important category of expenditures are investments in machines, equipment and software, which constitute one-third of expenditure (one-fifth in Austria). This *embodied technological change* is particularly important for those innovation systems that are catching up, such as those in Hungary or the Czech Republic. This was also the case for Austria up to the middle of the 1990s. In contrast, internal R&D efforts play

153 See CIS 2008, cf. FTB (2012).
154 This includes the purchase of patents and licenses, etc.

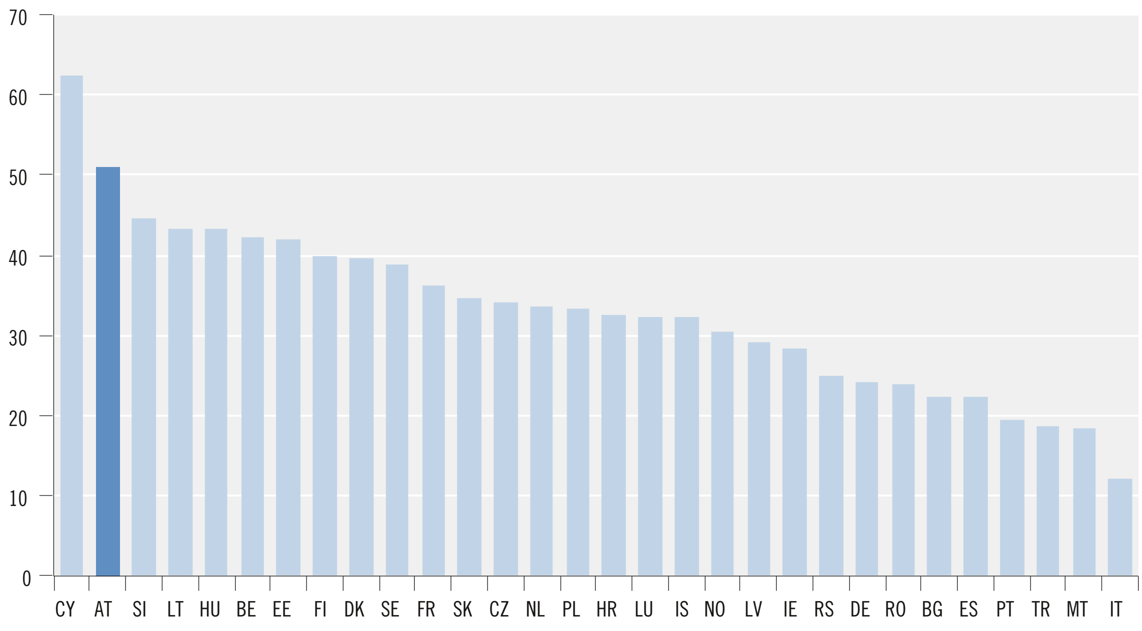
a larger role in "mature" innovation systems. In this regard, Austria has the highest proportion of R&D expenditure of all innovation expenditure among the reference countries, and has replaced Finland in the first-place ranking in comparison to the CIS 2008. Expenditure structures, however, have remained very consistent over time.[155]

Innovation cooperation

Both the innovative potential of individual stakeholders and their interaction in the form of cooperation networks are of major importance for an innovation system's performance. Intensive cooperative relationships among firms and between firms and (public) research institutions generate positive network effects in which newly generated knowledge continually flows among stakeholders, contributing to the rapid diffusion of new knowledge and innovations. Ultimately, these kinds of effects lead to the genesis of innovative milieus that have a high innovative potential and intensive exchange relationships. Fig. 53 shows the proportion of cooperating business enterprises among all firms with technological innovations.[156] In Austria, every second one of these firms is engaged in cooperation, which is the top value in Europe. In addition, the share of cooperating companies climbed by about 10 percentage points since the CIS 2008.

These cooperative ventures take place with different stakeholders. The CIS differentiates among the following categories: other firms within the enterprise group; suppliers; clients/customers; competitors; consulting firms/private R&D institutions; universities/universities of applied sciences as well as public non-university research institutions.

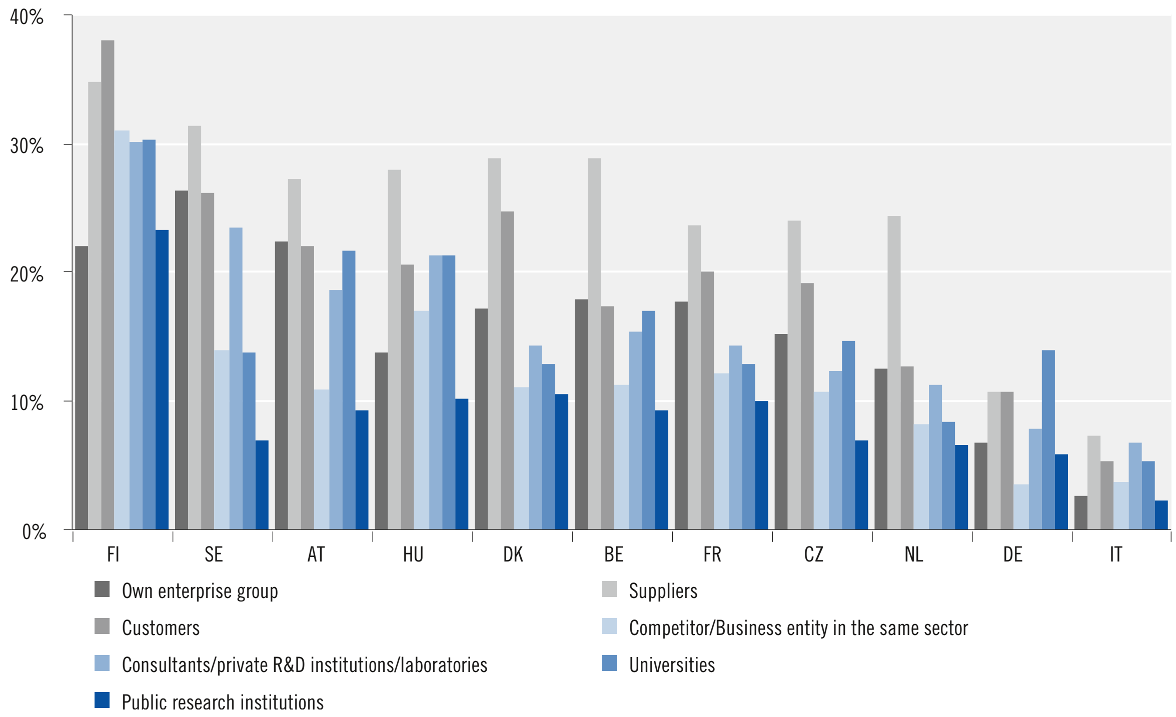
Fig. 53: Innovation cooperations in European comparison (as a % of all firms with technological innovations) in 2010



Source: Eurostat CIS 2010. Calculated by JOANNEUM RESEARCH.

155 See FTB (2012).
156 Surveying for cooperation partners is only done in the CIS for firms with product or process innovations as well as ongoing or discontinued technological innovation activities.

Fig. 54: Cooperation partners by groups of stakeholders (as a % of firms with technological innovation activities) in 2010



Source: Eurostat CIS 2010. Calculated by JOANNEUM RESEARCH.

The frequency of cooperation with these different groups of stakeholders is displayed in Fig. 54 for a series of selected countries.[157] Even if cooperation density among the countries varies widely, there is a uniform pattern in terms of the relative importance of groups of stakeholders for innovation cooperation. Suppliers, above all, and often customers too, are by far the most important cooperation partners. In a modern economy based to a high degree on the division of labour, innovation processes are organised along value creation chains in an interactive manner.[158]. Furthermore, innovation processes often take place in cooperation with consultants, private research institutions or public universities even if their importance does not reach that of vertical cooperative relationships. "Horizontal" cooperation with competitors or firms in the same industry play a lesser role in general. Cooperation with – comparatively few – public research institutions is even more rare.

Austria does not deviate from this general pattern in its cooperative relationships, even if Austria's cooperation intensity does not fully reach the extent of countries such as Finland or Sweden. A solid quarter of Austrian firms with technological innovations cooperate with suppliers, more than one-fifth with customers or

157 Differences in the country patterns between Fig. 42 and Fig. 43 can be explained by the respective types of questions: Fig. 42 shows the share of firms that reported engaging in some form of innovation cooperation. Fig. 43, in contrast, presents the proportion of cooperation with different partners, and multiple answers are possible. In Finland, for example, just under 40% of firms cooperate, yet they work together with many different partners on innovation projects.

158 The group of stakeholders designated "other firms within the corporate group" can also be included in these stakeholders because different subsidiaries within a corporate group are frequently organised according to the division of labour, meaning, for example, that subsidiary A is a supplier for subsidiary B in the same corporate group.

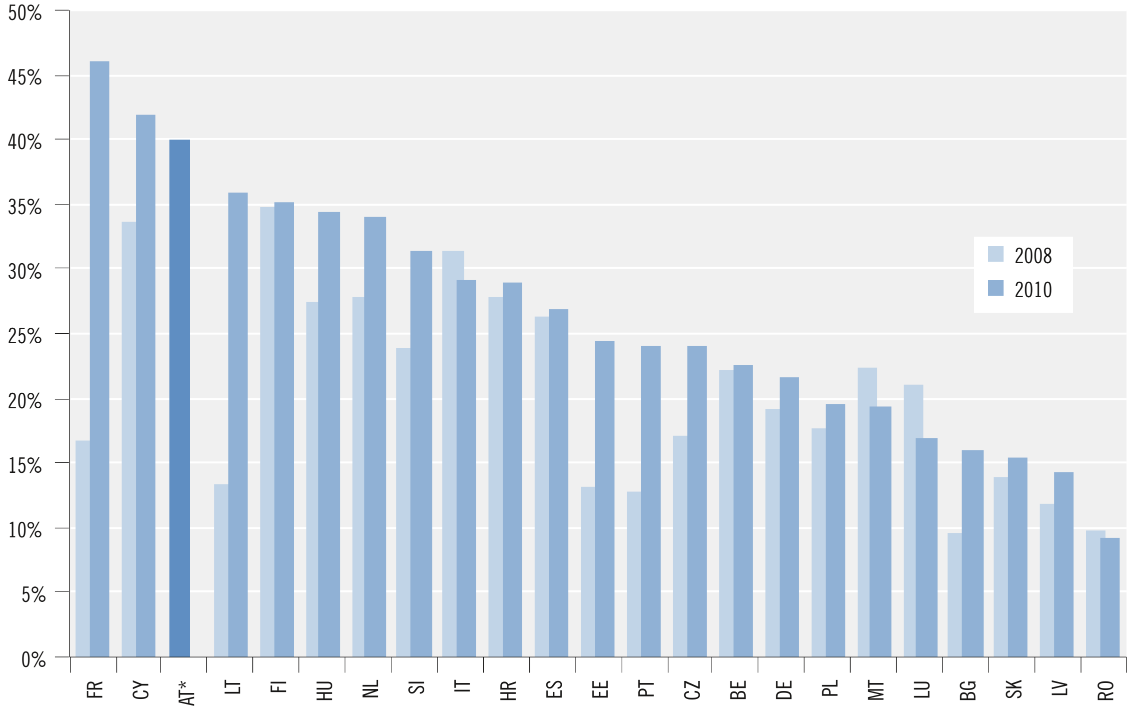
firms in their own corporate group. In comparison, in Finland, 35% work with suppliers and 38% with customers. Austria's relatively high cooperation density with universities and institutions of higher education is worthy of note. At 22%, it is significantly above the level found in most of the reference countries (Finland, one of the top countries, attains 30%). The Austrian innovation system has obviously become characterised by a comparatively intensive exchange relationship between the business enterprise sector and the university sector, which has been supported intensively by RTI policy for quite some time.[159]

Non-university research institutions play a markedly smaller role in Austria as cooperation partners in corporate innovation processes than do universities; just 9% of firms reported such arrangements. This is not unusual internationally (the only exception again is Finland, with 23%). It must be kept in mind that the non-university research sector in Austria is relatively small.

Innovation funding

Direct funding of corporate innovation activities is one of the central pillars of technology policy. This raises the question of the "range" – regardless of monetary framework[160] – that funding instruments have, i.e. whether they benefit a small group of firms or whether these instruments reach numerous innovative firms. Fig. 55 shows

Fig. 55: Innovation funding in European comparison (as a % of all firms with technological innovation activities), 2008/2010



Source: Eurostat CIS 2010 / 2008, * CIS 2008 only. Calculated by JOANNEUM RESEARCH.

159 See the comments in the FTB 2012.
160 In contrast to publicly funded shares of firm-related R&D expenditures, there was no information regarding the funding shares of total innovation expenditures in the business enterprise sector. Austria's funding system, with a funding share of 1% of R&D expenditures, is among the leaders in the European countries.

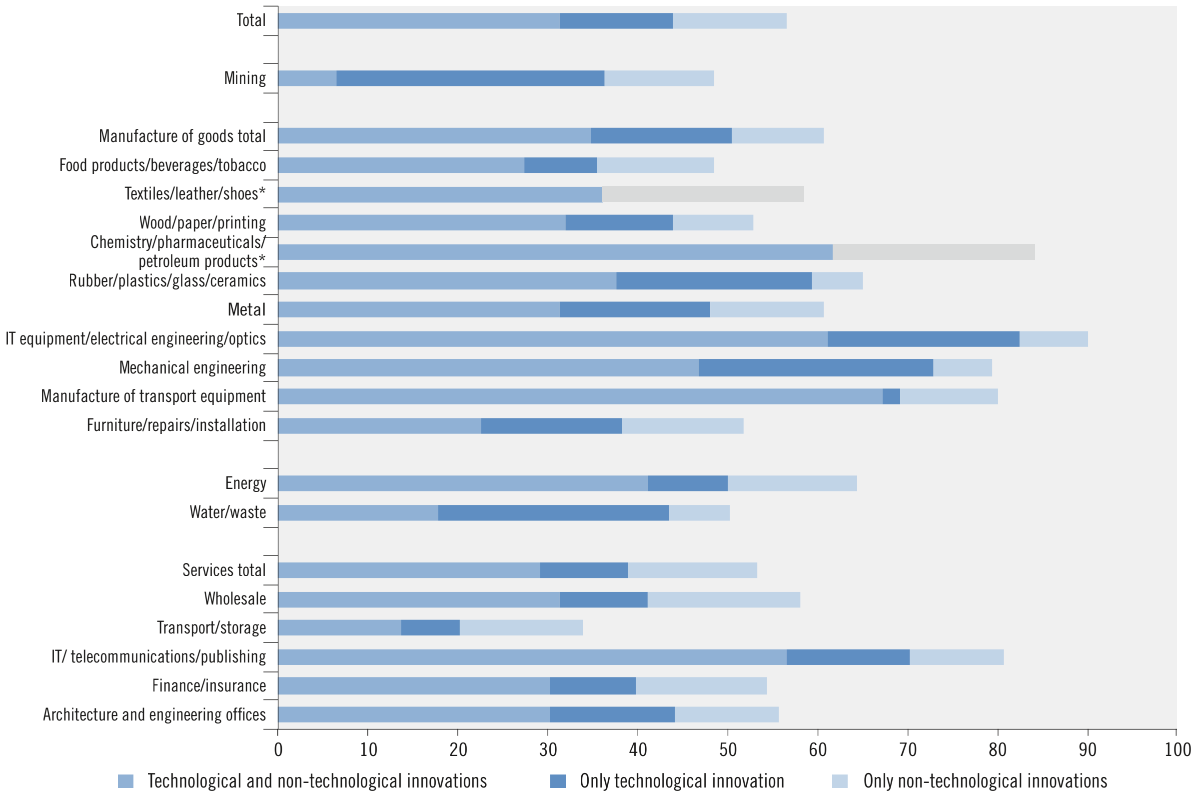
the results in European comparison. In Austria, about 40% of all business enterprises with technological innovation activities reported having received support measures from the public sector in 2008. Austria is at the top of all European countries in this regard. This question was no longer included in Austria in the CIS 2010. Current data show that in the meantime countries such as France have a similar ratio after a massive expansion in funding was carried out[161]. Nevertheless, the proportion of companies that receive support from public funds continues to be comparatively high in Austria.

5.2.2 Industry-specific results for Austria

The following discussion presents selected results from the Austrian Innovation Survey at the industry level. Differences according to company size are considered in detail in the following chapter.

Fig. 56 shows the innovator ratio in the individual industries, differentiated by type of innovation activity (technological versus non-technological). The proportion of companies actively engaged in innovation is about 50% or more in all industries; the only exception is transport and warehousing with 34%. There were especially

Fig. 56: Innovation ratio in Austria by industry (innovating firms as a % of all firms) in 2010



Note: * For the sake of confidentiality, Statistics Austria does not publish any figures for (non-) technological innovators in the textiles/leather/shoes and chemistry/pharmaceuticals/petroleum products industries.
Source: Statistics Austria CIS 2010. Calculated by JOANNEUM RESEARCH.

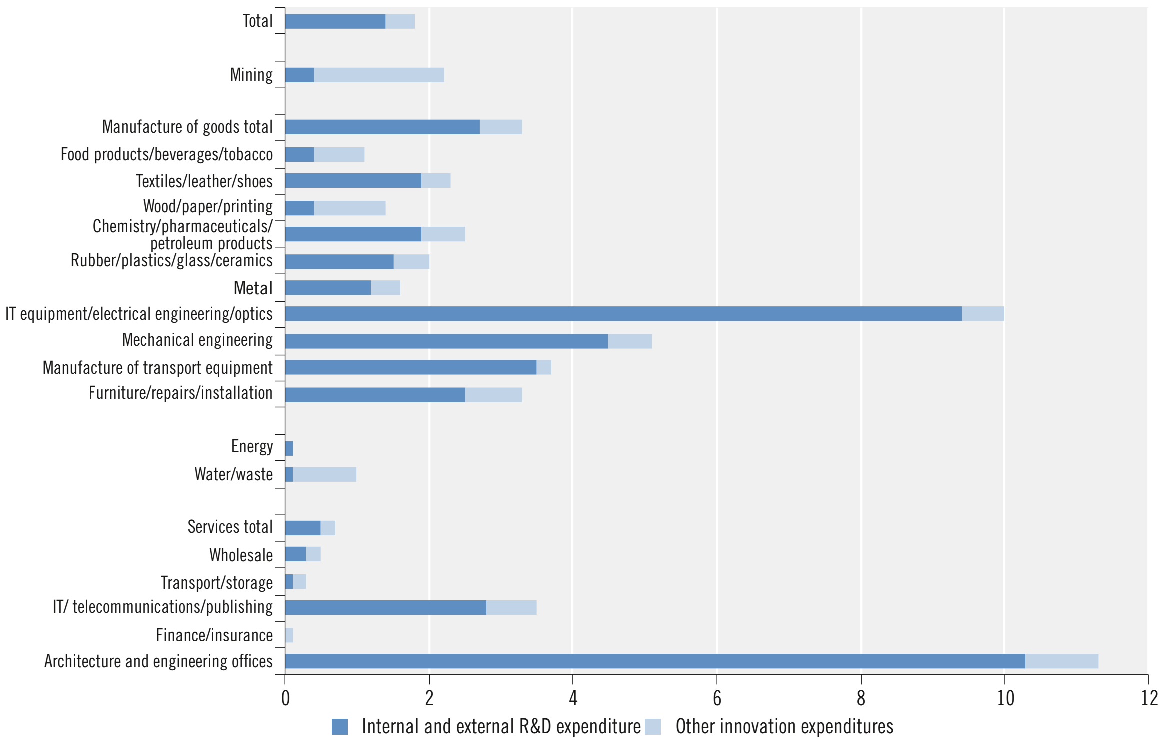
161 These include consolidation and development in areas of indirect R&D funding, cluster policy, innovation funding for SMEs by the OESO, and additional funds that are provisioned in the "Investments for the future" programme (see ERAWATCH Country Reports for France, various years).

outstanding figures in the "classic" technology industries of data processing/electrical engineering/optics (the innovator ratio here is 90%), the chemical and pharmaceutical industry (84%), and mechanical engineering, machinery and the automotive industry (each about 80%). The services sector in general has a somewhat lower innovator ratio (53%) than the manufacturing sector (61%). Heterogeneity within the services sector however is very high: along with the aforementioned last-place category of transportation/warehousing, it includes the IT industry (IT/telecommunications/publishing), which has one of the highest innovator ratios of all industries at 81%.

It is worth noting that in most industries the share of dual innovators, or firms that conduct both technological and non-technological innovation activities, dominates. Innovation processes are typically multi-dimensional and combine the development of new products or processes with organisational and marketing innovations.

In addition to the innovator ratio, this raises questions about the intensity of innovation processes and the extent to which this intensity differs among industries. A suitable measure for capturing the intensity of innovation processes is the share of innovation expenditures in turnover, which is presented in Fig. 57. There were

Fig. 57: Innovation performance by industry (share of innovation expenditures in turnover – firms with technological innovation activities) in 2010



Source: Statistics Austria CIS 2010. Calculated by JOANNEUM RESEARCH.

major differences between individual industries in this regard. While innovation activities are found with relatively steady frequency in the industries listed, the relative weighting of these innovation activities is distributed very unevenly. The front runners here are architecture and engineering firms with 11%, ahead of data processing/electrical engineering/optics with 10% of revenue spent on innovation expenditure. Intramural and extramural R&D expenditures dominate innovation spending in both of these sectors. This is the case in most industry sectors with high innovation expenditures intensity. In contrast, other innovation expenditures dominate in a few of the less innovation-intensive sectors, such as food products/beverages/tobacco, wood/paper/printing and publishing, water/wastewater, transport/warehousing, finance/insurance, and mining. There are also traditionally above-average R&D intensities in the mechanical engineering (approx. 5%) and manufacture of transport equipment (almost 4%) industries. In general, the average innovation expenditures intensity in manufacturing was 3.3%, which was significantly above the services sector (0.7%), whereby we must recall the previously mentioned heterogeneity in the services sector. We should also re-emphasise high structural persistence.

5.2.3 Innovation strategies at small and medium-sized enterprises

Small and medium-sized enterprises (SMEs) are especially important for the Austrian economy. Eurostat defines this class of companies as those firms that employ between one and 249 employees[162]. This group comprises 97% of all Austrian firms, accounts for two-thirds of all employment, and generates almost 60% of gross value added (Tab. 23). The innovation performance of all SMEs, however, cannot be fully examined because the European Innovation Survey (CIS) does not include small firms with fewer than ten employees. This analysis therefore concentrates on small and medium-sized enterprises with ten to 249 employees (hereafter referred to as SMEs). Due to the multitude of small companies, SMEs defined in this way account for only 12% of all firms; however, they are still responsible for 42% of all employees and 41% of gross value added, which makes them the backbone of the Austrian economy (Tab. 23).[163] This high level of importance raises the question of the extent to which innovation behaviour among Austrian firms depends upon the size of the firm and to what degree SMEs exhibit a specific pattern of innovation.[164] In the following analysis, please keep in mind that SMEs are not equally distributed across all industries. A few industry sectors have a lower proportion of firms with 10 to 249 employees: in the ICT sector (J), for example, this share is 7%; in mechanical engineering (C25) 29%, and in the paper industry (C17) 52%. The observable innovation behaviour of SMEs is therefore not due to their size alone, but rather to their specific industry affiliation. The influence of this sector affiliation cannot be checked or separately evaluated on the basis of the secondary statistical evaluation carried out here for the published overall results of the Austrian Innovation Survey of 2012. In Section 5.2.4, however, there are supplementary econometric analyses of the unpublished individual data, which allow the determination of the individual effect of a firm's size, in international comparison as well.

162 This includes micro-sized companies (1-9 employees), small enterprises (10-49 employees), and medium-sized enterprises (50–249 employees).
163 There is also the fact that in international comparison – and in contrast to other smaller countries, such as Switzerland, Finland, the Netherlands or Sweden – Austria's large firms are relatively "small" and that there are hardly any major corporations of note.
164 Kaufmann and Tödtling (2002) rightly point out that the SME sector is very heterogeneous and that this prohibits "simple generalisations". Nevertheless, the existing data provide the basis for a first impression.

Table 23: Share of company size classes in Austria's economic performance in 2010 (as a percentage)

	Number of firms	Annual average employees		Gross value added to factor costs
		Total	Employed	
Large companies (>= 250 employees)	0.3	33.1	36.8	42.0
SMEs (1-249 employees)	97.3	66.9	63.2	58.0
of which				
Micro-sized companies (< 10 employees)	87.4	24.8	17.3	17.3
Small and medium-sized enterprises (10-249 employees)	12.2	42.2	45.9	40.7

Source:Statistics Austria: Main results from the 2010 performance and structural statistics according to groups (3-digit) of the ÖNACE 2008 (sections B–N, S95) and by employment size classes. Calculated by JOANNEUM RESEARCH.

