Austrian Research and Technology Report 2014

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

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Preface

The Austrian Research and Technology Report 2014, 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, technology, and innovation; other specific areas of focus are also presented.

Statistics Austria currently projects gross domestic expenditure for research and experimental development (R&D) to reach €9.32 billion in 2014, representing a research intensity of 2.88%. Total R&D expenditure are estimated to rise 2.7% over 2013 levels; the federal government is projected to increase research funding by 2%, and business enterprises by 3.6%. Fortunately, Austria continues to invest in research at a level far above the EU-28 average of 2.06% and remains in fifth place for research intensity in 2012 behind Finland, Sweden, Denmark, and Germany.

The results of the comprehensive R&D survey of 2011, published by Statistics Austria in 2013, confirm the very positive overall picture for research and development in Austria: R&D expenditure rose a total of 10.6% to some €8.3 billion since the previous comprehensive survey in 2009. The increase was 12% in the business enterprise sector to about €5.7 billion and 8.5% in the higher education sector to roughly €2.2 billion. The public sector finances 36.4% of overall R&D expenditure, with the European Union accounting for 1.8%. The domestic business enterprise sector funds 46.2% of research and development. When foreign firms are included in this figure, the total share of private funding comes to 61.3%.

The number of those working in research and development came to 61,170 full-time equivalents (FTE) in 2011 (up 8.4% from 2009), including 16,096 in the higher education sector (+6.7%) and 42,098 in the business enterprise sector (+9.9%).

The Austrian federal government remains committed to its goal of moving the country up into the group of European innovation leaders. International innovation rankings represent one tool for measuring the status and progress in reaching objectives. But each innovation ranking is shaped by the decisions that were made in designing it – the selection and weighting of indicators and other subjective factors. This makes it all the more important to understand the theory and methodology underlying such rankings. That's why this report looks at the position of Austria in five international innovation rankings. The broad picture shows that Austria was able to significantly improve its innovative performance in the past fifteen years but that the dynamics of RTI investments have slowed somewhat since the financial crisis.

This year the Austrian Research and Technology Report once again offers an overview of the latest results and areas of focus in the implementation of the federal government's RTI strategy. Nine working groups have analysed key problem areas in the R&D system and recommended actions to be taken. Key actions taken by the responsible ministries in the year under review include creating a service centre for innovation-friendly public procurement, introducing regional university knowledge transfer centres, offering endowed professorships, expanding Austria's participation in European research infrastructures, providing robust funding for the "production technologies of the future," and much more. Other steps taken in implementing the RTI strategy will be outlined in the corresponding chapters.

In the field of scientific research and tertiary education, the report focuses on how Austrian universities compare to their international counterparts, the transfer of knowledge between universities and the private sector, and the development of the universities of applied sciences sector. The report also examines the challenges that lie ahead for scientific research and research agendas through the use of new social media in light of the fundamental changes taking place in research methodologies, communication, and publication.

In the realm of applied research and technology among business enterprises, the report also examines the position of Austrian manufacturing in global value chains, revealing that Austria's share in the production and export activity of other countries has risen continuously by some 7% since 1995. Another very positive trend over the past two decades has been the number of Austrian firms with innovation partnerships, a figure that has more than doubled and is above the international average. Entrepreneurial innovations can also be found elsewhere, however. This opens up new areas of activity for RTI policymakers in Austria, not only in identifying and supporting the potential for alternative forms of partnership and funding but also in the realm of intellectual property rights.

Austria has seen an explosion of innovative activity over the past 15 years. But reaching the ambitious goals of the RTI strategy and joining the ranks of Europe's innovation leaders will require extraordinary efforts and clear priorities even in the face of budget pressures.

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Federal Minister of Science,
Research and Economy

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Executive Summary

The Austrian Research and Technology Report 2014 is a status report on the country's federally funded research, technology, and innovation. It was commissioned by the Federal Ministry of Science, Research and Economy (BMWFW) and the Federal Ministry for Transport, Innovation and Technology (BMVIT). The report looks at current data and findings to describe significant trends in development and key themes in Austria's system of innovation and examine them in the international context.

Global estimate of R&D expenditure in 2014

The latest global estimate from Statistics Austria (May 2014) projects total expenditure on research and development (R&D) in Austria of €9.32 billion in 2014. This represents an increase of €248 million or 2.73% (nominally) over the previous year. The result is an R&D intensity – ratio of R&D expenditure to GDP – of 2.88% in 2014, meaning that current forecasts show a virtual stagnation of R&D intensity compared to 2013 and 2012 (each at 2.90% according to revised figures).

The business enterprise sector remains the most important source of funds for domestic funding, accounting for nearly 45% of total R&D expenditure at €4.15 billion and showing the strongest growth (+3.59%) over 2013. Funding from businesses has settled in between 44% to 45%. Federal sources of funds, which will account for 38.7% of projected research expenditure (€3.06 billion), has risen 2.0% year on year. Funds of €1.53 billion from abroad (primarily from foreign firms that contribute to the R&D expenditure of their Austrian subsidiaries) account for some 16% of research and development spending in Austria. Funding from this source is expected to rise 2.9% in 2014. This means that the business enterprise sector (domestic and international funding sources together) accounts for more than 60% of R&D funding. The other sources of funds ("regional governments" and "other," which includes local governments, professional associations, social insurance institutions, etc.) play only a minor role in R&D funding. Austria remains well above the average research intensity of 2.06% in the EU-28 (2012 reference year), ranking fifth behind Finland, Sweden, Denmark, and Germany.

The new European System of Integrated Economic Accounts (ESA 2010) will bring about major changes starting in September 2014. R&D expenditure, previously recorded as intermediate consumption, will now be regarded as gross fixed capital formation, which means they will factor into the gross domestic product. Although R&D will play a greater role in the ESA, this new accounting method will presumably lower the R&D intensity slightly.

R&D expenditure in Austria

Statistics Austria's comprehensive R&D survey of 2011 shows a very positive overall trend for Austria up to that time. R&D expenditure rose a total of 10.6% to some €8.3 billion since the previous comprehensive survey in 2009. R&D expenditure in the business enterprise sector rose 12% to €5.7 billion in this period, while the higher education sector increased expenditure by 8.5% to about €2.2 billion. Growth in the business enterprise sector can be traced to both the growing number of firms engaging in research and the simultaneous surge in R&D activities among those already conducting research. Despite this broadening of the research base, however, R&D expenditure in the business enterprise sector remains highly concentrated. This concentration, which is also apparent when comparing Austria to other countries, underscores the influence of a small number of major corporations in the R&D landscape.

In 2011 the business enterprise sector again paid for the lion's share of its R&D expenditure – some €3.7 billion (64.8%) – with its own funds. Funding from abroad accounted for some 22%, most of that from businesses – a high level of foreign funding compared to other countries. A major factor in the development of business sector R&D expenditure (and its stabilisation during the financial crisis) was corporate R&D funding: in 2011, some 13% (€756 million) of business R&D was publicly funded, a sharp rise of 34.9% from 2009.

As the size of a firm grows, so too does the role of foreign funding sources and indirect research subsidies (research premium). The expansion of subsidies for research, attributable primarily to the increase in the research premium, has caused a major shift in how public funds are used. In 2002, the business enterprise sector accounted for just 11% of such public funding. By 2011, this figure had risen to 25%. During the same period, the share going to the higher education sector fell from 74% to 62%.

The number of those working in research and development totalled 61,170 FTE in 2011 (+8.4% from 2009), including 16,096 in the higher education sector (+6.7%) and 42,098 in the business enterprise sector (+9.9%). Despite a clear trend toward greater participation by women in R&D, the 25% share of women among FTE is low both in absolute terms and internationally.

Austria's position in international innovation rankings

Austria has made great strides in its capacity for innovation in the past ten to fifteen years. This is evidenced by the trend in its overall economic R&D intensity, higher exports of medium- and high-technology goods, the growing share of the workforce with university degrees, and the increased international publishing activities of its universities. This trend was even evident until very recently in international innovation rankings that try to give a condensed picture of the innovative capacities of countries.

Despite greater investments in innovation, however, Austria has recently slipped in the rankings, in part because other countries have also intensified their innovation activities. Driving this development is a push toward greater competition in innovation and a long-term economic shift in which the role of knowledge-based activities (and as a result, innovation) in all countries has grown relative to traditional activities.

In five international innovation rankings – the *Innovation Union Scoreboard* and *EU 2020 Innovation Indicator* of the European Commission, the *Global Innovation Index* of INSEAD and WIPO, the *Innovation Indicator* of Deutsche Telekom Foundation and BDI, and the innovation-related indicators of the *Global Competitiveness Index* of the World Economic Forums – Austria currently ranks 11th to 20th among OECD and EU member states. Austria made great progress in the *Innovation Union Scoreboard* from 2004 to 2009, but by 2013 it had fallen back to its original ranking from the early 2000s. Austria also made significant gains through 2011 on the *Innovation Indicator* of Deutsche Telekom Foundation and BDI, though it remains in the middle among the countries analysed. By contrast, Austria's ranking in the innovation-related indicators of the *Global Competitiveness Index* has barely changed in the past seven years, but even here a variety of indicators show Austria coming up short in relation to the leading countries. In another study on innovation among EU member states, the *Innovation Union Progress Report* issued by the European Commission, Austria also lags significantly behind the innovation leaders in the five indicators cited but shows much higher growth rates than both the lead group and the EU as a whole in the period from 2000 to 2010.

Rankings are often viewed critically, since the indicators they choose can only ever offer an incomplete picture of a system of innovation, and because the significance and international comparability of many indicators is limited. Nevertheless, they can serve as a general barometer of trends and positioning. Regardless of Austria's position in international innovation scorecards, it makes sense to continue down the path toward greater knowledge and innovation, since this offers the greatest relative benefits in the international competition. The result does not necessarily have to be an improved position in innovation rankings. What's more important is that the structural shift toward research- and knowledge-intensive sectors continue and that all stakeholders take advantage of the innovative potential already available. Determining whether a country is on track to succeed here means looking at a variety of indicators (including those not covered by the ranking) and interpreting them through context-specific analyses. Innovation rankings may provide points of reference but can never give the full picture. There are many important areas that are inadequately reflected in innovation rankings, such as the quality of interaction between the scientific and business communities on the one hand and university educators on the other, the degree of innovation in low-technology industries and non-knowledge-intensive services, or the application of (key) technologies to boost productivity in a wide array of sectors.

Implementation of RTI strategy and the challenges ahead for Horizon 2020

The Austrian government, in its latest working agenda for the 25th legislative period, noted that the RTI strategy adopted in 2011 remains an important policy framework and that, in keeping with the stated objectives, it will systematically support the positive developments in RTI so that Austria can make the jump into the leading group of European research innovators by 2020. The federal government's "RTI Task Force" is a coordination and implementation tool designed to help the RTI departments at ministries work together more effectively on the various activities and initiatives, assisted by outcome-oriented impact assessments and impact-oriented budgetary planning. Working groups have been deployed in specific areas of activity in the RTI strategy, focusing on central problem fields in order to identify strengths and weaknesses in the structural shift and develop a concrete plan of action.

Austria's involvement in the 7th Framework Programme can certainly be regarded as a success. Between 2007 and 2013, Austria was able to bring in about €950 million in (earmarked) funding through its participations – not only an above-average rate of return but also an excellent result relative to the participations based on the potential of the Austrian researchers. Austria was also successful in its participation in the ERC grants, garnering the fourth-best approval rate internationally.

The new Horizon 2020 Framework Programme introduces several changes to which Austria must respond and in some cases already has responded in its RTI policy: defining new goals, increasing returns to at least €1.5 billion by 2020, increasing the number of ERC grants, and achieving quantitatively measurable successes in patenting, participations, and regulations. Reaching these goals means reorganising and improving the support and consulting services offered by the Austrian Research Promotion Agency (FFG), focusing on strategic consultation. The aim is to support Austrian universities develop independent capacities and areas of expertise, fostering the participation of their researchers. This is accompanied by the creation of new consulting agencies (the ERA Observatory Austria, which includes the ERA Policy Forum and ERA Council Forum) with the aim of supporting evidence-based decision-making and strengthening Austria's role in European policymaking.

Austrian universities in international comparison

University rankings play an important role in the international higher education policy debate and are garnering more attention in Austria. Their benefit is often viewed critically: On the one hand, rankings are regarded as an essential basis for realistically assessing the performance of individual universities and entire national systems of higher education. On the other hand, one must keep in mind the fundamental differences between university systems in different countries and between different types of universities – differences that limit the validity of such rankings. This report presents various international rankings and examines the position of Austrian universities in these rankings. The best Austrian universities achieve rankings of 100–200, which means they are among the top 10% of universities worldwide.

It is clear that size – and by extension, name recognition – is an important factor in rankings. Size, as determined by the number of students, is a factor in the measurement of many indicators. But when measured according to the output categories of better-placed universities in other countries, Austrian universities are at a relative disadvantage with up to ten times the number of students per researcher. Universities in the English-speaking world also benefit in the rankings due largely to their popularity, international reputation, and low language barriers for international students and researchers.

Recruiting more high-quality academics is one way to improve both the number of publications and the quality of instruction in the international competition for research locations. Compensation is one of the success factors in recruiting university researchers, especially those with the most qualifications. Austria's gross annual compensation is above both the EU and OECD average, but in some cases, salaries lag far behind those in the top countries. When seeking to properly evaluate the attractiveness of salaries and thus of university positions, however, one cannot view compensation in isolation from the overall conditions that researchers care about. The United States, together with a group of European countries, stands out for good overall packages and working conditions (such as academic positions that offer good career perspectives early on) as well as a high degree of autonomy for researchers, the quality and prestige of their researchers, and high salaries. In this international comparison, Austria ranks in the middle range.

Alongside teaching and research, the so-called "third mission" of universities – knowledge and technology transfer – is playing an ever greater role. In the context of the traditionally high percentage of public funding for R&D, a recent international ranking that examined R&D activities funded by the business enterprise sector placed Austria in the top third of OECD member countries. It was also determined that a relatively high percentage of business-funded R&D at universities comes from abroad. The research funded through competence centres were to be included in the assessment of the partnership between the scientific and business communities, Austria would be at the very top of the European field.

The universities of applied sciences in domestic R&D

Since the university of applied sciences sector (the UAS sector) was founded and the first courses were established in academic year 1994/95, capacities in the UAS sector have grown considerably both in relation to the primary education function as well as to the secondary research and development function. The UAS sector plays an important complementary role in the Austrian system of innovation alongside the educational and research activities of the universities and non-university research institutions. The universities of applied sciences expanded their R&D expenditure from €21 million in 2002 to €77 million in 2011, with 93% going to applied research and experimental development – a step forward in fulfilling their legal mandate in this regard. Austria's universities of applied sciences thus accounted for 7.3% of applied research and 7.8% of experimental development among R&D expenditure in the higher education sector.

The application-oriented research competencies of the UAS sector have been best realised through longer-term, broadly defined federal research promotion programmes aimed at establishing research infrastructures – such as FH-*plus*, COIN, and the Josef Ressel Centres. The UAS sector is building upon this with a focus on application-oriented, primarily regional R&D projects with the business community.

Global value chains and R&D partnerships

The trend toward globalisation in recent decades has brought about a drastic increase in the degree of international integration. This is also true in Austria, whose economy relies more and more on input from abroad to fuel its manufacturing and export sectors. The share of domestic value added in Austria's gross exports has declined slightly in recent years even though, in absolute terms, domestic value added in Austrian exports is growing each year by an average of 4.4%. This phenomenon can also be observed at the global level.

Austria has managed to position itself well in global value chains – both on the demand side as an importer of intermediate consumption input and as a major provider of key production input for other countries.

Austria's share in the production and exports of other countries has risen continuously, for example – averaging 7% between 1995 and 2011. This is particularly evident in the European market. In 2011, some 37% of the directly exported domestic value added was re-exported by the recipient countries. The bulk of this went to Germany, underscoring the importance of Germany for Austria's integration into global value chains.

The findings from patent statistics do not reveal any clear trend when it comes to international R&D partnerships on the part of Austrian firms, even though the rise in the number of international joint patents has slightly outpaced that of overall patents. The fact that foreign firms with patent activities in Austria are relying increasingly on Austrian resources can, however, be interpreted as an indicator of Austria's quality as a place to conduct R&D.

Entrepreneurial innovation in flux

The innovative activities of firms are influenced by various trends relating to the type of innovations, how they are funded, and the relationships to customers and competitors:

The term "open innovation" refers to the empirically observable trend of firms that increasingly work with customers, research institutions, suppliers, competitors, and other stakeholders to develop and implement innovations. A series of such forms and strategies, all of which can be seen as forms of open innovation, has taken hold in recent years. Examples include the concepts of "user-driven innovation" and "crowdsourcing," in which users are actively involved in the innovation process.

The analyses of the Community Innovation Survey offer empirical evidence that the innovation process is opening, even in Austria. Over the past two decades, for example, the number of Austrian firms with innovation partnerships has more than doubled to include nearly a quarter of all businesses, positioning Austria above average in the international community when it comes to business-academic partnerships.

"Crowdfunding" and "crowdinvesting" – in which the goal is to convince a greater number of investors to finance business ideas – are garnering increased attention as new models for funding innovation. This trend is just starting to take hold in countries such as the United States and Germany serve as models for the potential of such funding models. Some issues still need to be clarified, especially those pertaining to regulation and protections for investors. There are various potential roles for governments here

– as a promoter to raise awareness of (subsidised) projects, for example, or as a network and hub for community events.

Businesses that adopt a strategy toward open processes of innovation typically experience a higher success rate in product developments, more market innovations, and a measurably positive influence on the company's success. Studies also show the growing role that service innovations play in technological innovations, especially the role of knowledge-intensive business services (KIBS). Firms from KIBS sectors are also found to engage much more frequently in innovation partnerships, thereby making a major contribution to the distribution of knowledge across all sectors.

This opens up new areas of activity for RTI policymakers in Austria, not only in discovering and supporting the potential for alternative forms of partnership and funding but also in the realm of intellectual property rights.

Measuring the economic impact of innovation activities

Evidence-based RTI policies require indicators to track the development of innovation activities over time. Given Austria's unwavering commitment to join the group of innovation leaders despite budget consolidation measures, the debate is increasingly focused on indicators that can track the economic impact of innovation. Austria falls well below the average in the corresponding indicators of the Innovation Union Scoreboard (IUS) – 17th place compared to 10th place overall. This can be traced to an underestimation of the impact of innovation in the IUS, however: economic effects of innovation are tracked largely through indicators measuring the structural shift toward knowledge-intensive sectors, while the second key component – progress within sectors toward more knowledge-intensive segments – is lacking (sectoral upgrading or movement up the quality ladder within a sector).

Extending the IUS to include indicators that better reflect sectoral upgrading would yield a much more positive picture for Austria: if the measurement of performance is adjusted to reflect the quality of patents, the quality of exports, and the R&D intensity independently of structural effects, Austria advances to 9th place in the economic effects of innovation and 7th place overall. This result reflects the traditional economic strengths of Austria such as the continuous, incremental progress in global market niches. This does not lead to a high-tech economic structure, but it does yield a high level of competitiveness internationally.

But even with this recalculation, Austria's innovative performance still remains behind that of the "innovation leaders." This is why further efforts are needed, especially where structural effects result: expanding basic research, boosting the number of university graduates, and creating better funding for innovation risks (venture capital). Only then can Austria bridge the gap to the innovation leaders and secure its positive economic development.

1 Current Trends

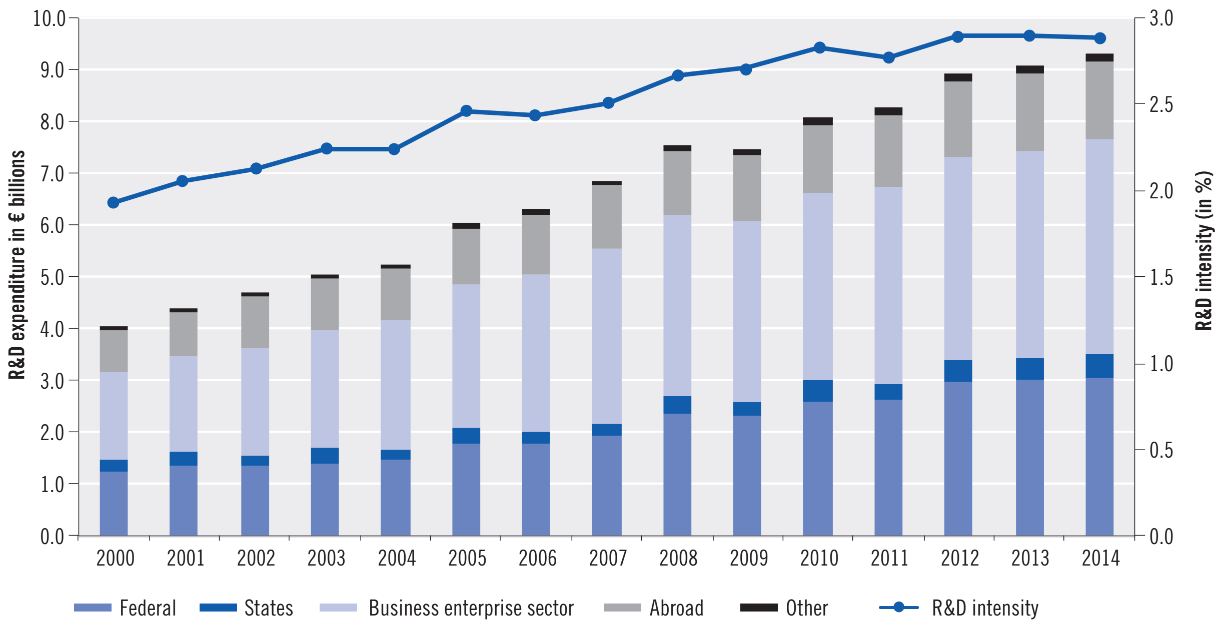
1.1 Trend of R&D expenditure based on new global estimate

Statistics Austria's latest global estimate from May 2014 projects total expenditure for research and development in Austria of €9.32 billion in 2014 – an increase of €248 million or 2.73% over 2013. Taken together with the trend in the gross domestic product (GDP), this yields an R&D intensity (gross domestic spending on research and development as a percentage of GDP) of 2.88% in 2014. Current forecasts thus project near stagnation of the R&D intensity at the level of 2013 and 2012 (revised at 2.90%, previously projected at 2.81% for both years in the 2013 global estimate).

Fig. 1 shows the trend of absolute contributions from the various sources of funds alongside the R&D intensity. Domestic R&D expenditure has steadily increased and the research intensity has remained at a consistently high level since 2009 – even throughout the financial and economic crisis. The projected R&D intensity of 2.88% places Austria well above the average research intensity of 2.06% in the EU-28 (2012 reference year), ranking fifth behind Finland, Sweden, Denmark, and Germany.

The current data and estimates yield the following picture of the various sources of funds (see also Fig. 2 and Fig. 3): The public sector is projected to account for €3.61 billion or 38.7% of total research expenditure in Austria in 2014. The federal government will contribute the lion's share of €3.06 billion (32.8%), up

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



Source: Statistics Austria, Global Estimate as at 7 April 2014, nominal values.

€ 59.0 million or 2.0% from the previous year.

Domestic businesses make up the largest funding sector in overall projected R&D expenditure in 2014 at 44.5% (roughly € 4.15 billion). R&D funding from businesses is expected to rise some € 144 million or 3.59% over 2013, more or less mirroring the expected nominal growth in GDP (3.49%).

A relatively large share of the R&D conducted in Austria is still funded from foreign sources. In 2014, € 1.53 billion or 16.4% of total R&D expenditure in Austria is expected to come from abroad. The primary sources are multinational corporations whose Austrian subsidiaries conduct R&D and, to a lesser extent, returns from EU research framework programs. R&D funding is up € 43 million or 2.9% over 2013.

Austria's regional governments are projected to spend € 440 million for research and development in 2014, representing 4.7% of overall R&D funding and a slight decline of € 1.7 million (-0.4%) from 2013. Other public institutions (local governments, professional associations, social insurance institutions) are estimated to contribute some € 110 million or 1.2% to overall research funding in Austria, up about € 3 million or 2.7% from the previous year. The private non-profit sector funds some 0.5% (€ 42.5 million, +2.7% from 2013) of overall projected R&D expenditure in 2014.

As the structural trend of R&D funding shows (see Fig. 2), public-sector R&D expenditure has been instrumental in not only maintaining but actually increasing R&D investments in Austria, even throughout the financial crisis. The data also shows that the share of funding from the business enterprise sector has stabilised between 44% and 45% in the past three years following a phase of relative decline (see Fig. 3). Taking into account the fact that most foreign R&D funding also comes from businesses, this yields a private-sector share of over 60% in 2014 (see also Chapter 1.2).

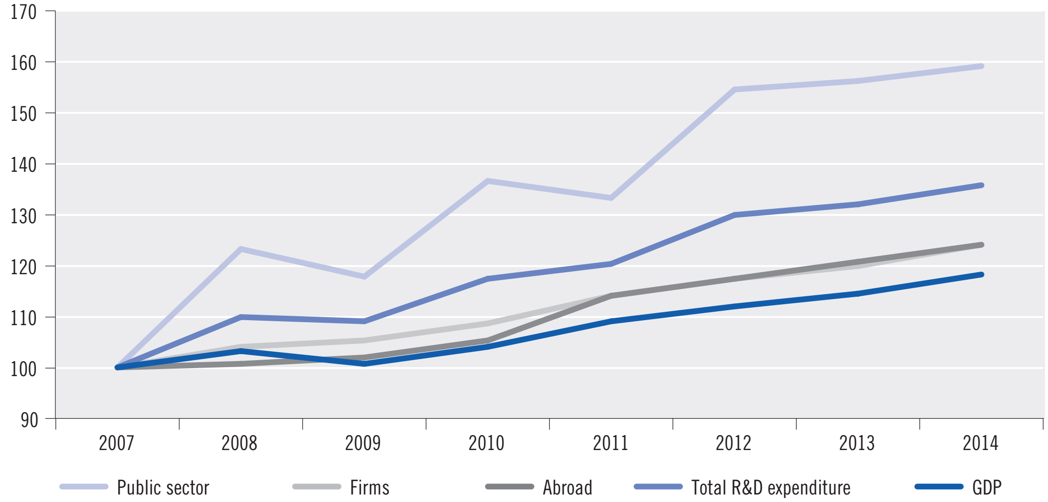
Revision of Integrated Economic Accounts in 2014

On 26 June 2013, the Official Journal of the European Union published Regulation (EU) No. 549/2013 of the European Parliament and of the Council of 21 May 2013 on the European System of Integrated Economic Accounts (ESA).[1] This regulation states that effective September 2014, the data submitted by member states to EUROSTAT must meet the latest EU accounting framework for a systematic and detailed description of a total economy.[2] This means that by the end of September 2014, the gross domestic product (GDP) and the main aggregates of the integrated economic account must be presented in annual (1995–2013) and quarterly (Q1 1995–Q2 2014) time series, and the public deficit and public debt must be presented in annual (1995–2013) time series.[3] ESA 2010 revises ESA 1995 and is based on the United Nations System of National Accounts 2008 (SNA 2008), which includes an internationally recognised standard set of recommendations for measuring the economic activities of a national economy.[4]

SNA 2008 is an international system of integrated economic accounts formulated as recommendations and published in 2009 by the European Union (EU), International Monetary Fund (IMF), Organisation for Economic Cooperation and Development (OECD), United Nations (UN), and the World Bank. SNA 2008 implements 44 changes from the previous version of SNA 1993, some with direct or indirect effects on the gross domestic product or gross national

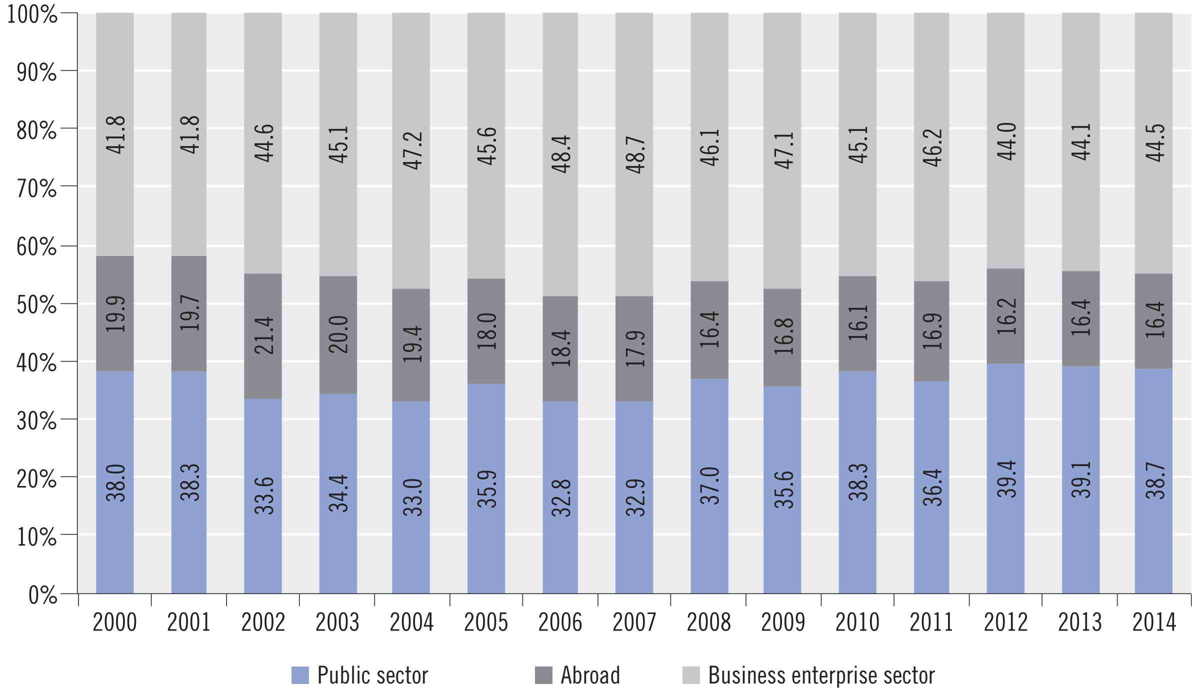
1 See European Union (2013).
2 See Braakmann (2013).
3 See Havel (2013).
4 See Spies (2013); United Nations (2014).

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



Note: The funding source "Other" (which includes the municipalities and the social insurance institutions as well as the private non-profit sector) was counted under the "Public Sector" here.
Source: Statistics Austria, Global Estimate as at 7 May 2014.

Fig. 3: R&D funding shares in Austria by sources of funds (in %)



Note: The funding source "Other" (which includes the Municipalities and the social insurance institutions as well as the private non-profit sector) was counted under the "Public Sector" here. Remainder to 100% = private non-profit sector.
Source: Statistics Austria, Global Estimate as at 7 May 2014.

income (GNI), others with methodological changes not affecting GDP or GNI. The most significant amendment in terms of its impact on GDP is the change to how expenditure on research and experimental development (R&D) are handled.

Up to now, R&D expenditure was treated in the Integrated Economic Accounts as intermediate consumption, internal costs, or non-market consumption. The introduction of ESA 2010 means that R&D expenditure are now recorded as gross fixed capital formation, so they flow into the gross domestic product. One reason for this change is the increasing importance of R&D, a growing segment now accounting for a significant portion of overall investments. Moreover, the definition of R&D expenditure as intermediate consumption was problematic, since countries with a high level of R&D investments not flowing completely into the production value of goods or services, as is usually the case, were significantly underestimated. But knowledge does serve a firm over the long term and is not consumed in the production process, which qualifies it for measurement under fixed assets in the subcategory of intangible assets.[5]

Non-recognition of R&D expenditure, as was the case before the implementation of ESA 2010, meant that these expenditure were visible only in the value added of the goods or services subsequently produced with the knowledge that was gained. This has two implications: First, R&D expenditure remained completely disregarded if no usable results were derived from the research. Second, it was not possible to allocate R&D expenditure to the year in which it occurred, which distorted the measured production in the reference year. While implementation of ESA 2010 improves economic assessments by recording the time period of R&D expenditure more accurately, this reclassification also means a weakening of the measurement of prosperity through GDP, since the GDP is higher without increased prosperity behind it.[6]

The reclassification of R&D expenditure has various effects on GDP:

- Purchased R&D services inflate the gross value added (GVA) of market producers[7] by the total amount of purchased services, since they are recorded as investments and no longer as intermediate consumption. This also increases GDP by the total amount of R&D expenditure.
- In-house R&D services by market producers increase the production value by the amount spent on the services, since they are measured as investments and no longer as internal costs. This also increases GVA and ultimately the GDP by the total amount of expenditure for the in-house R&D services.
- For non-market producers[8] who calculate gross value added as the total of all expenditure, in-house R&D services are viewed as investments and no longer as consumption expenses. The result is an increase in GDP by the depreciations for the in-house R&D services.
- It is similar with R&D services purchased by non-market producers. Measuring them as investments rather than government consumption increases the GDP by the amount of the depreciations.[9]

A preliminary estimate by Statistics Austria finds that the GDP for 2011 would be about 3.3% higher under ESA 2010 than previously

5 See Falkinger (2013a); Falkinger (2013b).
6 See Scheiblecker (2013).
7 Market producers are institutions or firms whose output is entirely or mainly intended for the market (EUROSTAT 2014a).
8 Non-market producers are institutions or firms whose output is entirely or mainly not intended for the market (EUROSTAT 2014b).
9 See Oltmanns et al. (2009).

calculated, with some three-quarters of this growth attributable to the reclassification of R&D.[10] GDP generally increases in a roughly linear pattern relative to R&D expenditure. One exception is disproportionately high percentages of R&D exports, which have a disproportionately weak effect on GDP. Disproportionately high percentages of R&D imports, on the other hand, have a disproportionately strong effect on GDP. The revision of the ESA affects all ratios linked to GDP. While the revision has only a marginal effect on the deficit ratio, the R&D intensity will decline slightly as the GDP increases and R&D expenditure remain unchanged. Statistics Austria estimates that the R&D intensity of 2007 would be adjusted from 2.51% to 2.46% under the revision.[11]

1.2 Financing and implementation of R&D in Austria

Statistics Austria conducts comprehensive biennial surveys among all institutions in all economic sectors that conduct research and experimental development (R&D) on the amount of funding and personnel they devote to R&D. Recent surveys on the reporting year 2011 were, like the preceding reports, carried out in accordance with the guidelines, definitions, and standards of the Frascati Manual, which is in use worldwide (OECD, EU, etc.) and thus ensures international comparability.[12] Frascati defines R&D as an activity *"undertaken on a systematic basis in order to increase the stock of knowledge ... and the use of this stock of knowledge to devise new applications."*

Novelty and originality (new findings, new knowledge, new knowledge systems, new applications) are therefore the most important criteria for distinguishing R&D from other scientific and technological activities. R&D in the sense of these statistics therefore includes not only the natural sciences and engineering but also the social sciences and humanities.

This report distinguishes between four sectors in which R&D is performed: the higher education sector, government sector, private non-profit sector, and business enterprise sector. The report also distinguishes between the various sources through which R&D is funded: the public sector, private non-profit sector, business enterprise sector, and foreign sources.

- The higher education sector encompasses public universities and universities of applied sciences, private universities, University for Continuing Education Krems, colleges of education, the Academy of Sciences, research facilities at Federal Higher Technical Institutes, and other university-level institutions.
- The government sector includes federal, state, and local institutions; chambers of commerce; institutions of the social insurance carriers; publicly funded and/or controlled private organisations; and the institutions of the Ludwig Boltzmann Gesellschaft that conduct R&D.
- The private non-profit sector includes non-commercial institutions whose status is predominantly private or governed by civil law, religious, or otherwise non-public.
- The business enterprise sector is comprised of the company R&D sub-sector ("firmeneigener Bereich") and the institutes' sub-sector ("kooperativer Bereich"). The R&D sub-sector comprises all firms, both private and public, that produce for the market with the aim of earning profit. The institutes' sub-sector ("kooperativer Bereich") includes research

10 see Spies (2013); Havel (2013).
11 see Falkinger (2013b).
12 see OECD (2002).

service institutions that conduct R&D for firms and for the public sector. Most of these are members of Austrian Cooperative Research (ACR), competence centres, and other scientific institutions and research service providers.