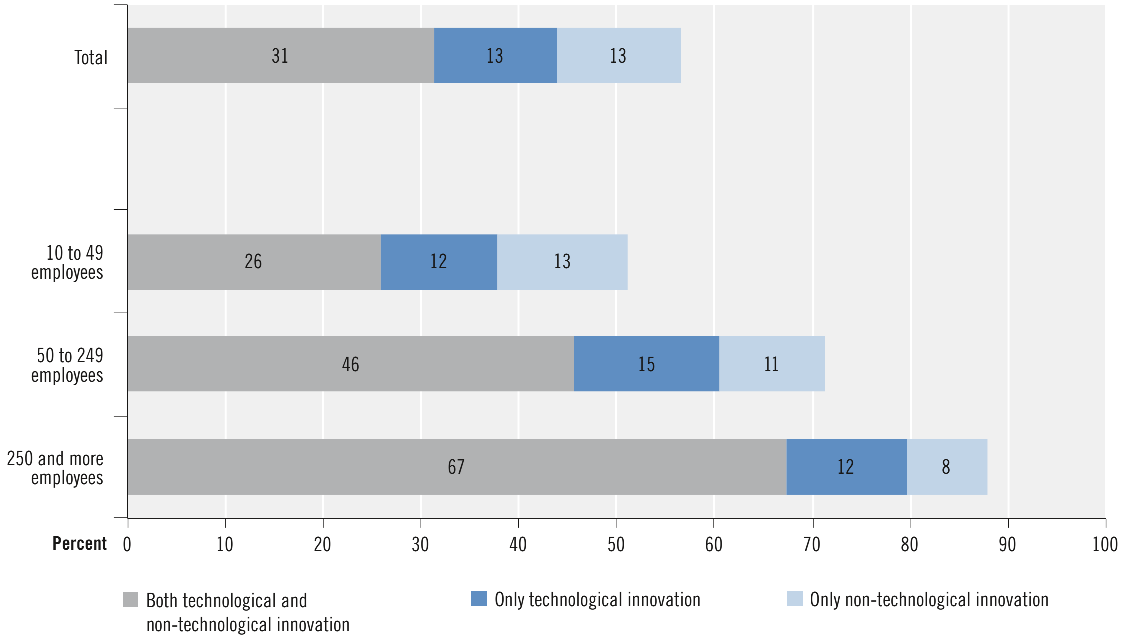
Innovation behaviour among SMEs – descriptive analyses

Fig. 58 shows that there is a pronounced connection between firm size and innovation regardless of industry sector: the larger a firm is, the more likely it is to perform innovation activities.

Half of small firms (10 to 49 employees) are innovative, while the figure for large companies stands at almost 90%. One of the main differences here is that SMEs are less often dual innovators, meaning that they produce both technical and non-technical (organisational and/or marketing) innovations.

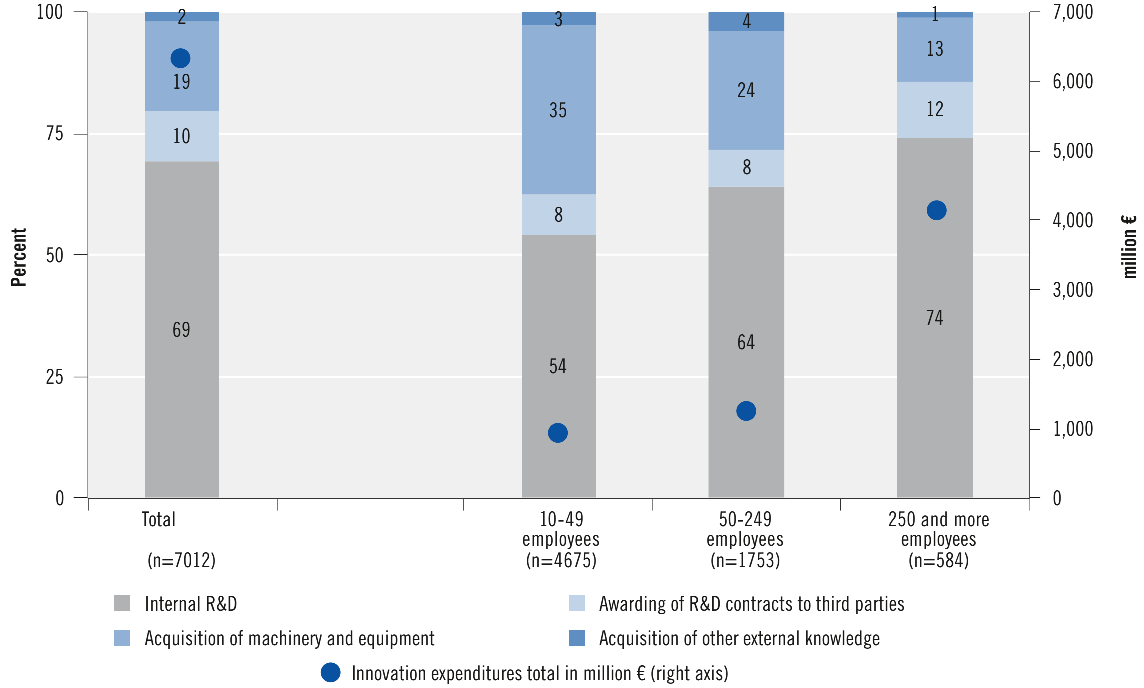
The results from Statistics Austria also show that small and medium-sized enterprises spend significantly less money on innovation than do larger firms (Fig. 59). This applies absolutely on one hand and relatively on the other whenever innovation expenditure is related to revenue: in-

Fig. 58: Forms of innovation and firm size in 2010



Source: Statistics Austria CIS 2010. Calculated by JOANNEUM RESEARCH.

Fig. 59: Innovation expenditures and activities and firm size in 2010



Source: Statistics Austria CIS 2010. Calculated by JOANNEUM RESEARCH.

novation expenditures intensity is significantly lower at small (1.3%) and medium-sized enterprises (1.2%) than at large firms (2.2%) (Fig. 60).

In structural terms, intramural R&D is the most important cost factor for SMEs and thereby the most important activity for the innovation process. In comparison to large companies, however, it is clear that other innovation activities enjoy relatively high importance. This applies in particular to the acquisition of machinery and equipment for innovation.

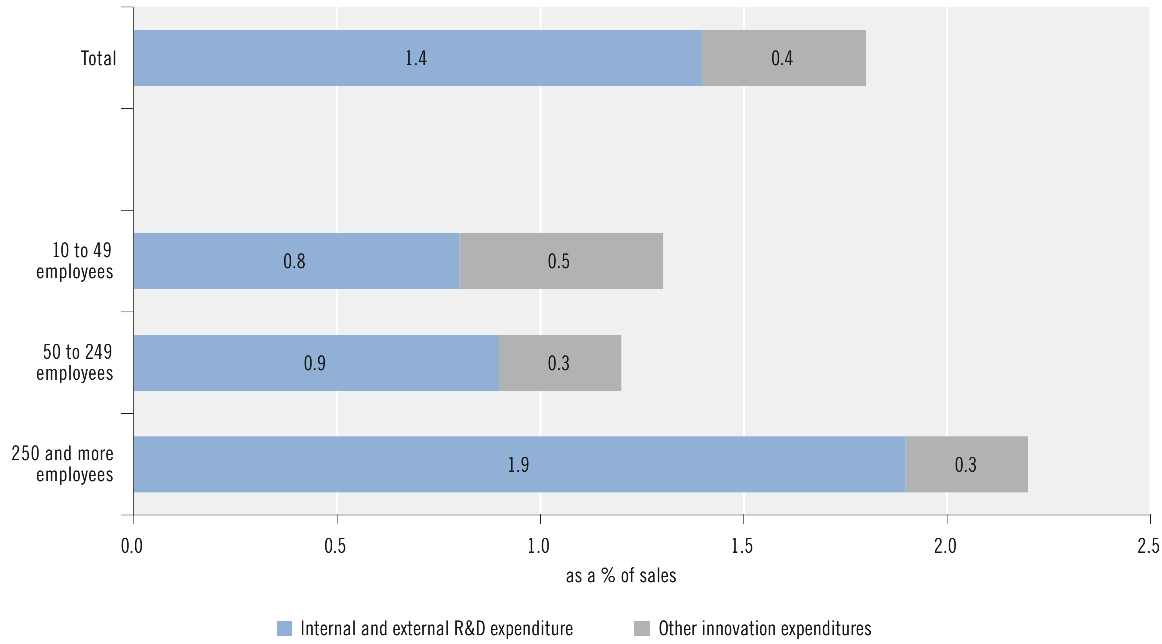
The relatively low importance of R&D for small and medium-sized enterprises is also made clear by the fact that the 49% share of SMEs conducting R&D (of all SMEs with technological innovation activities) is below the share for large firms conducting R&D (71%). In addition, SMEs conduct continuous intramural R&D less often (25%) than do large firms (57%). Analyses by Rammer et al. (2004) show that R&D and innovation activities are also less continuous in German SMEs and tend to fluctuate along the lines of economic cycles more closely than the activities of large companies.

The figures from the R&D Survey of 2009[165] also point to the lesser importance of R&D for SMEs. Though 86% of all units conducting R&D are SMEs[166], they account for only 29% of all R&D expenditure[167] and employ 37% of R&D employees.[168]

This is explained by the fact that conducting (continuous) R&D presents a major challenge for SMEs. These challenges include, in particular, costs (sunk costs) that are incurred for the main-

165 See Statistics Austria (2011).
166 Micro-sized companies are also included in the R&D survey. Micro-sized and small companies comprise 59%, medium-sized enterprises 26%.
167 Micro-sized and small companies 11%, medium-sized enterprises 18%.
168 Micro-sized and small companies 16%, medium-sized enterprises 21%.

Fig. 60: Share of innovation expenditures in turnover by employment size categories in 2010



Source: CIS 2010. Calculated by JOANNEUM RESEARCH.

tenance of R&D infrastructure, minimum size and time for R&D projects, as well as financial risks that follow from high uncertainty with regard to technology and economics that could endanger the existence of SMEs.[169]

The comparative low importance of (intramural) R&D for the innovation process does not mean, however, that SMEs overwhelmingly tend to outsource new developments. Smaller companies may tend to farm out the development of new products and processes more often than larger firms, yet over 70% of SMEs have developed products within their own company, and over 50% have done the same for processes. This is a share that is not much higher for large companies (80% and 64% respectively; see Tab. 24).

A prerequisite and a factor for success for intramural innovation activities is the quality and level of qualifications among employees. In terms of human resources – measured in the proportion of university graduates – the SME sector is more strongly divided than the group of large companies. There is therefore a relatively large proportion of SMEs that employ few to no university graduates: one-third of small firms do not have any university graduates on staff. On the other hand, the share of firms at which every second employee holds a university degree is significantly higher at small firms (8%) than at medium-sized and large companies (Fig. 61).

The figures for the R&D Survey of 2009[170] point to relatively low structural differences: about 60% of R&D personnel at micro-sized and small firms as well as large companies are scien-

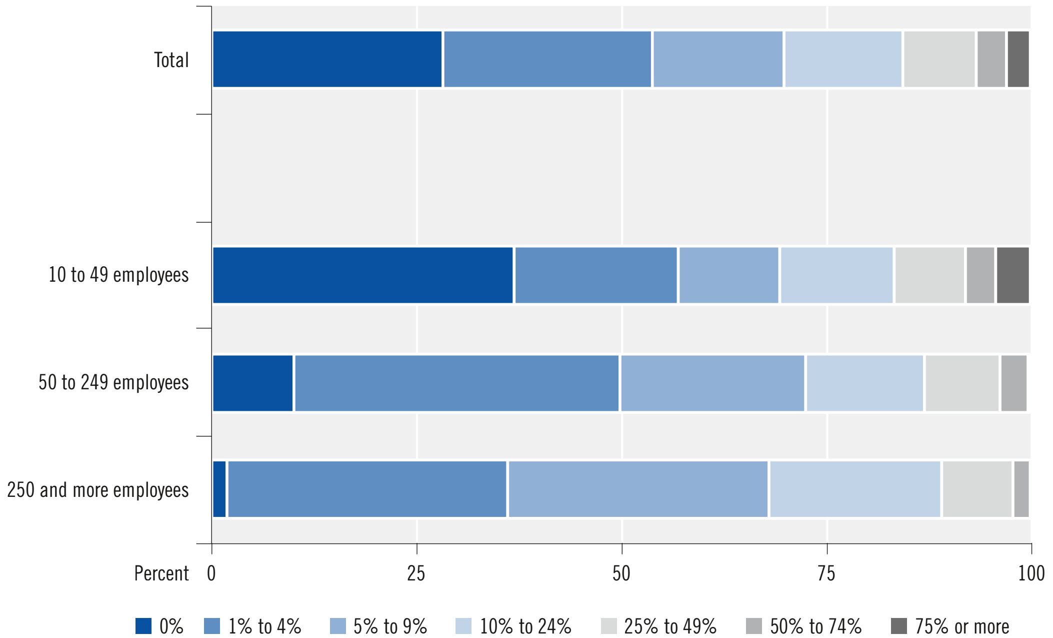
169 See Rammer et al. (2008).
170 See Statistics Austria (2011).

Table 24: Who developed product/process innovations from 2008 to 2010? (as a % of all firms with technological innovations, classified by company size)

	Employees	Development of product/process innovation(s) by ...			
		... own firm	... own firm together with others	... own adaptation/alteration of development by others	... other firms/institutions
Product	**Total**	**72.7**	**42.2**	**13.8**	**10.3**
	10–49	71.8	37.9	13.1	11.9
	50–249	71.6	46.2	15.0	8.7
	250 and more	80.2	58.1	15.1	4.5
Process	**Total**	**54.4**	**45.7**	**17.8**	**15.2**
	10–49	54.6	39.9	16.0	15.8
	50–249	50.5	52.7	20.1	14.9
	250 and more	63.7	64.4	24.1	11.5

Source: Statistics Austria CIS 2010. Calculated by JOANNEUM RESEARCH.

Fig. 61: Firms actively engaged in innovation by proportion of employees with a university degree among all employees in 2010 in %



Source: Statistics Austria CIS 2010. Calculated by JOANNEUM RESEARCH.

tists and engineers. Only in medium-sized enterprises is this number just under 50%. The share of higher-skilled, non-scientific personnel therefore stands at about 35% for micro-sized and small companies, and at 45% for medium-sized business enterprises.

Innovation cooperation

Innovative small and medium-sized enterprises participate in innovation cooperation less often than larger companies. This is due above all to the fact that small firms typically have fewer resources on hand so that the organisation of cooperative relationships is comparatively more expensive. This applies above all to working together with cooperation partners abroad (Tab. 25).

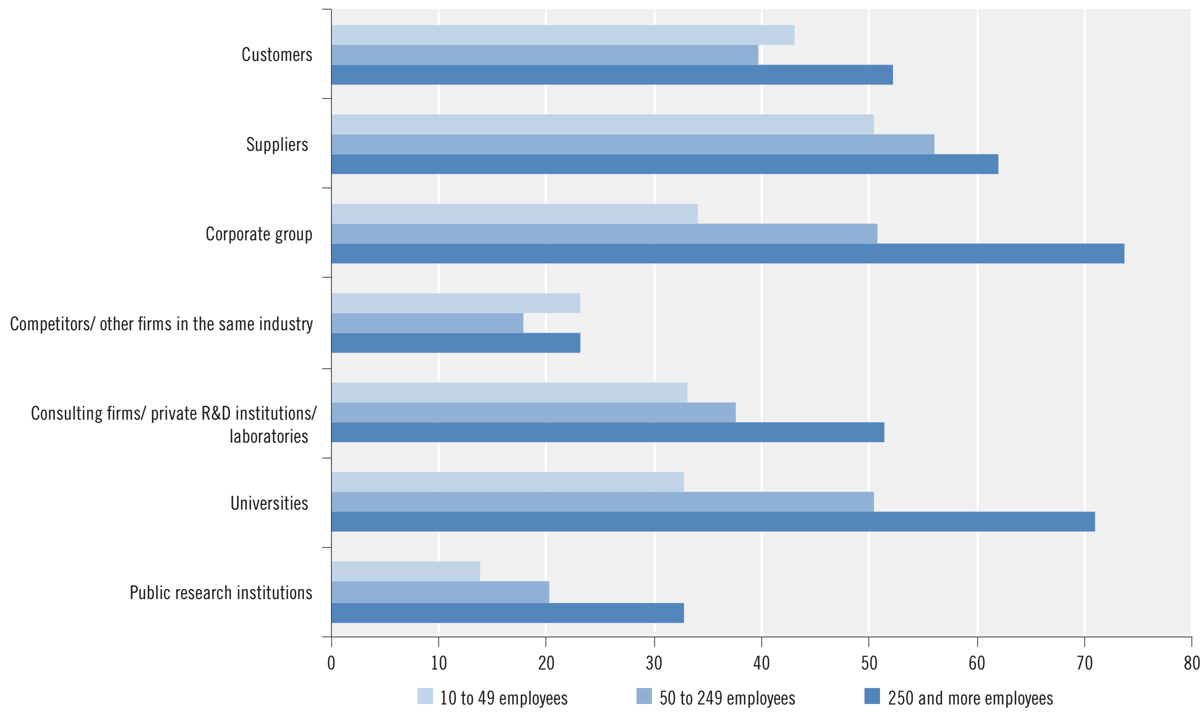
With regard to the type of cooperation partners, SMEs seek out interactive innovation activities with customers and suppliers nearly as often as do large companies (Fig. 62). Cooperation

Table 25:Share of firms with innovation cooperation (a) in % of all firms with technological innovation activities and (b) in % of all firms with innovation cooperation in 2010

Employees	(a) Firms with innovation cooperation	(b) Of which with	
		national partners	international partners
Total	**51.0**	**85.6**	**60.7**
10–49	44.7	83.5	55.5
50–249	59.1	87.4	61.7
250 and more	77.1	91.3	82.9

Source: CIS 2010. Calculated by JOANNEUM RESEARCH.

Fig. 62: Innovation cooperation with different stakeholders (in % of all firms with innovation cooperation, by employment size class) in 2010



Source: CIS 2010. Calculated by JOANNEUM RESEARCH.

within a group of companies, however, is more rare. This is essentially due to the fact that SMEs are rarely part of such corporate groups[171]: only 11% of small firms, 33% of medium-sized enterprises, and 62% of large firms belong to such a group. Another striking fact is that SMEs do not work very often with institutions of higher education. Cooperation with non-university research institutions is rare in general. The cause for this may be the basic orientation and timelines of such cooperation with research institutions, which sometimes places excessive resource demands on SMEs.

This explanation also applies to the focus on a few cooperation partners (or types): the data prove that SMEs work together more frequently with one or two kinds of cooperation partners (of all firms, 61% of small, 44% of medium-sized, and 21% of large companies engaged in innovation cooperation), while large companies (can) often have cooperative relationships with five or more types of cooperation partners (small: 15%, medium-sized: 27%, large: 51%).

Innovation output

The innovation process for large business enterprises results in their earning 14% of their turnover with innovative products. Medium-sized companies attain a similar level at 12%, while small firms only earn 8% of turnover from such products. New products for the market are responsible for a smaller proportion of turnover than product innovations that are new for a firm; this applies to all company size classes (Fig. 63).

5.2.4 Special features of SME innovation behaviour in Austria

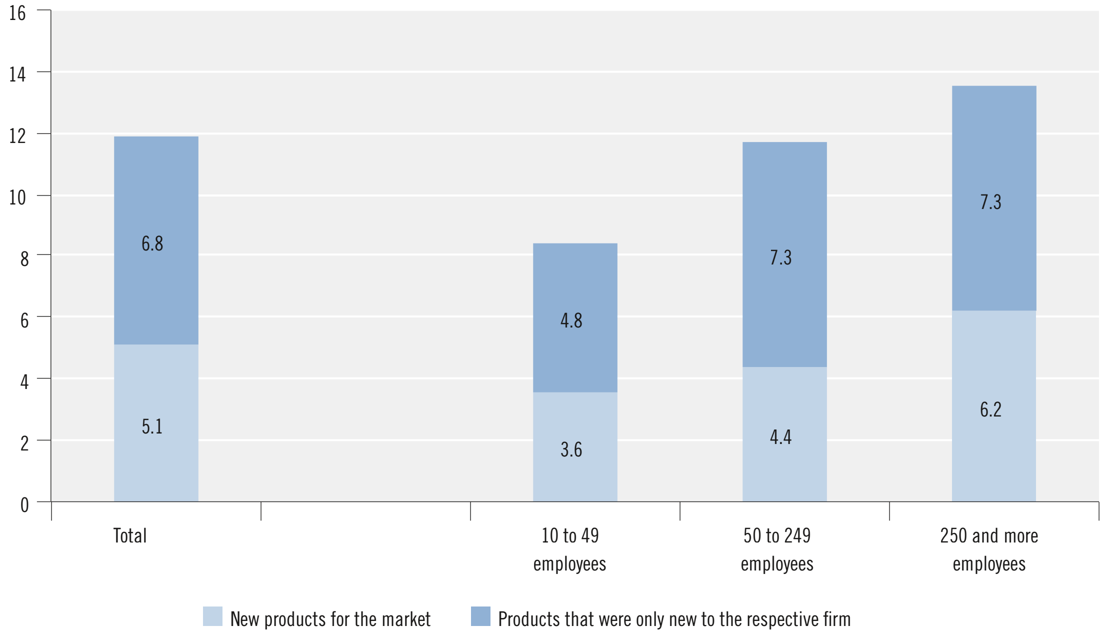
Multivariate regression analysis was used to determine the extent to which the innovation behaviour of SMEs in Austria differs from that of SMEs in other countries. This approach assesses the influence of company size on the individual indicators of innovation introduced above while simultaneously inspecting industry affiliation and other company-specific influences.[172] In comparison to a descriptive analysis at the macroeconomic level, this regression method has the advantage that like is compared with like, namely the innovation behaviour of firms working under similar circumstances. These analyses require access to the original data (microdata) from the CIS surveys in Austria and in reference countries. Eurostat provides access to this kind of data, yet their records do not contain the microdata for Austria. Such data can only be analysed by Statistics Austria.[173] This means that direct comparisons of innovation behaviour between Austrian SMEs and SMEs in other countries cannot be based on regression analyses. This is why we employ an approach in which we determine for each country the degree to which SMEs in that country differ in terms of their innovation activities from the large companies in the same country. To facilitate differentiated statements, we consist of four groups of SMEs: very small firms (10–19 employees), small firms (20–49 employees), medium-small firms (50–99 employees), and medium-sized enterprises (100–249 employees). The following analyses are based on CIS 2008 da-

171 Classification as an SME takes place on the basis of the employee count of the surveyed firm without considering any cross-ownership with other firms. The question regarding affiliation with a corporate group is also based exclusively on information provided by the surveyed firms on the questionnaire.

172 There is very little information in the CIS data in this regard. This analysis incorporates three groups of variables: affiliation with a corporate group; geographical market orientation (regional, national, European, sales markets outside of Europe – this information, however, is not available for firms from Finland); as well as relative productivity (turnover per employee compared to the industry average) as a measure for differences in efficiency that are expressed in different financing situations.

173 We would like to thank Statistics Austria for conducting this data analysis.

Fig. 63: Turnover from product innovations (in % of turnover, according to employment size classes) in 2010



Source: CIS 2010. Calculated by JOANNEUM RESEARCH.

ta because the CIS 2010 microdata were not yet available at the time of this analysis. Germany, France, the Netherlands, Norway, Sweden, and Finland, all countries with a similar degree of development, serve as reference countries in which innovation activities have a high importance, similar to Austria, for the competitiveness of business enterprises.[174]

The international comparison reveals a few special features of SME innovation behaviour in Austria:

- Involvement in innovation among medium-sized enterprises (100 to 249 employees) differs less strongly from that found in large companies than is the case in most other countries. This applies especially for technological innovations and marketing innovations.
- The difference in R&D activities between SMEs and large firms is relatively low in Austria. This applies to all size classes within the SME category. Medium-sized enterprises that conduct intramural R&D display a readiness to perform R&D on a continuous basis (meaning to set aside personnel for R&D or to maintain an internal R&D department) similar to that found in large firms. France and the Netherlands have minor differences similar to those found in Austria. As in Austria, both of these countries have tax-related R&D funding that reaches a broad mass of SMEs and thereby contributes to a larger proportion of SMEs conducting R&D activities.
- In terms of taking advantage of public funding support for innovation activities, the differences between SMEs and large firms in Austria are smaller than those in Germany and Finland, yet greater than those in France and the Netherlands. If, however, we also consider the different inclinations towards R&D among SMEs and large firms, Austria

174 There were no data available for Denmark and Belgium, which would otherwise also serve as reference countries.

has – in contrast to France and the Netherlands – no statistically significant gap in claiming public funding. This is reflected in the easy access that firms performing R&D have to tax-related R&D incentives via the research premium. This programme provides all SMEs in Austria that perform R&D with de facto financial support.

- There were no special features evident in the cooperation behaviour of SMEs, meaning that the difference here to large firms in Austria was similarly high as in most of the reference countries.
- Innovation expenditure in relation to turnover is significantly higher in smaller Austrian firms than in large firms (as long as only companies with technological innovation activities are evaluated). This effect was not observed in any of the reference countries. Comparatively high expenditures for intramural R&D and for the acquisition of machinery and software led in 2008 to a higher innovation intensity for smaller firms in Austria.
- Medium-sized Austrian business enterprises that have introduced product innovations display a high likelihood, similar to that of large firms, of introducing new products to market. In contrast, large companies in the reference countries (excluding Norway) are significantly more often in the position to introduce new products to market. SMEs attain higher shares of their turnover with new products than larger firms. This applies to Austrian SMEs as well as SMEs in most reference countries.

Table 26: Differences in innovation participation between SMEs and large firms in selected countries in 2008

Innovation indicator (Basis: all firms)	Size class	AT	DE	FR	NL	NO	SE	FI
		Deviation of firms with 250 or more employees in % points						
Share of firms with technological innovations	10-19	-26	-27	-23	-21	-15	-32	-32
	20-49	-27	-26	-21	-16	-12	-27	-24
	50-99	-21	-22	-15	-11	-11	-24	-23
	100-249	-9	-17	-8	-6	-10	-17	-14
Share of firms with non-technological innovations	10-19	-26	-22	-22	-25	-13	-32	-33
	20-49	-19	-14	-17	-21	-11	-24	-23
	50-99	-19	-11	-14	-15	-10	-17	-19
	100-249	-9	-13	-7	-9	/	-15	-14
Share of firms with intramural R&D activities	10-19	-17	-28	-17	-16	-20	-30	-39
	20-49	-16	-27	-15	-12	-19	-24	-32
	50-99	-12	-26	-10	-8	-11	-21	-29
	100-249	-6	-21	-6	-5	-11	-16	-18

Note: Deviation in percentage points in the test for industry affiliation, affiliation with a corporate group, regional market orientation and relative productivity.
"/": no statistically significant difference with an error probability of < 5%.