A total of some €8.3 billion was spent on R&D in Austria in 2011, up 10.6% from the previous comprehensive survey in 2009. Table 1 shows a rough breakdown of R&D expenditure by research sector and source of funds. This shows that the business enterprise sector accounts for about 69% of total R&D expenditure, the higher education sector for 25.6%, the government sector for 5.1%, and the private non-profit sector for 0.5%.

The public sector funds 36.4% of total R&D expenditure. The European Union provided €150 million, or 1.8% of total funding volume. Most R&D expenditure was funded by the business enterprise sector. The domestic business enterprise sector accounted for 46.2% of R&D expenditure, a figure that rises to 61.3% when foreign firms are included.

Fig. 4 shows an overview of the funding streams between the financing sectors and the sectors of performance, illustrating the interrelationships among the various sectors. The boxes show the scope of R&D expenditure among the sectors of performance, while the arrows symbolise the funding streams.

The **business enterprise sector** invested just over €5.7 billion in R&D in 2011. Compared to 2009, the year of the last comprehensive survey, this represents increased R&D expenditure of about 12%. The majority of expenditure, some €3.7 billion (64.8%), come from the businesses' own funds. Own funding in business enterprise R&D climbed by 8.7% over 2009. The business enterprise sector also contributed €109 million in R&D funding to the higher education sector, €18 million to the government sector, and €6 million to the private non-profit sector. Some 13% (€756 million) of business enterprise R&D is funded publicly. Although the rise in R&D expenditure in Austria stemmed largely from the business enterprise sector, the public sector also made an important contribution to the noticeable momentum by funding R&D. There was a remarkable 34.9% increase in government-financed business enterprise R&D over 2009. This means that Austria still has one of

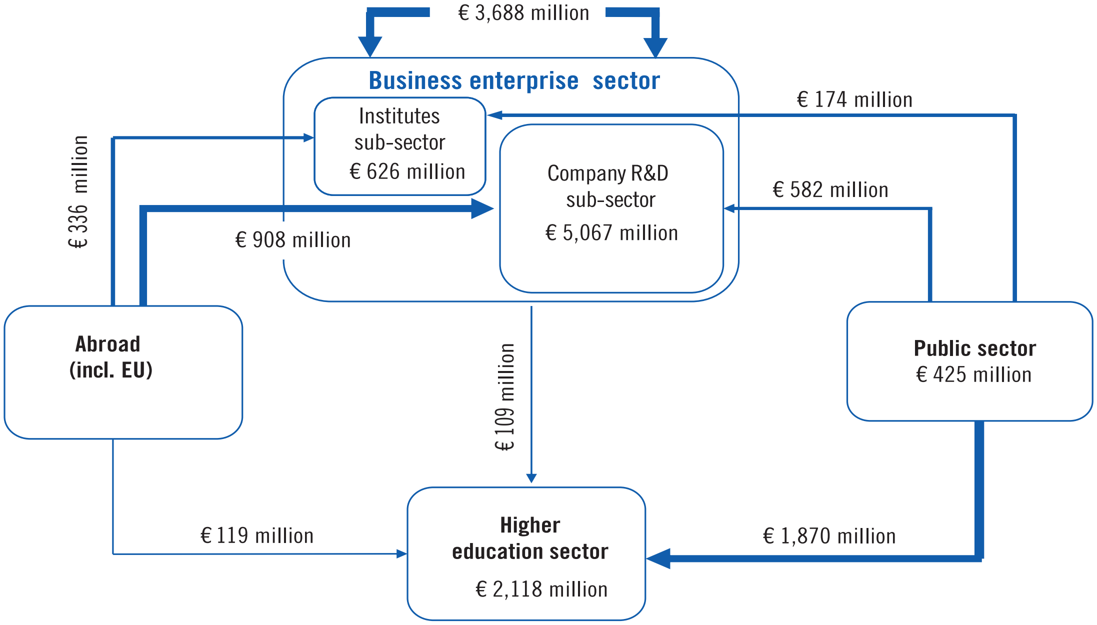
Table 1: R&D expenditure broken down by sector of performance and sources of funds (2011)

Sectors of performance	in € millions	Share in %	Sources of funds	in € millions	Share in %
Business enterprise sector	5,693	68.8	Business enterprise sector	3,821	46.2
Institutes' sub-sector ("kooperativer Bereich")	626	7.6	Public sector	3,015	36.4
Company R&D sub-sector ("firmeneigener Bereich")	5,067	61.2	Private non-profit sector	39	0.5
Higher education sector	2,118	25.6	Abroad	1,402	16.9
Government sector[1]	425	5.1	Foreign firms[3]	1,252	15.1
Private non-profit sector[2]	41	0.5	EU funds	150	1.8
Total	8,277	100	Total	8,277	100

1 Federal institutions (not including those combined in the higher education sector), state, local government, and chambers of commerce, R&D institutions of the social insurance carriers, public sector-financed and/or controlled private non-profit institutions as well as R&D institutions of the Ludwig Boltzmann-Gesellschaft; including regional hospitals. The regional hospitals were not surveyed by questionnaire, but instead Statistics Austria prepared an estimate of the R&D expenditure based on the reports of the offices of the provincial governments.
2 Private non-profit institutions whose status is predominantly private or under civil law, sectarian, or other non-public.
3 Foreign firms, including international organisations (without EU)

Source: Statistics Austria (R&D survey 2011). Calculated by JOANNEUM RESEARCH.

Fig. 4: Performance and funding of R&D in Austria (2011)



Note.: The private non-profit sector is not shown in the interest of clarity.

Source: Statistics Austria. Calculated by JOANNEUM RESEARCH.

the highest percentages of public funding for research in the business enterprise sector among the countries surveyed. Foreign funding accounts for a total of € 1,244 million, which corresponds to 21.9% (+9.3% over 2009).

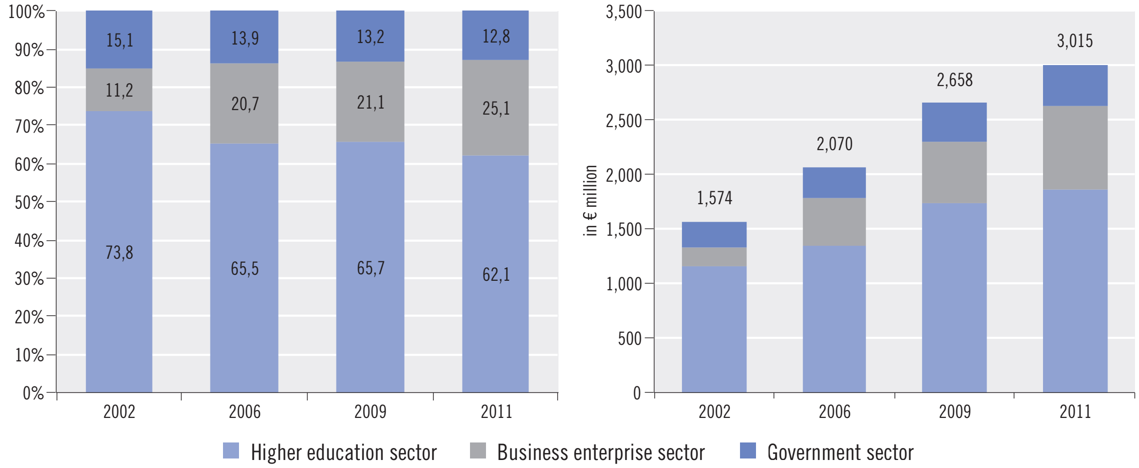
R&D expenditure in the **higher education sector** rose from € 1,952 million (2009) to € 2,118 million (2011), an 8.5% increase. Funding of university R&D by the business enterprise sector (contract research) rose to € 109 million in 2011 (+7.5%). Increases were also reported in funding from the public sector (€ 1,870 million, +7.1%) and above all in the volume of funding from abroad (€ 119 million, +37.8%), even though the overall level was low.

Research grants play a major role in the funding of research in general. The most important source of funding from the **public sector** is the research premium[13] of € 382 million, up about 50% from 2009 (€ 255 million). The strong expansion of research grants, especially from the increase in the research premium, brought about a major shift in recent years in how public funds are used. In 2002, 11% (€ 175 million) of all public funding went to the business enterprise sector; by 2011, this figure had risen to 25% (€ 756 million). During the same period, the share going to the higher education sector fell from 74% to 62% (Fig. 5).

The absolute volume of public-sector funding grew from € 1.574 million in 2002 to € 3.015 million in 2011. Public funding of higher education R&D rose from € 1.157 million (2002) to € 1.870 million (2011). This means that between 2002 and 2011, public-sector funding of R&D rose by € 713 million in the higher education

13 The research premium is an instrument of indirect research funding that could be applied for until the end of 2010 in the amount of 8% of R&D expenditure (since 1 January 2011, 10%). Because the research premium – in contrast to the research tax allowance permitted up to the end of 2010 – represents a direct transfer to a firm's tax account, the Frascati Manual requires this type of financing to be subsumed under the "public sector" source of funds.

Fig. 5: Distribution of public R&D funds by sector (2002–2011), in % and absolute



Note.: The private non-profit sector was not included due to its minor share.

Source: Statistics Austria. Calculated by JOANNEUM RESEARCH.

sector and by €581 million in the business enterprise sector.

Trend of R&D funding structure in Austria

Fig. 6 offers a detailed breakdown of the trend of R&D funding from 2002 to 2011. It comes as no surprise that the higher education and government sectors are fed largely from public funds. The percentage of public-sector funding in the business enterprise sector has risen sharply in recent years, from 5.6% (2002) to 13.3% (2011). The percentage of internally funded R&D in the business enterprise sector has fallen since the financial crisis, returning in 2011 to the level from 2002 (64%).

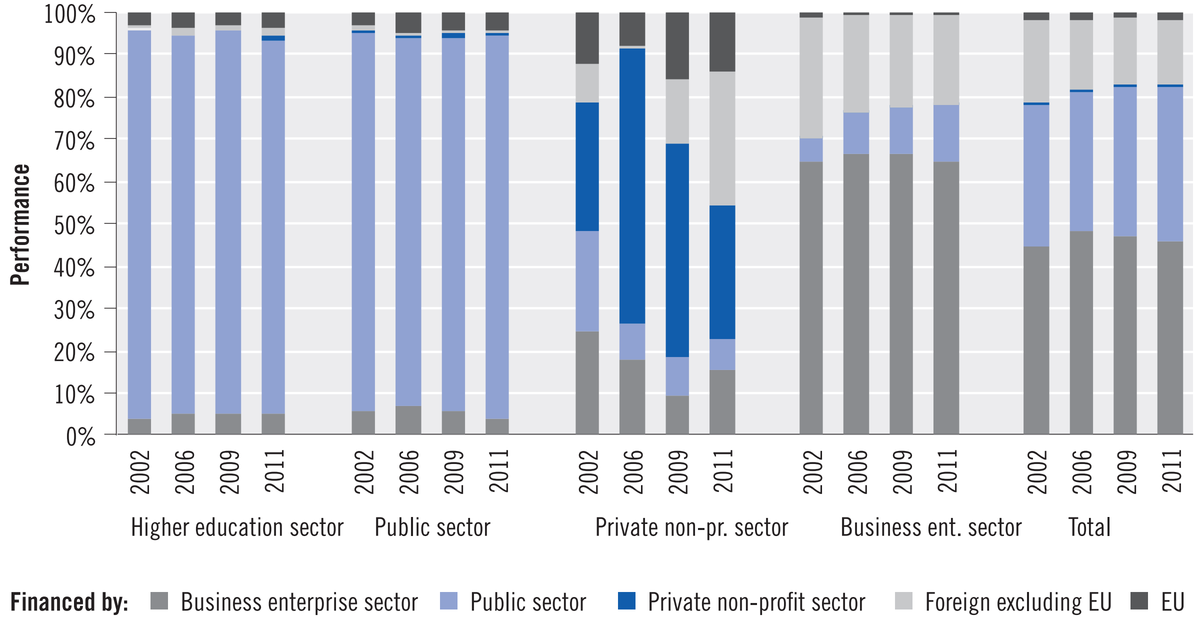
Some of the shifts in the (much smaller) private non-profit sector are much more conspicuous, especially the growing share of foreign funding even as public funding declines. But the €41 million spent in this sector represent only 0.5% of overall research expenditure.

Businesses were the source of 46.2% of overall research funding. It is clear that further efforts are needed to achieve one of the key objectives of the European RTI policy and thus of the national RTI strategy – to increase the business enterprise sector's share in overall funding to 66%, and ideally even to 70%, by 2020.[14] However, it should be noted that Austria can boast a high percentage of foreign funding compared to other countries – 17% currently, up from 15% in 2009 – and that the lion's share of this comes from businesses. Research funding from the EU stands at 1–2% and is reported separately. Domestic and foreign businesses together account for about 63% of overall research expenditure in Austria in 2011 – as was the case in 2009 – which is already quite close to the target (see Fig. 7).

As in past years, the largest shares of **research expenditure** go primarily to personnel (2011: 51%) and material expenses (41%). Broken down by type of research, one sees a disproportionately sharp rise in expenditure on basic research, with investments of €1,576.5 million in

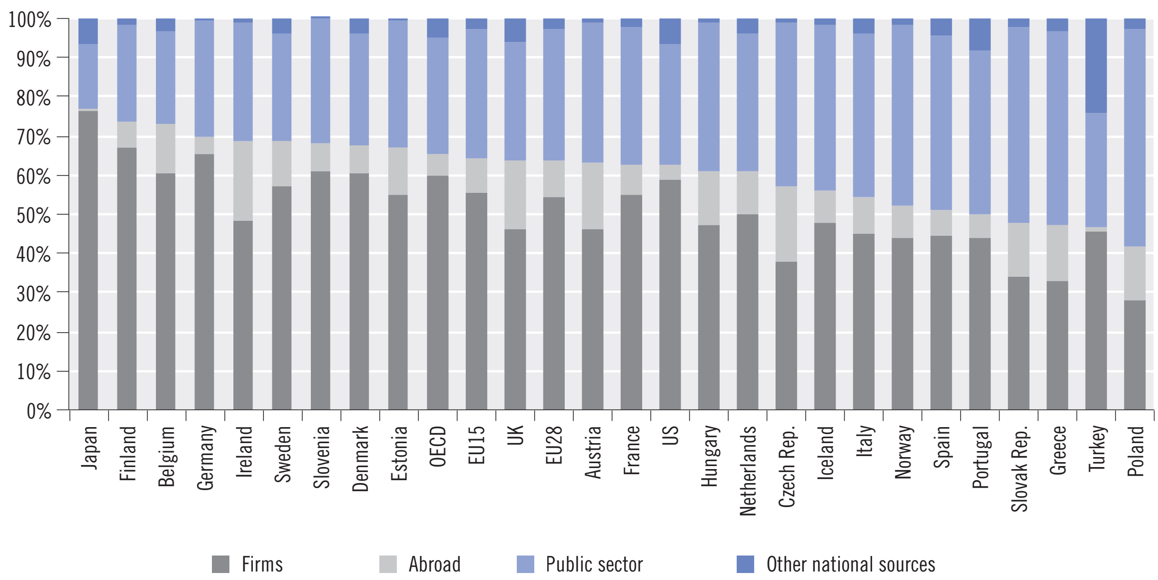
14 RTI Strategy (2011), p. 7

Fig. 6: R&D expenditure in € millions: 2002/06/09/11, by sources of funds



Source: Statistics Austria (R&D survey). Calculated by JOANNEUM RESEARCH.

Fig. 7: Funding structure of R&D expenditure in country comparison (2011)



Note: some countries with estimates.

Source: OECD (MSTI 2014). Calculated by JOANNEUM RESEARCH.

2011 nearly double the volume of 2002 (€819 million, +93%). Expenditure for experimental development (+76% to €3.642 million) and applied research (+68.3% to €2.907 million) were also up sharply over the period since 2002. The distribution of structures by type of research remains quite stable over the years. Experimental development accounts for 45%, applied research for 36%, and basic research for 19% of all research expenditure in 2011. Basic research is largely the domain of the higher education sector; businesses focus primarily on experimental development (61%) and applied research (34%).

R&D in the business enterprise sector in detail

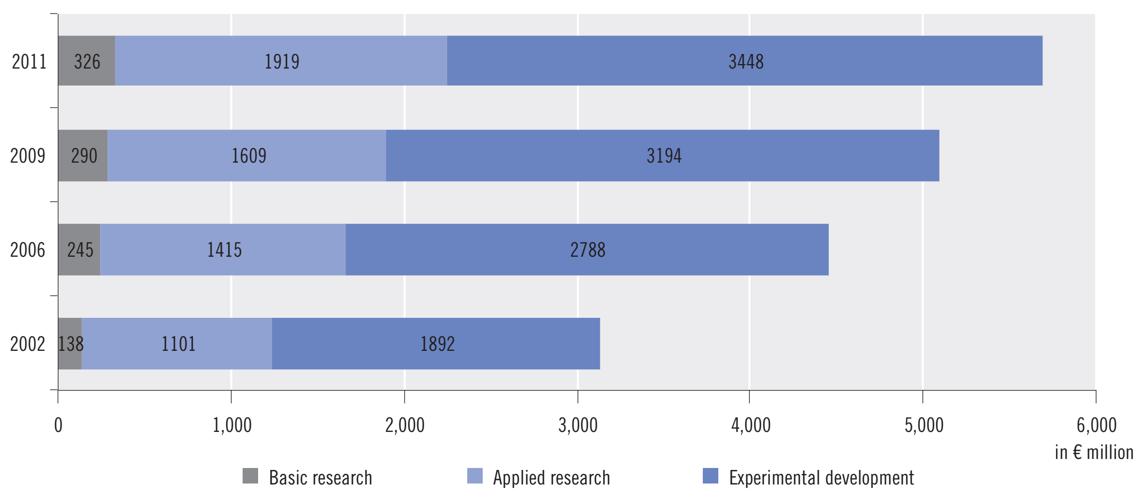
R&D expenditure in the business enterprise sector (including the institutes' sub-sector ("Kooperativer Bereich") has risen continuously in recent years, from €3.1 billion in 2002 up to €5.69 billion in 2011 (Fig. 8). This trend can be observed across all research types, but especially in basic research, which shows an expenditure increase of 136% (to €326 million). One reason for this increase could be that the few major businesses that conduct basic research to any significant degree have increased their spending on R&D since 2002 at a disproportionate rate from a very low level.

R&D expenditure are made up of four **types of expenses**: labor costs, current costs for items such as material and energy, expenditure for instruments and equipment, and expenses for land and buildings. In 2011, somewhat more than half (52.4%) went to personnel expenses, about 40% to ongoing R&D expenditure, 6.1% to investments in plants and equipment, and 2.0% for buildings and property. The picture is largely unchanged from previous years.

In 2011, about €3.63 billion (63.7%) of overall R&D expenditure of business enterprises went to **manufacturing**, which remained the major category of spending. The **services sector** is becoming more important, however, growing from 26.4% of overall R&D expenditure in 2002 to 35% (about €1.9 billion) in 2011. It should be noted that, as in other countries, the significance of this sector for R&D is well below its overall economic significance: this can be seen in the ratio of gross value added to factor costs, with the services sector showing a GVA nearly double that of the manufacturing sector.

The share of R&D expenditure in the **gross**

Fig. 8: R&D expenditure in € millions: 2002/06/09/11, by type of research in the business enterprise sector



Source: Statistics Austria (R&D survey). Calculated by JOANNEUM RESEARCH.

Table 2: R&D expenditure in the business enterprise sector, 2002/11

Sector	2011						2002					
	Number of survey units performing R&D	R&D expenditure	Gross value added (GVA)	R&D as component of GVA	Share in R&D expenditure	Share in GVA	Number of survey units performing R&D	R&D expenditure	Gross value added (GVA)	R&D as component of GVA	Share in R&D expenditure	Share in GVA
		[€ millions]	[€ billions]	%	%	%		[€ millions]	[€ billions]	%	%	%
Agriculture and forestry, fisheries	6	2	5	0.0	0.0	1.7	4	2	4	0.1	0.1	1.8
Mining	13	6	1	0.6	0.1	0.4	9	3	1	0.3	0.1	0.4
Manufacturing	1,504	3,626	50	7.3	63.7	18.5	1,169	2,273	39	5.9	72.6	19.4
High tech	*201*	694	5	13.8	12.2	1.9	229	867	4	23.4	27.7	1.9
Medium tech	*553*	2,154	16	13.2	37.8	6.0	672	1,265	22	5.7	40.4	11.1
Other manufacturing	*750*	778	29	2.7	13.7	10.6	268	139	13	1.1	4.5	6.5
Electricity, gas and water supply	52	20	6	0.4	0.4	2.1	17	14	7	0.2	0.5	3.3
Construction	81	47	18	0.3	0.8	6.6	53	12	14	0.1	0.4	7.1
Services	1,728	1,991	188	1.1	35.0	69.6	690	828	135	0.6	26.4	67.9
High-tech knowledge intensive	*778*	1,098	8	14.6	19.3	2.8	299	415	8	5.2	13.3	4.0
Other services	*950*	893	181	0.5	15.7	66.8	391	412	127	0.3	13.2	63.9
Total	**3,384**	**5,693**	**271**	**2.1**			**1,942**	**3,131**	**199**	**1.6**		

Note.: Economic sub-sectors according to ÖNACE 2008; technology intensity: high tech (21, 26), medium-tech (20, 27–30), other material goods (miscellaneous); knowledge intensity: high tech knowledge intensive (59–63, 72). In the R&D Survey of 2011 the classes 58-60 were aggregated, 61-63, 72 were included in the evaluation, the same approach was used for the gross value added. The differences in time frames with respect to the various types of technologies, especially when it comes to the medium-tech sector, can be attributed to the changes in the aggregate composition. Please refer to the footnote below for more.

Source: Statistics Austria (R&D survey, national accounts). Calculated by JOANNEUM RESEARCH.

Table 3: Financing of R&D expenditure by sources of funds, 2011

Sector				Public sector								
	Number of survey units performing R&D	R&D expenditure	Business enterprise sector	Federal government	Research premiums	Regional governments	Research Promotion Agency (FFG)	Other public Financing	Total	Private non-profit sector	Abroad (excluding EU)	EU
		[€ millions]	%	%	%	%	%	%	%	%	%	%
Agriculture and forestry, fisheries	6	1969	88.0	-	4.3	2.3	4.7	0.6	12.0	-	-	-
Mining	13	5978	49.4	-	5.0	3.3	8.4	1.8	18.5	-	32.1	-
Manufacturing	1,504	3,625,797	70.5	0.3	7.7	0.3	2.8	0.1	11.2	0.0	17.9	0.4
Electricity, gas and water supply	52	20,284	86.3	0.1	3.5	0.2	6.9	3.1	13.7	-	-	-
Construction	81	47,452	83.2	-	6.3	1.5	5.7	0.3	13.8	-	2.4	0.6
Services	1,728	1,991,361	53.8	4.3	4.9	2.4	4.8	0.7	17.1	0.3	27.1	1.7
Total	**3,384**	**5,692,841**	**64.8**	**1.7**	**6.7**	**1.0**	**3.5**	**0.3**	**13.3**	**0.1**	**21.0**	**0.9**

Source: Statistics Austria (R&D survey). Calculated by JOANNEUM RESEARCH.

value added of businesses rose from 1.6% in 2002 to 2.1% in 2011. This increase in R&D intensity was evident in all main groups, though it was only slight in some groups. Even when taking into account the methodological restrictions[15] that accompany the formation of classifications, one still sees an undiminished increase in the number of survey units conducting research: +29% among manufacturers (from 1,169 to 1,504) and an impressive +150% among service providers (from 690 to 1,728). One also sees a clearly positive connection between technology content and R&D intensity, with a research intensity among technology- and knowledge-intensive services of 14.6% compared to only 0.5% among all other service providers. The R&D intensity for manufacturing also varied by industry from 3% to 14% .

The trend among **funding sources for R&D** is overwhelmingly stable. About two-thirds (64.8% vs. 66.6% in 2009) of the R&D expenditure of the firms in the business enterprise sector were self-financed, followed by the foreign sector (21% without EU) and the public sector (13.3%). R&D funding by the EU and the private non-profit sector play a minor role. The services sector receives a high share of public funds (17.1%) and EU funds (1.7%), compensated for by a disproportionately low share of funding from the business enterprise sector (53.8%).

Breaking down the data by number of employees, we see that public R&D funding is especially important in small firms. As the size of the firm grows, so too does the role of funding from abroad and from the research premium. Funding from the latter in 2011 covered 4.0% of R&D expenditure by micro-enterprises with less than 10 employees compared to 7.3% by firms with more than 250 employees.

Table 4 underscores the significant role of large enterprises among R&D expenditure and all the indicators that derive from it. Here we see that large enterprises with more than 250 employees account for only 13% of researching firms (434 entities) but some 70% of all R&D expenditure in the business enterprise sector. By comparison, small firms with less than 50 employees (2,132 entities) account for nearly

Table 4: Financing of R&D expenditure by employment size category, 2011

				Public sector								
Size categories	Number of survey units performing R&D	R&D expenditure	Business enterprise sector	Federal government	Research premiums	Regional governments	Research Promotion Agency (FFG)	Other public Financing	Total	Private non-profit sector	Abroad (excluding EU)	EU
		[€ millions]	%	%	%	%	%	%	%	%	%	%
Less than 10 employees	1,191	166,364	68.6	2.2	4.0	2.1	12.8	2.4	23.5	1.7	3.3	2.9
10 - 19 employees	410	161,122	70.3	1.1	5.4	1.1	8.4	1.0	17.0	1.3	9.1	2.4
20 - 49 employees	531	335,499	73.9	1.4	5.6	2.1	6.8	1.4	17.3	0.1	6.4	2.3
50 - 249 employees	818	1,131,501	70.5	3.4	5.5	2.2	5.3	0.4	16.9	0.0	11.2	1.4
250 and more employees	434	3,898,355	61.9	1.2	7.3	0.5	2.1	0.1	11.3	0.0	26.3	0.5
Total	**3,384**	**5,692,841**	**64.8**	**1.7**	**6.7**	**1.0**	**3.5**	**0.3**	**13.3**	**0.1**	**21.0**	**0.9**

Source: Statistics Austria (R&D survey). Calculated by JOANNEUM RESEARCH.

15 Reclassifications of some (large) firms due to a change in their activity can have an effect on the aggregates and their significance. They can also cause certain reciprocal effects – e.g. a decline in research intensity in one area can lead to an increase in another area. For this reason care must be taken when interpreting data based on such classifications.

two-thirds (63%) of researching firms but only 11% of R&D expenditure.

Higher education sector

The federal government pays for the majority (88.3%) of R&D expenditure in the higher education sector. In 2011, this share came to some €1.8 billion (Table 5). The public-sector share is highest in the humanities at 97% and lowest in engineering, though still very high at 79%. The business enterprise sector funded some €109 million (5.2%) of R&D in the higher education sector, a ratio that was highest in engineering at 13.4% and lowest in the humanities at 0.7%. "Other public-sector funding", which includes the Austrian Research Promotion Fund, covers 12% of research expenditure by universities.

Employees in R&D

In 2011, over 61,000 FTE ("person years") were deployed for R&D in the various sectors (Table 6). About 108,000 employees were working on R&D. The number of employees involved in R&D grew +64% between 2002 and 2011 to a headcount of 107,949. As in recent years, this trend is seen most strongly in the business enterprise sector (+72%) and higher education sec-

Table 5: Financing of R&D expenditure in the higher education sector, 2011

				Public sector							
Fields of science	Number of survey units performing R&D	R&D expenditure	Business enterprise sector	Federal government	Regional governments	Local governments	Other public Financing	Total	Private non-profit sector	Abroad (excluding EU)	EU
		[€ millions]	%	%	%	%	%	%	%	%	%
1.0 to 4.0 Subtotal	740	1,598	6.3	70.5	2.4	0.1	13.5	86.4	0.6	2.4	4.3
1.0 Natural sciences	272	671	2.9	72.2	2.0	0.0	14.8	89.0	0.3	2.2	5.5
2.0 Engineering	225	384	13.4	61.7	3.6	0.3	13.2	78.8	0.7	2.5	4.6
3.0 Human medicine incl. hospitals	183	471	6.0	73.2	2.1	0.0	12.6	88.0	0.9	2.7	2.4
4.0 Agricultural sciences, VetMed	60	72	2.0	84.0	0.9	0.1	8.0	93.0	1.2	1.2	2.6
5.0 and 6.0 Subtotal	564	520	1.7	85.6	2.2	0.1	6.1	94.1	1.7	0.7	1.8
5.0 Social sciences	344	327	2.2	85.3	2.3	0.1	4.7	92.4	2.3	0.8	2.2
6.0 Humanities	220	193	0.7	86.3	2.0	0.1	8.6	97.0	0.7	0.6	1.0
Total	**1,304**	**2,118**	**5.2**	**74.2**	**2.3**	**0.1**	**11.7**	**88.3**	**0.9**	**2.0**	**3.7**

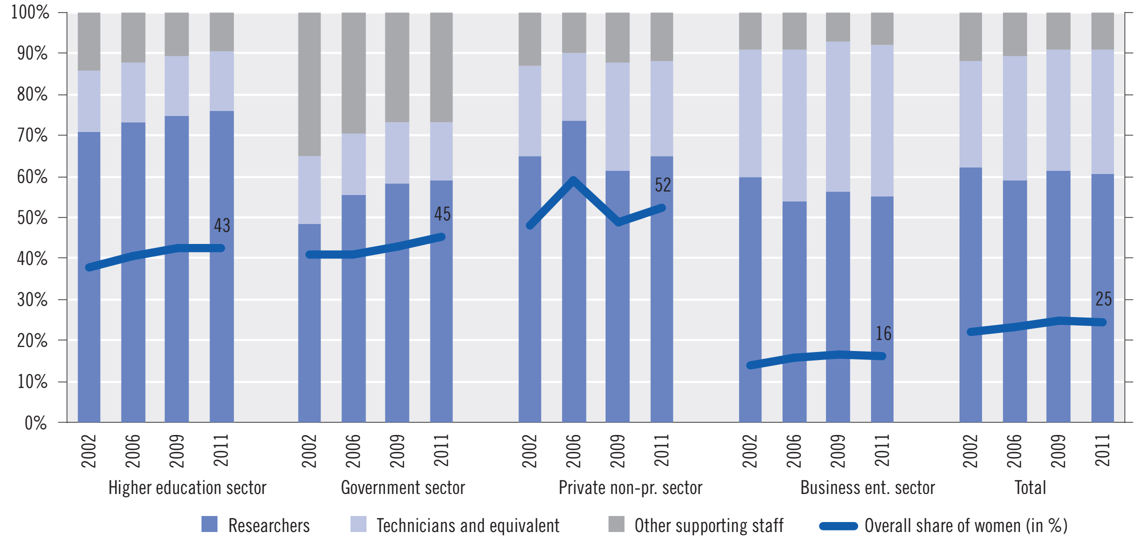
Source: Statistics Austria (R&D survey). Calculated by JOANNEUM RESEARCH.

Table 6: Employment in R&D, 2002/06/09/11

	Employees - headcounts					Employees - full-time equivalents					Ratio FTE/headcount			
Sector of performance	2002	2006	2009	2011	Change 02-11	2002	2006	2009	2011	Change 02-11	2002	2006	2009	2011
Higher education sector	25,072	32,715	39,084	42,291	+69%	9,879	12,668	15,059	16,096	+63%	39%	39%	39%	38%
Government sector	6,010	5,511	6,008	6,185	+3%	2,060	2,423	2,679	2,567	+25%	34%	44%	45%	42%
Private non-profit sector	623	404	742	830	+33%	227	161	397	410	+80%	36%	40%	53%	49%
Business enterprise sector	34,020	45,336	50,668	58,643	+72%	26,728	34,126	38,303	42,098	+58%	79%	75%	76%	72%
Total	65,725	83,966	96,502	107,949	+64%	38,893	49,377	56,438	61,170	+57%	59%	59%	58%	57%

Source: Statistics Austria (R&D survey). Calculated by JOANNEUM RESEARCH.

Fig. 9: R&D employment structure in FTE, share of women in FTE, 2002/06/09/11



Source: Statistics Austria (R&D survey). Calculated by JOANNEUM RESEARCH.

tor (+69%). The government sector also shows an increase in employee numbers for the first time since 2002.

The trend among full-time equivalents is similar (+57% to 61,170). The ratio between FTE and headcount has remained relatively stable since 2002, albeit with a slight decline from 2009 to 2011. The greatest stability has been in the higher education sector, where the time devoted to research must be seen in conjunction with teaching and administration. The average was 57% in 2011, with the business enterprise sector showing the highest ratio (72%).

The higher education sector has the highest percentage of scientific personnel (among FTE) at about 76%. The government sector and higher education sector have both steadily increased their percentage of scientific personnel since 2002, while this percentage has fallen in the business enterprise sector from about 60% (2002) to 55% (2011).

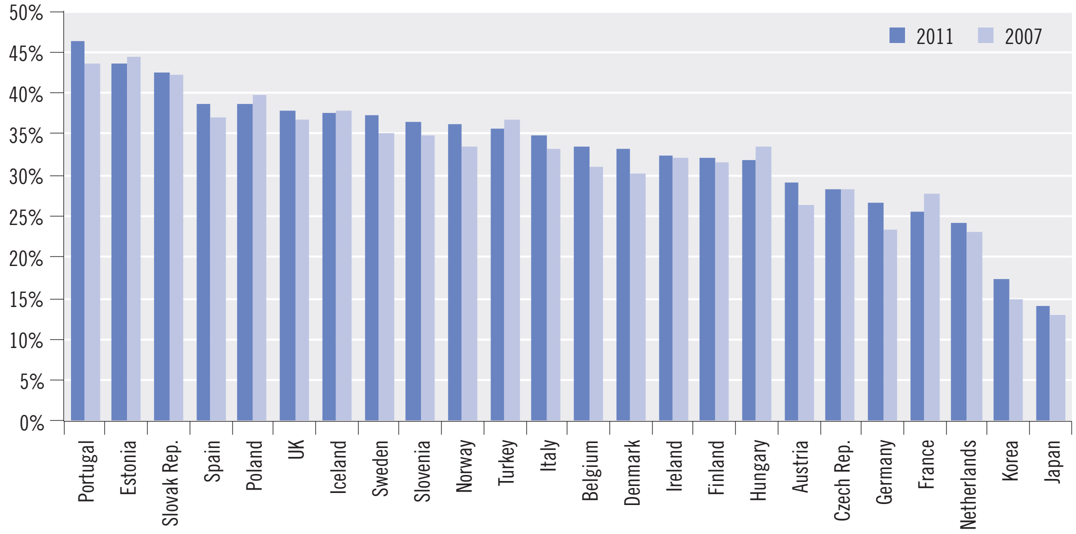
The percentage of women among FTE remained low at 25% in 2011 (Fig. 9). The percentage of women employed in R&D did rise slightly from 28% in 2002 to 31% in 2009 (headcount), but the percentage since 2009, and the percentage among FTE, has remained virtually unchanged. The low overall percentage of women is primarily attributable to the trend in the business enterprise sector, where only 17% of R&D employees in 2011 (and 16% of FTE) were women.

Austria ranks low in its representation of women in R&D compared to other countries as well (Fig. 10). Austria did manage to improve its ranking since 2007 among the 24 countries that provided comparable data, but it remains in the back ranks.