Source: CIS 2008. Calculations by ZEW/Statistics Austria.

Table 27: Differences between SMEs and large firms in innovative behaviour of companies with technological innovation activities in selected countries in 2008

Innovation indicator	Size class	AT	DE	FR	NL	NO	SE	FI
(Basis: firms with technological innovation activities)		Deviation of firms with 250 or more employees in % points						
Share of firms with cooperative ventures	10-19	-21	-18	-18	-25	-12	-28	-36
	20-49	-26	-22	-17	-24	-12	-23	-33
	50-99	-22	-17	-15	-19	-14	-25	-30
	100-249	-18	-20	-13	-10	-14	-11	-25
Share of firms with claim to public funding	10-19	-18	-28	-5	-12	unpublished	unpublished	-26
	20-49	-15	-26	-3	-9	unpublished	unpublished	-23
	50-99	-14	-28	-4	-7	unpublished	unpublished	-21
	100-249	/	-29	-3	-4	unpublished	unpublished	-19
Share of firms with claim to public funding when evaluating for R&D activity	10-19	/	-23	-3	(-7)	unpublished	unpublished	-19
	20-49	/	-20	/	-4	unpublished	unpublished	-16
	50-99	/	-23	-3	-4	unpublished	unpublished	-16
	100-249	/	-26	-3	/	unpublished	unpublished	-16
Share of innovation expenditures in turnover	10-19	+13	/	/	/	/	/	/
	20-49	+5	/	/	/	/	/	/
	50-99	/	/	/	/	/	/	/
	100-249	/	/	/	/	/	/	/

Note: Deviation in percentage points in the test for industry affiliation, affiliation with a corporate group, regional market orientation and relative productivity.
"/": no statistically significant difference with an error probability of < 5%. Values in brackets: Statistically significant with an error probability between 5 and <10% .

Source: CIS 2008. Calculations by ZEW/Statistics Austria.

Table 28: Differences between SMEs and large firms in innovative success with production innovations in selected countries in 2008

Innovation indicator	Size class	AT	DE	FR	NL	NO	SE	FI
(Basis: Firms with product innovations)		Deviation of firms with 250 or more employees in % points						
Share of firms that have introduced new-to-the-market products	10-19	(-9)	-13	-9	/	/	-8	-13
	20-49	(-9)	(-7)	-9	/	/	-13	/
	50-99	-16	-15	-8	-10	/	-8	-21
	100-249	/	-14	-11	-5	/	(-9)	-13
Turnover share from new products	10-19	+10	+9	+10	+11	+8	+7	+6
	20-49	/	+7	+7	+4	+6	+5	/
	50-99	/	+5	/	+4	/	/	/
	100-249	/	(+3)	+3	+3	/	/	/
Turnover share from new-to-the-market products (only firms with new-to-the-market products)	10-19	+11	+9	+9	+10	+9	+8	+7
	20-49	+6	+8	+7	+5	+7	+8	(+4)
	50-99	/	+4	/	+4	/	+4	+6
	100-249	/	/	+4	+3	/	+3	/

Note: Deviation in percentage points in the test for industry affiliation, affiliation with a corporate group, regional market orientation and relative productivity.
"/": no statistically significant difference with an error probability of < 5%. Values in brackets: Statistically significant with an error probability between 5 and <10% .

Source: CIS 2008. Calculations by ZEW/Statistics Austria.

In summary, the results underscore the importance of a broadly effective innovation funding system in terms of reducing the gap in innovation performance between SMEs and large firms. Austria was able to close the gap above all between medium-sized and large firms. Given Austria's business enterprise structure, with its low proportion of large firms in international comparison, this is important for accomplishing further improvements in innovation performance within the Austrian economy. In order to break into the ranks of the *Innovation Leaders*, the SME sector in particular must make important contributions. This is why a broad approach to innovation funding should be continued.

Summary

This analysis of the European Innovation Survey demonstrates that Austria occupies a good (to very good) position in European comparison. The share of innovating firms in Austria is significantly above the average for the EU-27, and the innovator ratio is high throughout all industries. Meanwhile, the structure of innovation spending, with its strong emphasis on R&D expenditure, points towards a "mature", modern innovation system with business enterprises that are continually generating new ideas and bringing them to market in the form of new products and services. Austrian firms have well-established innovation networks not only with their suppliers and customers, but also with research organisations and academic institutions. Austrian economic policy has long recognised the exceptional importance of corporate innovations and promotes corporate innovation behaviour with appropriate instruments. This gives Austria's funding system an outstanding range, meaning that innovation is addressed extensively; Austria is one of the top countries in the EU in terms of firms that benefit from innovation-specific funding measures. This horizontal impact of funding is a key reason why the discrepancy in innovation practices between large corporations and SMEs is lower in Austria than in most other highly industrialised nations in Europe.

5.3 Fast growing new companies

Scientific and political discussions assign the importance of the entrepreneurial dynamic of a national economy's business enterprise sector for competitiveness, innovation activity, structural change, and the generation of employment. Innovative start-ups are often singled out, especially rapidly growing new firms, to which observers often ascribe an essential role for structural change and the generation of employment. One of the first authors to address the importance of rapidly growing young and small companies for the development of employment was D.L. Birch,[175] who coined the term "gazelles"[176] for companies with high rates of growth. Recently, however, other scholars, such as Shane (2008), have expressed doubts that stimulation of start-up activity will increase the overall number of rapidly and sustainably growing firms. He argues more for concentration on a few newly emerging industries.

Rightly or wrongly, the EU Commission is focusing renewed attention to the topic of "fast growing companies". Starting in 2013, the proportion of fast growing new companies is planned to be a new headline indicator for measuring progress in the countries of the European Union in the context of "Europe 2020". Together with the indicators for labour productivity, patent activities of companies, employment in knowledge-intensive areas, and contribution to trade with innovation-related goods in the overall trade balance, the new indicator is meant to present a view of developments in the business enterprise sector.

Experience has shown that growth (as well as innovation behaviour) among new companies

175 See Birch (1979), Birch, Medoff (1994), Birch et al. (1995).
176 Birch defines a company with rapid growth as a firm that posts annual growth in turnover of at least 20 per cent for at least five years.

can differ significantly, even within industry groups. Classification at the industry level, oriented towards the respective average values, therefore entails certain risks of misinterpretation. So it makes sense for analyses to differentiate within the boundaries of sectors and industry groups. Little is known at present about differences in terms of growth; investigations into innovation behaviour show that only 15–20% of firms in the top technology industries actually have very high R&D intensities. Even industries that are less innovative on average have firms with high growth and very high R&D intensities.

There are numerous other factors and circumstances responsible for the growth trajectory that new companies actually travel, along with their engagement in terms of innovation activities. A few examples of such factors are:

- The strategic orientation of new companies with regard to the topic of "growth": Many founders, including those of high tech business enterprises, are often not seeking the maximum possible expansion of their business. It is more often the case that founders create a start-up company with a specific business idea that they want to work on in a self-contained way. A fast expansion of their company, where possible in connection with a guarantee of opportunities for external financiers to wield influence, would run counter to their founding concept.
- Market and competition conditions on the sales market: Not all markets offer opportunities for the fast and strong expansion of young companies. Critical factors in this regard are the growth of demand as well as options for protecting products (for example, through patents) from imitation or modification. The size of domestic market also plays an important role. Despite the European domestic market, there are still major differences in this regard for firms situated in Europe in comparison to those located in the US market.
- The "individual" conditions of young companies: A company's team of founders must have sufficient entrepreneurial, technological and business capabilities to be able to manage strong growth. Sufficiently skilled employees have to be hired and personnel policy must be designed accordingly. One obstacle that is very difficult to overcome in terms of financing growth is whenever returns on investment are delayed for too long.

These considerations illuminate the fact that the causes for growth – and especially for non-growth – can be highly divergent and diverse at new companies. The question of how these factors can be addressed by policy measures or administrative interventions remains completely open. This is precisely why there is particular interest in the extent to which a young firm's tendency to steer towards growth is evident on the first phase on the market, and how persistent this steering is. It is also of interest to consider whether differences among new business enterprises in terms of their early orientation towards growth, may be attributed to industry groups with different technological orientations or levels of knowledge-intensive work. The following section investigates in these questions.

5.3.1 Employment development in new Austrian business enterprises

The data base for this investigation comes from the Creditreform credit agency. Creditreform deliveres a complete copy of their comprehensive database twice yearly since 1996 to the Centre for European Economic Research (ZEW), located in Mannheim, for scientific purposes. Their database contains information on firms conducting business whose headquarters are in Austria (including information on businesses that have closed). The information on these firms is typically researched regularely and updated accordinglyin the database. Information on the closure of companies, whether in the course of insolvency proceedings or through voluntary closures, is included in the database. It is also possible to identify mergers or company takeovers. According to the information presently stored in this data base, there are almost 700,000 firms located in Austria, and around 350,000 of them are presently active on the market (not closed). It must be assumed that the data base used here entails under-reporting of sole proprietorships and freelancers; there is no complete picture of the scope of their activities. It is for this reason that analyses based on Creditreform data are mirrored against analogous calculations based on data from the labour market database of the Austrian Labour Market Service (AMS), thereby ensuring the findings' accuracy.

Can we assert a connection between the development of employment at start-up firms in their early years (at least on the whole) with later developments in employment? This is the core question that is assessed in the following remarks. The development of employment among Austrian start-ups founded in 2002 and 2003 is assessed and analysed for the years 2007 and 2011 to determine the extent to which there are systematic relations between employment development in the first four to five years of a firm's life and the four subsequent years.

5.3.2 Start-ups in all industries

First, all Austrian start-ups founded in 2002 and 2003 are included in the investigation, regardless of which industry they belong to. The surviving firms from both cohorts had an average of 5.8 employees in 2007 according to the Creditreform data (see Tab. 29). Counts include employees covered by national insurance and other employees. Counting is done on the basis of "heads", not in full-time equivalents. If the ZEW's Mannheim Enterprise Panel (MUP) – which is based on Creditreform data on companies located in Germany – is used as a benchmark, then we see that German firms founded in 2002 and 2003 were, with 4.6 employees, somewhat smaller in 2007 than their Austrian counterparts (see Tab. 29). To be able to appreciate the degree to which "early" employment growth is expressed in "later" employment growth, the population of Austrian firms that were founded in 2002 and 2003 are divided into two groups on the basis of different criteria (employment thresholds). The selection of these thresholds yields a step-wise approximation of "fast growing" start-ups. The further development of employment in the separated groups is then assessed up to 2011.

Start-ups are first divided on the basis of whether they had an above-average employment count in 2007 or whether they only had at least an average number of employees (> 5.8 versus ≤ 5.8). The distribution of employment numbers at start-ups founded in 2002 and 2003 is quite skewed in 2007. Only 10.4% of start-ups fall into the group with above-average employment numbers in 2007 (17.8% in Germany); accordingly, 89.6% of start-ups have, at most, average employment figures. The further development of employment in firms does depend on which of these two groups the firms are assigned to. Firms that had an above-average number of employees in 2007 had an average of 12.7 employees in 2011; the group with the highest average number of employees in 2007 had only three employees on average in 2011 (see Tab. 29). Start-ups that were founded in both of the years under analysis and that exited the market between 2007 and 2011 are included with an employee count of null for 2011. The average employment numbers for 2011 for German start-ups founded in 2002 and 2003, calculated in the same way based on MUP data and separated according to the same criterion (above-average or, at most, average employment numbers in 2007), point in the same direction and are also very similar to the figures for Austrian start-ups (see Tab. 29)[177].

The group of start-ups with "high" employment growth is further restricted in a second

177 The core density functions of employment distribution in 2011 in the groups defined by different employment thresholds show that the differences in the average values of the respective groups shown in Tab. 29 cannot be attributed to a few outliers; instead, they are also expressed in the distribution functions.

step. The average employment count does not serve here as the threshold that separates the groups; instead, an employment count of 10 in 2007 is used (> 10 versus ≤ 10). Only 4.5% of Austrian start-ups founded in 2002 and 2003 had more than 10 employees in 2007 (5.3% of German start-ups from both years). This group of firms had, on average, significantly more employees in 2011 (18.8) than firms that employed no more than 10 people in 2007 (4.2). Tab. 29 shows that this employment threshold results in the same trend and similar average employment numbers in the investigation of German firms.

A third step applies an even more strict criterion as an employment threshold. Firms were differentiated on the basis of whether they had more than 20 or fewer than 20 employees in 2007 (> 20 versus ≤ 20). The business enterprises in the group defined in this way as having "high" employment growth attained an employee count of over 20 in their first four to five years. This is a development which can certainly be described as "fast growth". Very few start-ups from the 2002 and 2003 cohorts fulfil this criterion, though; only 0.7% of the firms had more than 20 employees in 2007 (1.1% of German start-ups from both years). The further development that these firms went through up to 2011 is remarkable: they had, on average, 35.5 employees in 2011; start-ups with no more than 20 employees in 2007, however, only had an average of 5.9 employees (see Tab. 29). The analogous calculations for Germany for this employment threshold result in very similar figures.

Comparable investigation based on the labour market database of the Austrian Labour Market Service deliver the same qualitative results (see Tab. 29, middle column). Only those employees who are obligated to carry national insurance are included here; the survey unit here is the plant level and not, as in the Creditreform data for Austria and in the MUP, a firm. For this reason, it is not surprising that the specific calculated values deviate from those values based on the Creditreform data. The trend in the results, and also in the relational differences in terms of employment numbers in 2011 for groups defined under different employment thresholds in 2007, is clearly confirmed.

We can conclude that for start-ups in general, those that attain a "high" number of employees in their initial years have a significantly higher probability of increasing employment numbers in their next phase than those that remain small at first. The overwhelming share of "small" firms remain small after a few years.

Table 29: Average employment count in 2011 for all start-ups founded in 2002/2003 by different employment thresholds, 2007

Start-up cohorts 2002 and 2003 Average employment 2007	Creditreform data Austria 5.8	AMDB 3.4	MUP Germany 4.6
Average employment 2011			
2007 above-average	12.7	9.7	11.0
2007 average at best	3.0	1.9	3.0
Average employment 2011			
2007 more than 10	18.8	19.4	19.2
2007 10 at most	4.2	3.0	4.2
Average employment 2011			
2007 more than 20	35.5	31.1	33.3
2007 20 at most	5.9	3.8	5.2

Sources: Creditreform data Austria, Mannheim Enterprise Panel – calculations by ZEW. Labour market database (AMDB) of the Austrian Labour Market Service – calculations by JOANNEUM RESEARCH.

5.3.3 Start-ups in knowledge-intensive industries

Especial importance in terms of growth potential is often attributed to start-ups in research- and knowledge-intensive industries from manufacturing and the services sector. In order to arrive at an estimate of whether an "early growth trajectory" for start-ups in these industries is also connected to the development of later employment numbers – or may even be more pronounced than the average of all start-ups – our analysis will now focus on start-ups founded in research- and knowledge-intensive industries in 2002 and 2003 and how their employment numbers have developed over time.

The method selected for this process corresponds to the one applied in the previous section for analysing employment development among start-ups in all industries – including a comparison with analogous calculation for start-ups in research- and knowledge-intensive industries in Germany.

Austrian start-ups founded in 2002 and 2003 in the research- and knowledge-intensive industries had one more employee than the average for all start-ups after four or five years, with a total headcount of 6.8 (see Tab. 29). The proportion of firms founded in 2002 and 2003 in the research- and knowledge-intensive industries that exceeded the three selected employment thresholds in 2007 is not distinguished in a notable way from the proportion of all start-ups from these years. In this regard, there is not a more pronounced "growth orientation" among start-ups in these advanced economic sub-sectors. In 2007, 11.1% of start-ups in research- and knowledge-intensive industries in Austria among the assessed cohorts had a level of employment that was above average for these industry groups (as opposed to 10.4% of all start-ups); 6.2% of start-ups in advanced industries had more than ten employees (as opposed to 5.9% of all start-ups), and 1.5% of new companies in these industries had more than 20 employees (as opposed to 0.7% of all start-ups). German start-ups founded in 2002 and 2003 in research- and knowledge-intensive industries were on average much smaller than in Austria, with 4.8 employees on average in 2007 (see Tab. 30). The proportion of firms with more than 10 and more than 20 employees in 2007 scarcely differ with 6.4% and 1.5% from the Austrian figures (due to different average values, we do not provide a comparison of the share of start-ups with above-average employment counts).

Unlike in Germany, where the employment figures for start-ups in the research- and knowledge-intensive industries are separated into average values according to different employment thresholds and barely differ in 2011 from the average of all industries, in Austria, there are significant differences between start-ups in the advanced industries and all start-ups in general (see

Table 30: Average employment count in 2011 for all start-ups in the research- and knowledge-intensive industries founded in 2002/2003 by different employment thresholds, 2007

Start-up cohorts 2002 and 2003 Average employment 2007	Creditreform data Austria 6.8	MUP Germany 4.8
Average employment 2011		
2007 above-average	20.3	11.3
2007 average at best	3.5	3.1
Average employment 2011		
2007 more than 10	27.5	19.3
2007 10 at most	4.4	4.4
Average employment 2011		
2007 more than 20	64.9	30.4
2007 20 at most	6.3	5.6

Source: Creditreform data Austria, Mannheim Enterprise Panel – calculations by ZEW.

Tab. 30). The average number of employees in 2011 for those groups with employment numbers above the 2007 employment threshold are significantly higher than for all start-ups. Austrian start-ups founded in 2002 and 2003 in the research- and knowledge-intensive industries had, on average, 20.3 employees in 2011 if they had reported above-average employment in 2007 (in contrast to 12.7 employees among all start-ups). If new business enterprises in the industries considered here had more than 10 employees in 2007, then average employment in 2011 climbed to 27.5 people (in contrast to 18.8 for all other industries), and if they had more than 20 employees, they attained an average employee count of 64.9 by 2011 (in contrast to 35.5 for all start-ups). In the research- and knowledge-intensive industries from the manufacturing and service sectors, young Austrian firms that already set a course for growth at the beginning of their market activities exhibit a significant orientation to growth in the further development of their business activities. There were scarcely any differences between all start-ups and those firms that did not exceed the respective employment thresholds. This suggests that it depends on the growth orientation of firms as to whether they grow over the medium term, not on their industry affiliation.[178]

Summary

The findings presented here suggest that new business enterprises that already assemble a comparatively high number of employees in the very early phase of their market activity also have above-average employment numbers in the further course of their business activities, at least on average. The "tipping point" in a "growth path" is therefore located in a very early phase. It also becomes clear that only a small proportion of new companies actually swing into a growth path that leads to a noteworthy employment level. Both of these statements apply also to start-ups in the research- and knowledge-intensive industries (also called "innovative industries"). The fact that a firm selects a field of activity that classifies it into these industries does not alone permit any conclusions to be drawn as to its actual growth in employment. Even in these industries, there are very few firms that report appreciable gains in employment. A higher employment count after a few years for firms in the research- and knowledge-intensive industries is accompanied, on average, with even higher employment growth in the firm's next business phase than is the case for start-ups in other industries.

Early growth is therefore a good indicator that new companies have the potential for further growth and can serve as a reference point for investors or funding measures. It raises the question, however, of whether the absence of early employment growth is also a signal that the firm has no growth potential.

But this cannot be assumed. There can be many causes for the fact that start-ups do not hire a large number of employees in the early years of their existence. One very important reason for this is that most founders do not strive to grow their firms at all. Instead, they want to realise a specific business idea and work as independently as possible.[179] These founders would not be motivated to pursue a more expansive strategy with investment offers or offers of funding. Furthermore, we can assume that financing bottlenecks, development times that are too long for the market maturity of products, and a lack of qualifications among founders all act as restrictions on new companies and prevent growth. If the identification of such business enterprises is successful – a process that has to be done on an individual company basis, independently of industry category – then early engagement can help the firm to reach the "tipping point" and head towards growth.

178 The analysis of distributions of employment counts in 2011, separated by the three employment thresholds applied here to the employment numbers from 2007 for start-ups in the high-tech industries, supports the impression gleaned from an evaluation of the average values.

179 See Egeln et al. (2012).

6 Evaluations

Evaluations are an indispensable part of the process of introducing and implementing research and technology policy support measures today, both from a legal perspective and in daily practice. There is a set of legal foundations applicable to this process in Austria: the Research and Technology Promotion Act (FTF-G), the 2004 Act for Creation of the Austrian Research Promotion Agency (FFG-G), the Research Organisation Act (FOG; Reporting: Sections 6-9), and guidelines on the promotion of research[180] based upon these laws and for the promotion of economic-technical research and technology development, the so-called RTD guidelines.[181] The Research and Technology Promotion Act (FTF-G Section 15 para. 2) in particular has standardised the evaluation principles at a legislative level as being a minimum requirement for the guidelines. The guidelines stipulate that "*a written evaluation plan must be created for all subsidy programmes and measures based upon the RTD Guidelines. This plan must include the purpose, objectives, and procedures, as well as deadlines for evaluating the achievement of the funding objectives, and must define appropriate indicators*".[182]

Not least thanks to this statutory basis almost all research and technology programmes now use evaluations in their programme planning (ex-ante evaluations), their programme implementation (monitoring and interim evaluations) and their programme conclusion (ex-post evaluations), and this legal foundation is also viewed as essential, providing future direction for the further strategic development of Austria's research funding portfolio.

In order to provide a periodic overview of the evaluation activity of Austrian research funding programmes in past years, recent evaluations have been presented in the Austrian Research and Technology Report since 2009. The evaluations are presented here if they fulfil the following criteria:

- The evaluations are primarily relevant to federal policy.
- There is an approved report of the evaluation available.
- The evaluation report must be accessible to the public, meaning that the report has been published on the homepage of the research and technology evaluation platform.[183]

The results of some of the evaluations commissioned by the Federal Ministry are presented in summary below. They are: the evaluation of the Elise Richter and Hertha Firnberg Austrian Science Fund programmes (on behalf of the Federal Ministry of Science and Research (BMWF)), the interim evaluation of the Services Initiative (on behalf of the Federal Ministry of Economy, Family and Youth (BMWFJ)), the evaluation of the IV2S and IV2Splus strategic programmes (on behalf of the Federal Ministry of Transport, Innova-

180 Federal government guidelines on granting and executing funding pursuant to §§ 10–12 FOG, Federal Law Gazette No. 341/1981
181 Guidelines for the funding of economic-technical research and technology development (RTD Guidelines) pursuant to § 11 Z 1 to 5 of the Research and Technology Funding Act (FTFG) by the Federal Minister for Transport, Innovation, and Technology dated 27 September 2006 (GZ 609.986/0013-III/I2/2006) and by the Federal Minister for Economics and Labour dated 28 September 2006 (GZ 97.005/0012-C1/9/2006)
182 RTD Guidelines, Section 2.2., p. 4.
183 www.fteval.at

tion and Technology (BMVIT)), the interim evaluation of the Austrian security research programme KIRAS (on behalf of the BMVIT), and the interim evaluation of the regional contact points commissioned by the BMWF (on behalf of the BMWF).

6.1 Evaluation of the Elise Richter and Hertha Firnberg Austrian Science Fund programmes

Objective of the evaluation

The evaluation of the Hertha Firnberg and Elise Richter programmes focuses primarily on the question of what effects the programmes have on the scientists who receive support, as well as whether these programmes effect changes at university institutions and if so, in what form.[184]

Programme objectives and key information

Both the Hertha Firnberg and Elise Richter funding programmes are Austrian Science Fund programmes that focus specifically on supporting highly-qualified female scientists in the development of their scientific careers. The *Hertha Firnberg programme* targets highly-qualified female university graduates from all disciplines who should receive support at the beginning of their scientific career or as they re-enter their field after maternity leave. For this reason beneficiaries should also be established in the international scientific community, should participate in international cooperation projects, and be employed at the relevant research location following the funding. The *Elise Richter programme* complements this by providing explicit support for qualified researchers who are pursuing a university career. The programme aims to provide funding for the completion of a qualification stage that will enable the candidate to apply for a domestic or international professorship.

The Hertha Firnberg programme has supported 145 female scholars since its introduction in 1999, and the Elise Richter programme has assisted 70 female scholars since 2006. The annual budget for both funding programmes amounted to approximately € 6 million in recent years, allowing funds to be approved for around 12 to 13 research positions each year in each of the Hertha Firnberg and Elise Richter programmes. The approval quotas differ for both programmes. The Hertha Firnberg programme had an acceptance rate of 26% in 2010, while the Elise Richter programme approved 38.5% of its applications. The higher approval rate for the Elise Richter programme is due primarily to the higher quality of applications, which in turn is attributable to the greater amount of experience among applicants. Throughout the programme's entire lifespan, most funded positions in the Hertha Firnberg programme are in the life sciences (38%), followed by the natural sciences / engineering (34%), and the humanities and social sciences (28%). The Elise Richter programme is somewhat different: throughout its entire lifespan, most approved applications are in the humanities and social sciences (41%), followed by the natural sciences / engineering (30%) and life sciences (29%).

Results of the evaluation

Approval among those funded scholars who were surveyed is very high for both programmes, as can be seen in the recommendation rate: 94% of Hertha Firnberg (HF) and 96% of Elise Richter (ER) position holders as well as co-applicants report that they would recommend that their colleagues and junior scientists apply. Financial resources are viewed overall as largely appropriate. The approval figures ("agree", "somewhat agree") were over 80% for position holders.