Despite this development, a clear trend toward greater participation of women in R&D has emerged in the last decade: women made up just 16% of all scientists in 2002 but this figure was up to 23% by 2011. Upon closer examination[16]

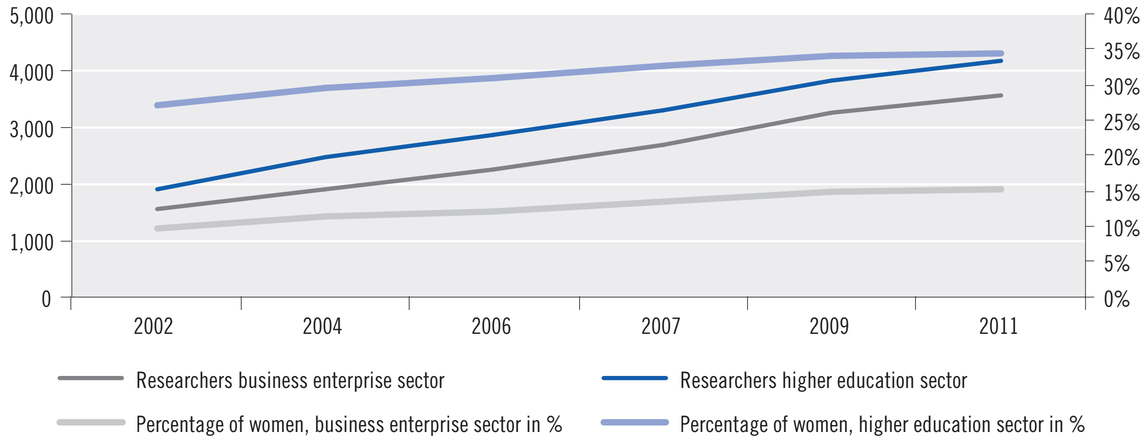
16 Holzinger (2013).

Fig. 10: Percentage of women amongst researchers (academics and equivalent employees; headcounts) in an international comparison, 2007/11



Source: OECD (MSTI). Calculated by JOANNEUM RESEARCH.

Fig. 11: Development in the number of female researchers and the percentage of women amongst research staff, 2002–2011



Source: Statistics Austria (R&D survey). Calculated by JOANNEUM RESEARCH.

of the group of researchers, we see that the higher education sector has grown much more rapidly over time with an average 8% annually compared to some 5% in the business enterprise sector (Fig. 11) The percentage of female scientists in the higher education sector grew from 27% (2002) to 34% (2011); in the business enterprise sector, the increase over the same time period was 10% to 15%. Given the high level of female scientists in the higher education sector at the start, one can speak of dynamic growth.

When one first considers that, up to 2011, the economic and growth crisis impacted employment in R&D less dramatically than in other economic sectors, it is interesting to note that the growth in the number of female scientists slowed considerably during this same time. The difference in the growth rates between women and men over time was 20% (2004), 9% (2006), 8% (2007), and 12% (2009) – but just 2% in 2011.

Slower growth of the number of female scientists could be interpreted to mean that women in R&D were more strongly impacted by the crisis than men.[17] Women were not pushed out of the R&D labour market during the crisis, but there was still a major slowing of the growth rate of female scientists. This could be the result of fewer women being newly hired, more women being laid off, or more women seeking another job outside R&D. The reasons for this development have not yet been studied, but the consequences are already evident: if the growth rates among female scientists do not recover, the percentage of women will continue to stagnate, and the prospect of closing the gender gap in R&D will recede far into the future. This is why further intensive efforts are needed, such as actions focused on achieving structural and cultural change[18] so that the gender gap in R&D can be reduced and the position of Austria in international rankings improved.

1.3 Structures and trends in international comparison

1.3.1 Position and development of Austria in international innovation rankings

The Austrian federal government has set out to make Austria a leading international centre for innovation. International innovation rankings offer an opportunity to assess the current status and progress in reaching this goal. Innovation rankings are analytical tools to summarise the innovative performance of countries (and sometimes regions) by measuring factors critical to innovative capacity and innovative success and aggregating them into a composite index. In this section, we look at the position of Austria in five international innovation rankings:

- the Innovation Union Scoreboard of the EU Commission (from March 2014)
- the new EU 2020 Innovation Indicator (from September 2013)
- the Global Innovation Index, which is published by Cornell University, INSEAD, and WIPO (from September 2013)
- the Innovation Indicator of Deutsche Telekom Foundation and BDI (from December 2013)
- the innovation-related elements of the Global Competitiveness Index of the World Economic Forums (from October 2013).

All innovation rankings rest on a theoretical understanding of innovation from which individual indicators of relevance are derived, standardised for measurement, and aggregated into a composite index. All the rankings examined rely conceptually on the innovation system approach[19] and measure innovative capacity along various phases and steps of an integrated economic process of innovation. This process typically includes education and science, legal, political, and social conditions, research and innovation activities of the business sector, as well as the interactions between individual stakeholders within the innovation system. The number of individual indicators that are considered vary widely among the rankings (5 for the *EU 2020 Innovation Indicator*, 84 for the *Global Innovation Index*), relying on both quantitative indicators (based on statistics) and qualitative indicators (based on expert assessments). The *Global Competitiveness Index* has an especially high number of qualitative indicators (24 of 31 innovation-related indicators), while the *Innovation Union Scoreboard* and *EU 2020 Innovation Indicator* only use quantitative indicators.

17 Ibid.
18 Ibid, p. 11 and p. 17.
19 see Freeman (2005); Patel, Pavitt (1994); Lundvall (1992); OECD (1999).

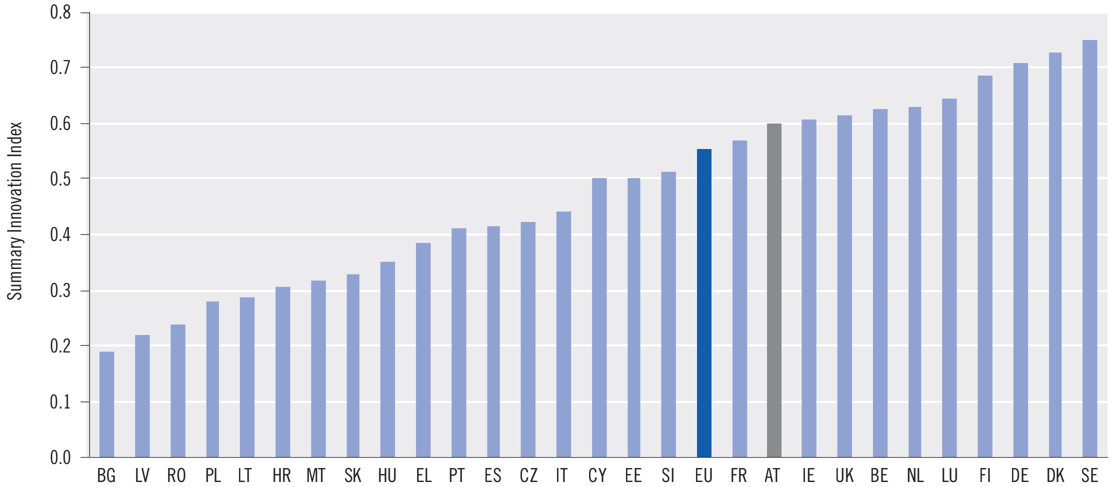
In all five rankings, the individual indicators are harmonised to a uniform basis of measurement using the so-called "minimum-maximum" method. This involves subtracting the value of the country with the lowest value from the individual indicator value of a country and dividing it by the difference between the highest and lowest value, so that the measured values for all individual indicators lie between 1 (= country with highest value) and 0 (= country with lowest value).[20] This statistical method can have a significant impact on the results, since extreme values of some countries influence the standardised indicator values of all countries. This means that a country's results may worsen even if the indicator value went up in case the value of the country with the lowest value went up even further. Weights are used to aggregate the individual indicators into sub-indicators (representing different aspects of innovative capacity) and a composite index. All rankings weight individual and sub-indicators equally.[21]

Current position of Austria

In recent years, Austria's position in international innovation rankings has been evaluated based first and foremost on the EU Commission's Innovation Union Scoreboard. The Scoreboard primarily compares EU member states but also includes a few other European and non-European countries. The current ranking, published in March 2014, puts Austria in 10th place among the 28 member states of the EU (see Fig. 12). Austria lost one place relative to last year, thanks to Ireland's gains, but kept its place in the composite index.

Other innovation rankings come to conclusions very similar to those of the Innovation

Fig. 12: Results from the Innovation Union Scoreboard 2014 for EU member states



Source: European Commission (2014).

20 To avoid too strong impact from extreme values, rankings either ignore or adjust extreme values. The Innovation Indicator follow a different approach by considering a pre-defined group of reference countries for determining minimum and maximum values.
21 The *Global Competitiveness Index* employs varied weights for the three sub-indicators "Basic requirements", "Efficiency enhancers" and "Innovation and sophistication factors" depending on the level of development in the relevant country. An equal weighting of the individual indicators was used to define the sub-indicators. Since only sub-indicators related to innovation are used here, the reported value of the rankings is based on an equal weighting.

Union Scoreboard. Depending on the ranking, Austria scored between 7th and 11th place among the EU-28. Many highly innovative countries are outside of Europe, however, so that a strictly European comparison is not adequate to assess Austria's innovative ranking within the international community. When Austria's results are compared to all the countries studied in the rankings, it ranks between 11th and 23rd place (see Table 7). Given the varying number of countries included in each innovation ranking (between 28 and 148), it does not make sense to compare placements, especially since some rankings include very small countries and countries with very specific economic structures (oil-exporting countries, small island nations, etc.).

To compare the individual rankings and Austria's prospects for joining the group of "innovation leaders," it helps to draw upon a reference group of comparable, economically and technologically sophisticated countries. These countries compete primarily among themselves for innovation and try to secure a competitive edge through innovation-oriented strategies. The reference group here includes all countries that have at least half of Austria's per capita GDP and at least half of Austria's population. Oil-exporting nations are excluded from the outset due to their very specific conditions. This reference group includes 22 countries – including Austria itself – of which 14 are in Europe.[22]

Austria occupies between 11th and 20th place within the reference group in the latest versions of the five innovation rankings (see Table 7). Austria ranks eleventh in the *Innovation Indicator*. In the innovation-related sub-indicators of the *Global Competitiveness Index*, Austria occupies 12th place. The *Innovation Union Scoreboard* and *EU 2020 Innovation Indicator* rank Austria as number 13, though this ranking only covers 16 of the 22 comparison countries, including just two outside of Europe (US and Japan). By far the worst ranking for Austria is on the *Global Innovation Index*, where it trails in 20th place. The varying positions of Austria can be explained by the different sets of indicators used by the individual rankings. The poor ranking in the *Global Innovation Index* can be attributed to the inclusion of general economic conditions and a few rather unconventional indicators to measure knowledge and technology output.

Table 7: Austria's position in selected international innovation rankings in 2013

Ranking	Publisher	Austria's rank			Number of countries considered		
		among all countries	in the EU	in reference group[1)]	Total	EU	Reference group[1)]
Innovation Union Scoreboard	European Commission	14	10	13	44[2)]	28	19[2)]
EU 2020 Innovation Indicator	European Commission	14	11	13	34	28	16
Global Innovation Index	Cornell University, INSEAD and WIPO	23	11	20	144	28	22
Innovation Indicator	Deutsche Telekom Foundation and BDI	11	7	11	28	13	20
Global Competitiveness Index – HTBI[3)]	World Economic Forum	13	8	12	148	28	22

1) Countries with at least 50% of Austria's GDP per capita (at current exchange rates) and at least 50% of Austria's population, excluding OPEC member countries (AT, AU, BE, CA, CH, DE, DK, ES, FI, FR, IE, IL, IT, JP, KO, NL, NO, NZ, SE, SG, UK, US).
2) For non-European countries on the basis of a limited set of indicators (12 out of 24 indicators).
3) Mean of the sub-indicators "Human capital and training", "Technological readiness", "Business sophistication" and "Innovation".

Sources: Deutsche Telekom Foundation and BDI (2013), European Commission (2013a, 2014), Cornell University et al. (2013), WEF (2013). – Compiled and calculated by: ZEW.

22 This is the following: Australia, Belgium, Denmark, Germany, Finland, France, Great Britain, Ireland, Israel, Italy, Japan, Canada, New Zealand, the Netherlands, Norway, Austria, Sweden, Switzerland, Singapore, Spain, South Korea and the US.

Switzerland leads four of the innovation rankings. Only the *EU 2020 Innovation Indicator* views the innovative performance of Switzerland less favourably (5th place), while it gives top honours to Japan, which does not make it among the top five most innovative countries in any of the other rankings (see Table 8). In addition to Switzerland, Sweden is also among the top five in all rankings, including three times in 2nd place. Germany makes the top five in three rankings. Finland, the US, and the Netherlands each has two top-five placements. The top five countries in all five rankings are all in the reference group studied here.

Austria's gap to the "innovation leaders," if that is how one wishes to designate the top five countries, is a relatively slim 7% in the *Global Competitiveness Index* (innovation-related sub-indicators only) and a substantial 26% in the *EU 2020 Innovation Indicator* (see Table 8, last column). The gap of 16% in the *Global Innovation Index* is moderate despite Austria's poor placement, but this is because the inclusion of developing countries in the standardisation of the indicator values has kept the gaps between the industrialised nations generally small. Closing a 16% deficit would require major improvements on a variety of indicators relative to the best-placed countries. Austria would have to improve its score in the *Innovation Indicator* of Deutsche Telekom Foundation and BDI and in the *Innovation Union Scoreboard* by 12% to reach the level of the top five countries.

Trend of Austria's position in the past ten years

For three of the five innovation rankings, it is possible to compare Austria's innovation performance with that of the reference countries over time.[23] In the *Innovation Union Scoreboard*, Austria managed to improve relative to the reference group between 2004 and 2009 and moved up to 8th place (see Table 9). But in 2010 and 2011, Austria dropped four places again and is now ranked at number 12 (within the EU: number 10). In the *Innovation Indicator*, Austria scored its highest ranking (8) in 2010 after placing 14th within the reference group in

Table 8: Comparison of the overall index for Austria in selected innovation rankings in 2013 with the five top ranked countries

	Rank 1	Rank 2	Rank 3	Rank 4	Rank 5	Austria 1)
Innovation Union Scoreboard	0.835 (CH)	0.750 (SE)	0.728 (DK)	0.709 (DE)	0.684 (FI)	0.599 (12%)
EU 2020 Innovation Indicator	134.2 (JP)	127.5 (SE)	126.1 (DE)	124.8 (IE)	121.5 (CH)	96.4 (26%)
Global Innovation Index	66.69 (CH)	61.36 (SE)	61.25 (UK)	61.14 (NL)	60.31 (US)	51.87 (16%)
Innovation indicator (Deutsche Telekom Foundation/BDI)	75.4 (CH)	72.9 (SG)	61.6 (BE)	61.3 (NL)	60.0 (SE)	53.5 (12%)
Global Competitiveness Index – HTBI 2)	5.70 (CH)	5.62 (FI)	5.61 (SE)	5.56 (US)	5.55 (DE)	5.21 (7 %)

1) In brackets: Difference between the value for Austria and the country ranked number 5 expressed in %.
2) Mean of the sub-indicators "Human capital and training", "Technological readiness", "Business sophistication" and "Innovation".

Sources: Deutsche Telekom Foundation and BDI (2013), European Commission (2013, 2014), Cornell University et al. (2013), WEF (2013). – Compiled and calculated by: ZEW.

23 Only values for 2010 and 2011 are available for the *EU 2020 Innovation Indicator*. The *Global Innovation Index* has been published since the reference year 2006, but comparisons over time are not recommended given the numerous changes to the methodology.

Table 9: Austria's rank in the Innovation Union Scoreboard and in the Innovation Indicator, 2002–2013 as well as in the Global Competitiveness Index (innovation-related sub-indicators), 2007–2013 within the reference group

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Innovation Union Scoreboard[1)]	11	12	12	11	11	11	9	8	11	12	11	12
Innovation Indicator (Deutsche Telekom Foundation/BDI)[2)]	17	14	14	13	13	11	12	14	13	8	11	11
Global Competitiveness Index – HTBI[3)]	-	-	-	-	-	12	13	14	14	13	12	12

1) Excluding Israel and South Korea since, for these countries only, values are only available for certain years. Dates given are those of the reference year of the relevant publication (i.e. 2013 for the edition that appeared in March 2014). The data used in determining the indicators' values is sometimes drawn from up to three years before the reference year.

2) Values calculated backwards to 2002 using the methodology introduced in 2011.

3) Global Competitiveness Index, mean value of the sub-indicators "Human capital and training", "Technological readiness", "Business sophistication" and "Innovation"; No comparative values are available prior to 2007 because of changes to the methodology.

Sources: Deutsche Telekom Foundation and BDI (2013), European Commission (2014), WEF (2013). – Compilation and calculations: ZEW.

2008. In 2011, it dropped three places again. In the innovation-related sub-indicators of the *Global Competitiveness Index*, however, Austria moved up two places between 2009 and 2011. The different tendencies in the three innovation rankings reflect not only Austria's performance but also that of other countries. It is possible to win (or lose) places, after all, when other countries slide backward (or improve more quickly). Another thing to keep in mind is that most of the indicators in the *Innovation Union Scoreboard* reflect data of one to three years before the reference year (i.e., the results for 2012 are based on data gathered for the years 2009 to 2011), while the indicators in the other two rankings refer to the specified year.

Despite the overall stability of Austria's innovation performance relative to other countries, is that the Austrian economy has greatly expanded its innovative activities and innovative orientation in the past decade. This can be seen in the noticeable rise in Austria's index scores in the rankings. In 2002, Austria achieved a score of 0.49 in the *Innovation Union Scoreboard* (when the index series is adjusted to reflect the methodology used since 2011). By 2013, this score had increased to 0.60. This put Austria's innovation performance on average within the reference group in 2013, up from 16% below average in 2002 (see Fig. 13). The gap to the top five countries did not shrink as quickly, however, since their innovation efforts also grew.

The picture is very similar with the *Innovation Indicator*. Austria's index score rose sharply from 0.41 (2002) to 0.54 (2013), while the average among the reference group rose less rapidly from 0.47 to 0.53. The gap to the lead group shrank most noticeably until the mid-2000s. The main reason for this was the direct impact of intensified efforts toward innovation-friendly policies (such as amending the tax incentives for R&D through the introduction of the research premium). Since 2007, however, the gap to the top five countries has grown again slightly.

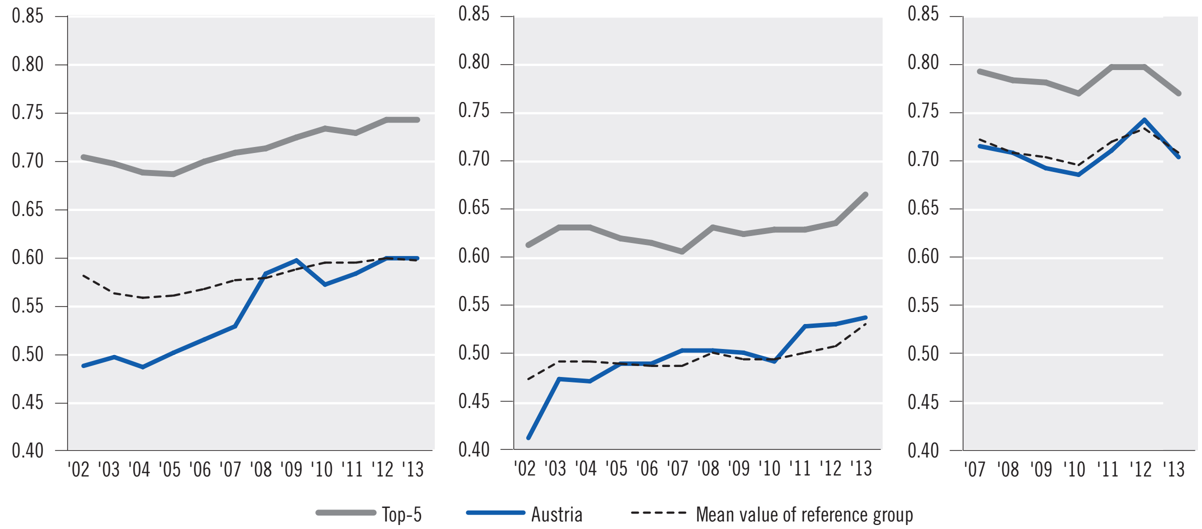
Austria greatly improved its index score in the innovation-related sub-indicators of the *Global Competitiveness Report* between 2010 and 2012, achieving a score slightly above average in the reference group. The gap to the five top-placed countries shrank noticeably during the same period. The scores for Austria and for the reference group as a whole went down in 2013, since fewer developed countries managed to achieve above-average gains in their innovation performance.

Austria in the individual innovation rankings

Innovation Union Scoreboard

The *Innovation Union Scoreboard* (IUS), published each year by the European Commission,

Fig. 13: Development of the overall index for Austria and the mean of the 5 best reference countries in the Innovation Union Scoreboard and in the Innovation Indicator, 2002–2013 as well as in the Global Competitiveness Index (innovation-related sub-indicators), 2007–2013



Innovation Union Scoreboard: chain-linked indices; Innovation Indicator: Index values revised on a scale from 0 to 1; HTBI: Sub-indicators "Human capital and training", "Technological readiness", "Business sophistication" and "Innovation" (Index values revised on a scale from 0 to 1).

Sources: Deutsche Telekom Foundation and BDI (2013), European Commission (2014), WEF (2013). – Compilation and calculations: ZEW.

compares the innovation performance of countries on the basis of 25 individual indicators. The IUS focuses on the European countries, so it can take into account indicators that exist only for European countries, most notably the indicators obtained from the biennial Community Innovation Survey (CIS). The IUS uses six CIS indicators. These indicators offer the potential to describe the innovative behaviour of firms from both the input and output side and with regard to the organisation of innovation processes better than in the other rankings. The comparability of the CIS indicators among the various countries is limited, however. For comparisons with non-European countries, the IUS uses just 12 indicators, focusing on R&D expenditure, patent and publication activities, export performance in the area of research- and knowledge-intensive goods, and aspects of higher education. The IUS relies entirely on quantitative indicators. The IUS was first published in September 2001 under the name "European Innovation Scoreboard" and has since been published annually. The methodology has been adjusted several times (including amendments/extensions to individual indicators), which limits the analyses of changes in the performance of countries over time.

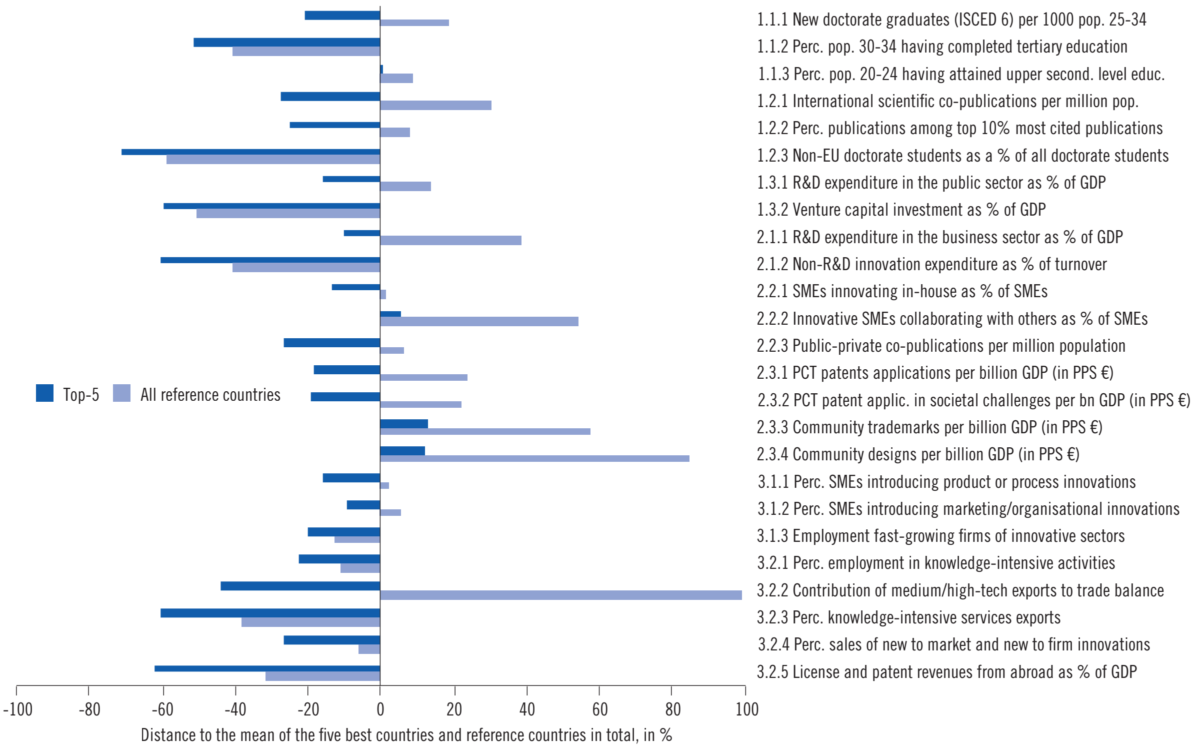
In 2014, Austria placed 14th among the 44 countries that the IUS studied and 13th within the reference group.[24] Austria scores better than the average of the five best-placed countries from the reference group on three indicators: percentage of innovative SMEs collaborating with others, community trademarks, and community designs. Austria's score is more than 50% below the average of the five best-placed countries from the reference group on six indi-

24 Non-European countries were assigned values based on their performance in 12 of the 24 individual indicators.

cators (see Fig. 14): venture capital investments, license and patent revenues from abroad, non-EU doctorate students, knowledge-intensive services exports, percentage of population aged 30–34 having completed tertiary education, and non-R&D innovation expenditure in the business sector.

Overall, the IUS can be regarded as a balanced system of indicators providing a comprehensive picture of innovation performance at the national level. But it fails to consider important institutional and social conditions for innovation (such as the extent of public funding for research and innovation). The IUS also includes some indicators whose link to innovation performance is not obvious. Examples include the percentage of non-EU doctorate students (which depends largely on historic relationships between some countries and developing nations, the availability of doctoral grants for non-EU citizens, and the importance of English as a language of instruction at universities), the intensity of venture capital investments (which does not reveal much unless the structure of the overall corporate financing system is also considered), or the intensity of license revenues (which depends heavily on the film industry, publishers, and intercompany trade). Moreover, the two indicators on foreign-trade performance of research-intensive goods and knowledge-intensive services have significant design flaws (see the following section for details). This means that most of the indicators in which Austria's scored particularly low can be regarded as less critical for assessing the innovation performance of a national economy.

Fig. 14: Comparison of Austria with the five top ranked countries and the mean values of reference countries in the Innovation Union Scoreboard 2014, by individual indicator



Source: European Commission (2014). – Calculations: ZEW.

Europe 2020 Innovation Indicator

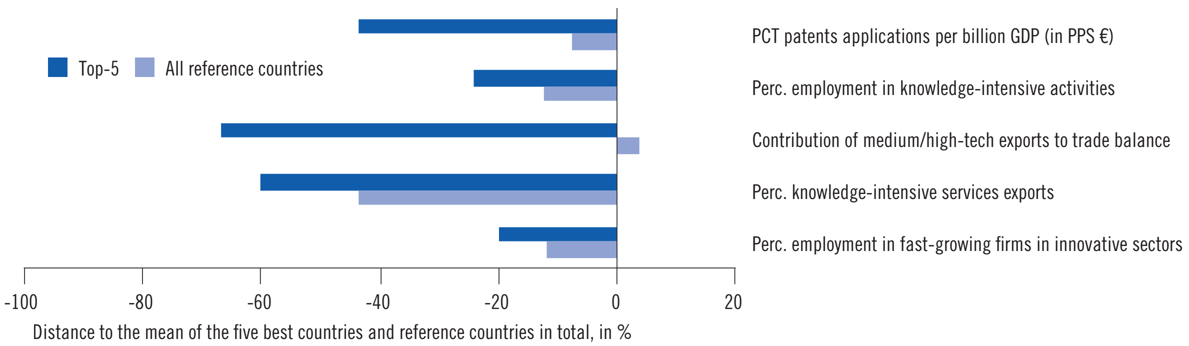
The Europe 2020 Innovation Indicator (EU2020-II) is designed as an output-oriented index complementing the input-oriented leading indicator of the EU Commission on the Lisbon Strategy – R&D expenditure as a percentage of GDP. The EU2020-II combines four indicators from the IUS with a new indicator designed to measure the importance of fast-growing firms in innovative sectors. The four IUS indicators are:

- PCT patent applications per billion GDP
- Contribution of medium/high-tech exports to trade balance
- Percentage of knowledge-intensive services exports
- Percentage of employment in knowledge-intensive activities

The two export-related indicators are only half-weighted when calculating the composite index. The new indicator (which will also be included in the IUS starting in 2014) measures the percentage of employment in fast-growing firms in innovative sectors among total employment in all fast-growing firms. Fast-growing firms are defined as firms exhibiting average annual workforce growth rates of 10% or more over a three-year period. Whether a sector is considered innovative is determined using the product of an innovation performance index (calculated using CIS data) and the percentage of university graduates in the workforce at the level of NACE groups (3-digit). The EU2020-II was first published in September 2013 with data from the years 2010 and 2011.

Austria scores lower in the EU2020-II than in the *Innovation Union Scoreboard*, the *Innovation Indicator*, and the innovation-related sub-indicators of the *Global Competitiveness Index*. The main reason for this is the two export-related indicators and the patent intensity (see Fig. 15). Austria's relatively low score in the contribution of medium- and high-technology exports to the trade balance is partly due to its export surplus in low-technology goods. The indicator does not measure the trade balance in medium- and high-technology exports on their own, but whether this balance is more favourable than the overall trade balance. This means that countries with a trade deficit in medium- and high-technology goods can still achieve a positive score on this indicator, while highly competitive trade surpluses can produce a negative score if the surpluses in low-technology trade are higher still. The low score on the percentage of knowledge-intensive services exports among all services exports is mainly due to Austria's high services exports in the area of tourism, which are not re-

Fig. 15: Comparison of Austria with the five top ranked countries and the mean values of reference countries in the Europe 2020 Innovation Indicator 2013, by individual indicator



Note: Deviations in the first four indicators in Fig. 14 are related to the availability of more current data for the calculations for the Europe 2020 Innovation Indicator. For more, see European Commission (2013d).

Source: European Commission (2013b). – Calculations: ZEW.

garded as knowledge-intensive, while logistics services (shipping, aviation, forwarding) are regarded as knowledge-intensive. Austria's below-average patent intensity among PCT applications primarily reflects the lack of large domestic corporations in the high-tech industries, since it is such corporations that dominate the patent activity in PCT applications.

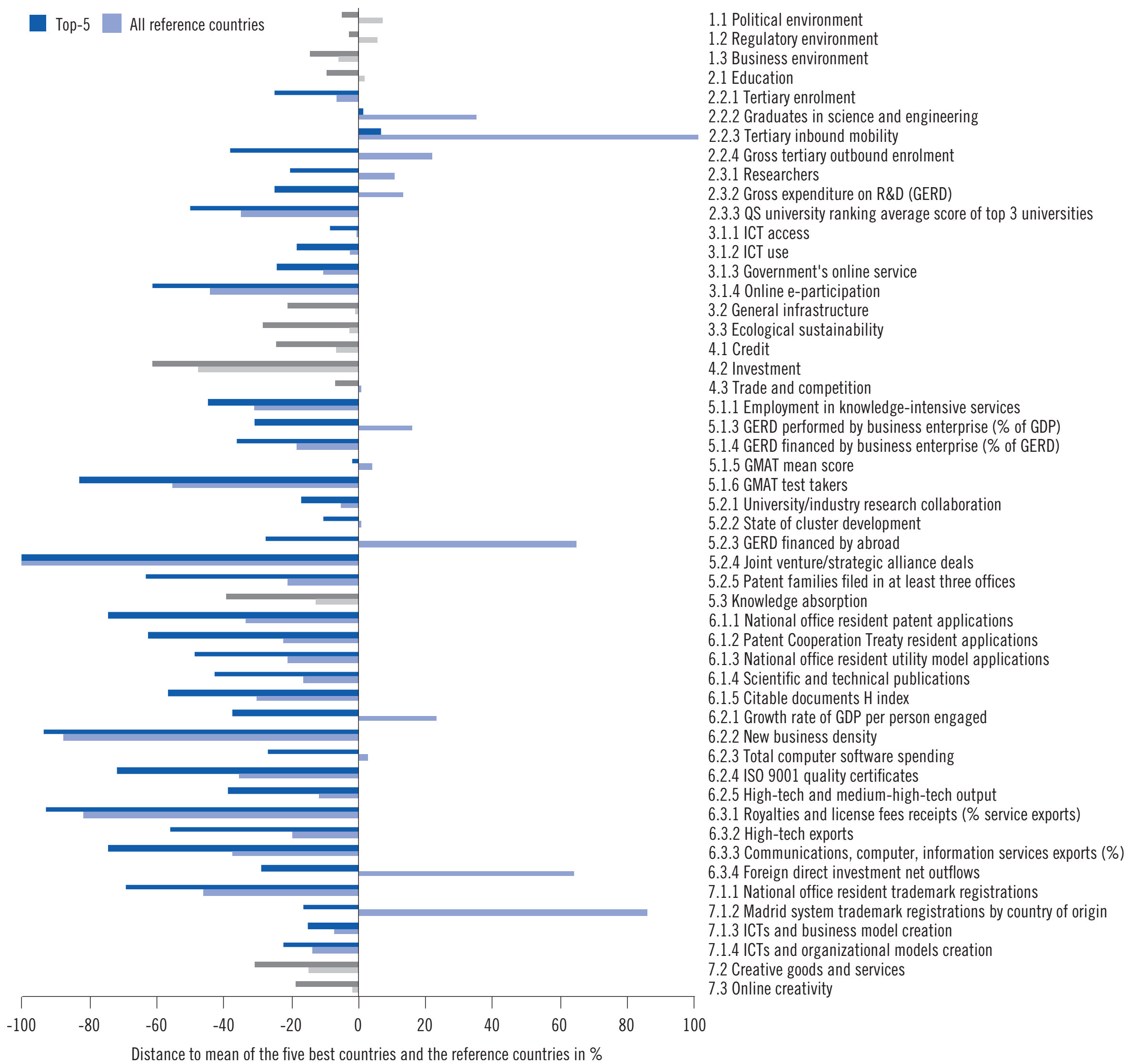
Overall, the EU2020-II focuses on the structural element of research- and knowledge-intensive sectors within a national economy, since four of the five indicators represent structural ratios. Even the fifth indicator, the patent intensity, is strongly influenced by the economic structure, since most patent applications come from firms in medium- and high-technology sectors. The EU2020-II neither records changes in the behaviour of firms and other stakeholders toward a more innovation-oriented approach nor the degree of successful innovations from a given deployment of resources. As a result, it overlooks a key component of the process toward greater innovation performance.

Global Innovation Index

The *Global Innovation Index* (GII) is designed to represent the innovation performance of as many countries as possible while taking into account political, legal, social, and infrastructure-related conditions. It does this with a very broad of individual indicators (84). All countries are included irrespective of their size or level of development as long as they have data for most of the indicators. GII 2013 examines 144 countries. The GII has seven sub-indicators (institutions, human capital and research, infrastructure, market sophistication, business sophistication, knowledge and technology outputs, and creative outputs), with the first five measuring innovation input and the last two measuring innovation output. The global index is calculated as the average of the input and output indices – which means that the two output sub-indicators have as much weight as the five input sub-indicators. GII relies largely on quantitative indicators while every seventh indicator is based on expert evaluations, most of which stem from the World Economic Forum's *Global Competitiveness Index*. By including indicators that describe general political, legal, social, and infrastructure conditions that are only loosely related to innovation decisions and results, the GII produces a picture that stands in sometimes stark contrast to other rankings. The GII also incorporates indicators that are typically viewed as negatively correlating with innovation performance and on which countries that are otherwise highly innovative score very poorly (especially in the sub-indicator "knowledge absorption"). This evens out country differences. Moreover, the inclusion of many very small countries means that these countries, through the minimum-maximum method applied to standardise the individual indicators, have a strong influence on the global results. This may explain the sharp differences between the GII on the one hand and the IUS and the Innovation Indicator on the other.