The programmes differ from other funding

184 See Pohn-Weidinger, Grasenick (2011).

programmes due to a series of specific measures. These include support from co-applicants as well as annual two-day coaching workshops or an option for individual coaching. The survey shows that these measures are considered "very important" or "important" by the majority. In the HF programme, 91% of survey respondents reported that co-applicant support was a "very important" or "important" element of the programme. About four-fifths (HF: 80%, ER: 77%) indicated that they found career coaching workshops to be "very important" or "somewhat important". This finding was also confirmed in the interviews.

Furthermore, measures for improving integration in international networks were also considered important. Four-fifths of Hertha Firnberg beneficiaries and about 70% of Elise Richter beneficiaries want these kinds of initiatives – a demand that is also implicitly directed towards the universities themselves. This also includes a demand to increase the integration of female scientists in the universities during the funding period, while also entrenching the Hertha Firnberg and Elise Richter programmes more firmly in the career-enhancement initiatives at the universities.

6.2 Interim evaluation of the Services Initiative

Objective of the evaluation

The interim evaluation of the Services Initiative includes a funding period from the end of 2009 up to and including October 2012. In addition to the presentation of funding figures, the primary goal was to analyse the effect of funding for innovative projects with Services Initiative funds at the firms receiving the funding. The focus was on the effects at the project level, the initiative level, the concept, processes, and the organisation of the Services Initiative.[185]

Programme objectives and key information

In late 2009 the Federal Ministry of Economy, Family and Youth (BMWFJ) opened up a new path to the funding of innovative services with the approval of the basic document for the Services Initiative. Instead of creating a completely new programme, existing Austrian Research Promotion Agency (FFG) research funding programmes were supplemented to include a special focus on services and expanded in budgetary terms. At the same time, accompanying research studies as well as various awareness activities were conducted (such as events and advising). The overarching goal of the Services Initiative is to increase the productivity, value creation and exports of service firms, as well as of firms in the manufacturing sector that provide services that accompany products, by means of increased support for service-related innovations that will also generate positive effects on employment and prosperity. The intention is for the following goals to be achieved in particular:

- Increasing the innovative potential of the Austrian service economy,
- Generating positive economic effects (above all revenue and jobs),
- Expanding awareness of potential (and new) Austrian Research Promotion Agency (FFG) clients in terms of the FFG funding offered,
- Proposing and generating new projects with which the Austrian Research Promotion Agency (FFG) has not yet been associated,
- Attaining new client classes and increasing the share of new Austrian Research Promotion Agency (FFG) clients,
- Establishing a knowledge base for service innovations in Austria (including through accompanying research),
- Increasing visibility of specific characteristics of service innovations in order to enable increased consideration in the funding portfolio of the Austrian Research Promotion Agency (FFG).

185 See Warta, Good (2012).

A special feature of the Services Initiative is that it was implemented in the context of two ongoing bottom-up funding programmes of the Austrian Research Promotion Agency (FFG): firstly, in application-oriented project funding as part of the general funding programmes, and secondly, in the COIN "Cooperation & Networks" line of structural programmes. Up to and including November 2012, a total of 78 projects were funded in the general programmes; of these, 14 projects were extended. Funding volume for the Services Initiative in the general programmes was € 13.9 million. Furthermore, there were three proposals in the COIN Cooperation & Networks programme line that focused on service-related innovations, and these projects received funding with a total funding volume of € 8.8 million. The Services Initiative also financed two accompanying studies on the service landscape in Austria and organised two public events.

Results of the evaluation

The main result is that for Cooperation & Network projects in COIN, project funding through the Services Initiative was, in a majority of cases, decisive for projects to get off the ground in the first place; this only applies to one in four service-related projects in the context of general programmes, even if project proposals could be implemented to a greater extent and in a more concentrated way than would otherwise be the case thanks to funding. There are also different results in terms of economic benefit: while economic effects are distributed across different network partners in COIN Cooperation & Network projects, the economic benefit is primarily enjoyed by the project manager in service projects in the general programme. The leverage effect of funding is particularly clear for start-ups; 47% of funding recipients in the COIN Cooperation & Network programme line were new clients. It is worth noting that, so far, funded service innovation projects (74%) have shown a significant sectoral concentration in information services and technologies. One extremely positive development is that services have been established as a crossover subject at the Austrian Research Promotion Agency (FFG). This means that as of 2012 all projects are evaluated to this effect, whether they pertain to services or not. Another development is that experiences have been thoroughly positive relating to the implementation of the Services Initiative in two areas of bottom-up funding by the Austrian Research Promotion Agency (FFG). Given this fact, it is therefore recommended that the Services Initiative be continued with the selected and existing structure. Over the long term, the Initiative should be designed in such a way that its own success will render it superfluous. In order to do this, it is essential that the interface with the general programmes be structured in an active and transparent way; the understanding of the target group and awareness measures must also be reconsidered and revised for the future direction of the Services Initiative.

6.3 Evaluation of the European Space Policy Institute (ESPI)

Objective of the evaluation

The objective of the evaluation[186] was to trace and evaluate the establishment and development of the European Space Policy Institute (ESPI) since its founding in Vienna in 2003 (official opening in 2005), and then to deduce the appropriate conclusions and make recommendations for further development.

Programme objectives and key information

The objective of the ESPI is to function as a think tank which analyses and works on medium to long-term topics in space travel, and to use the

186 See Kaufmann, Streicher (2012).

results in order to support the strategic decision-making process for this policy area in Europe. In 2002 the ESA Council selected Vienna as the location for a new institution in the area of space policy (research). The organisations founding include on the one hand the ESA (European Space Agency) and on the other the Austrian Aeronautics and Space Agency within the Austrian Research Promotion Agency (ALR/FFG), which represents the Federal Ministry of Transport, Innovation and Technology (BMVIT). In the meantime the number of members has grown to 13 organisations (including important stakeholders in the aerospace community), and this strategy of slow growth will continue in future.

The ESPI was founded as an organisation under Austrian civil law because of advantages such as low capital requirements, flexibility concerning membership changes, public status and a significant level of independence.

After a phase of institutional and organisational establishment, intense growth followed from 2007 onwards. The annual budget alone rose from € 228,000 in 2005 to € 609,000 in 2011, and the number of employees had increased by 2008 to 12 staff members as planned originally; today there are 16 employees, including management and internships. In the period from 2004 to 2011, a total of 25 different nationalities were represented in the institute's staff. The fact that the gender balance is almost even is also striking (55% male, 45% female).

ESPI's output is quite substantial. By the end of 2011, 128 different products had been completed, including 39 ESPI reports, 60 publications in scientific journals and 11 commissioned studies which were not published. In addition, there were numerous network activities as well as events and conferences. Furthermore, the ESPI is receiving increasing numbers of invitations from European universities and public research institutes to give lectures and presentations that focus on aerospace.

Results of the evaluation and recommendations

The evaluation team certifies that the ESPI has successfully completed its development and expansion period, which is within expectations and targets. The starting points for the recommendations focus on making the process of selecting policy issues more transparent (for example, through more intensive incorporation of external experts in the discussion process). Additional recommendations relate primarily to the areas of quality assurance on the one hand and active policy influence by the ESPI on the other. In relation to quality assurance, the evaluators suggest for example that the balance between senior and junior staff be optimised. Over the longer term more cooperation with universities should be considered, with the intention of offering joint international master's and/or PhD programmes. This should be viewed in the context of the fact that the internships on offer are already in strong demand from an international pool of applicants. With regard to ESPI's inclusion in relevant policy discussions, the evaluators determined that the focus on aerospace policy as such should be increased, inclusion in networks with supranational networks should continue to expand in the coming years, and relationships with think tanks outside of Europe which focus on aerospace issues should be intensified. In addition, there should be considerations as to how to define the relationship between ESPI and the European Commission in future.

6.4 Evaluation of the IV2S and IV2Splus strategic programmes

Objective of the evaluation

The evaluation sought to assess programme development up to the beginning of 2012 (IV2S from 2002 to 2006, IV2Splus starting in 2007), whereby the evaluation focused on analysis of the effects emanating from the research projects supported by the programme. In the case of IV2Splus, however, this was an interim evaluation because the programme and many of the projects funded by it are still ongoing, and effects are therefore expected to emerge in the coming years.

Programme objectives and key information

The IV2S strategy programme, which is comprised of Intelligent Transportation Systems and Services (2002 to 2006) and its successor programme IV2Splus (2007 to 2012), are programmes that provide strategic support for research and development in the area of mobility and transportation technologies. They fall under the auspices of the Federal Ministry of Transport, Innovation and Technology (BMVIT) and are implemented and handled operatively by the Austrian Research Promotion Agency (FFG). The programme seeks to provide additional stimulus for transportation and environmental policy agendas through funding research and development. The programme therefore has the following three target areas:

- Setting overall goals in the area of transportation and environmental issues
- Increasing entrepreneurial competitiveness via RTI
- Networking and cooperating (both nationally, especially between science and business, and at the European/international level)

IV2S was divided into three different programme lines: (i) railway technology, (ii) automobile industry suppliers and (iii) telematics / logistics. The programme is therefore oriented towards the strengths of Austrian manufacturing and simultaneously links RTI funding measures with challenges to society as a whole ("mission") in terms of transportation and the environment.

The programme relies on non-refundable grants for R&D projects based on the RTD Guidelines as the funding tool. The spectrum of fundable project categories ranges from basic research to the demonstration and validation projects, with the focus on partnership projects (above all between science and manufacturing). Operational implementation included several calls for project proposals conducted for each programme line. The topics were selected in close coordination with the relevant communities.

Results of the evaluation

A total of around 450 R&D projects were initiated in both programmes up to the beginning of 2012 with almost € 100 million in funds. These projects include R&D expenditures of approximately € 190 million. There were a total of 483 participating organisations in IV2S, and at the time of the evaluation there were 375 different organisations involved in IV2Splus. The community of programme participants is characterised by a few central stakeholders from research, manufacturing (a few large firms) and operators. Over 50% of funds are concentrated on just 10% of all participating organisations. At the same time, however, the programme is completely open to newcomers as well as small and medium-sized enterprises (SMEs), even if their financial project share is considerably smaller in scope.

Research proposals in the area of applied research (industrial research and experimental development) clearly dominate in terms of project type. The proportion of basic research in both programmes was under 10% in terms of overall project costs. In terms of completed cooperative arrangements, it is clear that the extent of cooperation in both programmes was very high, each having a proportion of cooperative projects at 90%, whereby the average number of consortium members per project stood at three to four organisations. A majority of cooperative projects feature participants from both science and industry. Furthermore, the programmes have contributed to bolstering networking between public research institutions and firms and have led to entirely new cooperative ventures with firms outside of the actual transportation sector (for example, ICT firms).

The potential dead-weight effects of the programmes can be described as limited. An analysis of rejected project proposals has shown that less than 10% of all rejected projects were then carried out without funding.

Significant economic effects (such as revenues, patents, user licences and cost and resource savings from efficiency gains) and scientific effects (such as publications and lectures) have already been identified for the IV2S programme. The extent of effects stemming from the IV2Splus programme is of course lower because the programme was still ongoing at the time of the evaluation, and many of the funded projects were still at the processing stage.

Finally, it should be mentioned that the evaluation team ranked the quality of programme fulfilment and implementation as high.

6.5 Interim evaluation of KIRAS, the Austrian security research programme

Objective of the evaluation

In 2009 the Federal Ministry of Transport, Innovation and Technology (BMVIT) commissioned an evaluation consortium to conduct ongoing efficacy evaluations of the security research programme KIRAS. Thus the interim evaluation is but one component in supporting evaluations and focuses on the quantitative and qualitative analysis of previous effects and results of KIRAS.[187]

Programme objectives and key information

The Austrian security research programme KIRAS supports national research proposals with the aim of increasing security for Austria and its population. KIRAS accordingly pursues a series of strategic programme goals:

- Increasing security and security awareness among citizens
- Generating the knowledge required for security policy
- Achieving leaps in terms of knowledge, procedures and technologies
- Growth in the domestic security business
- Establishing and expanding excellence in the area of security research

In order to achieve these strategic goals, KIRAS pursues an integrated approach that is not just based on technological solutions, but also on incorporating the social sciences and humanities. This approach should be supported in particular by achieving strategic crossover targets that consider social issues in all aspects of security research.

Responsibility for the programme itself lies with the Federal Ministry of Transport, Innovation and Technology (BMVIT), which commissioned the Austrian Research Promotion Agency (FFG) with programme and overall management. The first programme phase for KIRAS was scheduled for 2005 to 2013 (nine years), with the period from 2005 to 2007 being the development phase. KIRAS had funded a total of 107 projects, or about 34% of project applications, by the time that the interim evaluation report was submitted. Costs per project amount to approximately € 498,000.

Results of the evaluation

Up to this point, all the funded projects of the Austrian security research programme KIRAS have made a contribution to the primary goal of increasing public security. The projects address areas in which there is a specific threat potential or a perceived threat. Along with the programme's specific focus on protecting critical infrastructure sectors, thematic areas such as criminality (with topics such as "terrorism"), "accidents", and "natural disasters" have gained in importance recently. Although these topics mirror ex-

187 See Pfirrmann et al. (2012).

isting fears and perceived threats among the population, the contributions of KIRAS projects to increasing security awareness among people has so far been rather moderate (only one-third of KIRAS projects include specific measures and activities to raise awareness among the population). The findings regarding knowledge generation are far better: around 45% of funded firms report that they would not have initiated projects without KIRAS funding; with expiry of the KIRAS project support, around 60% of institutions surveyed are already working on designing a successor project; furthermore, KIRAS projects tend to be more technically complex and significantly more intensive in terms of cooperation, and exhibit a higher strategic importance than other innovation and research activities at participating institutions. The overall economic effects of the KIRAS programme are thoroughly positive: funding volume of € 37 million and total project volume of € 53 million generated around € 74 million in value added volume through direct, indirect and induced effects. A total of about 570 highly qualified positions were retained and about 240 highly qualified positions were created through this.[188]

The future definition and organisation of KIRAS should focus above all on generating improved common understanding of projects with essential users and consumers. Furthermore, project planning should incorporate more thorough consideration of the complexity and temporal dependency of interconnected KIRAS projects.

6.6 Interim evaluation of the regional contact points commissioned by the Federal Ministry of Science and Research

Objective of the evaluation

The objective of the interim evaluation was to analyse the effectiveness and efficiency of the structure and services of the regional contact points commissioned by the Federal Ministry of Science and Research (BMWF) as part of the consulting and advising network that was established upon Austria's accession to EU research programmes. Working from this foundation, recommendations for future optimisations as well as the basis for possible subsequent commissions were to be developed while incorporating changes anticipated at the EU level. The evaluation covers the period from 2009 to 2012.[189]

Programme objectives and key information

In order to provide local professional support to potential applicants in the EU Research Framework Programmes and other European programmes, the Austrian federal government established a consulting and advising network under the aegis of the Federal Ministry of Science and Research. This network is comprised on the one hand of the federal European and International Programme (EIP) department of the Austrian Research Promotion Agency (FFG) and on the other of the regional contact points (RCPs) in the Austrian states. The research service offices at universities and research institutions form an additional level. The EIP department assumes the important function of coordinating the network, with the aim of ensuring quality assurance and content coordination in the entire national network, and it is therefore a direct point of contact for the regional contact points. The regional contact points are financed by commission contracts through the Federal Ministry of Science and Research, with four regional contact points currently appointed to advise researchers in respective regions for the purposes of optimising Austria's participation in EU programmes:

- CATT Innovation Management GmbH (Upper Austria)

188 These figures are in turn related to the period up to the evaluation.
189 See Good, Radauer (2013).

- ITG – Innovations- und Technologietransfer Salzburg GmbH (Salzburg – appointed through a cooperation contract with the state of Salzburg)
- SAT – Standortagentur Tirol/Tiroler Zukunftsstiftung (Tyrol, Vorarlberg)
- SFG – Steirische Wirtschaftsförderungsgesellschaft (Styria, Carinthia)[190]

The goal of the RCPs is to provide the best possible information, consultation and advice services to regional stakeholders in science, industry and administration in terms of EU Research Framework Programmes and other European programmes. According to agreements with the state governments, the states co-finance the commissions of the Federal Ministry of Science and Research (BMWF) at the rate of 50%; the Federal Ministry of Science and Research uses its budget to finance about 1.15 to 1.26 FTEs per year at the RCPs. It is worth noting that all RCPs follow a uniform consultancy concept and thereby fulfil their guiding function. In recent years, however, their target group has changed: universities have ceased to be important clients because they have built their own research service centres and professionalised their consultancy services. RCP budgets have nonetheless remained constant; they have taken on additional responsibilities in the form of strategic activities related to Horizon 2020 and in connection with regional economic and innovation strategies.

Results of the evaluation

Overall, the RCPs have fulfilled their anticipated function as a guide and orientation aid in terms of European and alternative funding programmes. The integration of the RCPs into the state agencies also increased professionalisation and the focus placed on firms and clients (in contrast to focus on the funding programme) in its consultancy must also be viewed as very positive. The high client satisfaction rate proves the success of this consultancy approach. The central factors for the success of the RCPs are the dedicated and trained consultants who are responsive to the firms' needs and are local points of contact who know the situation in the specific region.

There are some significant differences between the RCPs in terms of their types of target group, the size and composition of the regional target group for which EU funding is relevant and the intensity of the consultancy services on offer. The main clients of the RCPs are firms, especially SMEs. Additional clients include affiliates of non-university research institutions, universities of applied sciences, private universities and intermediaries. In contrast to the past, most RCPs no longer have universities as clients, meaning that they are confronted with a shrinking target group, for which EU funding programmes are only partly relevant. In light of this development, we must therefore ask whether the actual and possible benefit of the RCPs in the consultancy network justifies the funding allocation. The evaluation team is very aware of the heterogeneity of the RCPs, and points out the difficulty in delivering unambiguous recommendations for action.

190 The RCP for Lower Austria is also part of the regional consultancy network – the TIP Technology and Innovation Partner of the Lower Austrian Economic Chamber, which is not financed by the Federal Ministry of Science and Research and therefore was not included in this evaluation.

7 Literature

Aghion, P., Boulanger, J., Cohen, E. (2011): Rethinking industrial policy. Bruegel Policy Brief, 4.

Aiginger, K. (2006): Industrial policy: a dying breed or a re-emerging phoenix; Journal of Industry, Competition and Trade, 7, 297–323.

Aiginger, K., Falk, M. (2005): Explaining Differences in Economic Growth among OECD Countries; Empirica, 32, 19-43.

Aschhoff, B., Brandes, F., Crass, D., Cremers, K., Diaz-Lopez, F., Grimpe, C., Klein Woolthuis, R., Mayer, M., Montalvo, C., Rammer, C. (2010): European Competitiveness in Key Enabling Technologies. Background Report to the EU Competitiveness Report 2010, Mannheim and Delft: ZEW and TNO.

Austria Innovativ (2012): "Qualitätssicherung: Was das neue Rahmengesetz den heimischen Hochschulen für Änderungen bringt", 6a/2012, Vienna.

Bauer, B., Stieg., K. (2010). An overview of the publishers that work with hybrid models can be found in the sub-directory of the SHER-PA/RoMEO-Seite „Publishers with Paid Options for Open Access", http://www.sherpa.ac.uk/romeo/PaidOA.html, last accessed on 23 April 2013.

Baumol, W. (1967): Macroeconomics of unbalanced growth: the anatomy of urban crisis, in: The American Economic Review, 3, 425–426.

Birch, D.L. (1979): The Job Generation Process: a Report, prepared by the Massachusetts Institute of Technology Program on Neighborhood and Regional Change for the Economic Development Administration. US Department of Commerce. Washington and Cambridge / Mass: MIT, Press.

Birch, D.L., Haggerty, A., Parsons ,W. (1995): Who's Creating Jobs?, Boston, Cognetics.

Birch, D.L., Medoff, J. (1994): "Gazelles", in: L. C. Solomon / A.R. Levenson (eds.): Labor Markets, Employment Policy, and Job Creation, Westview: Boulder Co., pp. 159–168.

Blanchard, O., Illing, G. (2010): Makroökonomie. 5th edition, Pearson: Munich.

Bloomberg (2012): Global trends in renewable energy investment, Frankfurt School of Finance & Management GmbH

BMWF (2011): Universitätsbericht 2011, dem Nationalrat vom Bundesminister für Wissenschaft und Forschung gemäß § 11 Universitätsgesetz 2002, Federal Law Gazette I No. 120/2002, Vienna.

BMWF, BMVIT, BMWFJ (2012): Austrian Research and Technology Report 2012. Report of the Federal Government to the Parliament (National Council) under Section 8 (2) of the Research Organisation Act, on federally subsidised research, technology and innovation in Austria.

BMWF, UNIKO (2011): Kapazitätsorientierte Universitätsfinanzierung, Vienna, December 2011.

BMWFJ (2012): Österreichs Warenverkehr 2011.

Boston Consulting Group (2009): The Innovation Imperative in Manufacturing. How the United States Can Restore Its Edge, Boston.

Butschek, F. (2012): Österreichische Wirtschaftsgeschichte. Von der Antike bis zur Gegenwart. 2ne edition, Böhlau: Vienna, Cologne, Weimar.

Dachs, B. (2009): Strukturwandel und F&E-Intensität im österreichischen Unternehmenssektor. In: Leitner, K. H., Weber, M., Fröhlich, J. (eds.): Innovationsforschung und Technologiepolitik in Österreich, Studienverlag: Innsbruck, 45–64.

Dachs, B., Hunya, G., Hanzl-Weiss, D., Foster, N., Kampik, F., Leitner, S., Scherngell, T., Stehrer, R., Urban, W., Zahradnik, G. (2012): Internationalisation of business investments in R&D and analysis of their economic impact. European Commission, Directorate-General for Research and Innovation, Final Report.

Dachs, B., Webersberger, B., Kinkel, S., Waser, B. (2006): Offshoring of production – a European perspective. European Manufacturing Survey Bulletin, 2.

Debande, O. (2006): De-industrialisation; EIB Papers, 11, 65-82.

Den Haan, W. (2011): Why do we need a financial sector? VOX, http://www.voxeu.org/article/why-do-we-need-financial-sector, last accessed on 23 April 2013.

Deutsche Telekom Stiftung und BFI (2012): Innovationsindikator 2012, Bonn and Berlin.

Economist Intelligence Unit (2009): A New Ranking of the World's Most Innovative Countries, London: Economist Intelligence Unit.

EFI (2012): Gutachten 2012: Gutachten zu Forschung, Innovation und technologischer Leistungsfähigkeit Deutschlands, http://www.e-fi.de/fileadmin/Gutachten/EFI_Gutachten_2012_deutsch.pdf, last accessed on 23 April 2013.

EFI (2013): Gutachten 2013; Gutachten zu Forschung, Innovation und Technologischer Leistungsfähigkeit Deutschlands, Expertenkommission Forschung und Innovation.

Egeln, J., Fryges, H., Höwer, D., Müller, B., Müller, K. (2012): Wachstumsbedingungen bzw. Wachstumshemmnisse für junge Unternehmen, Studie zum deutschen Innovationssystem No. 14–2012, http://www.e-fi.de/fileadmin/Innovationsstudien_2012/StuDIS_14_ZEW_KfW.pdf, last accessed on 23 April 2013.

Erlinger-Schacherbauer, E. (2012): Positionen des BMWF zur Neuordnung der externen Qualitätssicherung in Österreich, in: Benz, W., Kohler, J., Landfried, K. (eds.): Handbuch Studium & Lehre, Raabe Verlag.

European Commission (2009a): Preparing for our future: Developing a common strategy for key enabling technologies in the EU, COM(2009) 512, Brussels, 30 Sept. 2009.

European Commission (2009b): Current situation of key enabling technologies in Europe, Commission Staff Working Document, SEC(2009) 1257, Brussels, 30 Sept. 2009.

European Commission (2010a): Europe 2020 Flagship Initiative – Innovation Union; COM (2010) 546 final.

European Commission (2010b): European Competitiveness Report 2010, SEC(2010) 1276, Brussels, 28 Oct. 2010.

European Commission (2011a): Innovation Union Scoreboard 2010; Report für die Generaldirektion Unternehmen und Industrie, Brüssel. http://ec. europa.eu/enterprise/policies/innovation/facts-figures-analysis/innovation-scoreboard/indexen.htm.

European Commission (2011b): National Open Access and Preservation Policies in Europe: Analysis of a questionnaire to the European research Area Committee, abrufbar unter: http://ec.europa.eu/research/science-society/document_library/pdf_06/open-access-report-2011_en.pdf.

European Commission (2011c): EU industrial structure 2011. Trends and performance.

European Commission (2012a): A stronger industry for growth and economic recovery. Industrial policy communication update, COM 582.

European Commission (2012b): A European strategy for Key Enabling Technologies – A bridge to growth and jobs, COM(2012) 341, Brussels, 26 June 2012.

Fagerberg, J. (1995): User-producer interaction, learning and comparative advantage, Cambridge Journal of Economics 19, 243–256.

Falk, M., Spitzlinger, R. (2013): Erfolgsfaktoren für neue Arbeitsplätze von F&E-durchführenden Unternehmen; Austrian Institute of Economic Research (WIFO), commissioned by the Austrian Research Promotion Agency (FFG), Vienna.

Finch, D.J. (2012): Accessibility, sustainability, excellence: how to expand access to research publications. Report of the Working Group on Expanding Access to Published Research Findings.

Fishman, C. (2012): The insourcing boom; The Atlantic Magazine, December 2012.

Gassler, H., Polt, W., Rammer, Ch. (2006): Schwerpunktsetzungen in der Forschungs- und Technologiepolitik – eine Analyse der Paradigmenwechsel seit 1945, in: Österreichische Zeitschrift für Politikwissenschaft (ÖZP), year 35, vol. 1, 7–23:

Gehrke, B., Rammer, C., Frietsch, R., Neuhäusler, P. (2010): Listen wissens- und technologieintensiver Güter und Wirtschaftszweige – Zwischenbericht zu den NIW/ISI/ZEW Listen 2010/2011, Berlin, http://www.e-fi.de/fileadmin/Studien/Studien_2010/StuDIS_19-2010.pdf, last accessed on 23 April 2013.

Gehrke, B., Schasse, U. (2012): Wirtschaftsfaktor Umweltschutz: Neuabgrenzung potenzieller Umweltschutzgüter – Liste potenzieller Umweltschutzgüter 2012. Methodenbericht zum Forschungsprojekt "Wirtschaftsfaktor Umweltschutz: Analyse der wirtschaftlichen Bedeutung des Umweltschutzes durch Aktualisierung wichtiger Kenngrößen" commissioned by the Austrian Environment Agency (Umweltbundesamt). Niedersächsisches Institut für Wirtschaftsforschung e.V. (NIW), Hannover, December 2012. To be published shortly.

Gnan, E., Janger, J., Scharler, J. (2004): Ursachen des langfristigen Wachstums in Österreich – Plädoyer für eine nationale Wachstumsstrategie; Geldpolitik und Wirtschaft, 1, 25–49.

Good, B., Radauer, A. (2013): Zwischenevaluierung der vom BMWF beauftragten Regionalen Kontaktstellen (RKS), Final report, Vienna.

Guerri, P., Maliciai, V. (2005): Technology and international competitiveness: The interdependence between manufacturing and producer services. Structural Change and Economic Dynamics, 16, 489–502.

Harrison, R. (2008): Does Innovation stimulate employment? A firm-level analysis using comparable micro-data from four european countries; in: NBER Working Paper Series 14216.

Hartwig, J. (2012): Testing the growth effects of structural change, in: Structural Change and Economic Dynamics, 23, 11–24.

Helper, S., Krueger, T., Wial, H. (2012): Why does manufacturing matter? Which manufacturing matters? A policy framework. Brookings.

High-level Expert Group on Key Enabling Technologies (2011): Final Report, European Commission, http://ec.europa.eu/enterprise/sectors/ict/files/kets/hlg_report_final_en.pdf, last accessed on 23 April 2013.

INSEAD (2010): The Global Innovation Index 2009-10, o.O.: INSEAD.

Institut der deutschen Wirtschaft Köln (Cologne Institute for Economic Research) (2012): Innovationsmonitor 2012 – Die Innovationskraft Deutschlands im internationalen Vergleich, Cologne.

Janger, J. (2012): Strukturwandel und Wettbewerbsfähigkeit in der EU; WIFO-Monatsberichte, 8, 625–640.

Jorgenson, D.W., Timmer, M.P. (2011): Structural Change in Advanced Nations, Scandinavian Journal of Economics 113, 1, 1–29.

Kaldor, N. (1967): Strategic factors in economic development. Ithaca.

Kaldor, N. (1972): The irrelevance of equlibrium economics, 82, 1237–1255.

Kattinger, M. (2012): Gelungene Wandlung des Industriestandortes Steiermark; Neue Zürcher Zeitung, 29 March 2012, 29.

Kaufmann, A., Tödtling, F. (2002): How effective is innovation support for SMEs? An analysis of the region of Upper Austria, Technovation 22(2002), 147–159.

Kaufmann, K., Streicher, J., Sheikh, S. (2012): Evaluation of the European Space Policy Institute (ESPI), Vienna.

Krugman, P. (1994), The Age of Diminished Expectations, MIT Press, Boston.

Lewis, D. (2012): The Inevitability of Open Access, College & Research Libraries, 73, 5, 493-506.

Loprieno, A., Menzel, E., Schenker-Wicki, A. (2011): Zur Entwicklung und Dynamisierung der österreichischen Hochschullandschaft – eine Außensicht. Rahmenkonzept für einen Hochschulplan, August 2011.

Ludwig, U., Brautzsch, H.U., Loose, B. (2011): Dienstleistungsverbund stärkt Bedeutung der Industrie. Wirtschaftsdienst, 9, 648–650.

Malerba, F. (2005): Sectoral systems. How and why innovation differs across sectors; in: Fagerberf, J., Mowery, D., Nelson, R. (eds.): The Oxford Handbook of Innovation. Oxford University Press: Oxford, 380–406.

Marin, D. (2008): The new corporation in Europe. Bruegel Policy Brief, 7.

Marin, D. (2010): The opening up of Eastern Europe at 20 – jobs, skills and "reverse Maquliadoras" in Austria and Germany. Bruegel Working Paper, 2.

Maroto-Sanchez, A., Cuadrado-Roura, J. (2009): Is growth of services an obstacle to productivity growth? A comparative analysis; Structural Change and Economic Dynamics, 20, 254–265.

Marsh, P. (2012): The new industrial revolution. Consumers, globalization and the end of mass production. Yale University Press: New Haven, London.

McCasland, D., Theodossiou, I. (2012): Is manufacturing still the engine of economic growth? Journal of Post Keynesian Economics, 35, 79–92.

McKinsey (2012): Manufacturing the future: The next era of global growth and innovation.

Miles, I. (2005); Innovation in services; in: Fagerberf, J., Mowery, D., Nelson, R. (eds.): The Oxford Handbook of Innovation. Oxford University Press: Oxford, 4433–458.

Necmi, S. (1999): Kaldor's growth analysis revisited; Applied Economics, 31, 653–660.

Nentwich, M., Stöger, H., Muth, V. (2012): Open Access und die Österreichische Akademie der Wissenschaften, Mitteilungen des VÖB, 65 (2).

Nickel, S., Redding, S., Swaffield, J. (2008): The uneven pace of deindustrialisation in the OECD; The World Economy, 31, 1154–1184.

O'Mahony, M., Timmer, M. (2009): Output, Input and productivity measures at the industry level: the EU KLEMS database; The Economic Journal, 119, 374–403.

Oberholzner, T., Fischl, I., Haefeli, U., Mandl, S. (2012): Evaluierung der Strategieprogramme IV2S und IV2Splus, Vienna.

OECD (2002): The Measurement of Scientific and Technological Activities. Proposed Standard Practice for Surveys on Research and Experimental Development. Frascati Manual 2002, OECD, Paris 2002.

OECD (2005): Enhancing the performance of the services sector. Paris.

OECD (2008): OECD Compendium of Productivity Indicators 2008. Paris.

OECD (2011a): OECD Science, Technology and Industry Scoreboard 2011. Paris.

OECD (2011b): Fostering innovation for green growth. Paris.

Oh, D., Heshmati, A., Lööf, H. (2012): Technical change and total factor productivity for Swedish manufacturing and service industries; Applied Economics, 44, 2373-2391.

Osborn, A. (2013): Open access publishing takes a step forward, University World News, 2 March 2013, http://www.universityworldnews.com/article.php?story=20130228122434881, last accessed on 23 April 2013.

Paque, K.H. (2009): Die Bilanz. Eine wirtschaftliche Analyse der deutschen Einheit. Hanser: Munich.

Pechar, H., Park, E., Brechelmacher, A., Ates, G. (2012): Zur Umsetzung des Kollektivvertrags an österreichischen Universitäten, Erhebungen im Auftrag des Bundesministeriums für Wissenschaft und Forschung, Vienna.

Penender, M. (2003): Industrial structure and aggregate growth, in: Structural Change and Economic Dynamics, 14, 427-448.

Peneder, M. (2008): Was bleibt vom Österreich-Paradoxon? Wachstum und Strukturwandel in der Wissensökonomie. WIFO. Vienna.

Pfirrmann, O., Heinrich, S., Riesenberg, D., Dinges, M., Haller, R., Hofer, R., Streicher, G., Ecker, B. (2012): Evaluierung des österreichischen Sicherheitsforschungsprogramms KIRAS, Interimsevaluation 2011/2012, Vienna.

Pilat, D. (2012): Resurrecting industrial policy; OECD Observer, 29, 9.

Pilat, D., Cimper, A., Olsen, K., Webb, C. (2006): The changing nature of manufacturing in OECD economies. OECD Science, Technology and Industry Working Papers 2006/09.

Pisano, G., Shih, W. (2009): Restoring American competitiveness; Harvard Business Review, July-August, 1-14.

Pohn-Weidinger, S., Grasenick, K. (2011): Elita – Evaluierung der FWF Progamme Elise Richter und Hertha Firnberg, Endbericht, Vienna.

Porter, M.E. (1990): The Competitive Advantage of Nations, London: Macmillan.

Ragacs, C., Resch, B., Vondra, K. (2011): Wettbewerbsfähigkeit der österreichischen Sachgütererzeugung; Geldpolitik und Wirtschaft, 3, 38–65.

Rammer, C., Czarnitzki, D., Spielkamp, A. (2008): Innovation Success of Non-R&D-Performers – Substituting Technology by Management in SMEs, ZEW Discussion Paper No. 08-092, Mannheim

Rammer, C., Penzkofer, H., Stephan, A., Grenzmann, C. (2004): F&E- und Innovationsverhalten von KMU und Großunternehmen unter dem Einfluss der Konjunktur – Studien zum deutschen Innovationssystem No. 22-2004, Berlin.

Rattner, S. (2011): The secrets of Germany's success. What Europe's manufacturing powerhouse can teach America; Foreign Affairs, July/August, 7–11.

Reckling, F., Scherag, E. (2012): FWF-INFO, 10-2012.

Reiner, C. (2012): Play it again, Sam: Die Renaissance der Industriepolitik in der Großen Rezession. Wirtschaft und Gesellschaft, 1, 15–56.

Reinstaller, A., Sieber, S. (2012): Veränderung der Exportstruktur in Österreich und der EU; WIFO-Monatsberichte, 657–668.

Reinstaller, A., Unterlass, F. (2012): Strukturwandel und Entwicklung der Forschungs- und Entwicklungsintensität im Unternehmenssektor in Österreich im internationalen Vergleich; WIFO-Monatsberichte, 8, 641–656.

RFTE (2009): Strategie 2020, Rat für Forschung und Technologieentwicklung, Vienna.

Riess, A., Välilä, T. (2006): Industrial policy: a tale of innovators, champions, and B52s; EIP Papers, 11, 11–34.

Rifkin, J. (2011): The third industrial revolution. Palgrave Macmillan: Hampshire.

Rodrik, D. (2011): The manufacturing imperative. Project Syndicate.

Rossini, M. (2012): Starting a Repository – Workshopbericht (Klosterneuburg, 3. Juli 2012), Mitteilungen des VÖB, 65 (2).

Rowthorn, R., Coutts, K. (2004): De-industrialization and the balance of payments in advanced economies. UNCTAD Discussion Paper, 170.

Rowthorn, R., Ramaswamy, R. (1998): Growth, trade and deindustrialization. IMF Working Paper, 98/60.

Rürup, B., Heilmann, D. (2012): Fette Jahre. Warum Deutschland eine glänzende Zukunft hat. Hanser: Munich.

Schettkat, R. (2006): The shift to services employment: A review of the literature; Structural change and economic dynamics, 17, 127-147.

Schettkat, R. (2010): Dienstleistungen zwischen Kostenkrankheit und Marketization. WISO Diskurs. Friedrich Ebert Stiftung.

Schibany, A., Gassler, H. (2010): Nutzen und Effekte der Grundlagenforschung; POLICIES Research Report 98-2010, Vienna.

Schumpeter, J. (2005): Kapitalismus, Sozialismus und Demokratie. 8th edition, Francke: Tübingen, Basel.

Shane, S. A. (2008): The Illusions of Entrepreneurship – The Costly Myth that Entrepreneurs, Investors and Policy Makers live by, New Haven and London, Yale University Press.

Shanmugalingam, S., Puttick, R., Westlake, S. (2010): Rebalancing act. NESTA Research Report.

Shih, W., Pisano, G. (2012): Does America really need manufacturing? Harvard Business Review, March 2012, 94-102.

Siebert, H., Lorz, O. (2007): Außenwirtschaft. 8th edition, Lucius & Lucius: Stuttgart.

Spence, M. Hlatshwayo, S. (2011): The evolving structure of the American Economy and the employment challange. Council on Foreign Relations. Working Paper.

Statistics Austria (2010): Innovation. Ergebnisse der Sechsten Europäischen Innovationserhebung (CIS 2008). Vienna.

Statistics Austria (2011): Erhebung über Forschung und experimentelle Entwicklung 2009, http://www.statistik.at/web_de/statistiken/forschung_und_innovation/f_und_e_in_allen_volkswirtschaftlichen_sektoren/index.html, last accessed on 23 April 2013.

Statistics Austria (2012): Innovation 2008-2010 – Ergebnisse der Innovationserhebung CIS 2010. Vienna.

Syverson, C. (2011): What determines productivity? Journal of Economic Literature, 49, 326-365.

Tassey, G. (2010): Rationales and mechanisms for revitalizing US manufacturing R&D strategies; Journal of Technology Transfer, 35, 283-333.

The Economist (2012): A third industrial revolution. Special Report.

The Information Technology and Innovation Foundation (2009): The Atlantic Century. Benchmarking EU & U.S. Innovation and Competitiveness, Washington.

The White House (2012): An America built to last. Washington.

Tichy, G. (2010): Front-Runner-Strategie: Definition und Umsetzung. In: Plattform fteval, 34, 48–67.

Tidd, J., Bessant, J., Pavitt, K. (1997): Managing innovation. Wiley: Chichester.

Titscher, S. (2004): Profilentwicklung an Österreichs Universitäten. in: Höllinger, S. (ed.): Die österreichische Universitätsreform. Zur Implementierung des Universitätsgesetzes 2002. Vienna.2004, 264–283.

Unger, M., Dünser, L.,Thaler, B., Laimer, A. (2011): Evaluierung des formelgebundenen Budgets der Universitäten, Vienna.

UNIDO (2009): Industrial Development Report.

uniko (2010): Empfehlungen der Österreichischen Universitätenkonferenz zu einer Open Access-Politik der Universitäten, Beschluss vom 12. Jänner 2010, http://www.uniko.ac.at/upload/Uniko-Empfehlungen_Open_Access_01_2010.pdf, last accessed on 23 April 2013.

van de Velde, E., C. Rammer, M. de Heide, F. Pinaud, A. Verbeek, B. Gehrke, K. Mertens, P. Debergh, P. Schliessler, F. van der Zee, M. Butter (2013): Feasibility study for an EU Monitoring Mechanism on Key Enabling Technologies, Brussels: European Commission.

von Lucke, J., Geiger, P. C. (2010): Open Government Data – Frei verfügbare Daten des öffentlichen Sektors, p.3, http://www.zu.de/deutsch/lehrstuehle/ticc/TICC-101203-OpenGovernmentData-V1.pdf, last accessed on 23 April 2013.

von Tunzelmann, A., Acha, V. (2005): Innovation in ‚low-tech' industries; Fagerberf, J., Mowery, D., Nelson, R. (eds.): The Oxford Handbook of Innovation. Oxford University Press: Oxford,
407–432.

Warta, K., Good, B. (2012): Zwischenevaluierung der Dienstleistungsinitiative des BMWFJ, Endbericht, Vienna.

Wienert, H. (2009): Wachstumsmotor Industrie? Zur Bedeutung des Verarbeitenden Gewerbes für die Entwicklung des Bruttoinlandprodukts. Beiträge der Hochschule Pforzheim, 130.

Wolfmayr, Y., Mayerhofer, P., Stankovsky, J. (2007): WIFO White Paper: Exporte als Wachstumsmotor; WIFO-Monatsberichte, 3, 249–261.

8 Annex

8.1 Country codes

AT Austria
BE Belgium
BG Bulgaria
CH Switzerland
CN China
CY Cyprus
CZ Czech Republic
DE Germany
DK Denmark
EE Estonia
ES Spain
FI Finland
FR France
GR Greece
HR Croatia
HU Hungary
IE Ireland
IS Iceland
IT Italy
JP Japan
LT Lithuania
LU Luxembourg
LV Latvia
MT Malta
NL Netherlands
NO Norway
PL Poland
PT Portugal
RO Romania
RS Serbia
RU Russia
SE Sweden
SI Slovenia
SK Slovakia
TR Turkey
UK United Kingdom
US United States

8.2 Research priorities at Austria's universities in the period of the performance contracts 2013–2015

University	"Research priorities"*
University of Vienna: Research platforms	Active Ageing
	Cognitive Science
	Religion and Transformation in Contemporary European Society
	Migration and Integration Research
	Characterisation of Drug Involved Mechanisms
	Alternative Solvents as a Basis for Life Supporting Zones in (Exo)Planetary Systems
	Wiener Osteuropaforum
	Structural and functional analysis of mRNA Molecules Targeted by the RNA-binding Protein Tristetraprolin
	Theory and Practice of Subject Didactics/Teaching Methodologies
	Translational Cancer Therapy Research
	Human Rights in the European Context
	Life Science Governance
	Inter-faculty research platform and documentation unit for the cultural history of central and southern Asia
	Repositioning of women and gender history in the changed European context
	Gödel Research Center
	Ethics and law in medicine
	Interdisciplinary research platform for archaeology
University of Graz: Research priorities	Learning – Education – Knowledge
	Heterogeneity and cohesion
	Intellectual and cultural history of Europe
	Models and simulation
	Molecular enzymology and physiology (MEP)
	The brain and behaviour
	The environment and global change
University of Innsbruck: Research priorities	Molecular biosciences
	Physics
	Alpine space – man and the environment
Medical University of Vienna: Research clusters	Allergology / immunology / infectious diseases
	Cancer research / oncology
	Neurosciences
	Cardiovascular medicine
	Imaging
Medical University of Graz: Research fields	Neurosciences
	Cancer research
	Cardiovascular disease
	Molecular foundations of lipid disorders
Medical University of Innsbruck: Research priorities	Oncology
	Neurosciences
	Molecular and functional imaging
	Infectious disease and immunology & organ and tissue replacement

* As described in the performance agreements.

University of Salzburg: Research priorities	Biosciences and health
	Law, economics and labour
	Science & art
	Salzburg Centre of European Union Studies
Vienna University of Technology: Research priorities	Computational science and engineering
	Information and communication technology
	Materials and matter
	Quantum physics and quantum technologies
	Energy and environment
Graz University of Technology: Fields of expertise	Mobility & production
	Advanced materials science
	Sustainability systems
	Information, communication and computing
	Human and biotechnology
The University of Leoben: Core areas of expertise	Raw materials harvesting and processing
	High-performance materials
	Environmental technology & recycling
	Process and product engineering
	Energy technology
	Metallurgy
	Plastics technology
University of Natural Resources and Applied Life Sciences, Vienna: Fields of expertise	Soil and terrestrial ecosystems
	Water – atmosphere – environment
	Living space and landscape
	Renewable raw materials and resource-oriented technologies
	Foodstuffs – nutrition – health
	Biotechnology
	Nanosciences and nanotechnology
	Resources and social dynamics
Veterinary medicine University of Vienna: Profile lines	Physiological processes
	Infection, prevention, focus on working animals
	Food security and risk evaluation
	Animal models and veterinary biotechnology
	Animal behaviour and human-animal relations
Vienna University of Economics and Business Administration: Research priorities	Information Systems, Computing and Supply Chain Management
	Finance and Accounting
	International Business Taxation
	Applied Economics and Socioeconomics
	Business and Economic Law
	International Business, esp. CEE
	Empirically-Focused Research on Management, Marketing and Strategy
University of Linz: Fields of excellence	Corporate law
	Social systems, markets & the welfare state
	Management & Innovation
	Nano-, bio- and polymer systems
	Computation in Informatics & Mathematics
	Mechatronics and Information Processing

University of Klagenfurt: Research topics	Educational research
	Energy management and technology
	Human Centered Computing and Design
	Sustainability
	Self-organising Systems
	Business Enterprise
	Visual Culture
The Danube University at Krems: Research priorities	Health and medicine
	Education, culture and architecture
	Economics and globalisation
Academy of Fine Arts Vienna: Priorities in research, development and inclusion of the arts	Institute for the Visual Arts
	Institute for Arts and Architecture
	Institute for Art Teachers
	Institute for Conversation-Restoration
	Institute for Artistic and Cultural Studies
	Institute for the Natural Sciences and Technology in the Arts
Vienna University for Applied Arts: Disciplines	Architecture
	Visual and Medial Arts
	Design
	Conservationa and Restoration
	Artistic and Cultural Studies
	Natural sciences
	Language arts
	Art and knowledge transfer
	Art pedagogy and teaching
Vienna University of Music and Performing Arts: Three pillars	Concert performance
	Music pedagogy
	Performing arts
Graz University of Music and Performing Arts: Priorities	Chamber music
	Jazz
	Stage (theatre, musical theatre, stage design)
	Contemporary music
	Research
Mozarteum University of Salzburg: Development priorities	Contemporary art
	Stage art
	Chamber music / ensemble performance
Linz University of Art and Industrial Design: Profile priorities	Intermediality
	Spatial strategies
	Artistic-scientific research

8.3 List of the individual indicators in the "Innovation Indicator" of the Deutsche Telekom Foundation and the Federation of German Industries

Description	Stakeholder / subsystem	Input/ output
Share of international students among all students	Education	Input
Employees with at least secondary level II, without university degrees as share of all employees	Education	Output
Doctoral degree holders (ISCED 6) in MINT subjects as share of population	Education	Output
University graduates in relation to highly skilled employees who are 55+ years of age	Education	Input
Share of employees with tertiary education among all employees	Education	Output
Annual education expenditure (tertiary level including R&D) per student	Education / state	Input
Quality of the education system (scale from 1 to 7 based on expert assessments)	Education / state	Input
Quality of education in mathematics / natural sciences (scale from 1 to 7 based on expert assessments)	Education / state	Input
PISA Index: science, reading competence, mathematics (on an open scale with a median value of 500 and standard deviation of 100)	Education / state	Input
E-Readiness Indicator (scale from 1 to 10)	Society	Input
Evaluation of the probability of success for start-ups (according to self-reporting)	Society	Input
Number of personal computers per 100 population	Society	Input
Share of post-materialists (Inglehardt) in the population	**Society**	**Input**
Government demand for advanced technological products (scale from 1 to 7 based on expert assessments)	State	Input
Business enterprise sector demand for technological products (scale from 1 to 7 based on expert assessments)	Business	Input
Venture capital spent in the early start-up phase in relation to gross domestic product	Business	Input
Extent of marketing (scale from 1 to 7 based on expert assessments)	Business	Input
Share of international co-patents of all applications for transnational patents	Business	Input
Share of value added in high technology of all value added	Business	Output
Share of employees in knowledge-intensive services among all employees	Business	Input
Intensity of domestic competition (scale from 1 to 7 based on expert assessments)	**Business**	**Input**
Gross domestic product (GDP) per capita	Business	Output
Patent applications for transnational patents per capita	Business	Output
Patent applications to USPTO per capita	Business	Output
Value added per hour of work (in constant PPP - US $)	Business	Output
Trade balance account for high tech measured against population	Business	Output
Share of university R&D expenditure financed by the business enterprise sector	Business	Input
Intramural R&D expenditure by firms as share of GDP	Business	Input
B-Index of tax-related R&D funding: Share of R&D expenditure by firms that were financed by tax-related R&D expenditure	Industry/state	Input
Share of government-financed R&D expenditure by firms in GDP	Industry/state	Input
Number of researchers in full-time equivalent positions per 1,000 employees	Science	Input
Number of scientific technical articles in relation to population	Science	Output
Quality of scientific research institutions (scale from 1 to 7 based on expert assessments)	Science	Input
Number of citations per scientific technical publication in relation to global average (measured by the average of the respective discipline)	Science	Output
Number of patents from public research per capita	Science	Output
Share of international co-publications in all scientific technical articles	Science	Input
Share of R&D expenditure at government research institutions and universities of GDP	Science/state	Input
A country's share of the top 10% of the most frequently cited scientific technical publications	Science	Input

8.4 Classification of potential environmentally friendly merchandise (Gehrke et al. 2012)

This analysis of international trade flows follows a supply-oriented approach and is based on a new list of potential environmentally friendly merchandise that was prepared by the Lower Saxony Institute for Economic Research (NIW) together with the Federal Statistical Office of Germany in 2012. Potential-oriented in this context means that these goods can potentially be used in sectors relevant to the environment. These include on the one hand goods for using renewable energy sources and for increasing energy efficiency by means of rational energy use and conversion (potential climate protection goods, see box). On the other hand, this also includes goods that aim to protect classical environmental sectors (waste, water, air, noise) as well as cross-sector instruments and components for measuring, controlling and regulating environmental protection facilities.
The goods identified on the basis of (eight-digit) production statistics were recoded by the Lower Saxony Institute for Economic Research (NIW) into the international foreign trade system of the Harmonised System (HS) at the most detailed product level possible (six-digit) to facilitate foreign trade analyses. OECD foreign trade statistics and the Comtrade database of the United Nations were used as data sources. The period under analysis covers 2002 – 2011.
The potential climate protection goods represent the quantitatively most important group of goods. These are subdivided as follows:

- Renewable energy sources
  - Wind power
  - Solar energy
    - Solar cells and modules
    - Other solar energy goods (inverters, mirrors, etc.)
  - Heat pumps, biomass/-gas, hydropower
- Rational use of energy
  - Primarily insulation and thermal insulation
- Efficient energy conversion
  - Gas and steam turbines
  - Cogeneration units

8.5 Definition of industries by technology intensity according to the OECD classification at the NACE 2-digit level (Statistics Austria 2012)

High tech: Manufacture of pharmaceutical products (ÖNACE 21) as well as the manufacture of computer, electronic and optical products (ÖNACE 26).