The gap between Austria and the best-placed countries, which is larger in GII than in other rankings, is due in part to low scores in some scarcely innovation-related indicators relating to general economic conditions. Austria scores particularly low on the sub-indicator "Investment", for example, which includes aspects such as ease of protecting investors, total value of stocks traded, and venture capital deals (see Fig. 16). The sub-indicator "creative industries," which primarily measures the significance of the film and publishing industries, also lowers Austria's score. Another factor is that Austria lags behind on many of the GII's innovation-related indicators. Austria scored particularly low in the sub-indicator "knowledge creation" (6.1), which includes patent and utility model applications, the number of scientific publications, and the number of citable documents. The gap to the five best-placed countries is also large in the sub-indicator "knowledge diffusion" (6.3), which covers license receipts, high-tech exports, IT and communications exports, and foreign direct investments.

Fig. 16: Comparison of Austria with the five top ranked countries and the mean values of reference countries in the Global Innovation Index 2013, by individual indicator



Light bars: sub-indicators with limited connection to innovation.

Source: Cornell University, INSEAD and WIPO (2013). – Calculations: ZEW.

But Austria also lags far behind in the third sub-indicator of knowledge and technology outputs – "knowledge impact" (6.2) – due to its very low new business density and low number of ISO 9001 quality certificates. Other weak points include the indicators "joint ventures/ strategic alliances" (5.2.4), "Graduate Management Admission Test takers" (5.1.5), "online e-participation" (3.1.4), "national office resident trademark registrations" (7.1.1), "patent families filed in at least three offices" (5.2.5), and the average score of the top three universities in international rankings (2.3.3). Austria scores very high in the political and regulatory environment (sub-indicators 1.1 and 1.2), the percentage of STEM graduates among all university graduates (2.2.2), the percentage of foreign students (2.2.3), and the participants' results on the GMAT (5.1.5).

The large number of GII indicators that ultimately are weighted very similarly in the composite index (depending on the number of individual indicators per sub-indicator and the allocation to input or output indicators) proves to be more of a disadvantage relative to other rankings. After all, this weights indicators with a rather dubious link to a country's innovation performance relatively heavily in the overall results. This is true of many of the indicators in which Austria scores poorly.

Innovation Indicator (Deutsche Telekom Foundation/BDI)

The *Innovation Indicator* (II) compares the innovation performance of highly developed industrialised nations and a selection of larger emerging nations. The group of 28 countries is the smallest of all the innovation rankings examined here. The II has been published annually since 2005 and underwent a thorough methodological revision in 2010. A key element of the revision was to condense the over 150 indicators into a set of "relevant" indicators. The first step was to remove indicators that correlated strongly with other indicators. The next step was to check all input indicators to determine whether they had a statistically significant effect (including time-delayed) on related output indicators. The output indicators were also checked to determine whether they influenced economic performance and competitiveness indicators. In the end, 38 indicators were found to be relevant. II reports the innovation rankings calculated under the revised method back to the year 1990, but due to the lack of complete indicator coverage in the 1990s, comparisons are meaningful only for the period beginning in 2000.

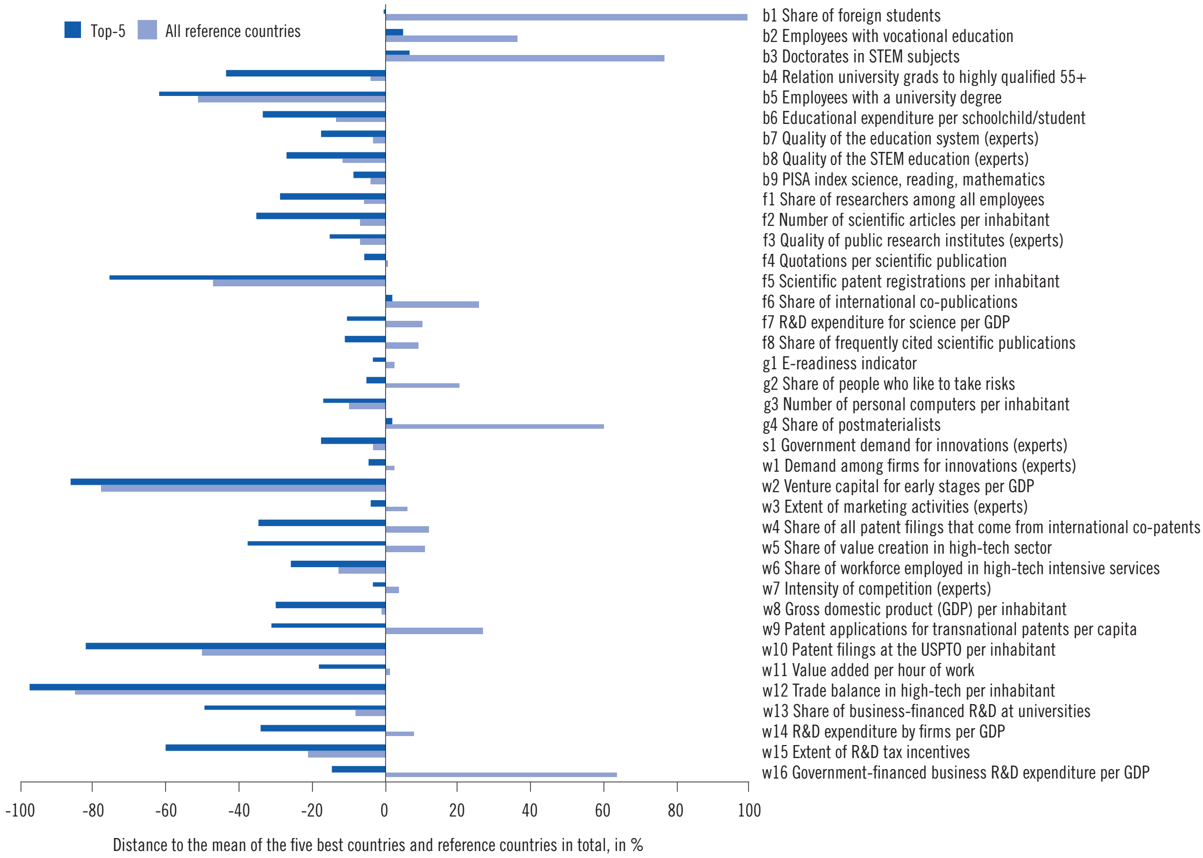
Austria scores relatively well in II, most recently placing 11th out of 20 reference countries. Austria scores higher than the average of the top five countries on four indicators (percentage of employees with a professional degree, percentage of population with doctorates in STEM fields, percentage of scientific publications that are international co-publications, percentage of population with a "post-materialistic attitude" – i.e., a strong preference for the quality aspects of goods; see Fig. 17). Austria scores especially low in the percentage of employees with university degree, patent applications by public research institutions, patent intensity, venture capital investments, and balance of trade in high-tech goods.. The extent of tax incentives for R&D (calculated on the basis of OECD's B index, cf. Warda 2001) in Austria also shows a significant gap to the countries with the most generous R&D tax incentives.

Many of the II indicators overlap with the *Innovation Union Scoreboard*, with the distinction that the II does not contain any CIS indicators while it includes government and social conditions and selected qualitative aspects of the innovation system. It also places more emphasis on indicators that show international integration and openness of a national innovation system, since these variables have proven to be key factors in a high innovation output. Austria, as a small and open economy, benefits from this indicator choice. Overall, the II seems to be adequately suited to represent Austria's innovation performance.

Global Competitiveness Index

The primary objective of the World Economic Forum's *Global Competitiveness Index* (GCI) is to evaluate the competitiveness of all countries. GCI does this through a broad set of indicators broken down into 12 pillars (institutions, infrastructure, macroeconomic environment, health and primary education, higher education and training, goods market efficiency, labour market efficiency, financial market development, technological readiness, market size, business sophistication, innovation), which are in turn consolidated into three sub-indices (basic equipment, efficiency drivers, innovation and busi-

Fig. 17: Comparison of Austria with the five top ranked countries and the mean values of reference countries in the Innovation Indicator 2013 produced by Deutsche Telekom Foundation and BDI according to individual indicators

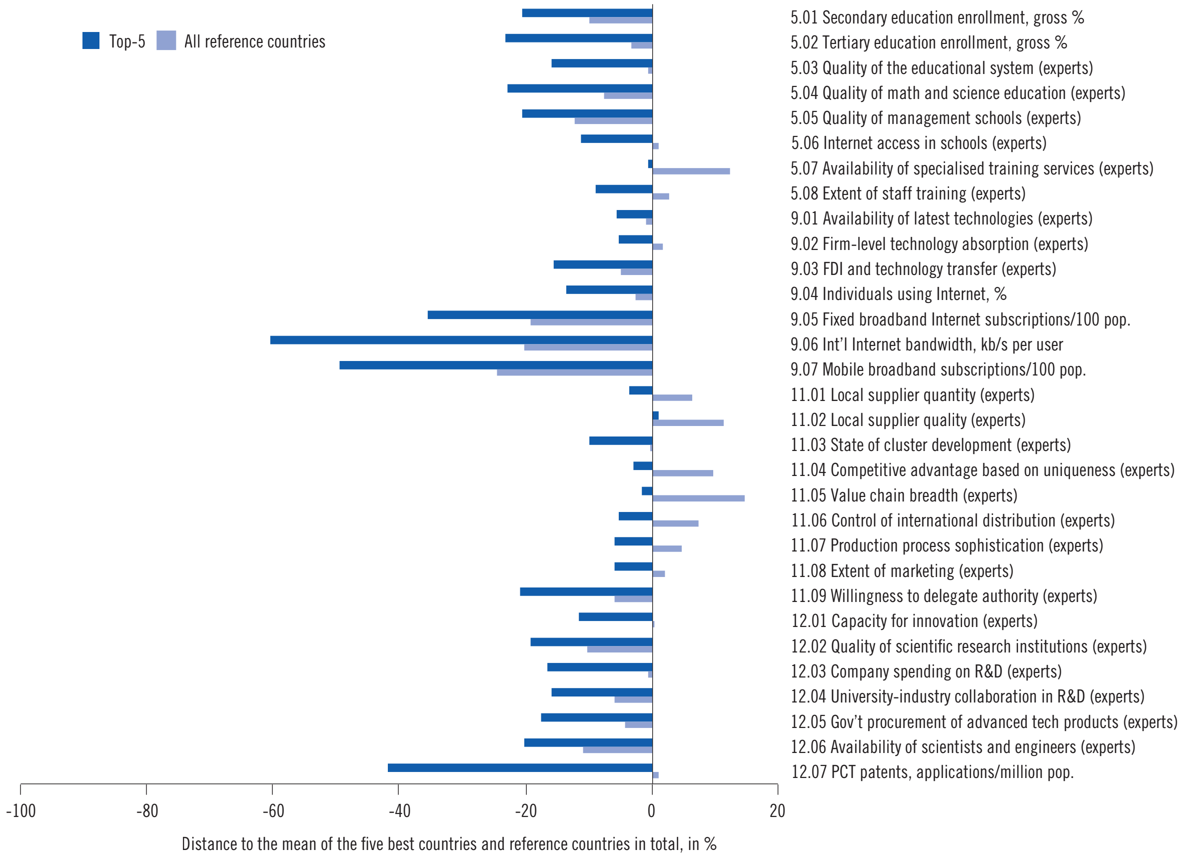


Source: Deutsche Telekom Foundation and BDI (2013). – Calculations: ZEW.

ness sophistication). Four of the twelve pillars cover innovation-related aspects similar to those examined in the rankings designed explicitly to rate the innovation performance of countries (higher education and training, technological readiness, business sophistication, innovation – totalling 31 indicators). What's unique about GCI is that 85 of the 114 indicators are qualitative in nature and stem from an annual global survey of leading business managers. In 2013, 13,638 managers from 144 countries took part in the survey (an average of nearly 100 per country). This gives GCI an entirely different data base than the other four rankings examined here. GCI even relies in part on expert assessments where reliable quantitative indicators are available (such as the volume of R&D expenditure in an economy).

Austria scores well below the top five countries from the reference group on four indicators (fixed broadband Internet subscriptions, Internet bandwidth per user, mobile broadband subscriptions, patent density; see Fig. 18), while it approaches or even exceeds the average of the top five on five indicators (availability of specialised training services, local supplier quantity, local supplier quality, competitive advantage based on uniqueness, and value chain breadth). While the four indicators with relatively low scores are quantitative ("objective"), all five in-

Fig. 18: Comparison of Austria with the five top ranked countries and the mean values of reference countries in terms of innovation-related sub-indicators in the Global Competitiveness Index 2013, according to individual indicators



Sub-indicator 5: Higher education and further training, sub-indicator 9: technological abilities, sub-indicator 11: firm's abilities, sub-indicator 12: innovation.

Source: WEF (2013). – Calculations: ZEW.

dicators in which Austria scores very high are based on expert assessments. Austria generally scores well on all 24 qualitative ("subjective") indicators. On the one hand, this can mean that the experts have additional, qualitative information alongside the objective, quantitatively observed factors (that are primary in the other rankings studied here) that lead to a more comprehensive and overall more favourable assessment of Austria's innovation performance. On the other hand, the approximately 100 Austrian experts that were surveyed may also offer an overly positive picture of their home country, perhaps because they lack a direct comparison with the innovation performance of other countries. In any case, it should be remembered that the expert assessment largely covers aspects for which no reliable quantitative indicators are available.

Though it is not the objective of GCI to measure the innovation performance of countries, the four innovation-related sub-indicators together do deliver a powerful picture, and with their focus on expert assessments, they complement the other four rankings, which rely solely (*Innovation Union Scoreboard* and *EU 2020 Innovation Indicator*) or largely on quantitative indicators. Expert assessments do, after all, address aspects that are otherwise disregarded. For this reason, the *Global Innovation Index* and *Innovation Indicator* have adopted some qualitative indicators from the GCI into their own sets of indicators.

Summary

Innovation rankings seek to offer a condensed picture of the innovation performance of countries by consolidating a large number of relevant factors into a composite index. The results vary widely from ranking to ranking due to the different sets of indicators and some differences in the methodologies by which the composite index is calculated. The varying results also make it clear that no ranking alone can claim to have the "right" result. Each innovation ranking involves making a number of different decisions, especially when it comes to selecting and weighting the indicators. This means trade-offs between a focus on quantitative indicators (generally more reliable, "objective" data, which may, however, be unable to reflect certain key aspects) and qualitative indicators (more comprehensive picture, but dependent on subjective assessments), and between a broad set of indicators (covering many aspects, but difficult for weighting the various indicators) and a concentration on a few indicators (clearer, more transparent result but disregarding many aspects).

Austria has made great strides in its capacity for innovation in the past ten to fifteen years. This is evidenced by the trend in its overall economic R&D intensity, higher exports of medium- and high-technology goods, the share of the workforce with university degrees, and the increased publication activities of its universities. At the same time, Austria has made little headway in the rankings, and the gap to the lead group of "innovation leaders" remains high. This is because other countries have also intensified their innovation efforts. This process may point toward a forced competition for innovation among highly developed industrialised nations (and a few larger, fast-growing emerging economies). But it may also simply be the expression of a long-term economic shift in which the importance of knowledge-based activities (an innovation by extension) is eclipsing that of traditional activities.

Regardless of which interpretation one embraces, it makes sense for Austria to continue down the path toward greater knowledge and innovation, since this offers the greatest relative benefits in the international marketplace. The result does not necessarily have to be an improved position in innovation rankings. What's more important is that the structural shift toward research- and knowledge-intensive sectors continue and that all stakeholders take advantage of the innovative potential already available. Determining whether Austria is on the right path means looking at many indicators and conducting specific analyses. Innovation rankings can provide points of reference but are never enough. There are many important areas that are inadequately reflected in innovation rankings, such as the interaction between the scientific and business communities, the degree of innovation in low-technology industries and non-knowledge-intensive services, or the application of (key) technologies to boost productivity in a wide array of sectors.

The innovation rankings examined here can nevertheless yield a few general perspectives of how Austria can improve its own system of innovation. The persistently low percentage of employees with university degrees stands out in contrast to the innovation leaders. In an increasingly knowledge-based economy, the low rate of academics can only be partially offset by a higher percentage of employees with vocational training or a higher-quality secondary school education. Rather than job-specific specialised knowledge, today's jobs increasingly require people who can quickly learn new skills and solve complex problems. Both of these are skills typically acquired through higher education. The performance of Austria's scientific community lags behind the innovation leaders in terms of both publications and patent applications.

Since the interaction between the scientific and business communities is a critical factor for particularly powerful systems of innovation, a strong scientific community is needed as a partner for an innovation-oriented economy. This means striking a balance between leading-edge basic research and a scientific system that is prepared to share knowledge. Finally, better economic incentives and overall economic conditions are needed so that more firms implement original innovations and become technology and global market leaders in their segment. This sort of transformation would be evident in more patent activities, especially in international patent applications, where Austria still lags far behind the innovation leaders.

1.3.2 Austria's position in the Innovation Union Progress Report 2013

Europe's economic development depends largely on its ability to innovate. The introduction of new products and processes is a key force behind creating more jobs and overcoming the current crisis. This is the context in which the European Commission launched the "Innovation Union" strategy in 2010. This initiative seeks to engender an innovation-friendly environment, making it easier to turn new ideas into products and services, which in turn create jobs and growth.[25] The Innovation Union is one of the flagship initiatives of the "Europe 2020" strategy.

In its two progress reports from 2013, the European Commission found that the Innovation Union was off to a good start.[26] The growth in private and public R&D expenditure in the member states held steady even in the face of budget consolidations. Many signs indicate, however, that the convergence in R&D among member states evident over the past decade has come to a standstill. The extraordinarily long and difficult crisis in various member states has begun, in the view of the Commission, to weaken the European-wide consensus on the need to increase public R&D expenditure.

The progress report of the European Commission also analyses the strengths and weaknesses of individual member states.[27] These country profiles are based in part on various statistical data already familiar from other international comparisons like the Innovation Union Scoreboard (see Chapter 1.3.1). But the European Commission is also introducing newly formed indicators that measure structural shift toward a knowledge-intensive society or excellence in science. The following more closely examines and analyses the country profile for Austria.

Austria's investments and input in international comparison

The Innovation Union Progress Report draws upon six key indicators to measure the performance of countries in terms of research, innovation, structural change, and competitiveness – from both the input and output end (see Table 10).

Table 10: Indicators of the Innovation Union Progress Report

Dimension	Investments and Input	Performance/economic output
Research	R&D intensity	Excellence in science and technology
Innovation and structural change	Index of economic impact of innovation	Knowledge-intensity of the economy
Competitiveness	Hot-spots in key technologies	High-tech and medium-tech contribution to the trade balance

Source: European Commission (2013c), p. 13.

25 Non-European countries were assigned values based on their performance in 12 of the 24 individual indicators.
26 see European Commission (2013b, c).
27 see European Commission (2013c).

The Innovation Union Progress Report measures the investments and input of various countries in science and research using three indicators: the *R&D intensity*, an index of the *economic impact of innovation*, and the *specialisation in various key technologies* ("hots-pots").

The first input indicator is the *R&D intensity*. The trend of Austria's R&D intensity is handled in detail in Chapter 1.3.1 of this report and in earlier editions of the Research and Technology Report; Austria has exhibited above-average growth in the period under review relative to the EU average and the US.

Four of the five indicators in the index of the *economic impact of innovation* are the same as the Europe 2020 Innovation Indicator described in Chapter 1.3.1. Only the percentage of employees in fast-growing firms in innovative sectors was replaced by the indicator *Sales of new-to-market and new-to-firm innovations as a percentage of turnover* familiar from the Innovation Union Scoreboard.

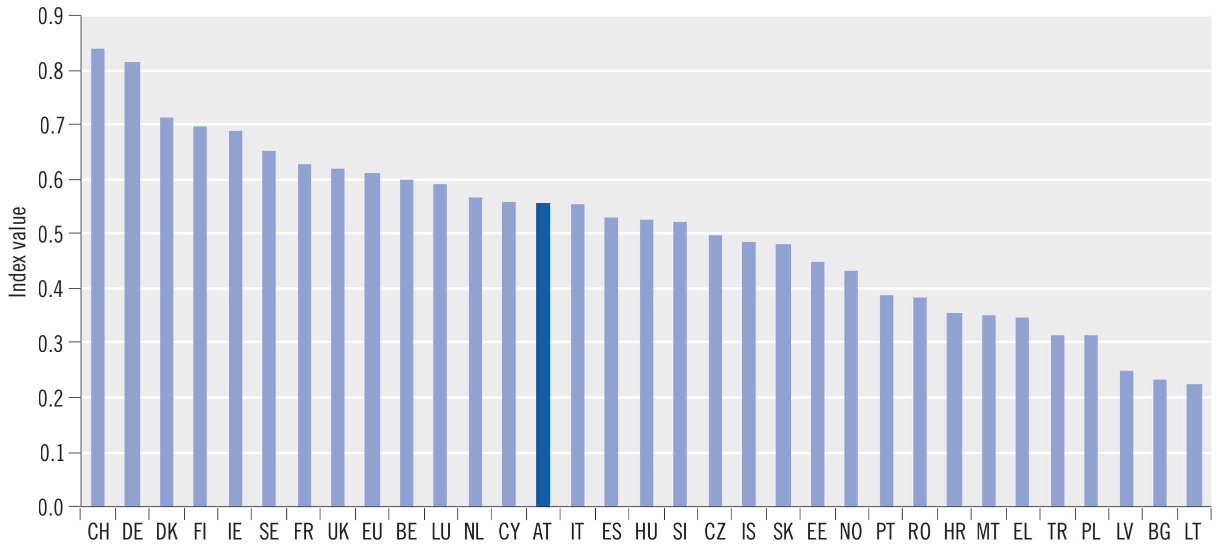
In the index of *economic impact of innovation*, Austria is not in the leading group of observed countries (see Fig. 19). Austria's relatively poor showing is due in part to its low score on the indicator *percentage of knowledge-intensive services exports among all services exports*. As discussed earlier, this is the result of Austria's strong tourism and how knowledge-intensive services are defined – to include shipping, for example. Austria's poor performance is also the result of the patent indicator, which is calculated in a way that disadvantages countries with a strong presence of foreign multinational corporations in research.

The third indicator for measuring input is the *key enabling technologies*("hotspots"), measured by the PCT patent applications at the regional level (NUTS2). Austria shows strengths here in energy, environmental, and transport technologies, in construction, and in production technologies. The European Commission does not produce a ranking here.

Austria's performance and output in international comparison

What most distinguishes the Innovation Union Progress Report from similar studies published by the European Commission in the past is the

Fig. 19. Indicator economic impact of innovation, 2010-2011



Source: European Commission (2013c), p. 5. Own reporting.

stronger inclusion of scientific output. This is captured in a composite indicator – *excellence in science and technology* (Fig. 20) – consisting of the following individual indicators:

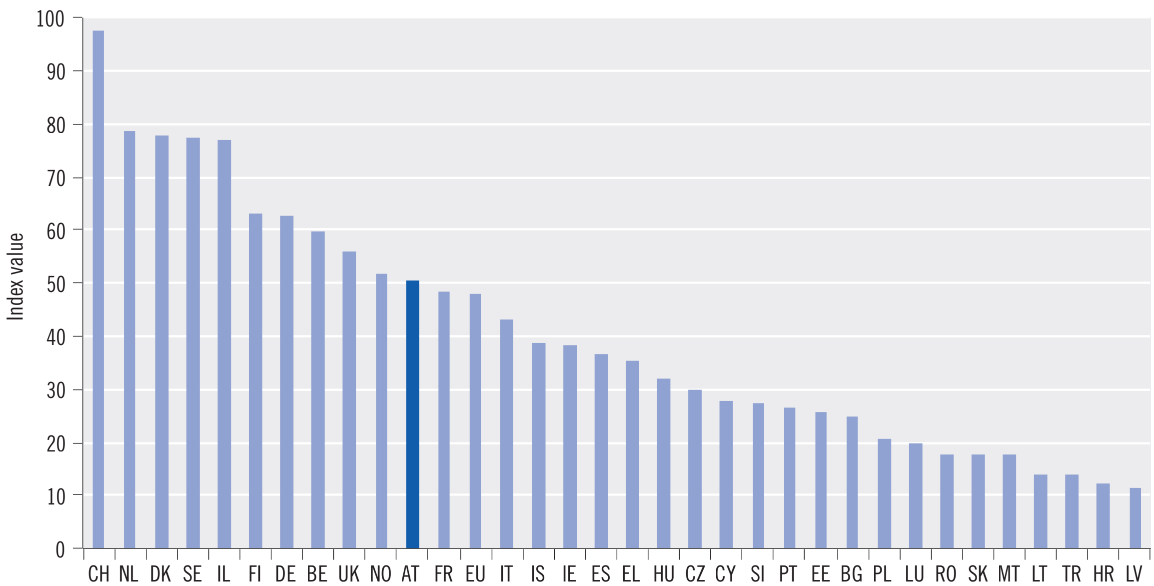
- Percentage of heavily cited publications (top 10%) among total national publications
- Number of global top 250 universities and top 50 research organisations of a country divided by its population
- PCT patent applications of a country divided by its population
- Number of received ERC grants divided by the R&D expenditure of universities and the public sector

The international comparison reveals a wide gap in this indicator between a group of leading countries – Switzerland, the Netherlands, Denmark, Sweden, and Israel – and the others. Three of these countries are among the innovation leaders that head up the European Innovation Union Scoreboard.

Austria's scores better in the indicator *excellence in science and technology* than in the indicator *economic impact of innovation*, but it remains behind the innovation leaders and the other smaller European economies. The gap to the leading country, Switzerland, is considerable – about as large as the gap to the last-ranked country. (The scores of the individual countries on this indicator have been scaled between 10 and 100.) But among those countries above the EU average, Austria has the second-highest growth rate for the period from 2005 to 2010, so that higher scores can be expected in the future.

The indicator *knowledge intensity of the economy* is a consolidation of eight individual indicators (Fig. 21) that measure R&D intensity, knowledge intensity of employees, sectoral specialisation, international specialisation, and internationalisation. Here, too, Austria lags behind the group of innovation leaders and the EU average – more so than for the indicator *economic impact of innovation*. Since the European Commission does not list the indicators it uses in its publication, it is not possible to analyse the reasons for this position.

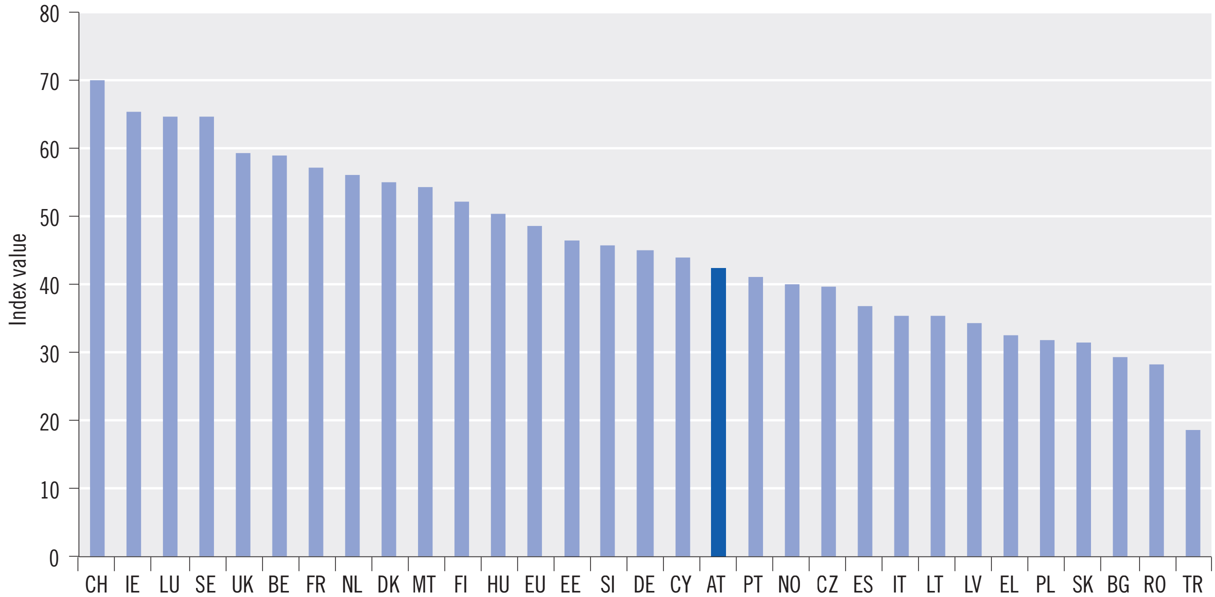
Fig. 20: Indicator excellence in science and technology, 2010



Source: European Commission (2013c), p. 5. Own reporting.

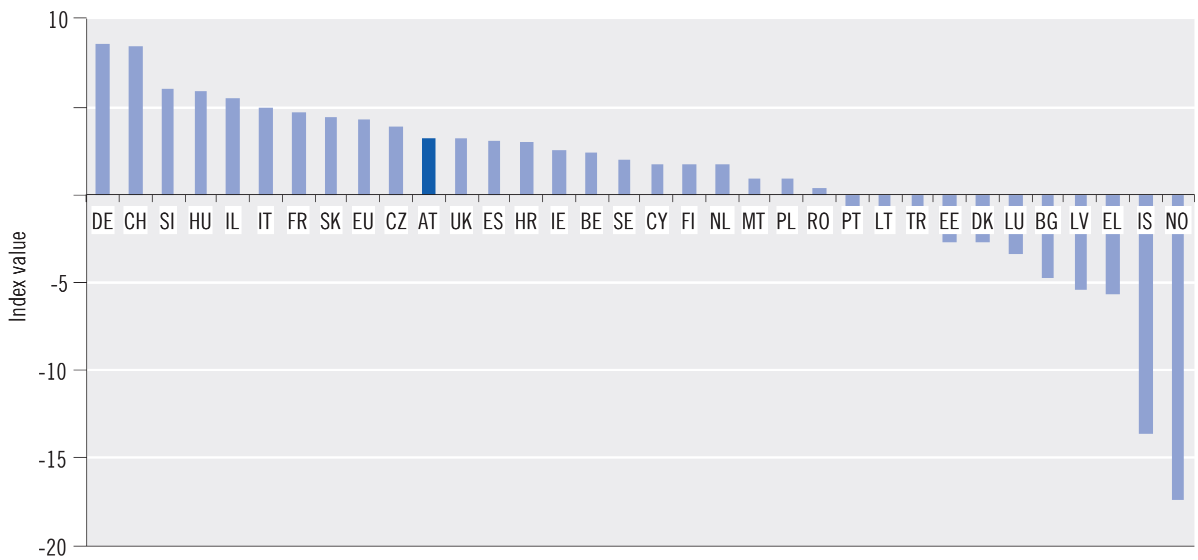
The last of the three indicators for measuring the performance and output of European countries is the *high-tech and medium-tech contribution to the trade balance* (Fig. 22). This indicator compares imports and exports of a series of medium- and high-technology products to a country's total imports and exports. A positive score is evidence of a structural surplus in the country for medium- and high-technology products. Austria's score shows such a surplus, but

Fig. 21: Indicator knowledge intensity of the economy, 2010



Source: European Commission (2013c), p. 5. Own reporting.

Fig. 22: Indicator High-tech and medium-tech contribution to the trade balance, 2011



Source: European Commission (2013c), p. 5. Own reporting.

it is again lower than the score for the innovation leaders and below the EU average, which is likely skewed by Germany.

Summary

The overall assessment of the Innovation Union Progress Report on Austria's performance in research and innovation is positive. But given Austria's goal of closing the gap to the innovation leaders, its score is inadequate. As Table 11 shows, Austria does not rank among the top five countries on any of the indicators. The gap to the leading group is the lowest for *R&D intensity* at 12% and the highest for *contribution of medium- and high-technology exports to the trade balance* at 70%. Overall, it is noteworthy that the gap for the input indicators is less than for the output indicators.

Austria does exhibit much higher growth rates for all indicators than both the leading group and EU average, so that if this trend continues, the gap may shrink in the future. In the period from 2000 to 2010, for example, Austria's score on the indicators *excellence in science and technology* and *knowledge intensity of the economy* grew faster than with any of the innovation leaders. Austria is also ahead of four of the five innovation leaders in growth rates for the indicator *contribution of medium- and high-technology exports to the trade balance* and *R&D intensity*.

In general, Austria's unsatisfactory position seems to derive in part from the selection of indicators used. One example is the indicator *knowledge-intensive services exports*, in which Austria lags far behind the innovation leaders. If services exports are adjusted for tourism, the percentage of knowledge-intensive services among all services exports in Austria is barely lower than that of the innovation leaders. Austria's score can thus be explained primarily by an inadequately constructed indicator. In reality, services – including knowledge-intensive services – are among the fastest-growing segments of Austria's exports.

Overall, the report shows that Austria is below the group of innovation leaders in all indicators and below the EU average in four of six indicators. But Austria shows much higher rates of growth than the leading group or the EU average in all indicators during the period under review, so that the gap may shrink in the future if these positive trends can be sustained. In general, Austria's poor showing seems to be primarily the result of the indicators selected.

Table 11: Austria's position in the Innovation Union Progress Report in comparison to the five top ranked countries

Ranking	1st place	2nd place	3rd place	4th place	5th place	Austria's value and difference between it and 5th place
R&D intensity	4.4	3.78	3.37	3.11	3.09	2.75
	IL	**FI**	**SE**	**IS**	**DK**	12%
Index of the economic impact of innovation	0.837	0.813	0.713	0.698	0.69	0.556
	CH	**DE**	**DK**	**FI**	**IE**	24%
Excellence in science and technology	97.59	78.86	77.65	77.2	77.13	50.46
	CH	**NL**	**DK**	**SE**	**IL**	53%
Knowledge intensity of the economy	70.05	65.43	64.75	64.6	59.24	42.4
	CH	**IE**	**LU**	**SE**	**UK**	40%
High-tech and medium-tech contribution to the trade balance	8.54	8.44	6.05	5.84	5.42	3.18
	DE	**CH**	**SI**	**HU**	**IL**	70%

Source: European Commission (2013c), p. 5. Own reporting.

1.4 Implementation and perspectives of the RTI strategy

The RTI strategy "Becoming an Innovation Leader," adopted by the federal government in 2011, has succeeded in presenting Austria with longer-term perspectives that have found widespread acceptance nationally and internationally and whose implementation continues to be steadily advanced. The strategy builds on a broad, systematic approach with the aim of moving into the group of innovation leaders.

Despite major reforms and investment efforts, Austria is faced with growing challenges in the competition for innovation. Above all, Austria's direct competitors have greatly increased their own efforts. Austria has maintained its position in the upper middle of EU countries here, but the gap to the leading group remains high. The Austrian federal government is therefore sticking to its RTI strategy in its working agenda for the 25th legislative period in order to make the jump into the group of European innovation leaders by 2020. The research strategy and its focuses continue to provide the long-term orientation to continue the impressive catching-up process of the past 20 years and lead Austria into the leading group of European innovators.

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 made it possible to reinforce the collaboration of the RTI ministries through various measures and initiatives, supported by the implementation of the impact assessment and impact-oriented budgetary planning.

Working groups have also been deployed in specific areas of activity in the RTI strategy, focusing on central problem fields in order to identify strengths and weaknesses in the structural shift and develop a concrete plan of action. In the following, a brief overview is given of the results so far and the current focus of the working groups (WG) of the RTI Task Force.