Medium-high tech: Manufacture of chemicals and chemical products (ÖNACE 20), manufacture of electrical equipment (ÖNACE 27), mechanical engineering, machinery (ÖNACE 28), manufacture of motor vehicles, trailers and semi-trailers (ÖNACE 29), and manufacture of other transport equipment (ÖNACE 30).

Medium-low tech: Coke, refined petroleum products (ÖNACE 19), manufacture of rubber and plastic products (ÖNACE 22), manufacture of glass, glass products, ceramics, and mineral products (ÖNACE 23), manufacture of basic metals (ÖNACE 24), manufacture of metal products (ÖNACE 25), and repair and installation of machines and equipment (ÖNACE 33).

Low tech: Manufacture of food and feed products (ÖNACE 10), manufacture of beverages (ÖNACE 11), tobacco processing (ÖNACE 12), manufacture of textiles (ÖNACE 13), manufacture of wearing apparel (ÖNACE 14), manufacture of leather, leather wares and shoes (ÖNACE 15), manufacture of wood and of products of wood and cork (except furniture); (ÖNACE 16), manufacture of paper and paper products (ÖNACE 17), manufacture of printing products, reproduction of recorded media (ÖNACE 18), manufacture of furniture (ÖNACE 31), and manufacture of other products (ÖNACE 32).

Knowledge-intensive services: Shipping (ÖNACE 50), aviation (ÖNACE 51), publishing (ÖNACE 58), telecommunications (ÖNACE 61), provisioning of information technology services (ÖNACE 62), information services (ÖNACE 63), provisioning of financial services (ÖNACE 64), insurance, re-insurance and pension funds (excepting social insurance) (ÖNACE 65), activities connected with finance and insurance services (ÖNACE 66), and architecture and engineering firms, technical, physical and chemical analysis (ÖNACE 71).

Less knowledge-intensive services: Wholesale trade (except of motor vehicles and motorcycles) (ÖNACE 46), land transport and transport in pipelines (ÖNACE 49), storage and delivery of other transport services (ÖNACE 52), and postal, courier and express services (ÖNACE 53).

9 Statistics

1. Financing of gross domestic expenditure on R&D and research intensity in Austria[191] 2013

According to an estimate by Statistics Austria, more than € 8.96 billion in gross domestic expenditure are expected to be spent in Austria in 2013 on research and experimental development (R&D). This corresponds to a research intensity (gross domestic expenditure for R&D compared to the gross domestic product) of 2.81%. Compared to 2012, the total amount of Austrian R&D expenditure has increased by 2.9%.

Of the total forecasted research expenditures for 2013, the largest share of financing, or 43.9% (about € 3.93 billion), comes from Austrian firms. R&D funding from the public sector will reach € 3.62 billion and a 40.4% share of overall R&D funding. The federal government is contributing approx. € 3.09 billion; the regional governments approx. € 427 million, and other public institutions such as local governments, chambers and social insurance carriers about € 105 million. 15.2% (about € 1.36 billion) of Austria's research expenditures will be financed in 2013 from abroad. The majority of funding from abroad came from domestic firms affiliated with foreign firms that have subsidiaries conducting R&D in Austria. This also includes the returns from the EU Framework Programmes for Research, Technological Development and Demonstration. 0.5% (approx. € 49 million) will be financed by the private non-profit sector.

Based on information available to Statistics Austria concerning the development of R&D-relevant budget components and additional R&D subsidies, the financing of research by the federal government will continue to climb. Due in particular to refunds by the federal government to firms in connection with the research premium, there was an increase in 2012 of 14.2%; after a rise of 2.8% in 2013, federal funding will reach its highest value ever at € 3.09 billion.

Austria's research intensity, an indicator that represents gross domestic expenditure for R&D as a percentage of gross domestic product (GDP), has grown substantially in the last ten years. Despite the economic crisis, the R&D expenditure in Austria did not decline, or declined only slightly; the research intensity reached 2.71% in 2009 and increased in the following year 2.79% due to R&D funds from the public sector. Stronger growth of the gross domestic product compared to research spending resulted in a short-term decline in the research intensity to 2.72% in 2011; in 2012, research intensity increased slightly

191 On the basis of the results of the R&D statistical surveys and other currently available documents and information, in particular the R&D related appropriations and final outlays of the federal and regional governments, Statistics Austria annually creates the "Total estimate of the gross domestic expenditures for R&D." Under this annual compilation of the total estimate, any retroactive revisions or updates appear as based on the latest data. In accord with the definitions of the Frascati Manual, which is globally valid (OECD, EU) and thus guarantees international comparability, the financing of the expenditures for research and experimental development is presented as carried out in Austria. According to these definitions and guidelines, foreign financing of R&D done in Austria is included, although Austrian payments for R&D performed abroad are excluded (domestic concept).

above the level of 2010 to 2.81%. According to the latest information on the development of gross domestic product, research intensity is forecasted to remain at this level in 2013.
Austria clearly continues to outdo the average research intensity of the EU-27 and is clearly above the EU average of 2.03% for the comparison year 2011 (the last year for which international comparative figures are available). Finland, Sweden and Denmark have research intensities above 3%; after Germany, which edged out Austria at 2.84%, Austria has the fifth-highest ratio in the EU-27.
In estimating the Austrian gross domestic expenditures on R&D in 2013, the preliminary results of the R&D survey by Statistics Austria up to and including the reporting year 2011 were taken into consideration, along with the appropriations and final outlays of the federal government and the regional governments, as well as current economic data.

2. Federal R&D expenditure in 2013

2.1. The federal expenditure shown in Table 1 for R&D carried out in Austria in 2013 is composed as described below; according to the methodology used for the R&D global estimate, the core is the total amount of Part b of Annex T in the Auxiliary Document for the Federal Finances Act 2013. The estimate also includes the funds from the National Foundation for Research, Technology, and Development available for 2013, based on the currently available information, as well as the estimates of the 2013 payout for research premiums.[192]

2.2. In addition to its expenditures for R&D in Austria, in 2013 the federal government will pay contributions to international organisations aimed at research and the promotion of research amounting to € 95 million. They are shown in Annex T/Part a, but according to the domestic concept these are not included in the Austrian gross domestic expenditure on R&D.

2.3. The federal government expenditures summarised in Annex T (Part a and Part b) that impact research and which includes its research-effective share in contributions to international organisations (cf. above pt. 2.2), are traditionally included under the title "Expenditures of the federal government for research and the promotion of research." These correspond to what is called the "GBAORD" concept [193] that is used by the OECD and the EU on the basis of the Frascati Handbook. This concept refers primarily to the budgets of the central government and/or federal state. It includes (in contrast to the domestic concept) research-related contributions to international organisations and provides the basis for classification of R&D budget data by socio-economic objectives as required for reporting to the EU and OECD.

In 2013 the following socio-economic goals will receive the largest portions of federal expenditure for research and research funding:

- Funding of general knowledge advancement: 30.4%
- Funding of trade, commerce, and industry: 27.6%
- Funding of health care: 20.8%
- Funding of research covering the earth, the seas, the atmosphere, and space: 4.5%
- Funding of social and socio-economic development: 3.5%
- Funding of environmental protection: 3.3%
- Funding of agriculture and forestry: 2.8%

192 Source: BMF.
193 GBAORD: Government Budget Appropriations or Outlays for R&D.

3. R&D expenditures by the Austrian states

The research financing by the Austrian government as collated in Table 1 is listed from the state budget-based estimates of R&D expenditure reported by the offices of the regional governments. The R&D expenditures of the regional hospitals are estimated annually by Statistics Austria by a methodology agreed on with the regional governments.

4. An international comparison of 2010 R&D expenditure

Overview Table 13 shows Austria's position compared to the other European Union member states and the OECD in terms of the most important R&D-related indices.[194]

5. Austria's participation in the European Framework Programmes for research, technological development and demonstration activities

Tables 14 through 16 provide an overview of Austria's participation in the European Framework Programmes for research and development based on PROVISO, an ongoing monitoring and reporting system.

6. Research funding by the Austrian Science Fund (FWF)

Tables 17 through 19 provide detailed information about funding and the number of projects in Austrian Science Fund (FWF) projects.

7. Funding by the Austrian Research Promotion Agency (FFG)

Tables 20 and 21 provide detailed information on 2012 funding approvals by the Austrian Research Promotion Agency (FFG).

8. The aws technology programmes

Table 22 shows an overview of disbursed funding under the auspices of the aws technology programmes.

9. Christian Doppler Society

Tables 23 to 25 depict the status and historical development of the CD laboratories.

194 Source: OECD MSTI 2012-2.

List of Tables

Table 1: Global estimate 2013: Gross domestic expenditure on R&D financing of research and experimental development carried out in Austria 1993 – 2013

Financing	1993	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
1. Gross domestic expenditure on R&D (in € millions)	**2,303.31**	**2,885.55**	**3,123.21**	**3,399.84**	**3,761.80**	**4,028.67**	**4,393.09**	**4,684.31**	**5,041.98**	**5,249.55**	**6,029.81**	**6,318.59**	**6,867.82**	**7,548.06**	**7,479.75**	**7,980.24**	**8,186.91**	**8,707.82**	**8,962.33**
of which financed by:																			
Federal government[1)]	957.12	1,066.46	1,077.59	1,097.51	1,200.82	1,225.42	1,350.70	1,362.37	1,394.86	1,462.02	1,764.86	1,772.06	1,916.96	2,356.78	2,297.46	2,586.43	2,630.28	3,004.26	3,087.36
Regional governments[2)]	129.67	159.06	167.35	142.41	206.23	248.50	280.14	171.26	291.62	207.88	330.17	219.98	263.18	354.35	273.37	405.17	408.73	412.51	427.40
Business enterprise sector[3)]	1,128.40	1,290.76	1,352.59	1,418.43	1,545.25	1,684.42	1,834.87	2,090.62	2,274.95	2,475.55	2,750.95	3,057.00	3,344.40	3,480.57	3,520.02	3,572.24	3,703.82	3,815.68	3,930.91
Abroad [4)]	59.69	337.00	478.21	684.63	738.91	800.10	863.30	1,001.97	1,009.26	1,016.61	1,087.51	1,163.35	1,230.24	1,240.53	1,255.93	1,278.54	1,301.14	1,327.16	1,362.99
Other[5)]	28.42	32.27	47.47	56.86	70.59	70.23	64.08	58.09	71.29	87.49	96.32	106.20	113.04	115.83	132.97	137.86	142.94	148.21	153.67
2. Nominal GDP[6)] (in € billions)	159.27	180.56	184.32	191.91	199.27	208.47	214.20	220.53	225.00	234.71	245.24	259.03	274.02	282.74	276.15	286.40	300.71	309.90	319.15
3. Gross domestic expenditure on R&D as a % of GDP	***1.45***	***1.60***	***1.69***	***1.77***	***1.89***	***1.93***	***2.05***	***2.12***	***2.24***	***2.24***	***2.46***	***2.44***	***2.51***	***2.67***	***2.71***	***2.79***	***2.72***	***2.81***	***2.81***

As at: 11 April 2013.
Source: STATISTICS AUSTRIA (Bundesanstalt Statistik Österreich).

[1)] 1993, 1998, 2002, 2004, 2006, 2007 and 2009: survey results (federal incl. Austrian Science Fund (FWF), Research Promotion Fund (FFF)/Austrian Research Promotion Agency (FFG) as well as 1993, 1998 and 2002 also incl. ITF).
1996, 1997, 1999-2001, 2003, 2005, 2008, 2010-2011: Annex T/Part b of the Auxiliary Document for the Federal Finances Act (outlays).
2005: In addition: € 84.4 million from the National Foundation for Research, Technology and Development, as well as € 121.3 million in paid-out research premiums.
2008: In addition: € 91.0 million from the National Foundation for Research, Technology and Development, as well as € 340.6 million in paid-out research premiums.
2010: In addition: € 74.6 million from the National Foundation for Research, Technology and Development, as well as € 328.8 million in paid-out research premiums.
2011: In addition: € 75.1 million from the National Foundation for Research, Technology and Development, as well as € 314.3 million in paid-out research premiums.
2012: In addition: Annex T/Part b of the Auxiliary Document of the Federal Finances Act 2013 (financing proposal). In addition: € 53.9 million from the National Foundation for Research, Technology and Development, as well as € 574.1 million in paid-out research premiums (Source: BMF, April 2013).
2013: Annex T/Part b of the Auxiliary Document of the Federal Finances Act 2013 (financing proposal). In addition: € 83.3 million from the National Foundation for Research, Technology and Development, as well as € 550 million in research premiums that are scheduled for disbursement (BMF estimate, April 2013; due to a new reporting obligation for own research activities funded by the Austrian Research Promotion Agency (FFG) research premiums, the current estimate should be viewed as "preliminary").

[2)] 1993, 1998, 2002, 2004, 2006, 2007 and 2009: survey results. 1996, 1997, 1999-2001, 2003, 2005, 2008 and 2010-2013: Based on the estimates of R&D expenditure reported by the state government offices.

[3)] Financing by industry.
1993, 1998, 2002, 2004, 2006, 2007 and 2009: survey results. 1996, 1997, 1999-2001, 2003, 2005, 2008 and 2010-2013: Estimates made by Statistics Austria.

[4)] 1993, 1998, 2002, 2004, 2006, 2007 and 2009: survey results. 1996, 1997, 1999-2001, 2003, 2005, 2008 and 2010-2013: Estimates made by Statistics Austria.

[5)] Financing by local governments (excluding Vienna), chambers, social insurance institutions and other public financing and from the private non-profit sector. 1993, 1998, 2002, 2004, 2006, 2007 and 2009: survey results. 1996, 1997, 1999-2001, 2003, 2005, 2008 and 2010-2013: Estimates made by Statistics Austria.

[6)] 1993-2011: Statistics Austria. 2012: Austrian Institute of Economic Research (WIFO) on behalf of Statistics Austria. 2013: Austrian Institute of Economic Research (WIFO), economic forecast March 2013.

Table 2: Global estimate 2013: Gross domestic expenditure on R&D financing of research and experimental development carried out in Austria in percent of GDP, 1993 to 2013

Financing	1993	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
1. Gross domestic expenditure on R&D (in % of GDP)	***1.45***	***1.60***	***1.69***	***1.77***	***1.89***	***1.93***	***2.05***	***2.12***	***2.24***	***2.24***	***2.46***	***2.44***	***2.51***	***2.67***	***2.71***	***2.79***	***2.72***	***2.81***	***2.81***
of which financed by:																			
Federal government[1)]	0.60	0.59	0.58	0.57	0.60	0.59	0.63	0.62	0.62	0.62	0.72	0.68	0.70	0.83	0.83	0.90	0.87	0.97	0.97
Regional governments[2)]	0.08	0.09	0.09	0.07	0.10	0.12	0.13	0.08	0.13	0.09	0.13	0.08	0.10	0.13	0.10	0.14	0.14	0.13	0.13
Business enterprise sector[3)]	0.71	0.71	0.73	0.74	0.78	0.81	0.86	0.95	1.01	1.05	1.12	1.18	1.22	1.23	1.27	1.25	1.23	1.23	1.23
Abroad [4)]	0.04	0.19	0.26	0.36	0.37	0.38	0.40	0.45	0.45	0.43	0.44	0.45	0.45	0.44	0.45	0.45	0.43	0.43	0.43
Other[5)]	0.02	0.02	0.03	0.03	0.04	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.05
2. Nominal GDP[6)] (in € billions)	159.27	180.56	184.32	191.91	199.27	208.47	214.20	220.53	225.00	234.71	245.24	259.03	274.02	282.74	276.15	286.40	300.71	309.90	319.15

As at: 11 April 2013.
Source: STATISTICS AUSTRIA (Bundesanstalt Statistik Österreich)

Footnotes cf. Table 1.

Table 3: Federal expenditure on research and research promotion, 2010 – 2013
Breakdown of Annex T of the Auxiliary Document for the Federal Finances Act 2012 and 2013

Ministries [1]	Outlays				Budget appropriation			
	2010[2]		2011[3]		2012[3]		2013[3]	
	€ million	%	€ million	%	€ million	%	€ million	%
Federal Chancellery (BKA)[4]	1.973	*0.1*	1.898	*0.1*	2.385	*0.1*	2.237	*0.1*
Federal Ministry of the Interior (BMI)	0.789	*0.0*	0.801	*0.0*	0.933	*0.0*	0.911	*0.0*
Federal Ministry for Education, Arts and Culture (BMUKK)	62.380	*2.7*	63.436	*2.7*	70.793	*2.9*	66.842	*2.6*
Federal Ministry for Science and Research (BMWF)	1,652.719	*72.9*	1,669.825	*71.5*	1,738.305	*70.3*	1,823.278	*71.5*
Federal Ministry for Labour, Social Affairs and Consumer Protection (BMASK)	2.232	*0.1*	2.736	*0.1*	2.171	*0.1*	2.501	*0.1*
Federal Ministry for Health (BMG)	4.959	*0.2*	3.772	*0.2*	5.374	*0.2*	4,916	*0.2*
Federal Ministry for European and International Affairs (BMEIA)	2.147	*0.1*	2.259	*0.1*	2.383	*0.1*	2.386	*0.1*
Federal Ministry of Justice (BMJ)	0.098	*0.0*	0.098	*0.0*	0.130	*0.0*	0.130	*0.0*
Federal Ministry of Defence and Sports (BMLVS)	2.440	*0.1*	2.079	*0.1*	2.589	*0.1*	2.380	*0.1*
Federal Ministry of Finance (BMF)	31.437	*1.4*	33,970	*1.5*	34,466	*1.4*	34,620	*1.4*
Federal Ministry for Agriculture, Forestry, Environment and Water Management (BMLFUW)	60.927	*2.7*	77.425	*3.3*	86.609	*3.5*	76.048	*3.0*
Federal Ministry of Economy, Family and Youth	103.200	*4.5*	110.489	*4.7*	107.076	*4.3*	104.338	*4.1*
Federal Ministry for Transport, Innovation and Technology (BMVIT)	344.685	*15.2*	366,903	*15.7*	417,905	*16.9*	428,502	*16.8*
Total	**2,269.986**	***100.0***	**2,335.691**	***100.0***	**2,471.117**	***100.0***	**2,549.089**	***100.0***

As at: April 2013.
Source: STATISTICS AUSTRIA (Bundesanstalt Statistik Österreich)

1) In accordance with the applicable version of the Act Governing Federal Ministries of 1986 (Federal Law Gazette I no. 3/2009).
2) Auxiliary Document for the Federal Finances Act of 2012.
3) Auxiliary Document for the Federal Finances Act of 2013 (financing proposal).
4) Including the highest executive bodies. - Rounding differences not compensated for.

Table 4: Annex T of the Auxiliary Document for the Federal Finances Act 2013 (financing proposal)

ANNEX T	Budget appropriation 2013		Budget appropriation 2012		Outlays 2011	
	Total	Research	Total	Research	Total	Research
	€ million					
Part a*	110,115	95,028	108,976	94,813	107,358	94,776
Part b**	6,275,091	2,454,061	6,101,554	2,376,304	5,715,722	2,240,915
Total	6,385,206	2,549,089	6,210,530	2,471,117	5,823,080	2,335,691

As at: April 2013.
Source: Federal Ministry of Finance.

* contributions to international organisations which aim at (i.a.) research and research promotion

** federal expenditures on research and research promotion (federal research budget).

Table 5: Federal expenditure on research and research promotion by socio-economic objectives, 1997 – 2013

Breakdown of Annex T of the Auxiliary Document for the Federal Finances Act (Parts a and b)

Reporting years		Total federal expenditure for R&D	of which												
			Funding of research covering the earth, the seas, the atmosphere, and space	Funding of agriculture and forestry	Funding of trade, commerce, and industry	Funding of energy production, storage and distribution	Funding of transport, traffic and communications	Funding of schools and education	Funding of the health system	Funding of social and socio-economic development	Funding of environmental protection	Funding of urban and physical planning	Funding of national defence	Funding of other objectives	Funding of general know-ledge advancement
1997[1)]	in € 1,000	1,132,901	54,939	49,177	155,087	21,884	30,385	15,713	265,641	79,076	43,121	6,433	31	11,178	400,236
	in %	*100.0*	*4.8*	*4.3*	*13.7*	*1.9*	*2.7*	*1.4*	*23.4*	*7.0*	*3.8*	*0.6*	*0.0*	*1.0*	*35.4*
1998[2)]	in € 1,000	1,207,908	85,538	69,262	173,102	22,694	34,064	14,514	270,452	86,414	41,747	10,090	57	11,549	388,424
	in %	*100.0*	*7.1*	*5.7*	*14.3*	*1.9*	*2.8*	*1.2*	*22.4*	*7.2*	*3.5*	*0.8*	*0.0*	*1.0*	*32.1*
1999[3)]	in € 1,000	1,281,498	91,387	75,421	188,151	25,314	32,337	15,552	280,577	91,162	42,771	10,136	12	11,348	417,329
	in %	*100.0*	*7.1*	*5.9*	*14.7*	*2.0*	*2.5*	*1.2*	*21.9*	*7.1*	*3.3*	*0.8*	*0.0*	*0.9*	*32.6*
2000[4)]	in € 1,000	1,287,326	86,343	79,177	194,247	21,365	29,644	14,299	291,038	89,881	43,301	10,006	336	11,502	416,187
	in %	*100.0*	*6.7*	*6.2*	*15.1*	*1.7*	*2.3*	*1.1*	*22.6*	*7.0*	*3.4*	*0.8*	*0.0*	*0.9*	*32.2*
2001[5)]	in € 1,000	1,408,773	92,134	78,480	251,049	25,093	36,435	15,342	306,074	94,474	43,909	10,739	174	11,939	442,931
	in %	*100.0*	*6.5*	*5.6*	*17.8*	*1.8*	*2.6*	*1.1*	*21.7*	*6.7*	*3.1*	*0.8*	*0.0*	*0.8*	*31.5*
2002[6)]	in € 1,000	1,466,695	94,112	85,313	243,301	26,243	42,459	16,604	315,345	97,860	45,204	11,153	21	12,579	476,501
	in %	*100.0*	*6.4*	*5.8*	*16.6*	*1.8*	*2.9*	*1.1*	*21.5*	*6.7*	*3.1*	*0.8*	*0.0*	*0.9*	*32.4*
2003[7)]	in € 1,000	1,452,124	96,812	86,018	241,728	25,960	39,550	15,787	316,273	92,762	49,487	10,665	4	12,966	464,112
	in %	*100.0*	*6.7*	*5.9*	*16.6*	*1.8*	*2.7*	*1.1*	*21.8*	*6.4*	*3.4*	*0.7*	*0.0*	*0.9*	*32.0*
2004[8)]	in € 1,000	1,537,890	84,670	61,182	308,316	25,716	41,489	10,846	362,961	73,670	41,336	13,260	163	15,724	498,557
	in %	*100.0*	*5.5*	*4.0*	*20.0*	*1.7*	*2.7*	*0.7*	*23.6*	*4.8*	*2.7*	*0.9*	*0.0*	*1.0*	*32.4*
2005[9)]	in € 1,000	1,619,740	85,101	57,618	347,841	28,320	35,275	9,557	362,000	73,978	46,384	13,349	243	16,165	543,909
	in %	*100.0*	*5.3*	*3.6*	*21.5*	*1.7*	*2.2*	*0.6*	*22.3*	*4.6*	*2.9*	*0.8*	*0.0*	*1.0*	*33.5*
2006[10)]	in € 1,000	1,697,550	76,887	57,698	411,462	20,951	42,795	18,997	379,776	81,812	53,279	9,602	126	-	544,165
	in %	*100.0*	*4.5*	*3.4*	*24.2*	*1.2*	*2.5*	*1.1*	*22.4*	*4.8*	*3.1*	*0.6*	*0.0*	-	*32.2*
2007[11)]	in € 1,000	1,770,144	80,962	64,637	435,799	28,001	40,013	19,990	373,431	90,639	56,075	9,673	27	894	570,003
	in %	*100.0*	*4.6*	*3.7*	*24.6*	*1.6*	*2.3*	*1.1*	*21.1*	*5.1*	*3.2*	*0.5*	*0.0*	*0.1*	*32.1*
2008[12)]	in € 1,000	1,986,775	87,751	66,273	525,573	24,655	39,990	37,636	422,617	90,879	57,535	12,279	142	-	621,445
	in %	*100.0*	*4.4*	*3.3*	*26.5*	*1.2*	*2.0*	*1.9*	*21.3*	*4.6*	*2.9*	*0.6*	*0.0*	-	*31.3*
2009[13)]	in € 1,000	2,149,787	104,775	66,647	538,539	32,964	47,300	42,581	456,544	97,076	67,985	14,522	133	-	680,721
	in %	*100.0*	*4.9*	*3.1*	*25.1*	*1.5*	*2.2*	*2.0*	*21.2*	*4.5*	*3.2*	*0.7*	*0.0*	-	*31.6*
2010[14)]	in € 1,000	2,269,986	103,791	67,621	587,124	39,977	56,969	50,648	472,455	99,798	67,114	12,792	123	-	711,574
	in %	*100.0*	*4.6*	*3.0*	*25.9*	*1.8*	*2.5*	*2.2*	*20.8*	*4.4*	*3.0*	*0.6*	*0.0*	-	*31.2*
2011[15)]	in € 1,000	2,335,691	108,228	67,184	623,537	41,836	56,489	52,607	477,955	82,839	80,959	13,078	119	-	730,860
	in %	*100.0*	*4.6*	*2.9*	*26.7*	*1.8*	*2.4*	*2.3*	*20.5*	*3.5*	*3.5*	*0.6*	*0.0*	-	*31.2*
2012[16)]	in € 1,000	2,471,117	111,154	68,069	655,208	55,368	64,950	61,590	514,882	85,952	93,053	13,914	111	-	746,868
	in %	*100.0*	*4.5*	*2.8*	*26.5*	*2.2*	*2.6*	*2.5*	*20.8*	*3.5*	*3.8*	*0.6*	*0.0*	-	*30.2*
2013[16)]	in € 1,000	2,549,089	115,312	71,467	702,590	46,169	59,997	58,949	529,652	89,934	83,923	14,483	112	-	776,501
	in %	*100.0*	*4.5*	*2.8*	*27.6*	*1.8*	*2.4*	*2.3*	*20.8*	*3.5*	*3.3*	*0.6*	*0.0*	-	*30.4*

As at: April 2013.

Source: Statistics Austria (Bundesanstalt Statistik Österreich).

[1]) Annex T of the Auxiliary Document for the Federal Finances Act 1999, outlays. - [2]) Annex T of the Auxiliary Document for the Federal Finances Act 2000, outlays. Revised data. - [3]) Annex T of the Auxiliary Document for the Federal Finances Act 2001, outlays. Revised data. - [4]) Annex T of the Auxiliary Document for the Federal Finances Act 2002, outlays. - [5]) Annex T of the Auxiliary Document for the Federal Finances Act 2003, outlays. - [6]) Annex T of the Auxiliary Document for the Federal Finances Act 2004, outlays. - [7]) Annex T of the Auxiliary Document for the Federal Finances Act 2005, outlays. - [8]) Annex T of the Auxiliary Document for the Federal Finances Act 2006, outlays. Revised data. - [9]) Annex T of the Auxiliary Document for the Federal Finances Act 2007, outlays. - [10]) Annex T of the Auxiliary Document for the Federal Finances Act 2008, outlays. Revised data. - [11]) Annex T of the Auxiliary Document for the Federal Finances Act 2009, outlays. - [12]) Annex T of the Auxiliary Document for the Federal Finances Act 2010, outlays. - [13]) Annex T of the Auxiliary Document for the Federal Finances Act 2011, outlays. - [14]) Annex T of the Auxiliary Document for the Federal Finances Act 2012, outlays.[15]) Annex T of the Auxiliary Document for the Federal Finances Act 2013 (financing proposal), outlays. - [16]) Annex T of the Auxiliary Document for the Federal Finances Act 2013 (financing proposal), budget appropriation.
- Rounding differences not compensated for.

Table 6: Federal expenditure on research and research promotion by socio-economic objectives and ministries, 2011

Breakdown of annual values for 2011[1]) from Annex T of the Auxiliary Document for the Federal Finances Act 2013 (financing proposal, Part a and Part b)

Ministries		Total federal expenditure for R&D	of which												
			Funding of research covering the earth, the seas, the atmosphere, and space	Funding of agriculture and forestry	Funding of trade, commerce, and industry	Funding of energy production, storage and distribution	Funding of transport, traffic and communications	Funding of schools and education	Funding of the health system	Funding of social and socio-economic development	Funding of environmental protection	Funding of urban and physical planning	Funding of national defence	Funding of other objectives	Funding of general know-ledge advancement
BKA[2]	in € 1,000	1,898	-	-	-	48	-	-	-	1,145	-	551	-	-	154
	in %	*100.0*	-	-	-	*2.5*	-	-	-	*60.4*	-	*29.0*	-	-	*8.1*
BMI	in € 1,000	801	-	-	-	-	-	-	-	801	-	-	-	-	-
	in %	*100.0*	-	-	-	-	-	-	-	*100.0*	-	-	-	-	-
BMUKK	in € 1,000	63,436	2,649	-	319	-	-	29,452	-	5,595	-	-	-	-	25,421
	in %	*100.0*	*4.2*	-	*0.5*	-	-	*46.4*	-	*8.8*	-	-	-	-	*40.1*
BMWF	in € 1,000	1,669,825	79,866	28,297	305,828	13,578	27,865	22,545	425,369	60,318	27,312	10,676	88	-	668,083
	in %	*100.0*	*4.8*	*1.7*	*18.3*	*0.8*	*1.7*	*1.4*	*25.5*	*3.6*	*1.6*	*0.6*	*0.0*	-	*40.0*
BMASK	in € 1,000	2,736	-	-	-	-	-	-	188	2,548	-	-	-	-	-
	in %	*100.0*	-	-	-	-	-	-	*6.9*	*93.1*	-	-	-	-	-
BMG	in € 1,000	3,772	-	62	-	-	-	-	3,709	1	-	-	-	-	-
	in %	*100.0*	-	*1.6*	-	-	-	-	*98.4*	*0.0*	-	-	-	-	-
BMEIA	in € 1,000	2,259	-	-	-	1,105	-	-	-	1,146	-	-	-	-	8
	in %	*100.0*	-	-	-	*48.9*	-	-	-	*50.7*	-	-	-	-	*0.4*
BMJ	in € 1,000	98	-	-	-	-	-	-	-	98	-	-	-	-	-
	in %	*100.0*	-	-	-	-	-	-	-	*100.0*	-	-	-	-	-
BMLVS	in € 1,000	2,079	-	-	-	-	-	-	-	-	-	-	31	-	2,048
	in %	*100.0*	-	-	-	-	-	-	-	-	-	-	*1.5*	-	*98.5*
BMF	in € 1,000	33,970	1,100	785	6,329	288	604	489	7,511	5,562	604	230	-	-	10,468
	in %	*100.0*	*3.2*	*2.3*	*18.6*	*0.8*	*1.8*	*1.4*	*22.1*	*16.4*	*1.8*	*0.7*	-	-	*30.9*
BMLFUW	in € 1,000	77,425	997	34,608	-	-	-	88	-	1,854	39,633	-	-	-	245
	in %	*100.0*	*1.3*	*44.7*	-	-	-	*0.1*	-	*2.4*	*51.2*	-	-	-	*0.3*
BMWFJ	in € 1,000	110,489	-	-	108,663	540	-	-	-	1,286	-	-	-	-	-
	in %	*100.0*	-	-	*98.3*	*0.5*	-	-	-	*1.2*	-	-	-	-	-
BMVIT	in € 1,000	366,903	23,616	3,432	202,398	26,277	28,020	33	41,178	2,485	13,410	1,621	-	-	24,433
	in %	*100.0*	*6.4*	*0.9*	*55.2*	*7.2*	*7.6*	*0.0*	*11.2*	*0.7*	*3.7*	*0.4*	-	-	*6.7*
Total	**in € 1,000**	**2,335,691**	**108,228**	**67,184**	**623,537**	**41,836**	**56,489**	**52,607**	**477,955**	**82,839**	**80,959**	**13,078**	**119**	**-**	**730,860**
	in %	***100.0***	***4.6***	***2.9***	***26.7***	***1.8***	***2.4***	***2.3***	***20.5***	***3.5***	***3.5***	***0.6***	***0.0***	**-**	***31.2***

As at: April 2013.
Source: Statistics Austria.

1) Outlays. - 2) Including the highest executive bodies.

Table 7: Federal expenditure on research and research promotion by socio-economic objectives and ministries, 2012

Breakdown of annual values for 2012[1]) from Annex T of the Auxiliary Document for the Federal Finances Act 2013 (financing proposal, Part a and Part b)

Ministries		Total federal expenditure for R&D	of which												
			Funding of research covering the earth, the seas, the atmosphere, and space	Funding of agriculture and forestry	Funding of trade, commerce, and industry	Funding of energy production, storage and distribution	Funding of transport, traffic and communications	Funding of schools and education	Funding of the health system	Funding of social and socio-economic development	Funding of environmental protection	Funding of urban and physical planning	Funding of national defence	Funding of other objectives	Funding of general know-ledge advancement
BKA[2])	in € 1,000	2,385	-	-	-	47	-	-	-	1,279	-	897	-	-	162
	in %	*100.0*	-	-	-	*2.0*	-	-	-	*53.6*	-	*37.6*	-	-	*6.8*
BMI	in € 1,000	933	-	-	-	-	-	-	-	933	-	-	-	-	-
	in %	*100.0*	-	-	-	-	-	-	-	*100.0*	-	-	-	-	-
BMUKK	in € 1,000	70,793	2,405	-	319	-	-	37,393	-	6,272	-	-	-	-	24,404
	in %	*100.0*	*3.4*	-	*0.5*	-	-	*52.7*	-	*8.9*	-	-	-	-	*34.5*
BMWF	in € 1,000	1,738,305	81,358	29,605	320,174	14,135	29,069	23,520	457,638	62,102	28,545	11,141	93	-	680,925
	in %	*100.0*	*4.7*	*1.7*	*18.4*	*0.8*	*1.7*	*1.4*	*26.3*	*3.6*	*1.6*	*0.6*	*0.0*	-	*39.2*
BMASK	in € 1,000	2,171	-	-	-	-	-	-	184	1,987	-	-	-	-	-
	in %	*100.0*	-	-	-	-	-	-	*8.5*	*91.5*	-	-	-	-	-
BMG	in € 1,000	5,374	-	71	-	-	-	-	5,287	16	-	-	-	-	-
	in %	*100.0*	-	*1.3*	-	-	-	-	*98.4*	*0.3*	-	-	-	-	-
BMEIA	in € 1,000	2,383	-	-	-	1,138	-	-	-	1,236	-	-	-	-	9
	in %	*100.0*	-	-	-	*47.8*	-	-	-	*51.8*	-	-	-	-	*0.4*
BMJ	in € 1,000	130	-	-	-	-	-	-	-	130	-	-	-	-	-
	in %	*100.0*	-	-	-	-	-	-	-	*100.0*	-	-	-	-	-
BMLVS	in € 1,000	2,589	-	-	-	-	-	-	-	-	-	-	18	-	2,571
	in %	*100.0*	-	-	-	-	-	-	-	-	-	-	*0.7*	-	*99.3*
BMF	in € 1,000	34,466	1,102	804	6,406	298	596	506	7,597	5,777	596	238	-	-	10,546
	in %	*100.0*	*3.2*	*2.3*	*18.6*	*0.9*	*1.7*	*1.5*	*22.0*	*16.8*	*1.7*	*0.7*	-	-	*30.6*
BMLFUW	in € 1,000	86,609	836	33,930	-	-	-	109	-	1,671	49,850	-	-	-	213
	in %	*100.0*	*1.0*	*39.2*	-	-	-	*0.1*	-	*1.9*	*57.6*	-	-	-	*0.2*
BMWFJ	in € 1,000	107,076	-	-	105,394	-	-	-	-	1,682	-	-	-	-	-
	in %	*100.0*	-	-	*98.4*	-	-	-	-	*1.6*	-	-	-	-	-
BMVIT	in € 1,000	417,905	25,453	3,659	222,915	39,750	35,285	62	44,176	2,867	14,062	1,638	-	-	28,038
	in %	*100.0*	*6.1*	*0.9*	*53.3*	*9.5*	*8.4*	*0.0*	*10.6*	*0.7*	*3.4*	*0.4*	-	-	*6.7*
Total	**in € 1,000**	**2,471,117**	**111,154**	**68,069**	**655,208**	**55,368**	**64,950**	**61,590**	**514,882**	**85,952**	**93,053**	**13,914**	**111**	**-**	**746,868**
	in %	***100.0***	***4.5***	***2.8***	***26.5***	***2.2***	***2.6***	***2.5***	***20.8***	***3.5***	***3.8***	***0.6***	***0.0***	**-**	***30.2***

As at: April 2013.
Source: STATISTICS AUSTRIA (Bundesanstalt Statistik Österreich)

1) Budget appropriation. - 2) Including the highest executive bodies. - Rounding differences not compensated for.

Table 8: Federal expenditure on research and research promotion by socio-economic objectives and ministries, 2013

Breakdown of annual values for 2013[1]) from Annex T of the Auxiliary Document for the Federal Finances Act 2013 (financing proposal, Part a and Part b)

Ministries		Total federal expenditure for R&D	of which												
			Funding of research covering the earth, the seas, the atmosphere, and space	Funding of agriculture and forestry	Funding of trade, commerce, and industry	Funding of energy production, storage and distribution	Funding of transport, traffic and communications	Funding of schools and education	Funding of the health system	Funding of social and socio-economic development	Funding of environmental protection	Funding of urban and physical planning	Funding of national defence	Funding of other objectives	Funding of general know-ledge advancement
BKA[2])	in € 1,000	2,237	-	-	-	48	-	-	-	1,439	-	591	-	-	159
	in %	*100.0*	-	-	-	*2.1*	-	-	-	*64.4*	-	*26.4*	-	-	*7.1*
BMI	in € 1,000	911	-	-	-	-	-	-	-	911	-	-	-	-	-
	in %	*100.0*	-	-	-	-	-	-	-	*100.0*	-	-	-	-	-
BMUKK	in € 1,000	66,842	2,427	-	319	-	-	33,288	-	6,218	-	-	-	-	24,590
	in %	*100.0*	*3.6*	-	*0.5*	-	-	*49.8*	-	*9.3*	-	-	-	-	*36.8*
BMWF	in € 1,000	1,823,278	86,388	31,716	342,886	14,945	30,905	25,008	469,258	65,728	30,498	12,006	96	-	713,844
	in %	*100.0*	*4.7*	*1.7*	*18.8*	*0.8*	*1.7*	*1.4*	*25.7*	*3.6*	*1.7*	*0.7*	*0.0*	-	*39.2*
BMASK	in € 1,000	2,501	-	-	-	-	-	-	184	2,317	-	-	-	-	-
	in %	*100.0*	-	-	-	-	-	-	*7.4*	*92.6*	-	-	-	-	-
BMG	in € 1,000	4,916	-	71	-	-	-	-	4,841	4	-	-	-	-	-
	in %	*100.0*	-	*1.4*	-	-	-	-	*98.5*	*0.1*	-	-	-	-	-
BMEIA	in € 1,000	2,386	-	-	-	1,155	-	-	-	1,222	-	-	-	-	9
	in %	*100.0*	-	-	-	*48.4*	-	-	-	*51.2*	-	-	-	-	*0.4*
BMJ	in € 1,000	130	-	-	-	-	-	-	-	130	-	-	-	-	-
	in %	*100.0*	-	-	-	-	-	-	-	*100.0*	-	-	-	-	-
BMLVS	in € 1,000	2,380	-	-	-	-	-	-	-	-	-	-	16	-	2,364
	in %	*100.0*	-	-	-	-	-	-	-	-	-	-	*0.7*	-	*99.3*
BMF	in € 1,000	34,620	1,102	804	6,406	298	596	506	7,597	5,931	596	238	-	-	10,546
	in %	*100.0*	*3.2*	*2.3*	*18.5*	*0.9*	*1.7*	*1.5*	*21.9*	*17.1*	*1.7*	*0.7*	-	-	*30.5*
BMLFUW	in € 1,000	76,048	1,132	34,721	-	-	-	109	-	1,673	38,138	-	-	-	275
	in %	*100.0*	*1.5*	*45.7*	-	-	-	*0.1*	-	*2.2*	*50.1*	-	-	-	*0.4*
BMWFJ	in € 1,000	104,338	-	-	102,656	-	-	-	-	1,682	-	-	-	-	-
	in %	*100.0*	-	-	*98.4*	-	-	-	-	*1.6*	-	-	-	-	-
BMVIT	in € 1,000	428,502	24,263	4,155	250,323	29,723	28,496	38	47,772	2,679	14,691	1,648	-	-	24,714
	in %	*100.0*	*5.7*	*1.0*	*58.4*	*6.9*	*6.7*	*0.0*	*11.1*	*0.6*	*3.4*	*0.4*	-	-	*5.8*
Total	**in € 1,000**	**2,549,089**	**115,312**	**71,467**	**702,590**	**46,169**	**59,997**	**58,949**	**529,652**	**89,934**	**83,923**	**14,483**	**112**	**-**	**776,501**
	in %	***100.0***	***4.5***	***2.8***	***27.6***	***1.8***	***2.4***	***2.3***	***20.8***	***3.5***	***3.3***	***0.6***	***0.0***	**-**	***30.4***

As at: April 2013.
Source: STATISTICS AUSTRIA (Bundesanstalt Statistik Österreich)

[1]) Budget appropriation. - [2]) Including the highest executive bodies.

Table 9: General research-related university expenditure by the federal government (General University Funds), 1999 – 2013

Years	General university expenditure[1]	
	Total	R&D
	€ million	
1999	1,960.216	834.529
2000	1,956.167	842.494
2001	2,008.803	866.361
2002	2,104.550	918.817
2003	2,063.685	899.326
2004	2,091.159	980.984
2005	2,136.412	1,014.543
2006	2,157.147	1,027.270
2007	2,314.955	1,083.555
2008	2,396.291	1,133.472
2009	2,626.038	1,326.757
2010	2,777.698	1,310.745
2011	2,791.094	1,307.049
2012	2,946.922	1,384.819
2013	3,162.492	1,483.763

As at: April 2013.
Source: STATISTICS AUSTRIA (Bundesanstalt Statistik Österreich)

1) Based on Annex T of the Auxiliary Document for the Federal Finances Act.

Table 10: Research promotion schemes and contracts awarded by the federal government in 2011, broken down by sectors/areas of performance and awarding ministries
Analysis of the federal research database [1] without "major" global financing [2]

Ministries	Partial amounts 2011	of which awarded to																						
		Higher education sector							Government sector						Private non-profit sector			Business enterprise sector						
		Universities (including hospitals)	Art universities	Austrian Academy of Sciences	Universities of applied sciences	Pedagogical universities	Testing institutes at technical colleges	Total	Federal institutions (outside of the higher education sector)	Regional institutions	Local governments	Private non-profit facilities mostly run on public financing	Ludwig Boltzmann Gesellschaft	Total	Private non-profit sector	Individual researchers	Total	Institutes' sub-sector ("kooperativer Bereich") incl. competence centres (excluding AIT)	Austrian Institute of Technology GmbH - AIT	Company R&D sub-sector ("firmeneigener Bereich")	Total	Austrian Science Fund (FWF)	Austrian Research Promotion Society GmbH	Abroad
	in €	in %																						
BKA	160,295	29.1	-	-	-	-	-	29.1	-	-	-	24.0	-	24.0	-	-	-	-	-	21.1	21.1	-	-	25.8
BMEIA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BMASK	2,603,886	7.2	-	-	-	-	-	7.2	17.7	-	-	47.0	-	64.7	-	2.0	2.0	-	-	26.1	26.1	-	-	-
BMF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BMG	440,832	1.7	-	-	-	-	-	1.7	72.7	-	-	-	-	72.7	2.7	4.8	7.5	-	18.1	-	18.1	-	-	-
BMI	446,187	41.8	1.1	2.5	-	-	-	45.4	11.1	-	-	25.0	-	36.1	2.7	1.8	4.5	-	-	14.0	14.0	-	-	-
BMJ	179,893	-	-	-	-	-	-	-	-	-	-	100.0	-	100.0	-	-	-	-	-	-	-	-	-	-
BMLVS	294,469	13.8	-	-	32.1	-	-	45.9	-	-	-	-	8.6	8.6	17.0	18.3	35.3	-	-	10.2	10.2	-	-	-
BMLFUW	3,160,854	53.8	-	-	-	-	-	53.8	18.1	0.8	-	4.5	-	23.4	7.7	0.8	8.5	4.2	1.9	5.0	11.1	-	3.2	-
BMUKK	13,139,233	0.9	-	-	-	0.1	-	1.0	96.3	-	-	1.9	-	98.2	0.4	0.3	0.7	-	-	0.1	0.1	-	-	-
BMVIT	3,090,515	-	-	-	-	-	-	-	-	-	-	21.4	-	21.4	4.0	-	4.0	65.3	3.1	5.4	73.8	-	0.8	-
BMWFJ	1,343,027	2.2	-	-	-	-	-	2.2	6.8	-	-	18.6	-	25.4	1.4	-	1.4	7.6	-	18.1	25.7	-	45.3	-
BMWF	49,208,227	3.4	0.0	0.5	0.1	0.0	0.0	4.0	0.6	0.1	0.0	5.9	0.3	6.9	0.7	0.9	1.6	0.4	0.1	15.0	15.5	-	10.4	61.6
Total	**74,067,418**	**5.4**	**0.0**	**0.4**	**0.2**	**0.0**	**0.0**	**6.0**	**19.5**	**0.1**	**0.0**	**7.8**	**0.2**	**27.6**	**1.2**	**0.8**	**2.0**	**3.3**	**0.4**	**11.8**	**15.5**	**-**	**7.9**	**41.0**

As at: April 2013.
Source: Statistics Austria (Bundesanstalt Statistik Österreich).

[1]) Status: August 2012.

[2]) i.e. without global financing for: Austrian Science Fund (FWF), Austrian Research Promotion Agency (FFG), Ludwig Boltzmann Gesellschaft, Austrian Academy of Sciences, and AIT Austrian Institute of Technology GmbH.

Table 11: Research promotion schemes and contracts awarded by the federal government in 2011, broken down by socio-economic targets and awarding ministries
Analysis of the federal research database [1] without "major" global financing [2]

Ministries		Partial amounts 2011	of which											
			Funding of research covering the earth, the seas, the atmosphere, and space	Funding of agriculture and forestry	Funding of trade, commerce, and industry	Funding of energy production, storage and distribution	Funding of transport, traffic and communications	Funding of schools and education	Funding of the health system	Funding of social and socio-economic development	Funding of environmental protection	Funding of urban and physical planning	Funding of national defence	Funding of general know-ledge advancement
BKA	in €	160,295	-	-	-	-	-	-	-	160,295	-	-	-	-
	in %	*100.0*	-	-	-	-	-	-	-	*100.0*	-	-	-	-
BMEIA	in €	-	-	-	-	-	-	-	-	-	-	-	-	-
	in %	-	-	-	-	-	-	-	-	-	-	-	-	-
BMASK	in €	2,603,886	-	-	-	-	-	-	2,600	2,501,884	-	-	-	20,000
	in %	*100.0*	-	-	-	-	-	-	*0.1*	*96.1*	-	-	-	*3.8*
BMF	in €	-	-	-	-	-	-	-	-	-	-	-	-	-
	in %	-	-	-	-	-	-	-	-	-	-	-	-	-
BMG	in €	440,832	123,086	289,689	-	-	-	-	-	-	-	-	-	28,057
	in %	*100.0*	*27.9*	*65.7*	-	-	-	-	-	-	-	-	-	*6.4*
BMI	in €	446,187	-	-	-	-	-	-	-	422,757	-	-	-	23,430
	in %	*100.0*	-	-	-	-	-	-	-	*94.7*	-	-	-	*5.3*
BMJ	in €	179,893	-	-	-	-	-	-	-	175,893	-	-	-	4,000
	in %	*100.0*	-	-	-	-	-	-	-	*97.8*	-	-	-	*2.2*
BMLVS	in €	294,469	-	-	7,500	-	-	-	58,206	53,873	-	-	50,000	124,890
	in %	*100.0*	-	-	*2.5*	-	-	-	*19.8*	*18.3*	-	-	*17.0*	*42.4*
BMLFUW	in €	3,160,854	516,649	2,088,053	51,626	80,193	-	-	96,705	77,472	133,500	-	-	116,656
	in %	*100.0*	*16.3*	*66.1*	*1.6*	*2.5*	-	-	*3.1*	*2.5*	*4.2*	-	-	*3.7*
BMUKK	in €	13,139,233	-	-	-	-	-	12,407,892	-	217,847	-	-	-	513,494
	in %	*100.0*	-	-	-	-	-	*94.4*	-	*1.7*	-	-	-	*3.9*
BMVIT	in €	3,090,515	115,086	-	2,026,500	95,877	-	-	-	285,896	-	20,000	-	547,156
	in %	*100.0*	*3.7*	-	*65.6*	*3.1*	-	-	-	*9.3*	-	*0.6*	-	*17.7*
BMWFJ	in €	1,343,027	-	-	4,961	-	-	-	26,000	342,552	-	4,650	-	964,864
	in %	*100.0*	-	-	*0.4*	-	-	-	*1.9*	*25.5*	-	*0.3*	-	*71.9*
BMWF	in €	49,208,227	6,211,923	265	199,307	53,070	28,779	24,464	12,009,222	2,117,574	100,316	32,307	-	28,431,000
	in %	*100.0*	*12.6*	*0.0*	*0.4*	*0.1*	*0.1*	*0.0*	*24.4*	*4.3*	*0.2*	*0.1*	-	*57.8*
Total	**in €**	**74,067,418**	**6,966,744**	**2,378,007**	**2,289,894**	**229,140**	**28,779**	**12,432,356**	**12,192,733**	**6,356,043**	**233,816**	**56,957**	**50,000**	**30,852,949**
	in %	***100.0***	***9.4***	***3.2***	***3.1***	***0.3***	***0.0***	***16.8***	***16.5***	***8.6***	***0.3***	***0.1***	***0.1***	***41.6***

As at: April 2013.
Source: Statistics Austria (Bundesanstalt Statistik Österreich).

[1]) Status: August 2012.

[2]) i.e. without global financing for: Austrian Science Fund (FWF), Austrian Research Promotion Agency (FFG), Ludwig Boltzmann Gesellschaft, Austrian Academy of Sciences, and AIT Austrian Institute of Technology GmbH.