- **WG 1** "Human potential" focuses on the subject of education as an innovative strength. The focus is on continuing and expanding targeted actions in the field of young talent and next-generation researchers, since this determines the quality of research, generates new knowledge, and is necessary to grasp, adapt, and utilise new insights and technologies that originated elsewhere. The STEM fields (science, technology, engineering, mathematics) should be seen as a primary area of joint focus across all (education) systems. The current activities of the various ministries will be more tightly integrated in this effort. The plans also call for developing inductively based natural science instruction with the goal of improving the STEM skills of all secondary school graduates, systematically reducing dropout rates, and expanding and adapting research expertise for industry through increased qualifications for those already working in research and innovation.
- **WG 2** "Climate change and diminishing resources" is devoted to topics such as a "carbon-neutral future" with a parallel focus on urban development, sustainable resources, and social transformation with reference to the "Perspective 2050" initiative. The aim is to realise a "double dividend": first, the focus on "green technologies" should make it easier to achieve climate targets, and second, one can expect positive side effects for society and the common good. Modern information technology makes it possible to achieve efficiency gains while maintaining a high level of service. Examples include the Climate Change Center Austria (CCCA) and the establishment of corresponding targets in the service agreements.
- **WG 3** "Quality of life and demographic change" addresses the developments in the healthcare sector, the growing awareness of the need for personal responsibility in one's healthcare, and the consequences for the public sector. In this context, the WG develops and implements funding priorities such as

test regions for smart homes, mobility, and individualised medicine while taking into consideration the aspects of urbanisation, migration, integration, and labour and employment systems. Implementation of these research priorities is supported by existing structures and programmes through service agreements with the universities and the Austrian Academy of Sciences (ÖAW), programmes implemented by the Austrian Research Promotion Agency (FFG), and funding from the Austrian Science Fund (FWF). The common objective is to enhance the efficiency and visibility of Austria in this field on the international stage.

- **WG 4** "R&D infrastructure" coordinates infrastructure planning, integrates existing infrastructures, and expands partnerships for shared infrastructure use. The Federal Ministry of Science, Research and Economy's research infrastructure database offers an overview of publicly funded research infrastructure, which is also fed into the European databases (MERIL). Further investments are needed to avoid falling behind in the area of research infrastructure at the European level. The plan of action put forward by an interministerial working group proposes classifying existing and future expenditure for research infrastructures by "international investments, national (major) basic research infrastructures, and applied research institutions." The WG recommends implementing the plan of action, continuing and extending those tools that have proven effective in the past, and expanding partnerships and the shared use of infrastructures.
- **WG 5** "Knowledge transfer and start-ups" develops programmes to build momentum for research-, technology-, and innovation-oriented start-ups in Austria. The aim is to achieve a three percent increase in start-ups by 2020 based on an established and uniform international definition and data base. The WG recommends supporting this project by adopting the appropriate legislative framework to strengthen corporate equity, implementing programmes to support firms in their start-up phase, and reviewing tax models. Four knowledge transfer centres (three regional centres, one theme-specific centre) were created in 2014 to improve knowledge transfer between universities, research institutions, and firms and to optimise the exploitation of scientific findings, including funding for patents and prototypes at universities. The relevant ministries are currently considering the development of a national IPR strategy.
- **WG 6** "Corporate research" works to improve the partnership between the scientific and business communities. One area of focus is to make indirect research subsidies effective and efficient. The evaluation of the "new" research premium planned for 2014 is one step in that direction. Other measures include increasing an inter-ministerial dialog on future university funding for R&D in the business enterprise sector.
- **WG 7a** "Internationalisation and RTI foreign policy" and WG 7b "plan of action for Austria and the European Science Area 2020" work hand in hand with prestigious non-university research institutions to formulate strategies for improving Austria's position internationally. In July 2013, the two working groups submitted final reports with a complete list of targets and proposed actions, which were published on the task force's website[28].
- **WG 8** "International rankings" is tasked with analysing and discussing international RTI rankings and tracking and developing individual RTI indicators, innovation indicator sets,

28 Beyond Europe. Die Internationalisierung Österreichs in Forschung, Technologie und Innovation über Europa hinaus. AG 7a's recommendations for the federal government's RTI task force (July 2013) and Austria's EU action plan (to be passed by the federal government): Strengthen Austria's RTI stakeholders – actively make use of Europe – join group of innovation leaders Version produced by Working group 7b (Europe) (July 2013) Download at: http://www.bundeskanzleramt.at/site/6485/default.aspx.

and the underlying methods and modes of evaluation. One project was to work alongside experts in adopting a joint statement on the new EU innovation indicator.

The working groups maintain an ongoing dialog and are key components of the RTI Task Force. The working groups also maintain close ties to the Council for Research and Technology Development. The Federal Ministry of Economy, Family and Youth and the Federal Ministry of Science and Research were consolidated effective 1 March 2014, and are now the Federal Ministry of Science, Research and Economy (BMWFW). This satisfies the long-standing call (from the EU and OECD, among others) for Austria to consolidate all its RTI competencies under one roof. Following the model of the EU research framework programme "Horizon 2020", the Federal Ministry for Transport, Innovation and Technology (BMVIT) and the Federal Ministry of Science, Research and Economy (BMWFW) can now manage the entire innovation chain from basic research to market launch.

The following offers an overview of the latest developments in RTI-related activities and the implementation of new projects and programs.

Innovation-friendly public procurement

The federal government adopted the IPP roadmap in September 2012 with the aim of making public procurement more innovation-friendly and has since implemented it. The Public Procurement Act (BVergG) was amended in July 2013, for example, to include innovation as a secondary procurement criterion. In late 2013, the Federal Procurement Agency (FPA) set up an IPP service centre[29] that serves as a point of contact for IPP questions, initiates and supports IPP pilot projects, partners with so-called IPP competence centre (AustriaTech, Energieagentur, aws, Research Promotion Agency [FFG]), and offers education and training modules. The centre also organises innovation platforms with industry in which procurers can interact both with public agencies and with one another. The focus in 2013 was on LED lighting. This involved establishing one platform for innovative indoor lighting and another platform for innovative outdoor lighting as well as organising meetings – a new event format that attracted great interest.

Production for the future

Production is a pillar of stability in the Austrian economy. The Federal Ministry for Transport, Innovation and Technology (BMVIT) has partnered with research and industry experts to develop a strategy for the "Production of the Future" framework initiative in order to confront the growing challenges of globalisation, demographic shifts, an aging society and labour market, the increasing scarcity of resources, and the need for energy efficiency and strict environmental standards. There is increased momentum in Austria to examine production research themes and issues and fund strategic collaborations between the business and scientific communities. Initial funding levels of €50 million in 2011 rose to €95 million in 2012, a high-water mark maintained in 2013. The demand remains strong, especially in the business community, with a 24% jump between 2012 and 2013 in the number of parties applying for collaborative projects. This testifies to manufacturing's strong interest in funding for innovative products, processes, technologies, and business models to improve competitiveness.

Frontrunners Programme

The Frontrunners Programme was launched in 2013. "Frontrunners" refers to a relatively small group of firms that are ahead of the pack when it

29 Download: www.bbg.gv.at/ioeb.

comes to technology, product innovation, and market presence, but that face the problem of higher-than-average R&D investments and high-risk, highly competitive markets. Such firms, as dominant niche players, are critical for Austria's international positioning as a centre for innovation, especially for the country's strategic efforts to become an "innovation leader" in key areas of technology. The Federal Ministry for Transport, Innovation and Technology (BMVIT) is funding this effort with €20 million in research and investment subsidies.

BMVIT endowed professorships

The objective of these endowed professorships is the long-term expansion of research expertise and study programmes for research themes that are of particular importance to Austria as a centre for innovation. The focus of the tool funded by the Federal Ministry for Transport, Innovation and Technology (BMVIT) is on those RTI priorities in which Austria already has significant academic prowess but where gaps persist. These gaps can be closed by endowed professorships where manufacturing demand is strong and a broad-based scientific environment is already in place in the universities. The call for proposals began in 2014 with the endowment of two professorships for the subjects of production and material sciences, which the Federal Ministry for Transport, Innovation and Technology (BMVIT) will fund with up to €2 million each. Industry co-financing is mandatory. The endowed professorships are also intended to serve as a model and encourage private foundations to follow suit. The Austrian Marshall Plan Foundation already issued a simultaneous call for applications for an endowed professorship funded at up to €1 million.

Knowledge Transfer Centres and Exploitation of IPR (WTZ-IPR)

The new "Knowledge Transfer Centres and Exploitation of IPR" programme from the Federal Ministry of Science, Research and Economy (BMWFW) aims to strengthen the collaboration between the scientific and business communities and better align basic research, applied research, and business. The creation of three regional knowledge transfer centres (in the East, South, West) and a life sciences knowledge transfer centre offers universities and public research institutions attractive incentives to intensify the transfer of knowledge from the scientific to the business community and into society.

The idea is that increasing the cooperation and coordination and aligning the profiling and prioritisation in the virtual knowledge transfer centres will create the ideal conditions to efficiently and successfully exploit research findings and expand the relevant networks. The creation of regional centres in particular is a conscious move to benefit regional research and business centres and intensify collaboration.

One particular focus of funding in collaborative projects is in the humanities, social sciences, and cultural studies. The aim is to strengthen the systematic knowledge transfer in these fields among participating universities, non-university research institutions, and federal museums. The programme also funds patents and prototypes that result from the basic research according to the requirements set forth in the program's special guidelines. The request for proposals under the "Knowledge Transfer Centres and Exploitation of IPR" programme ended on 31 January 2014. The first projects of the regional knowledge transfer centres are expected to launch in May and June 2014 following evaluation by an international jury. Austria Wirtschaftsservice GmbH has been hired to set up the programme.

European Strategy Forum on Research Infrastructures (ESFRI)

ESFRI supports and funds the implementation of pan-European research infrastructures. ESFRI activities include evaluating existing ESFRI projects and prioritising the infrastructure projects on the ESFRI Roadmap. This roadmap is an evolving process for identifying key European research infrastructures. The list currently identifies 48 ESFRI projects, and the stated goal is to implement 60% of them by 2015/2016. Currently, eleven have been evaluated as successfully implemented. To help push implementation, the European Commission is setting aside €90 million for research infrastructures as part of an initial request for proposals in the HORIZON 2020 research programme. ESFRI is tasked with drawing up a list of ESFRI projects that should receive this one-time EU funding.

Austria is currently participating in a total of ten ESFRI infrastructures.[30] In addition to the Graz-based BBMRI, Austria is helping to finance the following ESFRI infrastructures: E-ELT (astronomy), ESRF, ILL Upgrade (material and structural sciences), PRACE (e-infrastructure), and five research infrastructures in the humanities and social sciences (see following section).

ESFRI Roadmap – research infrastructures for the humanities, social sciences, and cultural studies

Austria is participating in all five research infrastructures for the humanities, social sciences, and cultural studies: SHARE, ESS, and CESSDA for the social sciences, and CLARIN and DARIAH for the humanities (which have been consolidated in Austria under the auspices of the Centre for Digital Humanities).

SHARE is an international, interdisciplinary, long-term panel study dedicated to studying the quality of life, health, professional biographies, and pensions of the population over 50 and developing strategies to maintain and improve high standards in the social, healthcare, and pension system. ESS (European Social Survey) is a representative public survey in over 25 European countries that seeks to provide an ongoing pan-European data base on the attitudes, behaviours, and living conditions of the European population. CESSDA is the Consortium of European of Social Science Data Archives, which documents and archives the various national data archives from social science surveys and works to establish a virtual pan-European data archive. CLARIN is devoted to making digital language technologies and resources easily accessible over the long term. This includes digital collections of texts or spoken language, dictionaries, glossaries, encyclopaedias, and tools that generate and process such data. DARIAH works to develop digital research methods – both generic basic services and virtual research environments in the humanities such as history, archaeology, philosophy, theology, linguistics, literature, art, music, theatre, film, and media studies.

The Federal Ministry of Science, Research and Economy (BMWFW) and Federal Ministry of Labour, Social Affairs and Consumer Protection (BMASK) will together spend some €1.8 million on SHARE over the next three years and about €200,000 per year on ESS. The Federal Ministry of Science, Research and Economy (BMWFW) plans to spend a total of about €1.6 million on CLARIN and DARIAH over the next three years and about €600,000 per year on CESSDA.

Biobanking and Biomolecular Resources Research Infrastructure (BBMRI)

Austria is the headquarters of the European biobanking research infrastructure, whose goal is to integrate current and future biobanks in Europe and improve access to biological samples for research. Biological samples (blood, tissue, DNA, etc.) and the medical data they provide are an essential basis for medical and pharmaceutical research to develop new preventive, diagnostic, and therapeutic approaches. A 2013 resolution by the European Commission established the headquarters of the BBMRI European Research Infrastructure Consortium (ERIC) in Graz under EU Regulation No. 723/2009. BBM-

30 For detailed information on Austria's participation in the ESFRI, see appendix I.

RI-ERIC commenced operations in 2014. It currently has 12 member states[31] and five observers.[32] The coordinating centre of the national biobank consortium, which also opened its doors in early 2014, is also based in Graz close to the BBMRI-ERIC offices. This should provide new opportunities for collaborations and a strong international positioning for Austria's domestic research environment.

Centre for Digital Humanities at the Austrian Academy of Sciences

Digital methods and technologies have transformed and enriched research in the humanities, social sciences, and cultural studies. The Centre for Digital Humanities responds to this development. The centre brings together various institutions – including the Austrian Academy of Sciences, the University of Vienna, and the University of Graz – and provides a forum for close collaboration between the research infrastructures of CLARIN and DARIAH in Austria. The Centre for Digital Humanities comprises three components with the following objectives: (i) Continue existing projects to build and expand humanities research infrastructures in Austria and embed them in the corresponding European projects or the long-term initiatives of CLARIN and DARIAH, and establish a research and service platform for collaboration of the Austrian consortiums of DARIAH-AT and CLARIN-AT. (ii) An initiative for scientific digitisation in the context of the digital humanities in Austria, including sub-projects in which the scientific digitisation of all types of materials represents an integral component of research activities, and in which the long-term availability of the digitised results and associated research data (metadata, annotations, user notes, etc.) is guaranteed in a dynamic and innovative format. (iii) An initiative to train young researchers in the field of the digital humanities, bundling and expanding existing teaching and training programmes in Austria into one systematic curriculum, then embedding this into international contexts. The Federal Ministry of Science, Research and Economy (BMWFW) will spend € 1.6 million on this in the next three years.

"Research Location Austria" international communications campaign

The year 2013 saw the completion of the third phase of the "Research Location Austria" international communications campaign, whose aim was to strengthen Austria's image as an attractive base for international RTI operations. The subsequent evaluation of the campaign was very positive, so it will be continued in 2014. Since 2008, a total of 57 R&D-related businesses were established with an investment volume of € 109 million.

1.5 Horizon 2020 and the challenges for Austria's RTI policy

Stabilising the economic and financial system while simultaneously creating programmes to ensure future economic prospects – these are the big challenges facing the European Union. Maintaining high standards of living and confronting social challenges requires intelligent investments, especially in research and innovation.[33] Horizon 2020 is considered the primary European tool to realise the European Research Area (ERA). It is designed to make an EU-wide knowledge- and innovation-based economy a reality and support the implementation of the Europe 2020 strategy.[34]

A broad public consultation in 2011 – in which

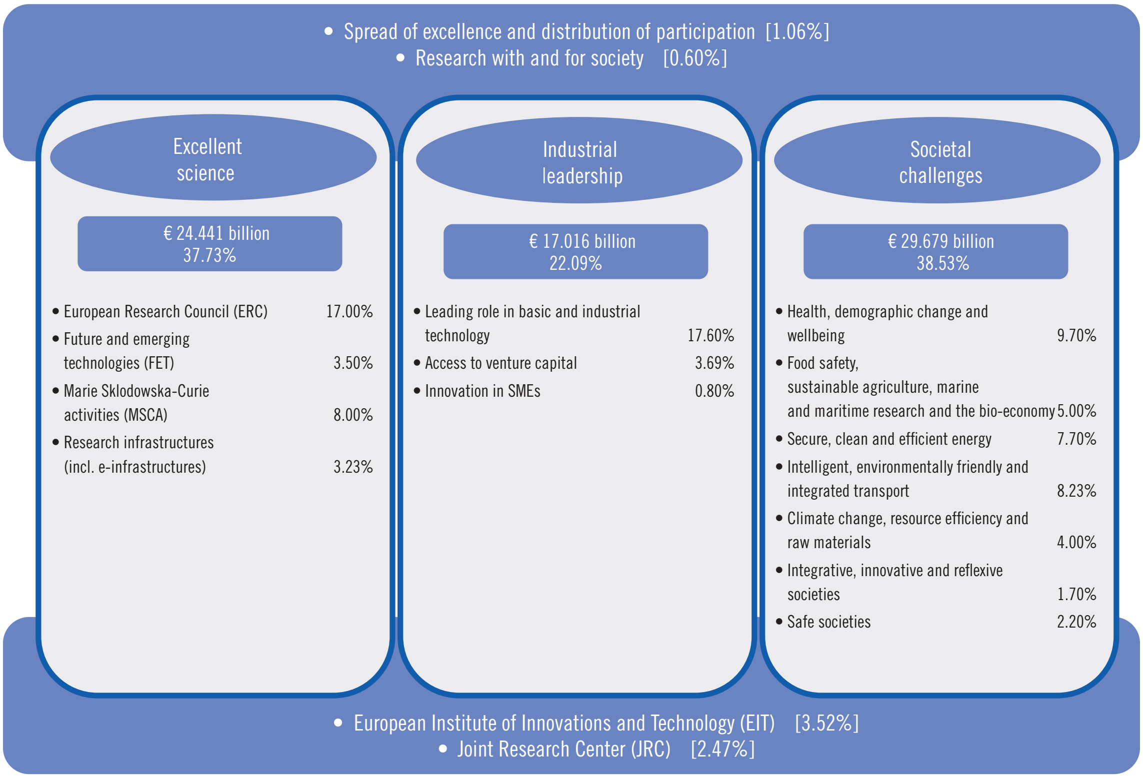
31 These are: Austria, Belgium, Czech Republic, Germany, Estonia, Finland, France, Greece, Italy, Malta, the Netherlands and Sweden.
32 These are the following: Switzerland, Norway, Poland, Turkey and the International Agency for Research on Cancer (IARC), a World Health Organisation (WHO) programme.
33 European Commission, COM(2011) 808 final.
34 European Commission, COM(2011) 809 final.

statements by the European Council, the member states, and stakeholders from manufacturing, higher education, and civil society were considered – was the launchpad for developing a common strategy for EU funding of research and innovation.[35] Austria contributed to this process through the "Austrian Reflection Paper on the Successor to the 7th Framework Programme".[36] With Horizon 2020 all **existing** EU funding programmes for research and innovation (7th Research Framework Programme), all innovation-related activities of the Competitiveness and Innovation Programme (CIP), and the European Institute of Innovation & Technology (EIT) were bundled together for the first time.[37]

Horizon 2020 began on 1 January 2014, and runs until 31 December 2020.[38] The budget for this period comes to some €70.2 billion (EU and EURATOM) in constant prices at 2011 levels. Taking into account annual inflation rates until 2020, this comes to nearly €80 billion.[39] The structure of Horizon 2020 (Fig. 23) rests on three pillars: i) excellent science, ii) industrial leadership and iii) societal challenges.

Re i): The pillar of *"excellent science"* is designed to make Europe an attractive destination

Fig. 23: Horizon 2020 structure, objectives and budget



Source: European Commission: Horizon 2020 official standard presentation / European Commission: Factsheet: Horizon 2020 budget / Austrian Research Promotion Agency (FFG) / European Commission, COM(2011) 809 final version.

35 European Commission, COM(2011) 809 final / European Commission: History of Horizon 2020.
36 The Federal Ministry of Science and Research (BMWF), European Knowledge Framework, Österreichisches Reflexionspapier für die Nachfolge zum 7. Rahmenprogramm, 2010.
37 European Commission, COM(2011) 808 final.
38 European Union, 2013a.
39 Ibid.

for outstanding researchers from around the world by funding elite research, thereby protecting Europe's scientific capacities.[40] The aim is to support, train, and retain talented researchers and give them access to premium research infrastructures.[41] International cooperation is an important concern in all areas of Horizon 2020, with common interests and mutual benefit are at the front and centre.[42]

Re ii): The pillar of *"industrial leadership"* is designed to accelerate technological developments and innovations in Europe. Besides key enabling technologies, this means above all helping innovate SME to expand into leading global enterprises.[43]

- The participation of SME is a key concern throughout the programme. A new integrated approach for SME is intended to increase their participation. Besides horizontal measures (simplifications, attractive amounts of funding), SME-specific programmes have also been introduced. The "Innovation in SME" campaign targets research-intensive SME. A new SME tool has also been introduced, and access to venture capital also has a strong SME focus.
- Economic participation has been increased through measures such as the designation of funding as venture capital and the introduction of provisions for further support through public-private partnerships.[44]
- Support for strategic investments in key enabling technologies (in Horizon 2020, these include ICT, nanotechnologies, advanced materials, biotechnology, advanced manufacturing and processing, space) is also seen as a basis for investments in current and emerging sectors.[45]
- Horizon 2020 strongly emphasises close ties between research and innovation. For the first time, a single system of rules applies to the entire innovation chain, with support for all phases of the innovation process, from idea to market-ready product.[46]
- Horizon 2020 is also based on a broad understanding of innovation that defines innovation not only as the introduction of new products and processes but also includes systematic, social, and service innovations.[47]

Re iii): Horizon 2020 seeks to generate a critical mass of research and innovation efforts to tackle societal challenges[48]. Research and innovation for the concerns of citizens of our society is the context for this pillar of the programme. This specifically includes supporting the development of ground-breaking solutions through an interdisciplinary partnership that includes the humanities and social sciences.[49]

The themes of "dissemination of excellence and broadening of participation" and "research with and for society" intersect this pillar. Another intersecting theme built into the programme structure is that the Joint Research Centre (JRC, non-nuclear section) should provide scientific and technological support through direct mea-

40 European Commission, COM(2011) 808 final; European Union, 2013a.
41 European Commission: Horizon 2020 official standard presentation / Austrian Research Promotion Agency (FFG): Horizon 2020. The EU's Framework Programme for research and innovation (2014-2020)
42 European Commission: Factsheet: International Participation in Horizon 2020.
43 European Commission, COM(2011) 809 final; European Union, 2013a.
44 European Commission: Factsheet on Industrial participation.
45 European Commission: Horizon 2020 official standard presentation / Austrian Research Promotion Agency (FFG): Horizon 2020. The EU's Framework Programme for research and innovation (2014-2020)
46 European Commission: Factsheet: Rules under Horizon 2020.
47 European Commission, COM(2011) 808 final, p. 10.
48 The societal challenges named in Horizon 2020 were: i) health, demographic change and general wellbeing; ii) Food safety, marine and maritime research and the bio-economy; iii) Secure, clean and efficient energy; iv) Intelligent, environmentally friendly and integrated transport; v) Climate protection, efficient use of resources and raw materials; and vi) Integrated, innovative and secure societies.
49 European Commission: Horizon 2020 official standard presentation / Austrian Research Promotion Agency (FFG): Horizon 2020. The EU's Framework Programme for research and innovation (2014-2020)

sures to help realise these goals. The European Institute of Innovation & Technology (EIT) is designed to integrate the so-called knowledge triangle of research, innovation, and education.[50] Key intersecting objectives of Horizon 2020 include equalising opportunities for women and sustainability – at least 60% of the total Horizon 2020 budget relates to sustainable development.[51]

One key innovation in Horizon 2020 is the streamlined structure of a single system of rules. This is intended to make it easier to set up, regulate, run, and monitor programs, significantly cutting red tape in both the application and project execution phases.[52] Horizon 2020 streamlined funding methods to apply one funding rate[53] to all the activities within a single project.[54] The funding rate is capped at 100% of refundable project costs for research projects and 70% for innovation projects (100% for non-profits). A uniform flat rate of 25% is applied to directly refundable indirect costs.[55] The European Parliament and Council approve the annual budget for Horizon 2020 within the limits of the multiannual financial framework.[56]

The European Commission is primarily responsible for running Horizon 2020, with separate agencies largely responsible for managing the individual projects. It receives support from the programme committees, where delegates from member states provide oversight of the division between EU and national RTI activities and adopt the biennial working agendas. The European Commission will also rely on support from independent experts to evaluate applications and monitor projects. These independent experts (stakeholders from research, industry, and civil society institutions) will form consultant groups, supporting the Commission in creating working agendas. The implementation of Horizon 2020 should also make greater use of synergies and overlaps between national and European research and innovation programs.[57]

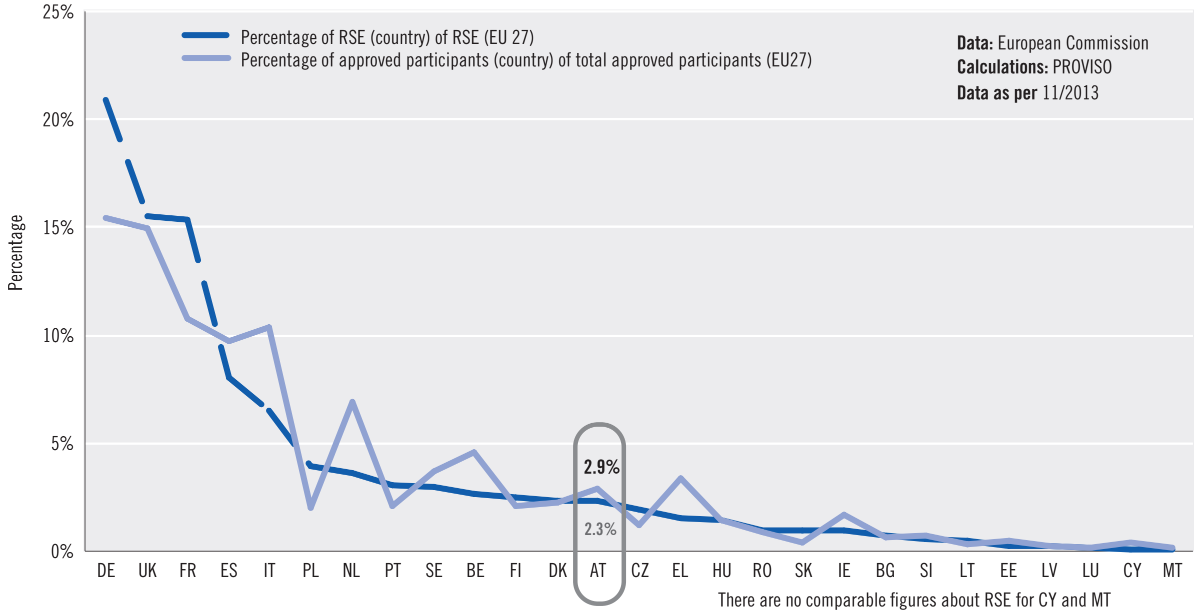
Current participation and future challenges for Austria's RTI policy

Austria's participation in the 7th Framework Programme can be regarded as a success based on the latest data from November 2013[58]: Austrian participations were able to gain a total of about 2.65% of the earmarked funding – currently some €949.1 million – over the duration of the 7th Framework Programme (2007–2013). This puts the rate of funding brought in above Austria's average share of the EU budget for the years 2007–2011,[59] yielding a rate of return of about 125%. Austria ranks 6th among the EU-27 countries for this indicator – behind Estonia, Sweden, the Netherlands, the UK, and Cyprus – and is one of the net recipients in the 7th Framework Programme.

Austria accounts for 2.3% of all scientists and engineers working in the EU, while Austrian participations account for a total of 2.9% of approved participations in the 7th Framework Programme (see Fig. 24). This means Austria is represented in the 7th Framework Programme well above its relative share of research capaci-

50 European Commission, COM(2011) 809 final; European Union, 2013a.
51 European Commission, COM(2011) 808 final, p. 6.
52 European Commission, COM(2011) 808 final / European Commission: Horizon 2020 official standard presentation / European Commission: Factsheet: Rules under Horizon 2020.
53 The funding rate is capped at 100% of refundable project costs for research projects and 70% for innovation projects (100% for non-profits). A uniform flat rate of 25% is applied to directly refundable indirect costs (European Union, 2013b).
54 European Union, 2013b.
55 Ibid.
56 Ibid.
57 European Commission: Horizon 2020 – The EU Framework Programme for Research and Innovation. Experts; European Union, 2013a.
58 See Ehardt-Schmiederer et al. (2013); The proviso provides Austrian ministries and their EU delegates with an information and support infrastructure as well as specialised, programme-specific and cross-programme analyses of Austria's participation in EU research programmes to assist them in realising their research policy agendas at the national, EU and international levels.
59 The proviso used the European Commission's 2011 financial report on the EU budget in the calculation of mean equity capital – insofar as this data related to the time period between 2007 and 2011.

Fig. 24: RP distribution of approved participations (EU-27) vs. Proportion RSE[1] by country (EU-27)



[1] RSE: researchers, scientists, engineers (full time equivalents); in acc. with OECD: Frascati Manual. Paris 2002; Sources: Eurostat, Data 2011 (exception LU: Data: 2010)

Source: Ehardt-Schmiederer et al. (2013).

ties and occupies 8th place among the EU-27 on this indicator.[60]

Another key success indicator is the participation in ERC grants – especially starting and advanced grants – where Austria also scores relatively high: Between 2007 and 2013, a total of 101 grants to Austrian institutions were approved. This puts Austria in 11th place among the EU-27. The approval rate across all countries is 11%, making Austria's approval rate of 14% above average and putting Austria in 4th place behind Switzerland, Israel, and France. The success with ERC grants can also be seen in the number of approved ERC grants by country per thousand researchers: Austria received some 2.7 ERC grants per thousand researchers, a score exceeded only by the Netherlands, the UK, Belgium, and Sweden.[61]

Given this success, Austria has also set ambitious goals for Horizon 2020: they include greatly expanding returns of funds and conducting more ERC-funded excellent research projects at Austrian institutions. Austrian firms should derive a clear benefit in the area of technological development through their participation in Horizon 2020, thereby improving their growth opportunities. Austrian participation should also help tackle societal challenges.

Regular performance monitoring will track the impact in terms of the aforementioned goals and continuously review the success of Austria's participation in Horizon 2020 based on the following indicators and outcomes:[62]

- The aim of supporting excellent basic research in Austria is to be achieved by greatly expanding the ERC grants to Austrian universities.
- An indicator that tracks the number of pat-

60 See Ehardt-Schmiederer et al. (2013).
61 See Ehardt-Schmiederer et al. (2013).
62 See Naczinsky (2014).

ents relative to the funding received is designed to measure whether Austrian firms experienced positive development through their participation in Horizon 2020: Austrian firms are presumed to have noticeably benefited from Horizon 2020 if there are three or more patents in the areas of ICT, nano, materials, biotech, manufacturing, and space per € 10 million in grants.

- Austria's participation should help tackle societal challenges. This should be reflected in the creation of at least one regulation per € 10 million in funding from the participation.
- The key indicator by which the success of Austria's participation is measured remains the returns in funding from Horizon 2020. According to the Minister for Science, Research and Economy, Austria's participations should gain at least € 1.5 billion in returns by 2020.[63] This requires increasing the return rate from the 7th Framework Programme by at least 50%. To achieve this objective is a central challenge for science and technology policymakers in Austria in the years ahead.

However, the rate of return alone is not an adequate indicator of the success and impact of Austria's participation in Horizon 2020. This indicator does not reflect economic and social gains, increases in knowledge and expertise, and networking effects that Austrian research institutions and firms can gain from participating in EU projects. Looking at the rate of return alone is therefore too narrow and must be coupled with a broad view of the impacts from Austria's participation in Horizon 2020.

The Austrian federal government is already taking actions to increase Austria's participation in Horizon 2020 and generate higher returns. The working agenda 2013–2018 of the Austrian federal government defines a different spectrum of consulting and support services for Austrian research institutions and firms for participation in Horizon 2020. A new resolution has also been adopted by several ministries (under the auspices of the Federal Ministry of Science, Research and Economy (BMWFW) and the Austrian Chamber of Commerce with the Austrian Research Promotion Agency (FFG) relating to the European and International Programmes (EIP) that shifts the focus of services toward strategic, institutional consulting. The Austrian Research Promotion Agency's FFG-Academy will continue to offer information services, individual consultation, proposal checks, and training, but more emphasis will be given to encouraging Austrian research institutions, especially larger institutions such as universities, to expand their skills to derive the most strategic benefit from the European programme portfolio. The Austrian Research Promotion Agency (FFG) should serve as an "information broker" that digests strategic and operational expertise from European bodies combined with domestic experience and offers it to R&D institutions, their researchers, and multipliers and supports decision-makers from the government, academic, and business sectors in European management processes.

Strengthening the availability of strategic knowledge is intended to create incentives for institutional learning processes. This shift in focus is supported by the reorganisation of the former PROVISO monitoring in the Austrian Research Promotion Agency (FFG). A monitoring department designed specifically for this purpose will ensure that international data is prepared, analysed, interpreted, and linked to national data archives.

These changes in the Austrian Research Promotion Agency's services also support develop-

63 Press release from the Federal Minister of Science, Research and Economy on Horizon 2020 dated 21 January 2014, http://www.ots.at/presseaussendung/OTS_20140121_OTS0114/mitterlehner-horizon-2020-staerkt-forschungsstandort-und-sichert-wettbewerbsfaehigkeit-bild#).

ments toward greater European and international orientation at universities. The 2013–2015 service agreements set targets for internationalisation strategies that included increasing competitively won funds from European and international research funding sources and establishing the appropriate conditions within the universities to achieve this goal. This includes professionalising the research service centres to better support researchers in their applications for international/European funds. Here, the changes in orientation in the Austrian Research Promotion Agency's consulting and support services toward European and international programmes align with the internationalisation strategies defined in the service agreements; the aim is to allow the universities to define and implement their strategies more accurately.

Structural reforms through the ERA Partnership

The focus on the new EU research framework programme Horizon 2020 and the challenges and opportunities this brings for Austria's system of innovation should not obscure the potential inherent in structural reforms of the entire European Research Area in the context of the ERA Partnership. The establishment of a joint European Research Area (ERA) is designed to increase the performance, quality, and efficiency of European research and the competitiveness of member states. Changes are sought in the following priority areas:

- More effective national research systems
- Optimal cross-border collaboration and corresponding competition
- Open labour market for researchers
- Gender equality and consideration of equal opportunity in research
- Optimal exchange and transfer of and access to scientific insights, including through the digital ERA

European research ministers have agreed to draw up a Europe-wide ERA roadmap by mid-2015 to support and advance the efforts of the individual member states. The roadmap should define a common understanding of strategic goals and a toolbox of best practices that can support member states in developing and implementing their domestic policies. The Austrian position can be formulated using the Austrian EU action plan, developed by the working group for implementation of the federal government's RTI strategy for "Austria and the European Research and Innovation Area 2020."

ERA Observatory Austria

ERA Observatory Austria was established to better integrate Austrian policy into the European research, technology, and innovation policies. It consists of two bodies – the ERA Policy Forum Austria and the ERA Council Forum Austria – which closely interact with each other on a regular basis. The goal of ERA Observatory is to support evidence-based decision-making and strengthen Austria's role in European policymaking.[64]

ERA Policy Forum Austria

ERA Policy Forum Austria is an interministerial steering committee made up of representatives of various federal ministries that commissions studies and analyses on current developments and needs for action in European research policy.[65] When necessary, the Policy Forum is expanded to include key stakeholders from Austria's RTI institutions (agencies, universities, non-university institutions, social partners, regional governments, etc.). The aim is to create a flexible tool to better diffuse European RTI policies into sectoral Austrian policies.

64 See ERA Portal Austria (http://era.gv.at/directory/166).
65 See ERA Portal Austria (http://era.gv.at/directory/167).

ERA Council Forum Austria

The Minister for Science, Research and the Economy established the ERA Council Forum Austria as a further initiative to strengthen the ties between Austria's system of innovation and the European research institutions, ensure the highest possible returns from the European level, and proactively identify and monitor the relevance of European developments for Austria. The forum is a high-level advisory body providing strategic recommendations in the context of Europe 2020, the Innovation Union, ERA Partnership, and Horizon 2020. The ERA Council Forum Austria devotes special attention to analysing the strengths of Austria's science and research system in the European context and best practices in the areas of transparency in the interaction between the scientific and business communities, careers in science, and opportunities for the future development of research in Austria. Helga Nowotny, former President of the European Research Council (ERC), is the new chair of the ERA Council Forum Austria. She is supported by Dr Jürgen Mlynek (President of Helmholtz-Gemeinschaft Deutscher Forschungszentren), Dr Reinhilde Veugelers (Professor for International Business Economics & Strategy, University of Leuven, Belgium), Dr Jana Kolar (Morana RTD, Director of Research, Slovenia), and Dr Hermann Hauser (venture capital lender for start-ups, co-founder of Amadeus Capital Partners).

The working agenda 2013–2018 of the Austrian federal government also defines the following areas of activity to strengthen Austria's international visibility as a centre for science, research, and innovation, which are also relevant in the context of Horizon 2020 and ERA:

- Ensure international branding as a centre for research and innovation
- Increase the mobility of researchers and establish a long-term network of researchers with ties to Austria
- Market top Austrian technologies globally and improve international scientific networking by establishing science and technology conventions with strategically relevant countries
- Scientific field offices (OSTA) and RTI attachés in priority countries[66]

Overall, several institutional changes have been and will be undertaken to achieve the ambitious goals of better connecting Austria's RTI system within the EU.

66 See Republic of Austria (2013), p. 30

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) is the country's central institution for the promotion of basic research. The Science Fund's mission is to intensify the development of the sciences at a high international level, thereby contributing to cultural development, to build a knowledge-based society and to increase Austria's value added and prosperity. The Austrian Science Fund's priorities can be summarised as follows:

- Strengthening Austria's scientific performance in international comparison and its attractiveness as a place to do research, 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 reciprocal relationship between science and all other areas of cultural, economic and social life; particular emphasis should be placed on increasing public acceptance of science through educational initiatives.

The Austrian Science Fund uses the international scientific community for its quality standards. The principle of peer review is applied consistently throughout the selection of research projects to be awarded funding, and this contributes to assuring and further improving the quality of the review processes.

Application volume reached its highest value yet in 2013 at €777.5 million, and approval volume exceeded the €200 million mark for the first time, coming in at €202.6 million. The number of new applications handled by the Austrian Science Fund board of trustees posted a slight increase to 2,386, while project approvals fell slightly to 632 (2012: 684). The growth in total grants (+3.2% compared to 2012) contrasts with a decrease in project approvals (-8%), which suggests the climbing time and cost intensity of research projects (see Table 12).

The gap between demand and grant opportunities has also grown; measured in terms of the number of approved new applications, the ratio decreased from 30.2% (2012) to 25.8% (2013). This means that in 2013, of only one out of four projects received funding. The ratio of new grant totals to requested funds fell from 24.2% to 23.6%.

Measured in distributed funds, stand-alone projects hold the lion's share of the Austrian Science Fund's funding activity (see Table 13). About half of all funding from the Austrian Science Fund, or a total of €355.7 million, went to this sector in 2013. Stand-alone projects are followed by START (€108.3 million) and the international programmes (€95.9 million).

Funding priorities are aligned with objectives and focused on financing scientific staff; the Austrian Science Fund makes a crucial contribution to the development of scientific human potential. By the end of 2013 the Austrian Science Fund had financed about 4,000 people working in the sciences, and about 43% of them were women (see Table 14). The share of women among applicants (about 31%) and among new approvals (about 28%) remained nearly the same as the previous year. The generally decreasing

Table 12: Number of funding grants in 2013

Funding programme	Applications decided[1]		New approvals		Approval rate in %		
	Number	% women	Number	% women	Rate	Women	Men
Stand-alone projects	1,177	25.1	347	22.2	29.5	26.1	30.6
International programmes	390	20.3	68	17.6	17.4	15.2	18.0
SRAs (special research areas)	47	25.5	22	22.7	15.4	0.0	20.0
START	101	26.7	14	28.6	13.9	14.8	13.5
Wittgenstein	21	23.8	1	100.0	4.8	20.0	0.0
Doctoral programmes (DPs)	7	14.3	5	0.0	27.8	0.0	31.3
Doctoral programme extensions	12	33.3	10	30.0	83.3	75.0	87.5
Schrödinger	126	35.7	57	36.8	45.2	46.7	44.4
Meitner	149	39.6	37	29.7	24.8	18.6	28.9
Firnberg	61	100.0	17	100.0	27.9	27.9	-
Richter	62	100.0	17	100.0	27.4	27.4	-
Clinical research (KLIF)	118	37.3	15	33.3	12.7	11.4	13.5
Programme for the Development and Inclusion of the Arts (PEEK)	73	42.5	8	37.5	11.0	9.7	11.9
OAJ	19	-	8	0.0	22.2	-	-
Communication in the sciences	23	39.1	6	16.7	26.1	11.1	35.7
Total	2,386	30.8	632	28.0	25.8	24.0	26.8
Concept applications for SRAs (special research areas)	13	16.7	4	25.0			
Concept applications for DPs	18	18.8	6	16.7			
Expressions of interest OAJ	36	-	19	-			

1 Decided applications are (new) applications handled by the Austrian Science Fund board of trustees.

Source: Austrian Science Fund.

Table 13: Funding totals by programme in 2013

Funding programme	Applications decided		New approvals		Approval rate in %		
	in € millions	% women	in € millions	% women	Rate	Women	Men
Stand-alone projects	355.7	25.0	102.7	22.8	28.9	26.3	29.7
International programmes	95.9	19.9	15.2	17.1	15.8	13.6	16.4
SRAs (special research areas)	19.5	24.6	9.3	22.6	17.8	0.0	23.0
START	108.3	26.7	8.1	32.1	7.5	8.8	7.0
Wittgenstein	31.5	23.8	1.5	100.0	4.8	20.0	0.0
Doctoral programmes (DPs)	16.3	9.2	11.4	0.0	30.	0.0	34.7
Doctoral programme extensions	35.6	40.4	23.1	41.1	64.8	65.8	64.2
Schrödinger	12.9	36.4	6.1	34.4	47.2	44.5	48.8
Meitner	18.4	40.2	4.5	31.1	24.2	18.9	27.8
Firnberg	13.2	100.0	3.7	100.0	27.8	27.8	-
Richter	18.0	100.0	4.9	100.0	27.4	27.4	-
Clinical research (KLIF)	27.4	35.8	2.7	29.6	9.9	8.3	10.8
Programme for the Development and Inclusion of the Arts (PEEK)	22.7	41.4	2.5	40.0	11.1	10.1	11.9
OAJ	1.2	-	0.4	-	21.0	-	-
Communication in the sciences	1.0	40.0	0.3	33.3	25.5	12.8	33.9
Total	777.5	29.3	196.4	28.3	23.6	23.3	23.7
Concept applications for SRAs (special research areas)	52.6	23.0	24.6	20.3			
Concept applications for DPs	37.2	11.8	12.1	12.4			
Expressions of interest OAJ	2.1	-	1.2	-			

Source: Austrian Science Fund.

approval rate did however affect the drop in project grants for female scientists (2013: 24%; 2012: 30.2%). This means, from the Austrian Science Fund's perspective, the proportion of Science Fund project applications submitted by women remains too low, particularly in light of how many women are completing university educations.

The distribution of overall grants has been rather stable in terms of scientific disciplines: distinctions are drawn between the life sciences, natural sciences and engineering, as well as the humanities and social sciences. Of the total grants awarded, € 80.2 million went to the life sciences, € 82.8 million into the natural sciences and engineering, and € 39.7 million into the humanities and social sciences (see Fig. 25).

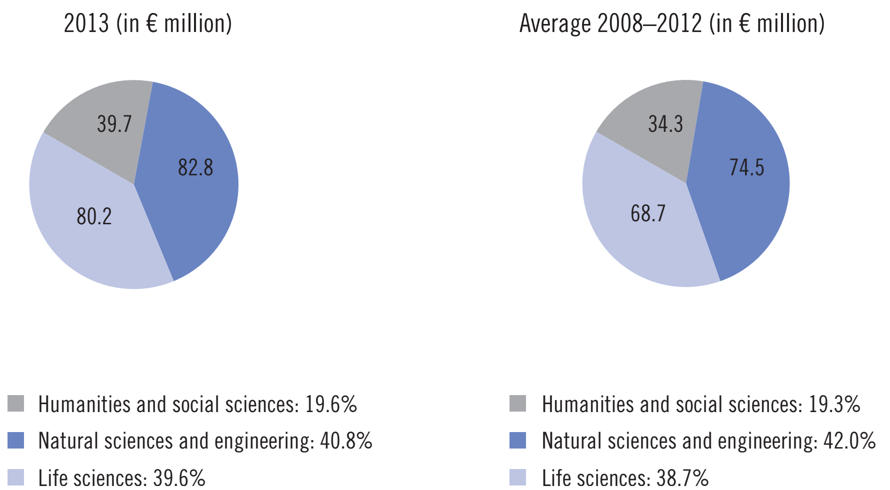
The option of compensation for overhead costs that was reintroduced in 2011 for stand-alone projects and the Programme for the Development and Inclusion of the Arts (PEEK) was recently topped up: whereas about € 1 million was paid to Austrian research institutions for overhead costs in 2011, by 2012 the number had already risen to € 5.6 million and by 2013 it was € 11.2 million. In this regard, the "matching funds" initiative, a successful submission in 2013 by the Austrian Science Fund to the Aus-

Table 14: Research personnel funded by the Austrian Science Fund (FWF), 2010–2013

		2010	2011	2012	2013
Postdocs	All	1,197	1,229	1,288	1,351
	% women	46.3	46.8	40.1	38.4
Doctoral candidates	All	1,683	1,771	1935	1967
	% women	42.2	42.1	42.3	42.7
Technical staff	All	122	137	173	170
	% women	67.2	71.5	68.2	72.4
Other staff	All	403	405	456	476
	% women	47.9	52.6	47.1	48.7
Total	All	3,405	3,542	3,852	3,964
	% women	45.2	46.0	43.3	43.2

Source: Austrian Science Fund.

Fig. 25: Approvals by scientific discipline (total overview of all Austrian Science Fund programmes)



Source: Austrian Science Fund.

trian National Foundation for Research, Technology and Development, also supports the financing of indirect project costs. The initiative aims to offer regional governments that are interested and active in research specific co-financing models that combine Austrian Science Fund standards for research quality with site-specific considerations about research. This model enables the Austrian Science Fund to match every euro invested by the regional government with National Foundation resources, thereby creating significant leverage. This co-financing initiative is funded with €3 million in Foundation resources for 2014. Within the Austrian Science Fund for programmes that support young women researchers (Herta Firnberg and Elise Richter), as well as funding for international cooperation, 20% of the overhead costs can be payed to research facilities in the federal states.

2.2 The Austrian Research Promotion Agency (FFG)

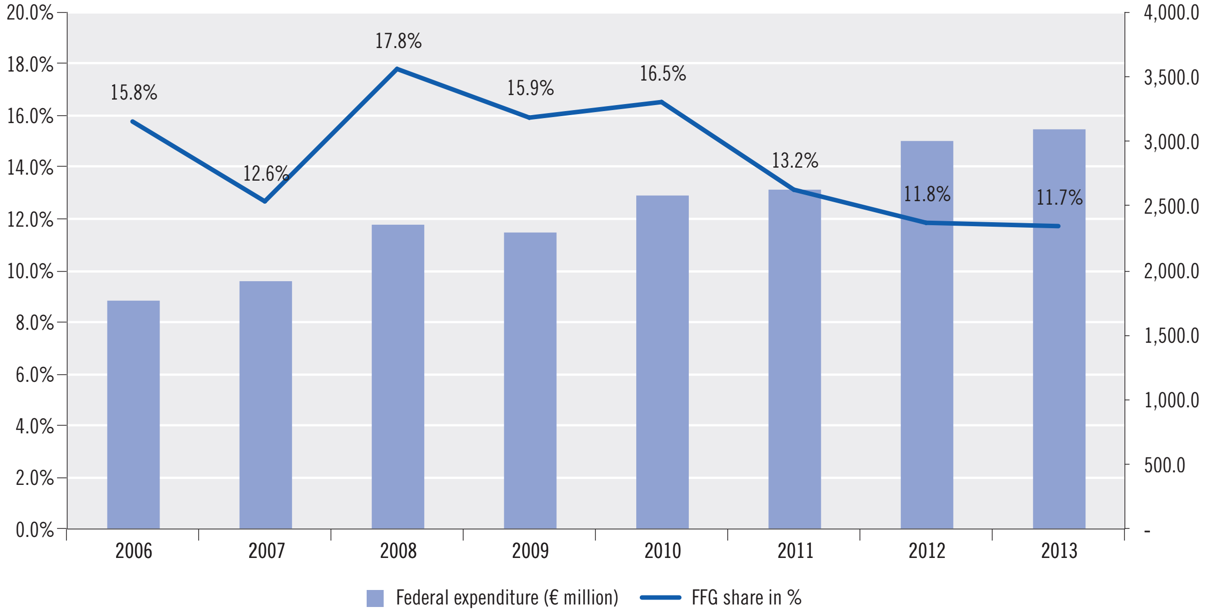
The Austrian Research Promotion Agency (Forschungsfördungsgesellschaft – FFG) offers a portfolio of sophisticated and targeted instruments for funding research, technology and development at firms and research institutions along the entire innovation chain. Using standardised sets of measures, consistent monitoring of themes, and cross-programme topic teams, the ongoing exchange of experiences among programmes has been intensified in recent years, including an agreement to coordinate measures along thematic lines.

New to the portfolio of the Research Promotion Agency (FFG) is the KLIPHA programme. It aims to support small and medium enterprises (SMEs) with their phase I or phase II clinical studies. Submissions can be made on an ongoing basis as single projects within the basic programme. This method of funding is a pure loan instrument with an upper limit of €1.5 million per study. If the study delivers negative results, it is possible under certain circumstances to convert the loan into a grant. Furthermore, dissertations are now funded in an ongoing funding programme instead of intermittently by means of theme-related calls for proposals. An ongoing call for proposals for "industry-oriented dissertations" opened in 2014 and is endowed with National Foundation funds. Projects can be submitted by firms or non-university research institutions that enable the completion of a dissertation in the context of an R&D project. Approximately €3 million are available for the programme.

Total funding volume (including liabilities and loans, excluding commissions) in 2013 was just over €486.1 million, which corresponds to a cash value of €361.7 million (+1.2% over 2012). This positive development in Austrian Research Promotion Agency (FFG) funding totals is consistent with the increased federal research investment in past years. However, it is found that the share of Austrian Research Promotion Agency (FFG) funding (cash value) in total federal R&D investments has decreased almost continuously since 2008, which marked the beginning of the financial crisis (Fig. 26). This share was 11.7% in 2013. One driver for this development may be the massive expansion of indirect research funding (research premiums) in recent years in Austria, which caused federal expenditures to rise overall. The funding budget of the Austrian Research Promotion Agency (FFG) remained stable while its share of federal expenditures decreased. The Austrian Research Promotion Agency (FFG) has been entrusted since early 2013 with the assessment of R&D expenditures related to the research premium. About 1,500 applications have been received and 1,300 expert assessments have been carried out since then.

Table 15 provides an overview of the number of projects, participations and stakeholders, and contractually secured funds in 2013. With a funding volume of €486.1 million, research proposals for a total amount of €977.9 were supported. Excluding commissions, 3,014 projects were funded with a total of 4,977 participations

Fig. 26: Austrian Research Promotion Agency (FFG) funding (cash value) to federal R&D expenditure (in %)



Source: Austrian Research Promotion Agency (FFG), Statistics Austria.

and 2,712 stakeholders. A comparison with the previous year shows that the number of projects may have grown (+3.5%), yet developments in participations (-2.9%) and stakeholders (-5.7%) were negative.

The largest share of Austrian Research Promotion Agency (FFG) funding is awarded through the general programmes. In 2013, 1,261 projects were supported with €167.9 million. There are different programme lines with specific aims (general programme, headquarters, high-tech start-up, etc.) within the general programmes. The number of funded projects in this sector (748) grew by 5.5% in comparison to the previous year. The Innovation Voucher programme line is particularly significant in terms of its number of projects; this programme focuses on supporting SMEs in the initiation of R&D activity. In 2013, a total of 432 (2012: 486) projects were funded in this sector.

The topical programmes represent the second-largest programme sector in the funding portfolio of the Austrian Research Promotion Agency (FFG), with a cash value of €125.1 million (2012: €96.2 million). These programmes aim to support national and international priority topics, including energy, ICT, production, and security research, which are all themes that are compatible at the European level with HORIZON 2020. The structural programmes constitute the third most quantitatively significant portion of the Austrian Research Promotion Agency's (FFG) funding portfolio, ahead of the topical programmes last year, with an approximate cash value of €63 million (2012: €111.4 million). The high cash value totals in 2012 resulted from the extension of several existing competence centres (COMET). Further funding priorities include European and international programmes, as well as the Austrian Space Applications Programme, ASAP.

Approximately 60% of committed funds went to business enterprises in 2013 (2012: 52%). The effect of the COMET programme led repeatedly in the past to swings in the share of research institutions, which would be higher one year (2012: 31%) than in the following year (2013: 19%). The proportion of universities improved a great deal

Table 15: Austrian Research Promotion Agency (FFG) funding statistics 2013 (in €1,000)

	Programme	Projects	Participation	Stakeholders	Total costs	Funding incl. liabilities and loans	Cash value
ALR	ASAP	25	41	32	6,404	5,309	5,309
		25	**41**	**32**	**6,404**	**5,309**	**5,309**
BP	General programme	656	673	535	392,169	220,351	99,818
	Headquarters	16	16	16	59,145	17,411	17,411
	High-tech start-ups	17	18	18	8,420	5,890	4,165
	Service innovations	30	32	32	9,882	6,026	4,875
	Frontrunners	26	26	26	65,589	17,485	17,485
	Rare diseases	3	4	4	3,409	2,385	1,447
		748	**769**	**603**	**538,614**	**269,547**	**145,201**
	BRIDGE	69	208	182	23,306	15,654	15,654
	EUROSTARS	12	16	16	7,349	4,148	4,148
	Innovation Voucher	432	864	667	3,278	2,905	2,905
		1,261	**1,857**	**1,368**	**572,546**	**292,255**	**167,908**
EIP	TOP.EU	8	8	7	641	481	481
		8	**8**	**7**	**641**	**481**	**481**
SP	AplusB	3	3	3	11,711	4,099	4,099
	COIN	36	140	123	27,417	17,920	17,920
	COMET	12	220	202	70,352	21,268	21,268
	FoKo	22	189	162	4,412	3,529	3,529
	Research Studios Austria	3	9	5	3,001	2,100	2,100
	Talents	1,236	1,312	708	12,824	7,861	7,861
	wfFORTE	7	33	33	10,369	6,129	6,129
		1,319	**1,906**	**1,108**	**140,085**	**62,907**	**62,907**
TP	AT:net	21	22	22	8,498	1,908	1,908
	benefit	26	56	48	11,836	7,289	7,289
	e!MISSION	53	191	142	41,049	27,071	27,071
	ENERGIE DER ZUKUNFT (energy of the future)	43	155	125	27,606	16,492	16,492
	Energy efficient vehicle tech	2	5	5	1,054	566	566
	FIT-IT	7	7	7	1,841	978	978
	GEN-AU	1	1	1	8	8	8
	IEA	40	68	30	4,481	4,384	4,384
	IKT der Zukunft (ICT of the Future)	54	91	73	78,106	14,592	14,592
	IV2Splus	7	18	18	1,956	1,031	1,031
	KIRAS	23	138	84	9,739	6,814	6,814
	Beacons for eMobility	1	13	13	5,123	2,235	2,235
	Mobilität der Zukunft	58	180	123	22,847	13,389	13,389
	NAWI	1	1	1	344	172	172
	Neue Energien 2020	6	26	23	2,629	1,365	1,365
	Produktion der Zukunft	34	100	80	24,340	15,846	15,846
	TAKE OFF	17	49	40	15,505	9,953	9,953
	Technology competences	7	44	38	1,198	1,046	1,046
		401	**1,165**	**705**	**258,159**	**125,137**	**125,137**
Austrian Research Promotion Agency (FFG) funding and expenses		**3,014**	**4,977**	**2,712**	**977,835**	**486,088**	**361,742**
Austrian Research Promotion Agency (FFG) commissions[1]					2,453	2,453	2,453
Austrian Research Promotion Agency (FFG) Operative Funds 2013 total						**488,541**	**364,195**

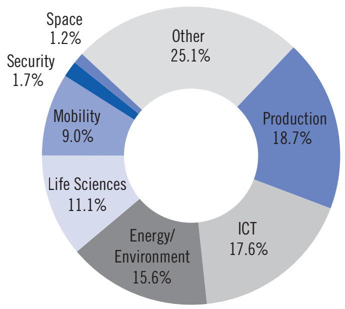
1 Commissions are ancillary measures financed by operative funds from the programmes.
Note: Quantitative figures refer to funding committed in 2013.

Source: Austrian Research Promotion Agency (FFG).

in comparison to previous years. In 2013, universities approached a level similar to that of research institutions at 18.6%, with a cash value share of 13.3% in 2011 (€46.2 million) and 11% in 2012 (€39.7 million) (see Table 16).

An analysis of the themes that receive funding shows that about 19% of funds go to the production sector (production technology, toolmaking and mechanical engineering, industrial processes, etc.), about 18% to information and communication technologies (ICT), and about 16% to energy and the environment (Fig. 27). The "Others" group summarises those sectors that cannot be assigned to thematic fields because of the heterogeneity and breadth of the individual fields, as well as the fact that projects are situated at the interfaces between different research areas. These include agriculture, food, mathematical and statistical processes, information and media, and social aspects.

Fig. 27: Austrian Research Promotion Agency (FFG) funding by thematic fields, 2013



Source: Austrian Research Promotion Agency (FFG).

2.3 Austria Wirtschaftsservice (aws)

Austria Wirtschaftsservice GmbH (aws) is the federal development and financing bank for the promotion and financing of companies. aws employs a broad range of instruments, such as grants, liabilities, and guarantees, as well as equity capital financing, to support firms in the financing and funding of their projects. Depending on the business stage and financial need, the bank develops a financing mix that takes account of the distribution of public and private risk. The bank also offers consulting services that specialise in large investment projects, innovation, and technology commercialisation. Funding logic is strongly oriented towards growth and innovation, covering a broad range of topics from start-up preparation to market introduction, to larger leaps in growth such as internationalisation in later business stages. The creation of the aws funding manager now offers a central point of contact and Internet-based communication platform for aws customers.

In 2013 about 5,200 firms received support for their growth and innovation projects in the total amount of €1.97 billion. Table 17 provides an overview of funding in the area of financial instruments. The number of approvals rose year-on-year to 5,346 funding cases (+21.5%), and the total funding provided by financing instruments amounted to €904.9 million (+3.7%). There was a significant drop (-24.0%) in the total project volume of funded projects. The main reasons for this decrease are sinking average

Table 16: Austrian Research Promotion Agency (FFG) funding by type of organisation, 2013 (in €1,000)

Type of organisation	Participations	Total funding [in €1,000]	Cash value [in €1,000]	Shares in cash value [in %]
Firms	2,817	339,868	215,879	59.7
Research institutions	824	68,416	68,058	18.8
Universities	1,001	67,203	67,203	18.6
Intermediaries	46	7,054	7,054	1.9
Other	289	3,548	3,548	1.0
Total	**4,977**	**486,088**	**361,742**	**100.0**

Source: Austrian Research Promotion Agency (FFG).

project size, as well as a trend towards stronger demand from smaller firms. This development is clear for all financing instruments to the same degree. While coaching measures had almost two-thirds less approvals (468) in comparison to 2012 (1,132), total funding remained quite steady at € 10.3 million in 2013.

A quarter of aws funding service, or € 196 million, went to assuming guarantees in 2013. The number of assumed guarantees (837) increased by 10.3% in comparison to the previous year. Grant funding saw a 3.5% decrease in the amount of grants. The number of funded cases was about a third higher than in the previous year, which can be attributed primarily to an increase in funding through the aws creative industries voucher programme. There was an increase in demand for loans, with 6% more loan volume disbursed than in 2012, amounting to approximately € 600 million (incl. about € 8 million for development cooperation).

The existing portfolio of equity capital instruments, including the aws small business fund and the aws venture capital initiative, was expanded to add two new instruments: the aws Start-up Fund, which invested in three participations in 2013, offers long-term growth capital through public silent partnership. Another new addition is the Business Angel Fund, which is meant to double the capital that a Business Angel brings into a start-up company. The first co-financing contract was concluded with a Business Angel in 2013.

There are also aws funding programmes that focus on technology- and knowledge-intensive start-up projects, including PreSeed and Seed financing, and the impulse initiative for the creative industries (see Table 18). The impulse programme's international jury selected 58 projects in 2013 and provided a total of € 4.2 million in financing. The creative industries voucher, awarded for the first time in 2013, was meant to stimulate demand among "traditional firms" for creative industry services for innovation projects. Six hundred vouchers of € 5,000 each were distributed.

Table 18: Overview of monetary aws programmes for increasing knowledge-intensive start-ups, 2013

	Projects [Number]	Total project volume [€ millions]	Funding support [€ millions]
PreSeed	23	4.8	3.7
Seed financing	26	109.5	15.4
Temporary management	1	0.1	0.1
impulse (creative industries)	58	8.9	4.2
Total	108	123.3	23.4

Source: aws.

The availability of monetary support was supplemented in 2013 to include a series of awareness and coaching measures, as well as placement services. The spectrum of services ranges from idea development to conception, planning, and implementation, all the way through to the commercialisation of project results (see Table 19). Measures for stimulating entrepreneurial spirit include Jugend Innovativ, a competition

Table 17: Funding, 2013

	Funding commitments [number]		Total project volume [€ millions]		Funding [€ millions]	
	2012	2013	2012	2013	2012	2013
Guarantees	759	837	458.0	454.4	199.9	196.0
Loans	1,068	1,232	1,454.2	1,205.0	558.2	593.1
Grants	2,567	3,270	1,643.2	1,108.3	103.5	99.9
Own capital	5	7	19.7	15.9	11.2	15.9
Total result	4,399	5,346	*2,588.3	*1,967.3	872.8	904.9

Note: * Total result, multiple entries removed.

Source: aws.

for school-age pupils that received 528 project ideas in 2013, and the Government Innovation Prize, which received 510 projects in 2013. In addition, education modules are provided for start-ups in growth fields of life sciences and the creative industries. More than 1,000 people took advantage of this programme in 2013.

aws, in cooperation with the Austrian Patent Office, has offered coaching for start-ups and SMEs ("discover.IP") since 2008, focusing on the development, utilisation, and commercialisation of intellectual property (IP). More than 188 firms made use of these services in 2013, together with IP commercialisation consulting.

Table 19: Overview of awareness, coaching, and placement services, as well as training measures, 2013

2013			Projects [number]
Awareness and coaching services			
	Competitions	Jugend Innovativ (youth innovation competition)	528
		Government Innovation Prize	510
	Intellectual Property (IP)	Consulting	176
		Commercialisation	12
	Knowledge transfer centres		33
	Total		1,259
Placement services			
	Business Angels exchange (I²)		135
Participants in training and education			
	Life Sciences		246
	Creative industries		830
	Total		1,076

Source: aws.

3 Scientific Research and Tertiary Education

University rankings are gaining in importance as a result of increased competition in the higher education sector, which is marked by a striving towards excellence and priority-setting and is premised on efficiency and effectiveness. The beginning of Chapter 3.1 is therefore dedicated to the dissemination, function and methodology of university rankings and discusses the position of Austrian universities in these rankings. This is followed in Chapter 3.2 by an examination of how Austria compares internationally with regard to researcher salaries, which is an important factor in preventing the loss of native Austrian researchers to institutions abroad and attracting highly qualified research staff to Austria. The funding of universities by Austrian firms will be examined in more detail in Chapter 3.3; Chapter 3.4 will look at the transfer of knowledge between the higher education sector and firms.

The sector comprised of universities of applied science has grown markedly in the past several years with respect to its primary educational function as well as its secondary function related to research and development. This development is described in Chapter 3.5 with respect to current R&D data, whereby particular attention is paid to the complementary function of the research and educational activities of both universities and non-university research institutions. Finally, Chapter 3.6 discusses the use of new social media in scientific research.

3.1 Austrian universities in international university rankings

Rankings play an important role in higher education policy internationally and are increasingly winning attention in Austria as well. The value of university rankings and their use is a controversial subject worldwide. Whilst some see in these rankings an indispensable basis for realistically assessing the performance of individual higher education institutions and a country's entire higher education system, others point to fundamental differences between higher education systems in various countries and between different types of higher education institutions, which makes any comparison or assessment on the basis of a limited number of indicators impractical, if not misleading.[67]

Though rankings do not play a central role in the development of Austrian universities strategic plans, universities that have ranked highly do increasingly make use of this fact in their public relations efforts, and these rankings increase the university's attractiveness for research staff and students. The Federal Ministry of Science and Research launched the project “Austrian Universities and University Rankings” in September 2013 to increase and evaluate possibilities for improving the positions of Austrian universities in the rankings and to identify and implement suitable measures to do so. Within the framework of this project, the twelve participating universities developed proposals, which are meant to be implemented by universities individually as well as in a concerted manner across universities and at a political level with due regard to prevailing strategies and the current political situation, in order to improve the positions of Austrian universities in the identified rankings. Appropriate measures and strategies were devised at the same

67 See Rauhvargers (2013).

time to optimise communications regarding this topic within the university and research sector as well as to the broader public. Preliminary results are expected in autumn 2014.

The following section presents several international rankings and identifies the position of Austrian universities in these. Shared characteristics amongst rankings are discussed first. This is followed by a detailed description of the Times Higher Education Ranking and an overview of the methods and results of the Shanghai Rankings, the Leiden Rankings and the Webometrics Rankings. These four rankings have been chosen because they use different methodological criteria. The section concludes with a presentation of U-Map and U-Ranking, two European initiatives for ranking universities.

Function and characteristics of rankings

Rankings can be found in a number of contexts in the business world and in society more generally. All of them hold in common the idea that a group of comparable units can be organised so that any unit's position in the series can be understood as an expression of value. The same is true of university rankings. They are meant to depict the quality of individual universities according to a variety of criteria (research, supervision, etc.) by the rank they occupy. The concept of university rankings originated in the US and Canada, where rankings are an essential piece of information for prospective students when choosing their place of study. These rankings were originally restricted to universities in one country.

University rankings have three characteristics in common: institutional differentiation, aggregation and the resultant ranking schema.[68] Institutional differentiation here means that the ranking is of the entire university and there is no differentiation made amongst individual component units. One finds this principle increasingly softening (all of the rankings discussed in this text began reporting results for individual units some time ago), but globally the emphasis is still on a comparison of universities as a whole.

The second defining characteristic shared by almost all international rankings is the aggregation, which is calculated on the basis of individual, weighted indicators: the so-called "composite indicator". This composite indicator is ultimately the figure that is able to describe the performance of a complex organisation such as a university.[69] The designers of each ranking determine the weighting that each individual indicator has in determining the composite indicator. The number of indicators that are taken into account in determining the aggregate value ranges from six to 13 with corresponding weights of anything between 2.25% to 30%. There are also differences in the indicators chosen. The Shanghai Ranking and the Times Higher Education (THE) Ranking attempt to depict the multiple aspects of the performance of a university by including a large number of indicators, whereas the Webometrics Ranking primarily emphasises a university's web presence; the Leiden Ranking, on the other hand, concentrates on bibliometric indicators in assessing a university's research performance.

The third fundamental element of ranking is the assigning of an exact position in the ranks, the so-called "league tables", whereby each aggregate value, which is derived from the weighted individual indicators, is translated into a specific position in the series.

The four rankings presented below pursue different methodological approaches: the Times Higher Education Ranking and Shanghai Ranking are examples of "international global league tables", the Leiden Ranking one of "bibliometric ranking" and Webometrics represents an example of "web ranking".

68 See Federkeil (2013).
69 See Federkeil et al. (2012).

Times Higher Education (THE) Ranking

The *Times Higher World University Ranking* has been a joint effort of the *Times Higher Education magazine*[70] with Thompson Reuters since the magazine ended its cooperative relationship with *Quacquarelli Symonds* in 2010. Currently, the world's best 400 universities are ranked. The top 100 universities are additionally ranked according to subject. The 13 indicators from five categories are meant to fully account for the primary functions of universities: education, research and science (see Table 20).

In addition to the use of bibliometric data in compiling the ranking, two large surveys are included, the results of which comprise the largest proportion of the education and research categories in accordance with the respective weighting of the individual indicators. The first survey is the *"Thomson Reuters academic reputation survey"*, an annual, global questionnaire in which academics rate the reputation of university institutions with respect to research and teaching. The second institution-focused survey collects detailed information about the activities of various units within the institution under examination. THE rates the *Citations* indicator, with is weighted at 30%, as the foundation for its ranking method. Around 12,000 journals from Thompson Reuters" *"Web of Science"* database are consulted. This is followed by the Research reputation and Teaching reputation indicators (see Table 20). The indicators are standardised by taking the mean value and dividing it by the standard deviation.

One criticism of the methodology behind the Times Higher Education ranking is that universities in English-speaking countries have an advantage when it comes to citations-based indicators such as the Times Higher Education "Citations" indicator, because researchers at universities in non-English-speaking countries will tend to publish at least some of their work in national languages other than English. The mean citation rates for these tend to be lower because only a smaller proportion of the scientific community has access to these publications.[71] This indicator also appears to provide an advantage to large universities since citations are not normalised according to the size of the university or its publications output.[72]

At the same time, the two reputation indicators based on surveys seem to privilege the most well-known universities from the largest countries since the sample size (10,000 participants worldwide for each) presumably allows the inclusion of only a limited number of people from smaller countries.

American and British universities occupied the top ten positions on the Times Higher Education Ranking 2013/14 (Table 21). Austria was represented amongst the best 200 universities with the University of Vienna at 170. For rankings lower than 200, the Times Higher Education Ranking provides ranges instead of precise ranks or composite indicators.

On comparing individual indicators, it becomes apparent that Austrian universities achieve lower scores especially when it comes to the teaching and research indicators. As mentioned above, these two indicators are based on surveys and thus dependent on the subjective assessments of respondents, which is presumably affected by the name recognition associated with any particular university. Smaller, specialised universities, which are characteristic of the Austrian higher education system, are likely to be less well-known and will therefore achieve lower results. The values achieved for citations and especially for the indicator "International perspective" are notably higher.

The Quacquarelli Symonds World University

70 See www.timeshighereducation.co.uk.
71 See van Leeuwen et al. (2001).
72 The Times Higher Education website states: "We examine research influence by capturing the number of times a university's published work is cited by scholars globally", and this can be accessed at: http://www.timeshighereducation.co.uk/world-university-rankings/2013-14/world-ranking/methodology.

Table 20: Times Higher Education indicators

Indicators	Weighting	Comments
Teaching		
• Educational reputation	15.00%	Based on questionnaires to around 10,000 academics globally
• Students per academic	4.50%	Measure for the quality of the teaching
• PhDs awarded to Bachelors awarded	2.25%	
• PhDs awarded per scientist	6.00%	
• Income per academic	2.25%	
Research		
• Research reputation	18.00%	Based on survey of around 10,000 participants
• Research productivity	6.00%	Adjusted to the number of employees and exchange rates. The various types of government funding for the individual research areas are also taken into account.
• Research funds	6.00%	
Income from manufacturing	2.50%	Commercialisation of the university's innovations measured against the number of employees
Citations	30.00%	Cited publications of the university in the Thomson Reuters "Web of Science" database consisting of 12,000 scientific periodicals
International outlook		
• International students	2.50%	
• International co-publications	2.50%	
• Ratio of international/domestic students	2.50%	

Source: website (www.timeshighereducation.co.uk). AIT graphic.