Table 12: Research promotion schemes and contracts awarded by the federal government in 2011, broken down by fields of science and awarding ministries

Analysis of the federal research database [1)] without "major" global financing [2)]

Ministries		Partial amounts 2011	of which					
			1.0 Natural sciences	2.0 Engineering	3.0 Human medicine	4.0 Agriculture and forestry, veterinary medicine	5.0 Social sciences	6.0 Humanities
BKA	in €	160,295	-	-	-	-	160,295	-
	in %	*100.0*	-	-	-	-	*100.0*	-
BMEIA	in €	-	-	-	-	-	-	-
	in %	-	-	-	-	-	-	-
BMASK	in €	2,603,886	-	-	2,600	-	2,601,286	-
	in %	*100.0*	-	-	*0.1*	-	*99.9*	-
BMF	in €	-	-	-	-	-	-	-
	in %	-	-	-	-	-	-	-
BMG	in €	440,832	35,578	-	-	405,254	-	-
	in %	*100.0*	*8.1*	-	-	*91.9*	-	-
BMI	in €	446,187	-	-	-	-	362,209	83,978
	in %	*100.0*	-	-	-	-	*81.2*	*18.8*
BMJ	in €	179,893	-	-	-	-	175,893	4,000
	in %	*100.0*	-	-	-	-	*97.8*	*2.2*
BMLVS	in €	294,469	172,890	30,133	58,206	-	33,240	-
	in %	*100.0*	*58.7*	*10.2*	*19.8*	-	*11.3*	-
BMLFUW	in €	3,160,854	742,287	125,000	-	2,111,066	182,501	-
	in %	*100.0*	*23.5*	*4.0*	-	*66.7*	*5.8*	-
BMUKK	in €	13,139,233	-	29,500	-	-	12,710,739	398,994
	in %	*100.0*	-	*0.2*	-	-	*96.8*	*3.0*
BMVIT	in €	3,090,515	309,886	2,445,877	-	-	316,752	18,000
	in %	*100.0*	*10.0*	*79.2*	-	-	*10.2*	*0.6*
BMWFJ	in €	1,343,027	137,000	11,961	76,000	-	1,092,869	25,197
	in %	*100.0*	*10.2*	*0.9*	*5.7*	-	*81.3*	*1.9*
BMWF	in €	49,208,227	42,033,760	1,416,229	1,429,837	145,638	3,431,425	751,338
	in %	*100.0*	*85.4*	*2.9*	*2.9*	*0.3*	*7.0*	*1.5*
Total	**in €**	**74,067,418**	**43,431,401**	**4,058,700**	**1,566,643**	**2,661,958**	**21,067,209**	**1,281.507**
	in %	***100.0***	***58.7***	***5.5***	***2.1***	***3.6***	***28.4***	***1.7***

As at: April 2013.
Source: Statistics Austria (Bundesanstalt Statistik Österreich).

1) Status: August 2012.

2) i.e. without global financing for: Austrian Science Fund (FWF), Austrian Research Promotion Agency (FFG), Ludwig Boltzmann Gesellschaft, Austrian Academy of Sciences, and AIT Austrian Institute of Technology GmbH.

Table 13: An international comparison of research and experimental development (R&D) in 2010

Country	Gross domestic expenditure on R&D (in % of GDP)	Financing of gross domestic expenditure of R&D by		Employees in R&D in full-time equivalents	Gross expenditure on R&D by the			
		Government	Business		Business enterprise sector	Higher education sector	State sector	Private non-profit sector
		in %			as a % of gross domestic expenditure on R&D			
Belgium	2.00	25.3[4)]	58.6[4)]	58,896	66.2	23.6	9.2	1.0
Denmark	3.07	27.1[c)]	60.7[c)]	57,310	68.2	29.3	2.1	0.4
Germany	2.80	30.3	65.6	548,526	67.1	18.1	14.8[o)]	.[n)]
Finland	3.90	25.7	66.1	55,897	69.6	20.4	9.2	0.7
France[a)]	2.24	37.0	53.5	392,875	63.2	21.6	14.0	1.3
Greece	0.60[c)2)]	46.8[1]	31.1[1]	35,531[c)2)]	28.6[c)2)]	49.2[c)2)]	20.9[c)2)]	1.3[c)2)]
Ireland [c)]	1.71	29.5	52.6	19,721	68.6	26.5	4.9	.
Italy	1.26	41.6	44.7	225,632	53.9	28.8	13.7	3.6
Luxembourg	1.48	34.8	44.3	4,988	67.6	12.7	19.7	.
Netherlands	1.85	40.9[4]	45.1[4]	100,544	47.9	40.4	11.7[o)]	.[n)]
Austria[c)]	**2.79[5]**	**38.7[5]**	**44.8[5]**	**58,992**	**68.1**	**26.1**	**5.3**	**0.5**
Portugal	1.59	44.9	44.1	52,348	46.1	36.7	7.1	10.1
Sweden	3.39[c)]	27.5[4]	58.8[4]	77,418[c)]	68.7[c)]	26.3[c)]	4.9[c)]	0.0[c)]
Spain	1.39	46.6	43.0	222,022	51.5	28.3	20.1	0.2
United Kingdom[c)]	1.80	32.3	44.0	350,766	60.9	27.0	9.5	2.5
EU 15 [b)]	**2.06**	**34.5**	**54.2**	**2,259,902**	**62.2**	**24.2**	**12.4**	**1.3**
Estonia	1.63	44.1	43.6	5,277	50.2	38.0	10.6	1.2
Poland	0.74	60.9	24.4	81,843	26.6	37.2	35.9	0.3
Slovak Republic	0.63	49.6	35.1	18,188	42.1	27.6	30.0[d)]	0.3
Slovenia	2.09	35.3	58.4	12,940	67.8	13.9	18.2	0.1
Czech Republic	1.55	39.9	48.9	52,290	62.0	18.0	19.4	0.5
Hungary	1.17	39.3	47.4	31,480	59.8[v]	19.9[v]	18.5[v]	.
EU 25 [b)]	**1.95**	**35.2**	**53.4**	**2,481,643**	**61.4**	**24.4**	**13.1**	**1.2**
Romania	0.46	54.4	32.3	26,171	38.3	24.5	36.8	0.4
EU-27 [b)]	**1.91**	**35.3**	**53.3**	**2,524,323**	**61.2**	**24.4**	**13.3**	**1.2**
Australia	2.20[c)]	34.6[3)]	61.9[3)]	137,489[3)]	58.0[c)]	26.6[c)]	12.4[c)]	3.0[c)]
Chile	0.42	37.3	35.4	11,491	38.7	30.6	8.4	22.3
Iceland	2.65[p)3)]	38.8[p)3)]	50.3[p)3)]	3,753[4)]	54.6[p)3)]	25.1[p)3)]	17.8[p)3)]	2.5[p)3)]
Israel [d)]	4.34	14.8[4]	39.0[a]	.	79.2	13.3[g)]	3.9	3.6
Japan	3.26	17.2[e)]	75.9	877,928	76.5	12.9	9.0	1.6
Canada	1.85	36.1[c)]	45.5	221,360[p)]	50.3	38.0	11.2	0.5
Korea	3.74	26.7	71.8	335,228	74.8	10.8	12.7	1.7
Mexico	0.44[4]	53.2[4]	39.1[4]	70,293[2)]	41.1[4)]	29.2[4)]	26.8[4)]	2.9[4)]
New Zealand [4)]	1.30	45.7	38.5	23,800	41.4	32.8	25.7	.
Norway	1.68	46.8[4]	43.6[4]	36,121	51.2	32.3	16.4	.
Switzerland[3)]	2.87	22.8	68.2	62,066	73.5	24.2	0.7[h)]	1.6
Turkey	0.84	30.8	45.1	81,792	42.5	46.0	11.4	.
United States[j)]	2.83	32.5	61.0[o)]	.	68.3	14.7	12.5[h)]	4.5[p)]
OECD total [b)]	**2.38**	**31.1**	**60.3**	**.**	**66.5**	**18.7**	**12.1**	**2.7**

Source: OECD (MSTI 2012-2), Statistics Austria (Bundesanstalt Statistik Österreich).

a) Break in the time series. - b) Estimate by the OECD Secretariat (based on national sources). - c) National estimate, where necessary the OECD Secretariat has adjusted them to meet the OECD standards. - d) R&D expenditure on national defence not included. - e) Results of national surveys. Figures have been adjusted by the OECD Secretariat to fit the OECD standards. - [h]) Only federal or central government funds. - [j]) Excluding investment expenditure. - [n]) Included elsewhere. - [o]) Includes other categories as well. - [p]) Preliminary values. - [v]) Sum of components does not equal total.

[1]) 2005. - [2]) 2007. - [3]) 2008. - [4]) 2009. - [5]) Statistics Austria; Results of the 2013 survey on research and experimental development.

Full time equivalent = person year.

Table 14: Austria's path from the 4th to the 7th EU Framework Programme for research, technological development and demonstration activities

	4. FP	5. FP	6. FP	7. FP
	1994–1998	1998–2002	2002–2006	Data as per 11/2012
Number of approved projects in which Austrians are participating	1,444	1,384	1,324	**1,882**
Number of approved Austrian participations	1,923	1,987	1,972	**2,622**
Number of approved projects coordinated by Austrian organisations	270	267	213	**300**
Funding for approved Austrian partner organisations and researchers for which a contract has been signed, in € millions	194	292	425	**729** [1]
Percentage of approved Austrian participations among all approved participations	2.3%	2.4%	2.6%	**2.5%**
Percentage of approved Austrian coordinators among all approved coordinators	1.7%	2.8%	3.3%	**3.4%**
Austrian share of retrievable funds (returns indicator, RI)	1.99%	2.38%	2.56%	**2.66%**
Austrian share of retrievable funds (RI) measured against the contribution Austria makes to the EU budget (return ratio)	70%	104%	117%	**126%**

Data: European Commission. Preparation and calculations: PROVISO.

[1]) The expected total funding for Austrian participations in all approved projects according to the data of 11/2012 is € 832 million (projection, average reductions in the course of contract negotiations are included).

Source: Ehardt-Schmiederer, M., Brücker, J., Milovanović, D., Kobel, C., Hackl, F.,Schleicher, L., Antúnez, A., Zacharias, M. (2012): 7. EU Framework Programme for research, technological development and demonstration (2007–2013) PROVISO overview report autumn 2012, Vienna.

Table 15: Austrian results in the 7th EU Framework Programme for research, technological development and demonstration activities

	7. EU Framework Programme [1]											
	Total	AT										
		AT Total	B	K	N	UA	S	ST	T	V	VIE	n/A[2]
Projects	18,111	1,882	7	66	216	147	77	352	156	20	1,049	152
Participations	104,331	2,622	7	77	240	172	86	417	176	24	1,271	152
Universities, Higher education	*N/A*	*941*	*0*	*25*	*14*	*69*	*44*	*182*	*110*	*5*	*492*	*0*
Non-university research institutions	*N/A*	*539*	*0*	*3*	*114*	*19*	*16*	*94*	*3*	*0*	*290*	*0*
Large firms (over 250 employees)	*N/A*	*175*	*0*	*19*	*11*	*26*	*5*	*45*	*8*	*6*	*55*	*0*
Small and medium-sized enterprises (up to 249 employees)	*N/A*	*479*	*7*	*28*	*52*	*45*	*14*	*83*	*50*	*9*	*191*	*0*
Other categories	*N/A*	*488*	*0*	*2*	*49*	*13*	*7*	*13*	*5*	*4*	*243*	*152*
Coordinators [3]	8,784	300	0	17	25	18	12	62	20	0	146	0
Universities, Higher education	*N/A*	*119*	*0*	*0*	*2*	*10*	*7*	*24*	*16*	*0*	*60*	*0*
Non-university research institutions	*N/A*	*92*	*0*	*0*	*19*	*4*	*5*	*23*	*0*	*0*	*41*	*0*
Large firms (over 250 employees)	*N/A*	*11*	*0*	*1*	*0*	*1*	*0*	*8*	*0*	*0*	*1*	*0*
Small and medium-sized enterprises (up to 249 employees)	*N/A*	*49*	*0*	*15*	*3*	*1*	*0*	*6*	*4*	*0*	*20*	*0*
Other categories	*N/A*	*29*	*0*	*1*	*1*	*2*	*0*	*1*	*0*	*0*	*24*	*0*

Data: European Commission. Preparation and calculations: PROVISO.

[1]) As of 11/2012, PROVISO only had part of the information about the results of the project negotiations. Because experience shows that there can be changes during the course of the contract negotiations (i.e. a contract for an approved project is not signed, consortiums change within a project, the "requested" subsidy amounts are reduced), this information must be seen as a reference only.

[2]) espec. Individual researchers in the people pillar (researchers, scholarship recipients/award winners in the people pillar) and the ideas pillar (principal investigators).

[3]) Does not include projects of the idea pillar or individual scholarships and awards of the people pillar.

Source: Ehardt-Schmiederer, M., Brücker, J., Milovanović, D., Kobel, C., Hackl, F.,Schleicher, L., Antúnez, A., Zacharias, M. (2012): 7. EU Framework Programme for research, technological development and demonstration (2007–2013) PROVISO overview report autumn 2012, Vienna.

Table 16: Overview of projects and participations in the 7th EU Framework Programme for research, technological development and demonstration activities

	Approved projects (Total)	Approved projects with Austrian participation	Percentage of approved projects with Austrian participation of approved projects (total)
Cooperation	5,542	1,189	21.5%
Ideas	3,189	112	3.5%
People	7,770	341	4.4%
Experts	1,610	240	14.9%
Total	**18,111**	**1,882**	**10.4%**

	Approved participants (Total)	Approved Austrian participation	Percentage of approved Austrian participation of approved participants (total)
Cooperation	61,801	1,730	2.8%
Ideas	6,726	139	2.1%
People	20,478	420	2.1%
Experts	15,326	333	2.2%
Total	**104,331**	**2,622**	**2.5%**

Data: European Commission. Preparation and calculations: PROVISO. Data as per 11/2012.

Source: Ehardt-Schmiederer, M., Brücker, J., Milovanović, D., Kobel, C., Hackl, F.,Schleicher, L., Antúnez, A., Zacharias, M. (2012): 7. EU Framework Programme for research, technological development and demonstration (2007–2013) PROVISO overview report autumn 2012, Vienna.

Note: According to the data of 11/2012, PROVISO only had a part of the information about the results of the project negotiations. Since experience shows us that there can be changes in the course of the contract negotiations, this information should be seen as a guideline only.

Table 17: Austrian Science Fund (FWF): Trend of funding of life sciences, 2010 – 2012

	2010		2011		2012	
	Total (in € million)	Share	Total (in € million)	Share	Total (in € million)	Share
Anatomy, pathology	1.9	1.1%	2.3	1.2%	4.9	2.5%
Med. Chemistry, med. physics, physiology	10.3	6.0%	14.1	7.2%	8.3	4.2%
Pharmacy, pharmacology, toxicology	6.1	3.5%	3.7	1.9%	3.1	1.6%
Hygiene, med. microbiology	6.0	3.5%	9.9	5.1%	9.5	4.8%
Clinical medicine	2.0	1.1%	5.1	2.6%	4.9	2.5%
Surgery and anaesthesiology	0.4	0.2%	0.3	0.2%	0.3	0.1%
Psychiatry and neurology	3.1	1.8%	3.1	1.6%	2.0	1.0%
Court medicine	0.0	0.0%	0.0	0.0%	0.0	0.0%
Other areas of human medicine	1.5	0.9%	0.7	0.4%	0.7	0.3%
Veterinary medicine	0.4	0.2%	1.4	0.7%	0.8	0.4%
Biology, botany, zoology	38.2	22.2%	43.1	22.1%	39.3	20.0%
Total life sciences	**69.8**	**40.7%**	**83.7**	**42.9%**	**73.8**	**37.6%**
Total grants awarded	**171.8**	**100.0%**	**195.2**	**100.0%**	**196.4**	**100.0%**

Table 18: Austrian Science Fund (FWF): Trend of funding in the natural sciences and engineering, 2010 – 2012

	2010		2011		2012	
	Total (in € million)	Share	Total (in € million)	Share	Total (in € million)	Share
Mathematics, informatics	20.2	11.8%	27.3	14.0%	31.5	16.0%
Physics, mechanics, astronomy	21.2	12.3%	25.9	13.3%	26.1	13.3%
Chemistry	11.1	6.4%	10.3	5.3%	12.0	6.1%
Geology, minerology	4.4	2.6%	2.2	1.1%	1.5	0.8%
Meteorology, climatology	1.2	0.7%	1.0	0.5%	2.2	1.1%
Hydrology, hydrography	0.7	0.4%	0.7	0.4%	0.7	0.4%
Geography	0.9	0.5%	0.7	0.3%	1.2	0.6%
Other natural sciences	1.9	1.1%	2.1	1.1%	1.7	0.9%
Mining, metallurgy	0.6	0.4%	0.6	0.3%	0.5	0.2%
Mechanical engineering, machinery, instruments	0.2	0.1%	0.5	0.3%	0.5	0.3%
Construction engineering	0.8	0.5%	0.1	0.1%	0.9	0.4%
Architecture	0.6	0.4%	0.2	0.1%	1.0	0.5%
Electrical engineering/electronics	0.9	0.5%	3.9	2.0%	2.0	1.0%
Technical chemistry, fuel and petroleum technology	0.4	0.2%	0.4	0.2%	0.4	0.2%
Geodetics, surveying	0.2	0.1%	0.4	0.2%	0.5	0.3%
Traffic engineering, traffic planning	0.0	0.0%	0.0	0.0%	0.0	0.0%
Other engineering sciences	1.9	1.1%	0.9	0.5%	1.8	0.9%
Farming, plant cultivation and protection	0.0	0.0%	0.2	0.1%	0.5	0.2%
Horticulture, orcharding	0.0	0.0%	0.0	0.0%	0.0	0.0%
Forestry	0.6	0.3%	0.5	0.2%	0.5	0.3%
Livestock breeding, animal production	0.3	0.2%	0.3	0.1%	0.3	0.2%
Other areas of agriculture and forestry	0.3	0.2%	0.1	0.1%	0.9	0.5%
Total natural sciences and engineering	**68.3**	**39.8%**	**78.2**	**40.1%**	**86.9**	**44.2%**
Total grants awarded	**171.8**	**100.0%**	**195.2**	**100.0%**	**196.4**	**100.0%**

Table 19: Austrian Science Fund (FWF): Trend of funding of humanities and social sciences, 2010 – 2012

	2010		2011		2012	
	Total (in € million)	Share	Total (in € million)	Share	Total (in € million)	Share
Philosophy	2.1	1.2%	1.3	0.7%	2.1	1.1%
Theology	0.8	0.5%	0.8	0.4%	1.1	0.5%
Historical sciences	8.0	4.7%	8.5	4.4%	8.5	4.3%
Linguistics and literary studies	3.6	2.1%	3.2	1.6%	4.0	2.0%
Other philological and culture sciences	1.7	1.0%	4.1	2.1%	2.7	1.4%
Art sciences	3.8	2.2%	3.7	1.9%	4.2	2.1%
Other humanities	0.8	0.5%	0.9	0.4%	0.5	0.3%
Political science	0.5	0.3%	0.6	0.3%	3.6	1.8%
Jurisprudence	0.9	0.5%	1.1	0.6%	1.0	0.5%
Economics	3.7	2.2%	3.5	1.8%	1.9	1.0%
Sociology	1.5	0.9%	1.3	0.7%	1.6	0.8%
Psychology	1.4	0.8%	2.0	1.0%	1.6	0.8%
Physical planning	0.1	0.1%	0.2	0.1%	0.2	0.1%
Applied statistics	1.8	1.1%	0.2	0.1%	0.1	0.1%
Pedagogy, educational sciences	0.7	0.4%	0.2	0.1%	0.6	0.3%
Other social sciences	2.2	1.3%	1.6	0.8%	2.1	1.1%
Total humanities and social sciences	**33.6**	**19.6%**	**33.2**	**17.0%**	**35.7**	**18.2%**
Total grants awarded	**171.8**	**100.0%**	**195.2**	**100.0%**	**196.4**	**100.0%**

Table 20: Austrian Research Promotion Agency (FFG) funding by state 2012

Regional governments	Participations	Total funding	Cash value	Percentage of cash value
Burgenland	52	7,713	5,138	1.4%
Carinthia	214	30,199	20,307	5.7%
Lower Austria	579	28,263	23,077	6.4%
Upper Austria	765	113,908	70,832	19.7%
Salzburg	201	18,780	9,093	2.5%
Styria	1,160	147,146	122,170	34.0%
Tirol	244	24,139	18,483	5.1%
Vorarlberg	117	12,405	6,708	1.9%
Vienna	1,522	97,945	82,373	22.9%
Abroad	271	1,164	1,164	0.3%
Total	**5,125**	**481,661**	**359,345**	**100.0%**

Table 21: Austrian Research Promotion Agency (FFG) project costs and funding by Subject Index Code, 2012

Subject Index Code	Total costs	Total funding	Cash value
Advanced materials	138,300	62,995	44,836
Industrial production	136,158	63,806	43,739
Electronics, microelectronics	129,259	53,893	31,309
Surface transport and technologies	67,438	39,736	31,180
Environment	77,139	27,013	25,273
ICT applications	47,883	27,349	20,604
Renewable energy sources	34,111	18,026	15,640
Information processing, information systems	35,124	19,587	14,373
Innovation, technology transfer	41,492	14,790	14,023
Medical biotechnology	34,953	16,293	12,850
Unclassified	19,947	12,390	12,390
Medicine, health	35,576	17,176	12,207
Energy savings	26,195	13,996	11,764
Energy storage, conversion and transport	15,350	9,831	9,556
Safety	12,926	8,775	8,709
Construction engineering	16,774	9,912	7,162
Biosciences	19,875	11,393	6,392
Other technologies	20,578	12,740	5,683
Measuring techniques	14,393	7,619	4,855
Sustainable development	6,221	3,486	3,459
Nanotechnology and nanosciences	5,369	3,498	3,415
Other energy topics	3,748	2,828	2,322
Regional development	2,662	2,094	2,094
Economic aspects	2,708	1,913	1,690
Foodstuffs	3,573	2,141	1,634
Aviation and technologies	2,815	1,831	1,511
Agriculture	3,313	1,819	1,414
Agricultural biotechnology	3,577	1,516	1,374
Mathematics, statistics	3,834	2,215	1,359
Industrial biotechnology	3,799	2,093	1,289
Space	1,574	934	934
Waste management	2,247	1,319	766
Robotics	2,011	1,420	597
Network technologies	1,735	1,127	504
Social aspects	671	504	504
Telecommunications	844	593	388
Business aspects	921	644	380
Information, media	672	336	336
Geosciences	411	305	305
Laws, regulations	278	278	278
Research ethics	2,866	1,433	233
Automation	13	10	10
Coordination, cooperation	5	5	5
Total result	**979,335**	**481,661**	**359,345**

Table 22: aws: Grants for technology funding, 2012

	Number	%	[in 1,000 €]	[in 1,000 €]	%
PreSeed					
LISA PreSeed	8	6.7	1,884	1,566	7.5
PreSeed ICT & Physical Sciences	19	15.8	4,237	2,580	12.3
Seed financing					
LISA Seed	8	6.7	75,516	6,050	28.8
Seed financing ICT & Physical Sciences	10	8.3	49,350	6,260	29.8
Creative industries					
Creative industries (impulse XL, XS)	72	60.0	8,610	3,687	17.5
Creative industries (impulse LEAD)	3	2.5	1,231	869	4.1
Start-up technology voucher	5	4.2	7	5	0.0
ProTRANS	21	17.5	10,080	3,151	15.0
Time management	3	2.5	11,955	82	0.4
Total	120	100.0	140,828	21,012	100.0

Table 23: CDG: CD laboratories according to universities/research institutions, 2012

University/research institution	Number of CD laboratories	Total laboratory budget in €
Medical University of Graz	1	173,680
Medical University of Innsbruck	1	220,000
Medical University of Vienna	10	3,684,542
Montanuniversität Leoben	6	2,737,793
Graz University of Technology	8	2,791,605
Vienna University of Technology	9	2,411,204
University of Natural Resources and Applied Life Sciences, Vienna	8	2,745,729
University of Graz	1	426,067
University of Innsbruck	2	631,862
University of Linz	7	2,753,317
University of Salzburg	3	1,205,000
University of Vienna	2	123,089
University of Veterinary Medicine Vienna	2	645,888
Research Center for Non Destructive Testing GmbH	1	132,292
Max-Planck-Institut für Eisenforschung GmbH	1	458,000
Munich University of Technology	1	322,000
University of Bochum	1	431,525
University of Göttingen	1	264,000
University of Cambridge	1	310,878
Total	**66**	**22,468,470**

Note: There are a total of 64 CD laboratories; there are two CD laboratories with dual management at different universities.

[1]) Plan as of 7 Dec 2012.

Table 24: CDG: Development of the CDG (1989 - 2012)

Year	Expenditures of the CD laboratories in €	Active CD laboratories	Active member companies
1989	247,087.6	5	
1990	1,274,681.5	7	
1991	2,150,389.2	11	
1992	3,362,572.0	16	
1993	2,789,910.1	17	
1994	3,101,676.6	18	
1995	2,991,213.9	14	
1996	2,503,324.9	15	6
1997	2,982,792.5	16	9
1998	3,108,913.4	17	13
1999	3,869,992.6	20	15
2000	3,624,962.6	18	14
2001	4,707,302.0	20	18
2002	7,295,956.9	31	40
2003	9,900,589.6	35	47
2004	10,711,821.9	37	63
2005	11,878,543.2	37	66
2006	12,840,466.3	41	79
2007	14,729,107.6	48	82
2008	17,911,783.7	58	99
2009	17,844,292.0	65	106
2010	19,768,684.4	61	110
2011	20,378,065.9	61	108
2012[1)]	22,468,470.0	64	114

[1]) Plan as of 7 Dec 2012.

Table 25: CDG: CD laboratories according to topical clusters 2012

Thematic clusters	Number of CD laboratories	Total laboratory budget in €
Chemistry	9	3,281,551
Life Sciences and environment	12	2,963,702
Manufacture of machinery and equipment, instruments	6	1,743,647
Mathematics, informatics, electronics	13	5,199,644
Medicine	11	3,937,122
Metals and alloys	10	4,323,623
Non-metal materials	3	1,019,180
Total	64	22,468,470