Table 21: Position of Austrian universities in the Times Higher Education Ranking, 2013/2014

Ranking	Universities	Total	Teaching	International outlook	Income from manufacturing	Research	Citations
1	California Inst. of Technology	94.9	94.4	65.8	91.2	98.2	99.8
2	Oxford University	93.9	89.0	90.2	90.3	98.5	95.4
3	Harvard University	93.9	95.3	66.2	40.6	98.5	99.1
170	University of Vienna	46.2	35.8	89.5	29.3	36.1	57.4
201 – 225	University of Innsbruck	-	25.2	91.4	40.2	17.2	70.6
226 – 250	Vienna University of Technology	-	39.2	72.4	66.6	30.8	40.9
251 – 275	Medical University of Vienna	-	25.9	69.4	33.7	16.9	68.3
351 – 400	University of Graz	-	24.6	59.9	29.5	14.4	51
351 – 400	University of Linz	-	20	57.7	41.9	15.3	51

Source: website (www.timeshighereducation.co.uk). AIT graphic.

Ranking (QS) should also be considered in conjunction with the Times Higher Education Ranking. The two cooperated in data acquisition up until 2009. The QS Ranking continues to use the process that was jointly developed, whereas the Times Higher Education Ranking adapted the process as of 2010. The QS Ranking additionally assigns positions to universities in various subject areas (subject ranking). A total of 29 subjects in five different subject areas are singled out. In Arts & Humanities, the University of Vienna was for instance ranked 54 and the Vienna University of Technology was ranked 195. The University of Vienna was ranked in the range of 51-100 in Mathematics, whilst the Vienna University of Technology placed in the range 101-150.

Subject rankings are gaining in importance internationally since performance can be analysed in a more differentiated manner at the level of individual subjects. The Shanghai Ranking (though only for five designated subject areas), the German-language ranking produced by the CHE (Centre for Higher Education Development) and the ranking provided by Leiden University (CWTS Leiden Ranking) all report results on the level of individual subjects. There is unfortunately insufficient space here to evaluate the performance of Austrian universities in these subject rankings in further detail.

Shanghai Ranking

The Academic Ranking of World Universities – or the 'Shanghai Ranking" for short – was originally commissioned by the Chinese government in order to classify the quality of Chinese universities in the globally competitive areas of research, the natural sciences and engineering.[73] The Shanghai Ranking has been produced by the Shanghai Ranking Consultancy since 2009 (before that it was produced by Shanghai Jiao Tong University).

The Shanghai Ranking is based on the number and rate of citations of scientific publications, articles published in leading journals and the number of prestigious awards such as the Nobel Prize (Table 22). It compares the world's top 500 universities. Each indicator is subject to standardisation, in which the best institutions are awarded a value of 100 and the remaining institutions are assigned a proportional score. The sum of the indicators after weighting provides the respective aggregate score for each institution. The top 100 universities are awarded exact rankings whilst only ranges are provided for the remaining institutions. A short note should be added here about the weighting in-

Table 22: Shanghai Ranking indicators

Indicators	Weighting	Comments
Quality of the education		
• Alumni: alumni who have received a Nobel prize or a Fields Medal	10%	Different weighting within the indicator according to degree completed at the relevant university by the prize winner: 100% … 2001 – 2010; 90% … 1991 – 2000; …; 10% … 1911 – 1920
Quality of the institution		
• Award: Researchers who have received a Nobel prize or a Fields Medal	20%	Different weighting within the indicator according to receipt of the prize: 100% … 2011 – 2013; 90% … 2001 – 2010; …; 10% … 1921 – 1930
• HiCi: Frequently cited researchers in 21 categories	20%	The relevant weighting was left to the cited individual's discretion in the case of citations in multiple categories. No information from the individuals resulted in automatic weighting.
Research output		
• N&S: Articles published in "Nature & Science" (2008–2012)	20%	Differentiation between primary (100%), secondary (50%) and tertiary (25%) sources.
• PUP: 'Science Citation Index-Expanded" & 'Social Science Citation Index" articles (2012)	20%	Different weighting: Science Citation / Social Science – 1 / 2
Size of the institution		
• PCP: Academic output in view of the size of the university	10%	For the calculation the weighted scores from the other indicators are divided by the number of full-time teaching academics. If the number for this teaching staff cannot be ascertained then this indicator is provided with the total result of the absolute indicators with a 10% weighting.

Source: website (www.shanghairanking.com). AIT graphic.

73 See Federkeil (2013).

volved in the indicators *Alumni* and *Award*. Universities whose researchers won awards between 2001 and 2010 are given a higher percentage score than universities with researchers who won awards before this period. Similar weighting decisions have been taken with regard to other indicators in order to make the process more transparent.[74]

The highest rank for an Austrian university is that of the University of Vienna in the range 151-200. With the exception of the Medical University of Vienna and the University of Innsbruck, all other Austrian universities are ranked in the bottom fifth. On examination of the particular indicators, it becomes clear that this poor performance is due to a lack of Nobel Prize or Fields Medal winners.

One critical response to the Shanghai Ranking is that the weighting of the *Alumni* and *Award* indicators disadvantage newer and smaller universities. The use of indicators based on the absolute number of a university's publications in the scientific journals Nature and Science or the absolute number of articles in journals that are included in the Science Citation Index and Social Sciences Citation Index create a bias towards large universities. Thus the University of Vienna fell at least 70 places in the Shanghai Ranking from 85 in 2005 to the range 151–200 in 2006 because of the new establishment of the Medical University of Vienna.

Leiden Ranking

In contrast to the Shanghai Ranking and the Times Higher Education Ranking, the ranking produced by the *"Centre for Science and Technology Studies"* (CWTS) at Leiden University is based solely on bibliometric information, more specifically the number of scientific publications produced by each university and how frequently they are cited by other publications. In addition to four citation indicators, so-called cooperation indicators have recently begun being included to account for a further aspect of scientific cooperation (Table 23). In addition, the Leiden Ranking does without a composite indicator, providing ranks for various individual indicators instead.

The Medical Universities of Innsbruck and Vienna found themselves listed amongst the top 200 universities, at places 170 and 176 respec-

Table 23: Leiden Ranking indicators

Indicators	Comments
Citation indicators	
• Total number of publications (P)	
• Median citation score (MCS)	Normalisation with regard to differences in specialist areas, year of publication and type of document.
• Median normalised citation score (MNCS)	
• Proportion of Top 10% publications (PPTop10%)	Publications by a university which is in the 10% most cited publications per subject and year compared with similar institutions.
Cooperation indicators	
• Proportion of inter-institutional co-publications (PP collab)	Publications which resulted from collaboration with one or more organisations.
• Proportion of international co-publications (PPInt collab)	Publications which resulted from collaboration with one or more countries.
• Proportion of industrial co-publications (PP UI collab)	Publications which resulted from collaboration with one or more industrial partners.
• Average distance of cooperation partners (MGCD)	

Source: website (www.leidenranking.com). AIT graphic

74 See www.shanghairanking.com.

tively, in the 2013 annual ranking of universities according to their number of top 10% publications. They are followed by the University of Vienna at place 249. What is remarkable from the Austrian perspective is the ranking according to international co-publications, in which the University of Vienna came in sixth, the Medical University of Innsbruck came in at 18 and the Vienna University of Technology at 19. The Leiden Ranking also provides indicators for international institutional comparison excluding non-English-language publications by virtue of the fact that it assigns different significance to non-English-language publications from universities in English-speaking and non-English-speaking countries.

Webometrics Ranking

The *"Ranking Web"*, also known as Webometrics, is released twice annually and is the largest ranking of universities worldwide, covering 22,000 higher education institutions. This ranking is also the only one that includes universities of applied sciences. Originally intended to fund online journals, web presence is now even more prominent as the central factor in this initiative, begun in 2004 by *CyberMetrics Lab* (Spain).[75] Online presence is regarded here as a measure of each institution's activity and visibility. The entirety of the World Wide Web is considered the data basis for the ranking, meaning the data used far exceeds the research output of any university. The indicator *Impact*, which is weighted at 50%, is the most significant, whereby the number of external links (backlinks) are considered to be representative of an institution's prestige and its academic performance among other various types of performance. As with other rankings, Webometrics also weights individual indicators (Impact, Presence, Openness, Excellence) and calculates a *composite indicator*.

In spite of the thoroughly different methodology, well-known American and British universities including Harvard, MIT and Stanford also lead the Webometrics tables. The University of Vienna's performance here, at place 78, is better than in other rankings, whilst Vienna University of Technology, the University of Innsbruck, the University of Graz and the Graz University of Technology are all included amongst the 500 best universities worldwide. What is notable is that the Medical Universities of Innsbruck and Vienna, both of which placed amongst the top 250 universities in the world in the Leiden Ranking, achieved poorer results here. This is evidence that publications play a more limited role in this ranking.

U-Map and U-Multirank

Since 2005 the European Commission has supported the development of a university classification scheme that aims to overcome the methodological weaknesses of existing rankings. The European Union is thus reacting to the recommendation made by the IREG (International Ranking Expert Group) in the context of a meeting held in Berlin in 2006 in which a collection of principals for good ranking practices was presented, the "Berlin Principles on Ranking of Higher Education Institutions".[76] This is a set of 16 principals of transparency (e.g. clarity and purpose of the survey, the disclosure of sources and method) that ought to be fundamental to any ranking schema.

Five years of funding was made available between 2005 and 2010 for the project "U-Map: The European Classification of Higher Education Institutions", the implementation of which was the responsibility primarily of the Centre for Higher Education Policy Studies (CHEPS) at the University of Twente in the Netherlands.

75 See www.webometrics.info.
76 See http://www.ireg-observatory.org/.

U-Map is not meant to rank universities; its development was meant to enable the classification of all European universities and thereby improve the international comparability of universities (and types of higher education institutions). The portfolio of activities that forms the basis of the examination includes far more than research and teaching. U-Map also allows for the inclusion of universities of applied sciences and colleges, which tend to be ignored by established ranking systems because of their limited focus on research. U-Map is based on activity indicators and does not include any output indicators for comparative performance assessment. It includes 29 indicators classed under Teaching and Learning Profile, Involvement in Knowledge Exchange, Student Profile, International Orientation, Research Involvement and Regional Engagement. These are meant to encompass all of the relevant aspects of a university's work.[77] The presentation of each profile is not based on a composite indicator but rather with the help of a graphic profile. Using these profiles, users ought to be able to determine whether a comparison of the chosen universities is reasonable according to the criteria they have selected (with respect to research performance, for example).

U-Multirank ("European Multidimensional Global University Ranking") is a ranking that has grown out of U-Map. The feasibility stage was completed in 2011 and preliminary results will be available in 2014. It uses the same groupings as U-Map but aims to provide a performance assessment. U-Multirank encompasses institutional and subject-based rankings with the objective of comparing similar universities (on the basis of their classifications). It is multidimensional and the indicators are designed so that they are not influenced by the size of the university. There is no simplification of the results through the use of a composite indicator.[78] Thus, in contrast to established current ranking systems, no decisive ranking is possible with this schema. U-Multirank distinguishes itself clearly from other ranking systems by virtue of the broad array of dimensions it takes into account and its foregoing the use of a composite indicator.

U-Map and U-Multirank require information that is in many cases only available from the universities themselves. The universities are therefore actively involved in the data collection process. Individual universities participate voluntarily. As a result, only certain Austrian universities are included in U-Map and U-Multirank. A comparison of entire national higher education systems is not possible.

Summary

The past several years have seen the appearance of numerous efforts to compare the performances of universities internationally and to express these findings in the form of rankings. These rankings are based on a variety of indicators, including publications, citations and third-party funding but also a university's reputation when it comes to research and teaching or its presence online.

The best Austrian universities rank in the range of 100-200, which means that Austrian universities are among the top 10% of universities worldwide. With its three universities placing amongst the Top 400 in the Times Higher Education Rankings, Vienna is one of the leading global locations for higher education. The University of Vienna is the highest ranked Austrian university in most rankings, which is also a result of its size. The Medical Universities of Vienna and Innsbruck do remarkably well according to bibliometric indicators, which can be put down partially to differences in publishing activity amongst various academic disciplines.

77 see Van Vught et al. (2010).
78 see Callaert et al. (2012).

There are generally no more than three or four Austrian universities represented on the lists.

A comparison of the Austrian universities that made the list indicates that size and therefore name recognition are important factors in being included in rankings. Size, based on the number of students, influences a large number of factors and results in a high per-head-value. Compared to other universities that have ranked very highly, Austrian universities have up to ten times more students per researcher yet still start off from a worse position. In addition, English-speaking universities especially benefit from their popularity and their international reputation (around 10,000 people are surveyed for the Times Higher Education Ranking, for example), which means that many less well-known universities must struggle to avoid getting lost in this global playing field.

Finally, university rankings should also be evaluated with respect to their significance for societal and economic development. Rankings results are determined by a relatively small group of the best academics worldwide who are able to contribute their excellent reputations and high number of citations. With respect to growth and engagement, however, academics who are not "star scientists" but who do the bulk of teaching contribute as much as do researchers with strong publication profiles.

Whilst the development of several methods over the past few years have addressed some of the criticisms, the sheer number of different approaches makes it difficult to appropriately interpret changes in a university's position in the rankings over time.[79] It is often noted that improvements in a university's position in the rankings may well be a result of a change in the methodology rather than any real improvement in performance. In spite of the continuous move towards subject-specific rankings, the primary focus internationally with respect to university rankings remains overwhelmingly on the results achieved by universities as a whole.

Given the structure and budgetary situation of Austrian universities, it is difficult to imagine them achieving an improved position on international league tables and bibliometric rankings. As discussed above, the established ranking methods privilege large universities from the English-speaking world, which have notably larger budgets available.[80] Many rankings (e.g. the Shanghai Ranking) do not adequately account for the size of the university in relation to its output. Funding of and improvements in the areas of publications and supervision are probably the most feasible way of improving the positions of Austrian universities in the rankings.

3.2 University researcher salaries

Researchers are a highly internationally mobile population. There are empirically based estimates that up to 50% of researchers work in a country other than that of their birth.[81] Young researchers at the beginning of their careers are especially internationally mobile, whereas established researchers tend to display decreased mobility.[82] It has additionally been noted that the direction of mobility is primarily towards the privileged, prestigious research universities in the US,[83] and that European PhD students (with up to 70% remaining)[84] and the most talented researchers tend to remain in the US.[85]

79 see Schleinzer (2013).
80 See Berner (2013).
81 See Hunter et al. (2009); Reinstaller et al. (2012).
82 see Laudel (2005).
83 see Docquier, Rapoport (2009); Tritah (2009).
84 see Finn (2010).
85 see Van Bouwel, Veugelers (2012), Grogger, Hanson (2013a, 2013a).

Those interested in the future of academic research must not only take note of the exodus of highly talented researchers, but also the ramifications this has on the conditions for scientific research in Europe. The suboptimal circumstances that result from the asymmetrical migration of researchers equally affects those scientists who remain in Europe. The potential for development in European science is therefore limited not only by migration (brain drain),[86] but also the reduced number of scientists who are active in Europe[87]

European universities must be able to provide attractive conditions if they hope to recruit highly qualified researchers. In the context of international mobility, these conditions can be seen as a motivation for mobility in terms of costs and benefits,[88] or in other words, highly qualified workers tend to migrate to those places where their skills are rewarded most handsomely.[89] The benefit can be estimated by comparing the push and pull factors. Push factors may include insufficient research funding, limited job availability and low salaries, whilst pull factors may revolve around a large academic job market, prestigious colleagues, career perspectives and high salaries. Costs may arise related to adapting to one's new environment (language, culture, quality of life), the loss of social and family circles as well as professional networks. In general, however, highly qualified researchers find that their costs are modest.

One survey that asked researchers[90] about the most important factors related to a university's attractiveness revealed that academic jobs which offer good career prospects thanks to expected research outcomes were especially important for young researchers, as was autonomy early on when it comes to research and funding. The quality of one's colleagues, the availability of research funding for one's own work (such as funding from Austria's Science Fund – FWF) and the balance between teaching and research are important for both young and established researchers. The quality of life only plays a role insofar as researchers tend to be interested in destinations in which the quality of life reflects that of the country in which they currently live. A better quality of life than that in their current home country does not appear to be a priority for researchers. Established researchers prefer positions with university-internal funding for their research, sufficient administrative support services and transparent performance-related salary scales.

In addition to the range of factors detailed above, compensation (including benefits such as health insurance and pension) plays an important role in determining the attractiveness of a job for researchers, and its importance increases with age.[91] The pool of funding for researcher compensation must be sufficiently high if a country is to fare well in the international competition for the cleverest individuals, a competition that is becoming increasingly tight.[92] Salaries at Austrian universities are subject to the relevant provisions contained in the collective agreements, which define minimum salaries for the employment categories A through C[93] as follows:[94]

86 In addition to the brain drain in the USA there are also flows in mobility which can be observed of researchers from less attractive to more attractive countries within the EU, with the individual EU Member States affected by brain drain at differing levels of intensity.
87 see Janger, Nowotny (2013).
88 see Docquier, Rapoport (2012).
89 see Borjas (1999), Heckman, Honoré (1990), OECD (2008).
90 see Janger, Nowotny (2013).
91 Ibid.
92 see Janger et al. (2012).
93 Classification into the employment categories is implemented primarily by the university administration using the relevant researcher qualification. Reaching a certain qualification level does not mean that the relevant individual automatically moves up to the next employment category. The additional presentation is limited to the employment categories involved in research, with e.g. the group of teachers involved purely in teaching (B2) disregarded.
94 see Collective agreement for university employees 2013, version with 4th supplement.

- A1: university professors who have been fully appointed
- A2: research or artistic staff in accordance with qualifications agreements
- B1: postdocs, senior scientists, senior artists, senior lecturers, project-specific staff members with the appropriate master's or degree programme qualification
- B2: lectors
- C: student employees who are not classified as project-specific staff as in B1

The salary structure covered by the collective agreement follows the principle of seniority. The minimum salary is determined by the number of years of service and increases follow after the completion of additional years of service. The monthly gross salary for a university professor (A1) as of 2013 amounts to at least €4,601.20 and increases after six years to €5,054.40 and to €6,413.80 after 24 years (see Table 24). The monthly starting gross salary for research and artistic staff in accordance with the qualifications agreement is €3,468.30 and this increases to €4,034.70 with a doctorate. Reaching the agreed qualification increases the gross salary to €4,374.60. After 24 years of service, researchers belonging to group A2 receive a salary of €6,187.30 as in accordance with the collective agreement. Postdocs and all other university researchers belonging to group B1 receive a gross monthly salary of €2,562.00, which increases after three years to €3,043.60. Depending on which group he or she previously

Table 24: Collective agreement salaries for researchers at Austrian universities, 2013 (in €)

	Employment categories		
	A1	A2	B1
	Gross monthly salary		
Salary at appointment (with applicable doctorate or PhD)	4,601.20	3,468.30 (4,034.70)	2,562.00
Following fulfilment of the qualification agreement (Section 27)		4,374.60	
After 3 years			3,043.60
After 6 years	5,054.40	4,827.80	
After 8 years at the relevant preliminary stage *)			3,411.70
			3,779.90
			3,978.20
After 12 years	5,507.50	5,280.90	
After 18 years	5,960.70	5,734.10	
After 24 years	6,413.80	6,187.30	

Source: Collective agreement for university employees 2013. Version with 4th supplement; section 49 note: A1: at least one positive evaluation is required in the relevant period according to the UG 2002; A2: once the qualification agreement is fulfilled the relevant salary increase takes place following a positive evaluation of the activity within the relevant period as an associate professor according to UG; B1: the three-year period may be reduced in the event of previous experience; first increase after eight years of activity may take place sooner through a doctorate if this was a prerequisite for a post-doc position.

*) The amounts are increased following eight years of activity in different ways depending on the prior classification.

belonged to, a researcher classified in group B1 will receive a gross monthly salary of €3,411.70, €3,779.90 or €3,978.20 after eight years.

More detailed figures regarding researcher salaries at Austrian universities that would, for example, shed light on average salaries at various stages of one's career separate from the collective wage agreement are not currently publicly available.[95] Any comparison of Austrian salaries to salaries worldwide is therefore possible only to a limited degree. Though universities are free to set salaries as they choose,[96] most tend to follow the collective agreement, especially for researchers in the lower salary groups, though it can be established that universities tend to make use of the right to exceed the stated salary ranges more frequently for men than they do for women.[97] On the other hand, the study that will be discussed below demonstrates that an international comparison of university researcher salaries according to career stages reveals no major differences, whether the comparison is based on minimum, average or even top salaries. Countries that provide higher minimum salary amounts also tend to pay higher salaries at the middle and top of the salary range, and vice versa. Thus a comparison of Austria with other countries is valid in spite of the limited availability of data.

The following international comparison is based on a study ordered by the European Commission,[98] in which researcher salaries were compared across the 28 EU member states (with the exception of Slovakia and Malta), eleven other European countries and nine additional countries for 2011.[99] Researchers were divided into four groups according to a classification scheme proposed by the European Commission[100] in order to provide correspondence amongst the various career paths and positions in the different national university systems.

- R1: First Stage Researcher (up to the point of PhD)
- R2: Recognised Researcher (PhD holders or equivalent who are not yet fully independent)
- R3: Established Researcher (researchers who have developed a level of independence)
- R4: Leading Researcher (researchers leading their research area or their field)

Table 25 presents an international comparison of the university researchers, gross annual salaries, adjusted for purchasing power. The minimum, average and top salaries for each career stage are depicted as percentages of the corresponding salaries in the country that pays the highest salary in each category (R1-R4).

One can see that salaries, adjusted for purchasing power, of researchers at Austrian universities lie notably above the averages for the EU as well as that for the OECD countries. This is true for all career stages R1-R4 and for the comparison amongst the EU-28 member states as well as the comparison amongst the EU-15.

95 Available sources such as the Court of Audit Report on average income and additional benefits for pensions in the public economy in the federation in 2011 and 2012 are limited to average values for salaries across all positions. This does not allow any inferences to be made regarding actual salaries for individual career stages and is therefore only of limited significance for this item.

96 See Collective agreement for university employees 2013. Version with 4th supplement; section 49 (13): "Overpayments based on individual agreements are permissible".

97 The Court of Audit Report on the "Effects of the collective agreement on employees at universities" (federation 2014/3) shows that both the proportion of researchers with a qualification agreement and of those with salaries above the collective agreement (overpayments) at the universities examined was significantly greater among men than among women. The Intellectual Capital Statements 2012 accordingly reveal an overall gender pay gap of around 10% across all positions to the detriment of women, i.e. the salaries of women adjusted for working hours equated overall to 90% of the salaries of men adjusted for working hours, with the difference distorted to the detriment of women as a result of the lower number of women at higher career levels.

98 see Unterlass et. al. (2013b).

99 This study does not take into account contracts or salary scales no longer offered, since those positions or contracts which are accessible to new hires are the ones which are relevant for international competition for highly qualified researchers. The focus was also placed on those positions which most closely resemble the university career model of doctoral candidate to professorship. Accordingly positions financed by third-party funds or project-related positions were not taken into account.

100 See European Commission (2011).

Austrian salaries represent between 65% (R1) and 80% (R2) of the salaries paid in the country with the highest salary, whereas the average for the EU-15 group is between 60% and 65%, and the average for the 28 EU member states is between 45% and 55%. In the OECD comparison,

Table 25: Gross annual salaries and doctoral grants of university researchers as a % of the highest-paying country in the relevant career level[101]

	Gross annual salary																Doctoral grants			
	R1				R2				R3				R4				R1			
		Min	Ø	Max		Min	Ø	Max		Min	Ø	Max		Min	Ø	Max		Min	Ø	Max
EU states	as % of the relevant international maximum values in the relevant career level, rounded figure																			
Belgium	>80	75	.	>80	80	75	.	80	80	65	.	>80	70	70	.	75	65	80	.	55
Bulgaria	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	20	20	<20
Denmark	75	65	>80	70	65	65	70	50	65	60	70	60	60	65	65	50	>80	>80	>80	70
Germany	80	80	.	75	70	70	.	65	65	65	.	65	60	65	.	50	40	45	.	35
Estonia	.	.	.	.	35	.	35	.	35	.	35	.	40	.	40	.	20	.	20	.
Finland	45	35	55	45	55	50	60	50	60	45	70	60	.	.	.	.	30	.	.	30
France	35	35	.	35	25	25	.	25	45	30	55	50	45	35	50	45	55	.	55	.
Greece	<20	.	<20	<20	50	45	55	45	45	40	50	45	40	40	45	35	20	.	20	.
Ireland	.	.	.	.	50	50	.	55	75	75	.	75	>80	80	.	>80	40	50	.	30
Italy	.	.	.	.	60	60	.	55	65	65	.	.	70	70	.	.	55	55	.	.
Croatia	50	.	50	.	45	.	45	.	45	.	45	.	55	.	55	.	30	.	.	30
Latvia	<20	<20	.	.	20	20	.	.	.	.	.	.	<20	<20	.	.	.	.	.	.
Lithuania	<20	<20	.	<20	<20	<20	.	<20	<20	<20	.	20	<20	<20	.	<20	<20	20	.	<20
Luxembourg	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Malta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Netherlands	65	60	>80	60	75	55	>80	80	>80	>80	>80	>80	>80	80	>80	80	.	.	.	.
Austria	**70**	**70**	**.**	**.**	**80**	**80**	**.**	**.**	**65**	**65**	**.**	**.**	**70**	**70**	**.**	**.**	**.**	**.**	**.**	**.**
Poland	25	20	.	25	30	25	.	30	30	25	.	40	30	25	.	35	20	20	.	.
Portugal	.	.	.	.	75	75	>80	60	65	65	75	60	60	70	65	50	50	45	60	45
Romania	<20	<20	20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	20	<20	20	20	.	.
Sweden	60	50	70	50	55	60	65	50	55	50	60	55	55	60	60	50	.	.	.	.
Slovakia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Slovenia	55	45	70	55	70	60	80	65	65	60	75	65	55	55	55	45	30	<20	25	65
Spain	40	40	50	35	45	50	50	40	60	50	70	65	55	55	60	50	50	55	55	40
Czech Republic	35	25	45	35	40	20	35	60	40	30	40	55	50	35	40	80	<20	<20	<20	<20
Hungary	25	25	.	.	25	25	.	.	25	25	.	.	35	35	.	.	20	.	20	.
United Kingdom	75	.	45	>80	55	50	65	55	65	50	70	70	75	80	75	.	70	55	55	>80
Cyprus	65	55	.	75	>80	>80	.	>80	>80	>80	.	>80	80	>80	.	70	.	.	.	.
Non EU-states																				
Brazil	>80	>80	.	.	>80	>80	.	.	>80	>80	.	.	>80	>80	.	.	.	.	.	.
China	.	.	.	.	25	25	25	25	25	25	25	30	25	20	25	35	.	.	.	.
Japan	75	55	>80	80	70	65	80	70	70	65	75	70	65	70	65	55	.	.	.	.
Canada	.	.	.	.	45	.	45	.	80	45	>80	>80	70	45	>80	.	30	<20	.	60
Norway	>80	75	>80	>80	80*	75*	>80*	75*	65*	60*	75*	65*	65	60	65	75	.	.	.	.
Switzerland	60	50	.	70	>80	>80	.	>80	>80	>80	.	>80	>80	70	.	>80	.	.	.	.
USA	75	40	>80	>80	>80	75	>80	75	>80	>80	>80	>80	>80	>80	>80	>80	55	.	55	.
EU-15 (until EU expansion 2004)	60	55	60	60	60	60	65	55	65	60	70	65	65	65	65	60	50	60	55	50
EU-13 (as of EU expansion 2004)	30	25	40	35	35	30	35	40	40	35	35	45	35	35	35	40	20	<20	20	25
EU-28	45	40	50	50	50	50	55	50	55	50	55	55	50	50	55	50	35	40	40	40
Third countries	50	45	55	55	50	50	50	50	55	50	55	55	55	50	55	55	35	30	45	35
OECD	55	50	65	60	55	55	65	55	60	55	65	65	60	60	65	60	40	45	40	45

Source: MORE2 expert survey, Austrian Institute of Economic Research (WIFO) chart. On purchasing-power parities. *) Associate Professor classified both as R2 and as R3, therefore values for R2 distorted upwards and R3 downwards. The following countries included in the MORE2 study are not reproduced in the table: Albania, Australia, Bosnia-Herzegovina, Faroe Islands, Iceland, Israel, Macedonia, Montenegro, Russia, Serbia Singapore, South Korea, Turkey.

101 The relevant first column for each career level represents the mean value of the three statistics. This makes it possible to compare between countries which do not have all values available. In order to account for any potential bias in terms of the data available the resulting values were rounded to 5% in each case and values above 80% or below 20% of the highest-paying country were not stated exactly.

the salaries lie between 5 (R3) and 25 (R2) percentage points closer to the country with the highest salaries than the average.

On the other hand, salaries lie significantly behind those in the US. Average salaries and grants in the US for the first career stage R1 tend to be relatively low when adjusted for purchasing power, though still around 5 percentage points higher than Austria's in comparison to the country with the highest salaries. However, salaries increase significantly in the subsequent stages. For career stages R2 through R4, the US belongs to the group of countries with the highest researcher salaries when adjusted for purchasing power, along with Belgium (R1), Brazil (R1 through R4), Ireland (R4), the Netherlands (R3 and R4), Switzerland (R2 through R4) and Cyprus (R2 through R4). PhD students in Denmark receive the highest grant payments. The Eastern European countries Bulgaria, Latvia, Lithuania, Romania and Hungary lie at the other end of the spectrum with very low salaries. In these countries university researchers sometimes earn less than 20% of what their colleagues in the best paying countries earn. Outside of the EU, salaries in Albania and China are comparably low.

The gross monthly salaries for researchers in Austria are most comparable to those in Germany, the Netherlands and Japan. Though German doctoral students, for example, earn notably more than Austrian students, German researchers in all later career stages earn less than their Austrian colleagues. The reverse is true for the Netherlands. In terms of comparison with other EU countries, researchers earn considerably more, when adjusted for purchasing power, in Belgium and Cyprus, but researchers in the Scandinavian countries lie quite a bit behind Austria for some stages. Salaries in Denmark are the closest to those in Austria. Outside of the European Union, Brazil, Norway and Switzerland, in addition to the US, pay notably higher salaries to researchers.

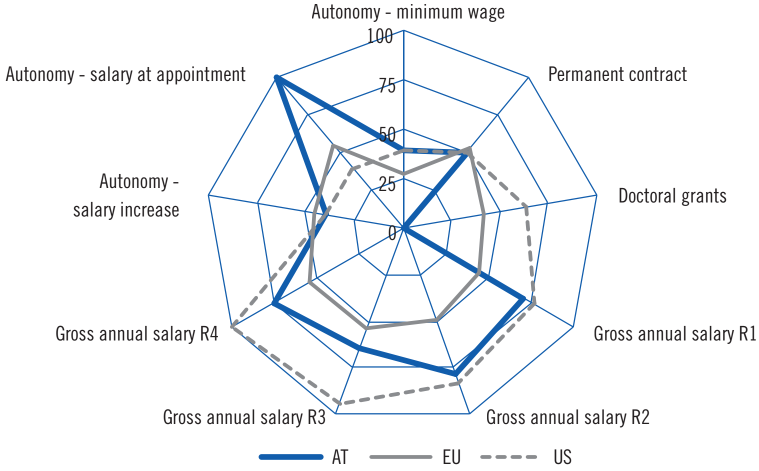
One important component in universities ability to recruit highly qualified researchers amidst international competition is the flexibility to offer attractive salaries or to be able to negotiate these individually. As was demonstrated by the MORE2 study, decisions about salaries in especially those countries that are designated "innovation leaders" are primarily taken by the universities themselves.[102] Austrian universities enjoy a great degree of autonomy, especially in negotiating salaries for new hires (see Fig. 28). Salary negotiations may be conducted on an individual basis; universities are markedly more autonomous than the EU average. The autonomy of Austrian universities related to negotiations about salary rises and minimum salary levels are similar to those in the US (see Fig. 28).

Any meaningful international comparison must take into account a wide number of other factors in addition to gross salary amounts. These include, in addition to differences in purchasing power and the cost of living, the quality of life, social security provisions, labour market regulations, taxes and social insurance contributions and, particularly in the case of researchers, the research environment and research infrastructure. Thus gross salary amounts in two different countries that are nominally the same for the same type of position may have radically different real values.

Similarly to many EU member states in comparison to non-EU countries, Austria possesses comprehensive coverage through a compulsory social insurance system. It is unclear whether this more comprehensive insurance scheme in EU countries can compensate for the slightly lower gross annual salaries in comparison to non-EU member countries (see Table 25). Whilst health insurance is a legally required part of an employee's compensation in almost all of the countries examined, universities in non-EU countries frequently provide additional health insurance coverage, and researchers in these countries, particularly in the US, tend to more frequently

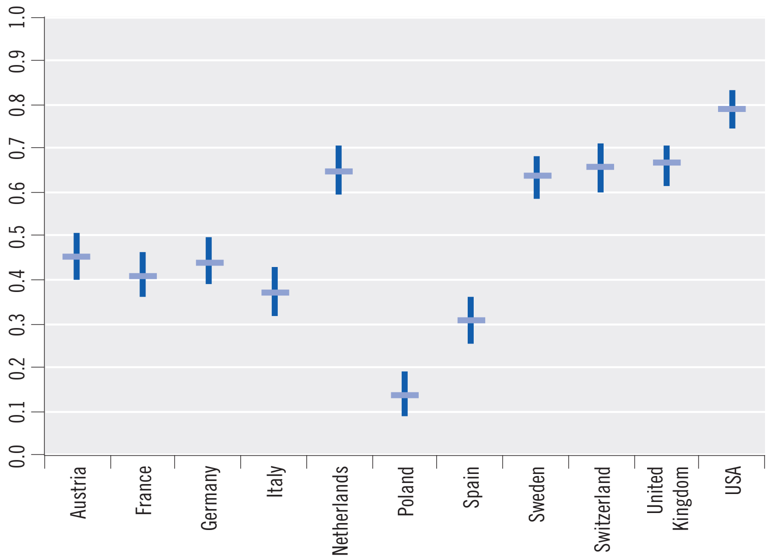
102 See Unterlass et al. (2013b).

Fig. 28: Selected indicators of relevant aspects in the salary scheme for university researchers. Austria in an international comparison



Source: MORE2 expert survey. Scaled, missing values (AT doctoral grants) set to zero. 'Salary increase autonomy', 'Autonomy about salary at appointment', "Minimum salary autonomy": institutional level at which the individual indicators are determined (national … 1, regional, e.g. regional governments … 2, sectoral or collective agreements … 3, university … 4, individual negotiations … 5). "Permanent contract": earliest career level (R1 to R4) at which a permanent contract is possible (maximum = R1). Gross annual salary R1 to R4, doctoral grant: on purchasing-power parities, as % of the relevant international maximum values in this career level.

Fig. 29: Attractiveness of positions at Austrian universities in an international comparison



Note: 0 … not very attractive positions, 1 … very attractive positions.[103]

Source: Janger et al. (2013).

103 The indicator averages scaled qualitative and quantitative partial indicators at values between 0 (minimum) and 1 (maximum) which are relevant for the attractiveness of research positions (salaries, quality of life, organisation of the doctoral studies, career prospects, research organisation, research units, ratio of teaching to research tasks, financing, quality of academic colleagues). In addition to the average value, the indicator made up of the individual categories also depicts a statistical fluctuation range in order to account for the potential bias in the qualitative indicators.

purchase private insurance coverage. The situation is similar with regard to pensions. Though most positions usually provide insurance coverage, universities outside of the EU tend to more frequently provide additional packages. As with health insurance, these more frequently tend to be private pension funds in those non-EU countries that were examined in the study.

Though Austria provides thoroughly attractive conditions for researchers when it comes to social security provisions when compared internationally (including in comparison to the US), the situation is slightly different when it comes to those conditions that researchers tend to rank as important aside from salary. Scientists rank the US as being particularly attractive as a place in which to conduct research, followed by a group of well-regarded European countries such as the Netherlands, Sweden, Switzerland and Great Britain. Austria ranks near Germany on this list, followed closely by France and Italy (see Fig. 29). In this analysis only Spain and Poland showed lower scores for attractiveness. Austria was considered relatively less attractive in international comparison when it comes to conditions for doctoral students, career perspectives for young researchers, research organisation at universities and the quality of colleagues in one's field.[104]

To summarise, Austria is above average in terms of university researcher salaries in comparison with other EU member states as well as in comparison with OECD countries, though salaries do tend to be notably lower than those in the countries with the highest salaries. Financial compensation, however, must not be examined separately from other conditions that researchers consider to be important if the aim is an accurate assessment of the attractiveness of salaries and university positions. The US especially, but also a group of European countries, distinguish themselves by virtue of superior general and working conditions (such as academic jobs that already offer clear career prospects from early stages) as well as high degrees of autonomy when it comes to one's research, the quality and prestige of researchers and high salaries. In this international comparison, Austria ranks in the middle range.

3.3 Business enterprise funding of universities

Compared with other countries, public funding traditionally constitutes a high proportion of the R&D funding structure in the Austrian higher education sector (2011: 88.3% This goes hand in hand with the fact that the business enterprise sector contributes a far lower portion of the funding (5.2%, for more see Chapter 1.2).

As part of the Times Higher Education World University Ranking of the "World Academic Summit Innovation Index"[105] assessed how much funding researchers at universities were able to secure for the acquisition of R&D from businesses, both nationally and internationally. With an average of US$11,300 per researcher, Austria came in 27th out of 30 countries (cf. Table 26). Researchers in South Korea (US$97,900) and Singapore (US$84,500) were the most successful in securing funding from business enterprises, followed by those in the Netherlands (US$72,800), which are at the top amongst European countries. Somewhat surprisingly, Germany and Switzerland came in at places 21 and 22, whilst the UKlay just ahead of Austria at place 26.

The results of the study gave further impetus to the already existing conversation in Austria about the necessity for greater interaction between the university and business sectors.[106] However, these results should be regarded with caution. The analysis did not include all of the universities and universities of applied science in each country, but only those that were listed at that time in the Times Higher Education

104 See Janger et al. (2013).
105 See Times Higher Education (2013a).
106 See derStandard.at (2013); DiePresse.com (2013); Salzburger Nachrichten (2013).

Table 26: Amount of funds for the acquisition of R&D per researcher according to the Times Higher Education survey 2013

Ranking	Country	Average value per researcher (US$)	Ranking	Country	Average value per researcher (US$)	Ranking	Country	Average value per researcher (US$)
1	South Korea	97,900	11	Russia	36,400	21	Germany	19,400
2	Singapore	84,500	12	Turkey	31,000	22	Switzerland	17,600
3	Netherlands	72,800	13	Canada	27,200	23	Brazil	14,900
4	South Africa	64,400	14	USA	25,800	24	Italy	14,400
5	Belgium	63,700	15	Australia	25,600	25	Israel	13,600
6	Taiwan	53,900	16	Japan	24,900	26	United Kingdom	13,300
7	China	50,500	17	Finland	24,500	27	Austria	11,300
8	Sweden	46,100	18	New Zealand	22,300	28	Norway	9,100
9	Denmark	43,600	19	France	21,000	29	Portugal	8,600
10	India	36,900	20	Hong Kong	20,000	30	Ireland	8,300

Source: Times Higher Education (2013a).

Ranking and which therefore belonged, according to the Times Higher Education Ranking, to the top 400 universities worldwide. This means that Austria was represented by the University of Vienna, the University of Innsbruck, the Vienna University of Technology, the University of Graz and the Johannes Kepler University Linz.[107] With the exception of the Vienna University of Technology, the research focus of the Austrian universities that were included in the ranking were on natural sciences, social sciences and the arts and humanities. These fields of science traditionally attract lower-than-average amounts of R&D funding from the business enterprise sector (under 2% in Austria for each field), whilst contributions to the technical sciences (13.4%) and human medicine or health sciences (6%) are notably above average.[108] With the exception of the Vienna University of Technology, those Austrian universities which are characterised by the high portion of R&D funding secured from the business enterprise sector were not included in this analysis. Thus, the basis for assessing the Austrian situation is somewhat distorted and cannot be regarded as representative.

A fully different picture emerges if one undertakes an international comparison of funding by the business enterprise sector of R&D at universities based on official R&D statistics (composed on the basis of the OECD's Frascati Manual,[109] which ensures an international comparability) (cf. Table 27). With US $10,800 (purchasing power parity) in national R&D expenditure from the business enterprise sector per researcher in the higher education sector, Austria sits comfortably in the top third of OECD countries. The list is led by Germany with an average of US $25,700 of funding from nationally based firms per researcher. South Korea, which achieves an average of US $97,900 per researcher according to the World Academic Summit Innovation Index, comes in 5th with an average value of US $16,200. Singapore has an average of US $3,100 (compared to US $84,500). After Germany, the Netherlands (US$18,700) and Switzerland (US$16,000) lead the list of Western and Central European countries. The average per researcher in the UK (with some of the world's best universities) of US $2,700 lies well below the EU-15 average value of US $8,500.

When adding OECD data additionally it is

107 See Times Higher Education (2013b).
108 See Statistics Austria (2013a).
109 See OECD (2002).

Table 27: Average corporate-financed R&D expenditure per researcher, 2011

Ranking	Country	national Ø value / researcher (FTE, $ PPP)	international Ø value / researcher (FTE, $ PPP)	Ranking	Country	national Ø value / researcher (FTE, $ PPP)	international Ø value / researcher (FTE, $ PPP)	Ranking	Country	national Ø value / researcher (FTE, $ PPP)	international Ø value / researcher (FTE, $ PPP)
1	Germany	25,700	n.a.	11	Sweden**	8,700	10,400	21	Iceland	4,600	n.a.
2	China	23,300	n.a.	12	Slovenia*	8,600	9,100	22	Greece	4,500	n.a.
3	Turkey*	22,300	22,400	13	Russia*	8,000	8,300	23	Australia*	4,400	n.a.
4	Netherlands	18,700	n.a.	14	Chile*	7,800	n.a.	24	Japan	4,100	n.a.
5	South Korea*	16,200	16,700	15	Chin. Taipei	7,200	n.a.	25	Ireland*	3,400	4,000
6	Switzerland*	16,000	n.a.	16	Spain*	7,000	7,200	26	Singapore*	3,100	3,600
7	Canada	14,000	n.a.	17	Finland*	6,600	8,100	27	France*	3,100	3,400
8	Belgium**	12,200	12,400	18	South Africa*	6,600	n.a.	28	Estonia	3,000	3,800
9	Hungary*	11,100	11,800	19	Norway**	6,300	6,500	29	United Kingdom*	2,700	3,700
10	Austria	10,800	12,700	20	Denmark*	4,800	5,100	30	New Zealand	2,500	n.a.

* 2010 data; ** 2009 data

Source: Own calculations based on OECD (2013).

possible to calculate what portion of a country's total R&D expenditure made by the business enterprise sector sources is made up of R&D financing from foreign businesses. This allows to calculate, for some countries, the entire amount of expenditure made by firms for R&D at universities. The amended values that include funding from foreign firms in the column labelled "intern. Ø-value/researcher (FTE, US$ PPP)" show that a comparable amount of R&D funding for universities from the business enterprise sector (21.17% in 2009) comes from foreign firms. Only Denmark, Estonia, Finland, Sweden, Ireland and the UK (which with 38.9% for 2010 generates by far the largest share of funding from abroad) have higher figures.

Though Austria does not occupy a top position in rankings even when the entire higher education sector is taken into consideration, the situation does appear far less troubling from the Austrian perspective. It is important to remember that the system of government funding for research in several of the countries under comparison is far less pronounced than it is in Austria (and thus firms directly fund university research to a greater degree) and that non-university research institutions play a more limited role in many countries than they do in Austria (this too leads to universities being directly funded by firms). Austrian competence centres (COMET programme), which have experienced dynamic growth in the past several years (for more, see Chapter 5.2), especially exhibit very close relationships with Austrian universities since the latter form the core of the centres, scientific partners. A minimum proportion of the funding for the competence centres is contributed by firms. If this share of 40% of R&D expenditure by firms would classify as a for funding flow from firms to universities, the average R&D expenditure made by businesses per researcher in the higher education sector would increase by about 27%.[110]

Austria's university researchers would then find themselves classed with those in Switzerland, South Korea and Canada. This would still be well below German levels, but represent a very good position in Europe overall.

110 See Statistics Austria (2013b), own calculations.

3.4 Knowledge transfer between the higher education sector and firms

3.4.1 Results of the European Knowledge und Technology Transfer Practise Survey

New knowledge generated through research and development activities is a major driver of technological change and economic growth. Universities and public research institutions play an essential role in this process.[111] For instance just under a third of Austrian R&D expenditure was invested by the public sector in 2011.[112] A functioning transfer of knowledge between universities or public research institutions and firms is especially important if the knowledge and skills resulting from this are to be used for economic purposes. For this reason, the Knowledge Transfer Study 2010/2012 examined among other things the implementation of the *"Recommendation on the management of intellectual property in knowledge transfer activities and Code of Practice for universities and other public research organisations"* , which was issued by the European Commission in 2008, and the performance of universities and public research institutions in relation to this type of knowledge transfer. A series of indicators was collected in two comprehensive qualitative surveys which looked at the implementation of measures aimed at improving knowledge transfer within European countries (EU plus associated states). This section examines the results of this examination in greater detail for Austria in 2012, with the focus of this analysis on the performance of universities and public research institutions. The analysis of universities and public research institutions in this study uses results from the *European Knowledge Transfer Indicators Survey (EKTIS)* for 2010 and 2011, which looked at questions on research activities, intellectual property rights, patents, licensing and other topics relevant for knowledge transfer at leading universities and public research institutions.

Austria performed exceptionally well in a country comparison on the implementation of the European Commission's recommendations, coming out on top of all countries under observation. The analysis showed that measures to improve knowledge transfer have either been implemented or at least planned in Austria for 93% of the recommendations. As such Austria is considerably above the European average figure of 53%, and ahead of both the UK (87%) and Germany (78%). If the focus is put on measures that have already been implemented, then Austria is with 85% in second place behind the UK in a country comparison (average of all countries under observation: 48%). The results show that the issue of knowledge transfer is given high importance politically in Austria.

The performance of universities and other public research institutions in terms of knowledge transfer was measured by surveying six key indicators and three additional indicators, which are listed in Table 28.

The indicators were assessed using a combination of data sets from 2010 and 2011 in order to make them more meaningful. This allowed 17 universities and public research institutions in Austria to be included in the study, corresponding with just under half of the base population. The values have been stated per 1,000 researchers so that the results can be compared between the individual countries.[113]

Unlike the results from the country comparison on implementation of the recommendations from the European Commission, Austria does not come out on top in Europe in terms of the indicators assessed for knowledge transfer. Both in an examination of the individual knowledge transfer indicators, as well as in a collective review of all the indicators, Austria was below the

111 See Salter, Martin (2001); Statistics Austria (2013a).
112 See Statistics Austria (2013a).
113 See Arundel et al. (2013).

Table 28: Indicators for assessing the performance of universities and public research institutions

Key indicators	Supplementary indicators
• Number of registered inventions • Number of original patent applications • Number of technically unique patent approvals • Number of start-ups • Number of licences or option agreements with firms • Amount of licence revenues	• Number of R&D agreements between institutions and firms examined • Number of patents approved with the USPTO • Number of start-ups with a product or process brought to market

Source: Arundel et al. (2013).

European average, and in some cases considerably below this figure (see Table 29).

In order to improve classification of the performance of Austrian universities and public research institutions in relation to knowledge transfer, a different approach was taken at the results of the Knowledge Transfer Study 2010–2012 (see Table 30):

The combined indicators in the two last columns show that very different levels and mechanisms of knowledge transfer are in operation here. For instance public technical universities contribute to knowledge transfer in Austria essentially through the above-average number of inventions that they register, the amount of their licence revenues and their number of R&D agreements. The fact that the number of registered patents is relatively low compared with the high number of registered inventions is connected with the fact that the rights to the inventions developed in cooperation with universities and firms are frequently assigned to the cooperation partner. The significant number of cooperation activities of public technical universities also explains the exceptionally high number of R&D agreements and the high licence revenues generated through assigning the rights to the inventions developed. While the very positive result regarding knowledge transfer for technical universities is of little surprise, the high value for colleges of art needs to be viewed with caution. It must be assumed here that this value arises primarily from the fact that a majority of people employed are allocated to teaching in these establishments. The units active in research and experimental development at public colleges of art are very small but exceptionally effective, which explains the extremely high values per 1,000 researchers.

The analyses provided by the authors also reveal results for individual specialist areas (see Table 31). This data allows inferences to be drawn as to the fields in which knowledge transfer was able to be implemented with particular success in Austria.

Table 31 shows that the fields of biomedicine and nanotechnologies and new materials are particularly successful at using generated knowledge. 29.8% of licence revenues at Austrian universities or other public research institutions were generated in the field of biomedicine. This is followed by the nanotechnologies and new materials sector with a share of 25.1%, above ICT with 18.1%. 64.7% of all research institutions stated that they had made at least one patent application in the biomedicine field in the years under review. For 35.3% of the establishments, this relates to patents in the ICT sector and for 29.4% the nanotechnologies and new materials sector. The values related to patents in the field of biomedicine are strikingly high. This is attributable to the fact that economic exploitation of research results is heavily dependent on patent applications in this field in particular.

3.4.2 Patent activities of Austrian universities

Exploiting research results via patents is a relevant channel for technology transfer between science and industry in many natural science, engineering and medical science disciplines.

Table 29: Combined results of the EKTIS, 2011 and 2012[114]

EKTIS 2011 and 2012: combined results for Austria (according to type of research institution)	Number of inventions registered per 1,000 researchers	Number of patent applications per 1,000 researchers	Number of patents granted per 1,000 researchers	Number of start-ups per 1,000 researchers	Number of licence agreements per 1,000 researchers	Licence income per 1,000 researchers (in EUR 1,000)	Number of R&D agreements per 1,000 researchers	Combined KT indicators with same weighting	Combined KT indicators with variable weighting
Austria	9.8	3.7	2.9	0.4	1.6	38	73.3	0.244	0.235
EU + associated countries	15.6	7.9	4.5	1.7	6.5	399	82.8	0.256	0.248
Highest value	78.5	69.1	35.9	6.4	23.9	3,130	300.2	0.387	0.391

Source: Arundel et al. (2013).

Table 30: Combined results of the EKTIS, 2011 and 2012 (according to type of institution)

EKTIS 2011 and 2012: combined results for Austria (according to type of research institution)	Number of inventions registered per 1,000 researchers	Number of patent applications per 1,000 researchers	Number of patents granted per 1,000 researchers	Number of start-ups per 1,000 researchers	Number of licence agreements per 1,000 researchers	Licence income per 1,000 researchers (in EUR 1,000)	Number of R&D agreements per 1,000 researchers	Combined KT indicator with same weighting	Combined KT indicator with variable weighting
Non-university	4.3	2.3	0.0	0.3	1.7	13.3	1.0	0.213	0.232
Public medical university	14.1	9.9	5.6	0.1	1.5	0.0	93.3	0.204	0.213
Public technical university	19.7	5.4	5.9	0.3	0.9	116.5	173.1	0.316	0.339
Public college of art	56.3	33.1	30.0	0.5	20.0	0.0	40.0	0.602	0.623
Other public university	7.6	1.7	0.9	0.6	1.3	12.3	18.4	0.178	0.154
Austria	9.8	3.7	2.9	0.4	1.6	38	73.3	0.244	0.235
EU + associated countries	15.6	7.9	4.5	1.7	6.5	399	82.8	0.256	0.248

Source: Arundel et al. (2013).

Table 31: Combined results of the EKTIS, 2011 and 2012 (according to field)

EKTIS 2011 and 2012: combined results for Austria (according to discipline)	Licence revenues	Proportion of research institutions with at least one patent application	Number of patent applications
Biomedicine	29.8%	64.7%	11
Information and Communication Technology, software (ICT)	18.1%	35.3%	6
Nanotechnologies and new materials	25.1%	29.4%	5
Low carbon and carbon-free energy technologies	0.0%	11.8%	2
Other disciplines	27.0%	35.3%	6
Total	100.0%	-	30

Source: Arundel et al. (2013).

114 The combined indicators include the results for all seven knowledge transfer indicators captured. A combined value was calculated for every indicator based on the individual institution. With this the smallest value for an indicator was first of all subtracted from the value of the institution. The resulting difference was divided by the difference between the highest and the lowest value for all values observed, resulting in a value of 1 for the institution with the highest value observed and of 0 for the institution with the lowest value observed. The results of the countries were ascertained by adding up the results at the institution level.

New regulations of the use of inventions discovered at universities were implemented as part of the Austrian Universities Act in 2002 (UG 2002). Since then the university's governing body must be notified of any inventions discovered as part of work activities, and this body will make a decision on whether to adopt the invention and apply for a patent. Separate offices have been set up or appointed for this purpose at most Austrian universities. The legal change was accompanied by several support initiatives for the universities from the federal government, in particular the [tecma] and uni:invent programmes.[115]

This section examines developments in the number of patent applications by Austrian universities (universities and universities of applied sciences, incl. the Austrian Academy of Sciences) since 2000. The data is from the patent database PATSTAT of the European Patent Office. Patent applications from Austrian universities were identified using a text field search in the "Applicant name" field.[116] Applications to all patent offices worldwide are taken into account. Patent applications to multiple offices are only counted once.[117] As a result of the interval between the priority date for a patent application (which is often the same as the time of the invention) and the publication of a patent application (which generally occurs 18 months after the application is received), only patent applications which were made by 2011 were capable of being recorded in full.

From a very low level in the early 2000s (10-15 applications per annum), the number of patent applications from Austrian universities rose swiftly from 2004, reaching their highest value in 2006 with 139 applications (Fig. 30). This heavy increase is the result of the application rights being transferred to the universities through the UG 2002 and the setting up of professional patent exploitation structures at the universities, which were essentially supported by the uni:invent programme set up in 2004. The high figure in 2006 is also partly the result of "catch-up effects", since older inventions were taken up in some cases with patent applications made for these based on the changes to the legal situation.[118] After 2006 the number of patent applications by Austrian universities fell somewhat and since that time the number has been around 100 to 120 applications per annum.

Applications were made for patents at Austrian universities for a total of almost 900 inventions in the twelve years between 2000 and 2011. Measured against the total number of patent applications by Austrian applicants, which came to around 35,000 in this period, the university share remains low at around 2.5%. Nevertheless this share increased considerably from 0.5% in 2004 to over 3% in 2006. Since then this value has been between 2.5 and 3.0% (Fig. 31).

The applications for an overwhelming share of patents from Austrian universities are made internationally, i.e. not just at the Austrian Patent Office, but at patent offices abroad (including the international application channels via the EPA and through the PCT procedure at the WIPO). The average percentage of international patent applications between 2000 and 2012 was 74% (see Fig. 32). This figure means that the universities are approaching the share for firms (84%), and have a more international focus in their patent activities than non-university and co-operative research establishments[119] (57%).

115 See Gassler et al. (2010).

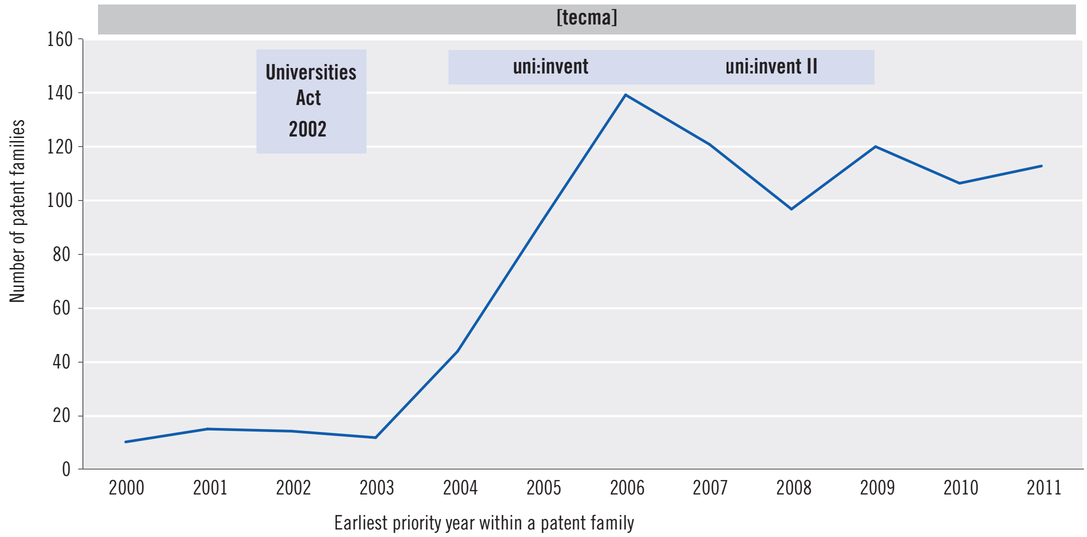
116 It is possible that a few patent applications from Austrian universities could not be captured as a result of different ways of writing the applicant universities and differences in the entry fields in the "Applicant name" text box. Applications by university professors were also taken into account in addition to the applications by the universities themselves, provided that the title University Professor or Professor was also stated in the "Applicant name" text box and the applicants were working at an Austrian university at the time of the patent application. These applications by the professors account for around 3% of the total number of patent applications by Austrian universities in the period 2000–2011, with the majority of applications made prior to 2006.

117 Patent applications made at multiple offices are designated as a patent family. The priority year of the first patent application within a family is used in order to determine the application year for patent families.

118 See Schibany et al. (2009).

119 Cooperative research not including AVL List.

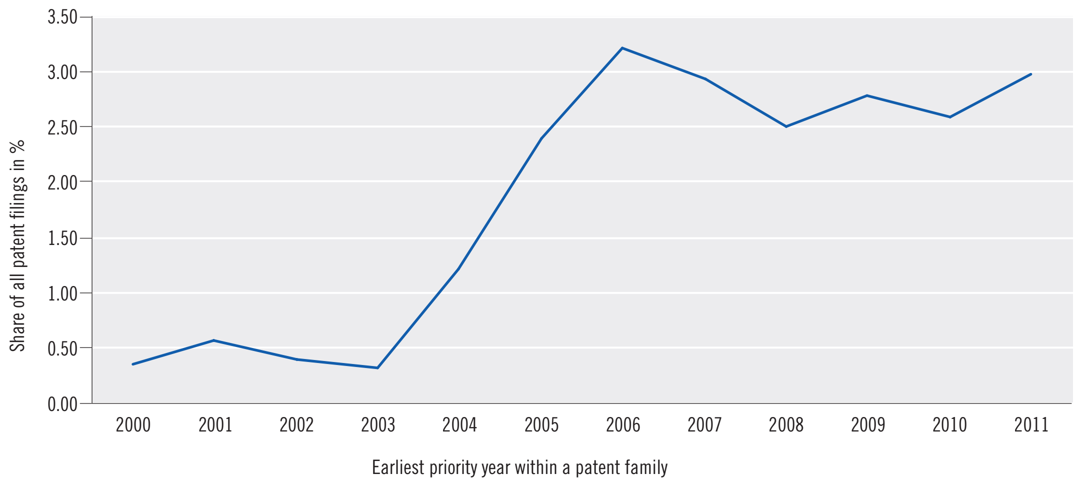
Fig. 30: Number of patent applications by Austrian universities, 2000–2011



The information in the boxes represents significant policy measures for patent activities at Austrian universities.

Source: EPO: Patstat. – Calculations: ZEW.

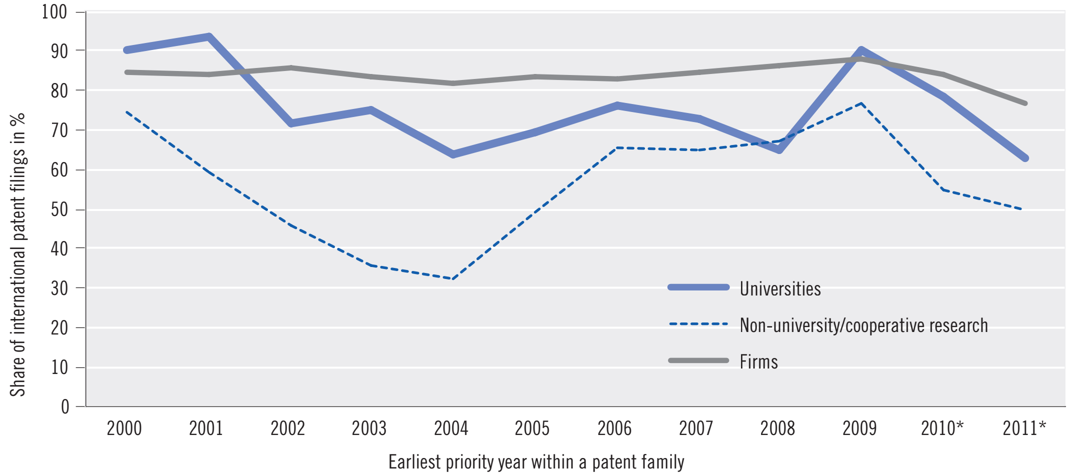
Fig. 31: Share of patent applications by Austrian universities in all patent applications by Austrian applicants, 2000–2011



Source: EPO: Patstat. – Calculations: ZEW.

The patent activities of the Austrian universities are focused around a few of the universities (Fig. 32). The two technical universities in Graz and Vienna collectively applied for 44% of all patents made by Austrian universities in the period 2000–2011 (Graz: 23%, Vienna: 20%). The third-biggest applicant was the University of Innsbruck (10%), followed by the Medical University of Vienna (8%), the University of Vienna (6%), the University of Linz (5%) and the University of Leoben (5%). The Austrian Academy of Sciences or its affiliated establishments applied

Fig. 32: Share of international patent applications, 2000–2011, by sector



* The share of international patent applications is probably underestimated as patent applications made in these years may in some cases still be made in later years at foreign or international offices.

Source: EPO: Patstat. – Calculations: ZEW.

for 2% of the patents. Among the universities of applied sciences, only the University of Applied Sciences Technikum Wien has made more than 10 patent applications since 2000. The breakdown of patent applications among the individual universities primarily reflects the difference in significance of technical inventions as a result of scientific research based on the disciplinary focal points of the universities and the size of the establishments.

The development of patent activities of the Austrian universities since the reforms of the UG 2002 can be viewed as positive overall. The transition of the initial access to inventions to the university's governing body has allowed intellectual patentable property to be managed professionally. The number of patented inventions increased considerably.[120] The result was that the large universities with engineering and natural and medical science faculties became major stakeholders in the Austrian patent system. For instance universities have regularly been among the ten Austrian organisations with the highest number of patent applications since 2006.[121]

Table 32: Number of patent applications of the Austrian universities 2000–2011

Graz University of Technology	207
Vienna University of Technology	174
University of Innsbruck	89
Medical University of Vienna	74
University of Vienna	49
University of Linz	45
University of Leoben	41
Medical University of Graz	38
University of Natural Resources and Life Sciences, Vienna	38
University of Graz	28
University of Veterinary Medicine Vienna	28
University of Applied Sciences Technikum Wien	19
Austrian Academy of Sciences	17
University of Applied Sciences Joanneum	5
Medical University of Innsbruck	5
UMIT – private university of Health Sciences, Medical Informatics and Technology	4
University of Music and Performing Arts Graz	3
University of Music and Performing Arts, Vienna	3
University of Salzburg	3
University of Applied Sciences St. Pölten	2
University of Applied Sciences Carinthia	2
Paracelsus Private Medical University of Salzburg	2
University of Art and Design Linz	2
University of Applied Sciences Campus Wien	1
MCI Management Center Innsbruck	1
University of Applied Arts Vienna	1
University for Continuing Education Krems	1
Vienna University of Economics and Business	1

Source: EPO: Patstat. – Calculations: ZEW.

This development has been accompanied essentially by technology-related measures implemented by the federal government. In addition to the consultancy offering of the programme administered by the aws [tecma], which has now been in place for over 15 years, the essential support on offer after the end of the uni:invent programme in 2009 has above all included the knowledge transfer centres set up with the new promotional programme "Knowledge Transfer Centres and Exploitation of IPR", including patent and prototype promotion, as well as the measures by the "National Contact Point – Intellectual Property" (e.g. online sample contract www.ipag.at). A further aws programme "Licence.IP" is currently being developed.

3.5 The Austrian universities of applied sciences and its role in the national research system

Since the university of applied sciences sector (the UAS sector) was founded and the first courses were established in academic year 1994/95, capacities in the UAS sector have grown considerably both in relation to the primary education function as well as to the secondary research and development function. The UAS sector has a complementary function to the research and education activities of the universities and of the non-university research institutions. The growth in the UAS sector is outlined below using R&D data from the universities of applied sciences. An analysis of participation levels in national funding programmes by the Austrian Research Promotion Agency (FFG) discusses the significance of the universities of applied sciences for Austrian research, and specifically for small and small and medium-sized enterprises (SMEs) operating at the regional level.

The university of applied sciences sector (UAS sector) in the R&D surveys 2002–2011

The Austrian UAS sector has the primary task of offering courses of study at university level for the purposes of a well-founded scientific professional education.[122] In order to guarantee this the relevant parties maintaining the UAS sector have to ensure that the teaching and research staff take part in applied research and development work, with this potentially taking place at the relevant establishment or through cooperation with other research and development institutions.[123]

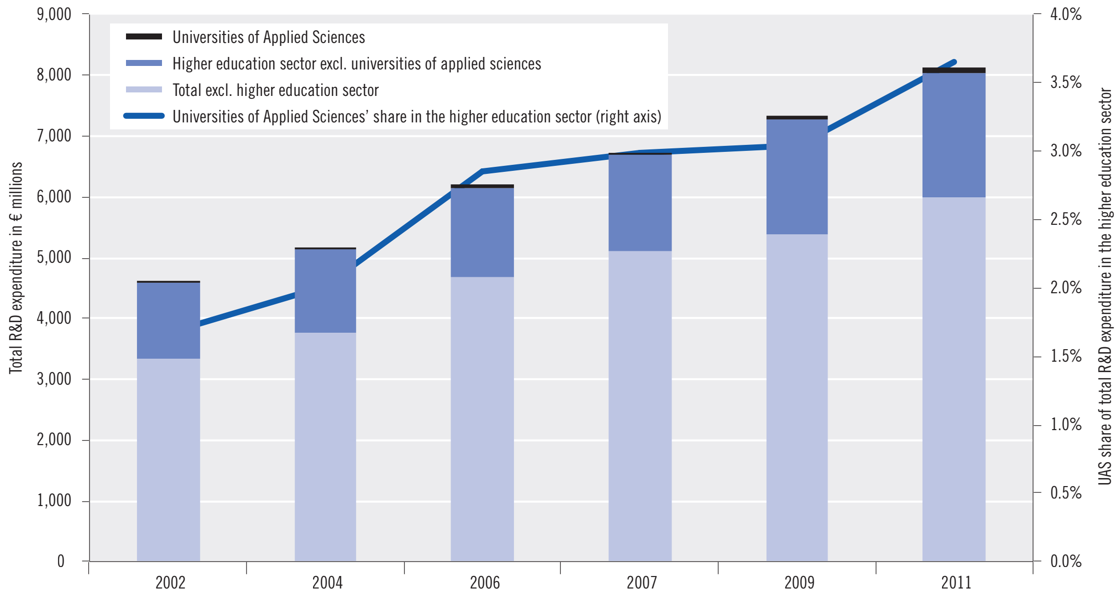
In accordance with their task of providing applied research and development which is enshrined in statute, the universities of applied sciences recorded a EUR 21 million increase in R&D expenditure to EUR 77 million in the period between 2002 and 2011.

Despite this heavy increase, the UAS sector continues to play a relatively minor role in the Austrian R&D scene overall. R&D expenditure in the UAS sector is around the same magnitude as that of the Austrian competence centres, and corresponds with 0.95% of overall Austrian R&D expenditure. In 2011 the R&D expenditure of the universities of applied sciences was 3.7% of the total R&D expenditure of the higher education sector (see Fig. 33).

Nevertheless it is apparent that the UAS sector has somewhat increased in importance with regards to R&D activities in the higher education sector. For instance the share of R&D expenditure for the UAS sector measured against the R&D expenditure for the higher education sector as a whole increased significantly over the entire period under review to 3.7% from a figure of 1.7% in 2002. Measured against re-

120 However, there is no systematic information regarding how many inventions made at universities had corresponding patent applications prior to the reform, since these inventions were often registered via cooperation partners of the universities (firms) and the link between these patents to the university research can only be established via the names of the inventors.
121 See the corresponding publications of the Austrian Patent Office on the ten organisations with the highest number of patents granted.
122 See section 3 (1) and section 10 (7) of the applicable version of the Austrian Universities of Applied Sciences Studies Act (FHStG).
123 Ibid.

Fig. 33: Absolute R&D expenditure (in € millions) and proportion of universities of applied sciences in the higher education sector (in %), 2002 to 2011



Source: Statistics Austria. Calculations: AIT.

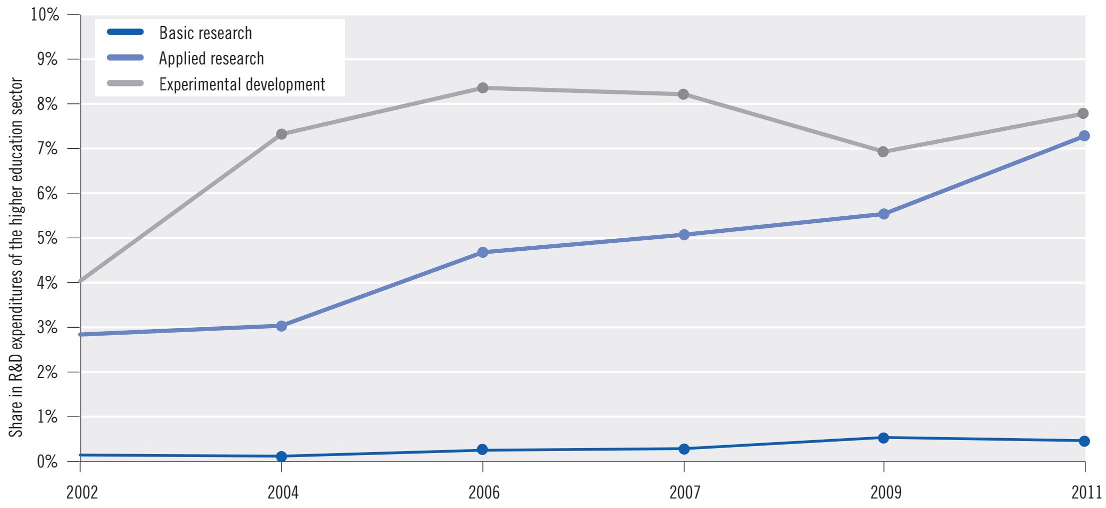
searchers (full-time equivalents), the UAS sector now accounts for 5.3% of research staff in the higher education sector (1.7% of total research staff in Austria).

The direction of the research undertaken in the UAS sector is also specifically application-oriented in nature. 93% of the research expenditure of the universities of applied sciences is attributable to applied research and experimental development, with only 6.9% attributable to basic research. As such, the low figure for the proportion of basic research corresponds roughly with the proportion for the business enterprise sector (5.7%) and differs significantly from that of the overall higher education sector (53.9%). However, while experimental development dominates in the business enterprise sector (60.6% of overall R&D expenditure), applied research is by far the prevailing type of research at the universities of applied sciences (75.6% of overall R&D expenditure).

Measured against the R&D expenditure for the higher education sector, the Austrian universities of applied sciences are responsible for 7.3% of applied research and 7.8% of experimental development (Fig. 34). This can be viewed as an indicator that the universities of applied sciences are becoming established in both of these application-related types of research.

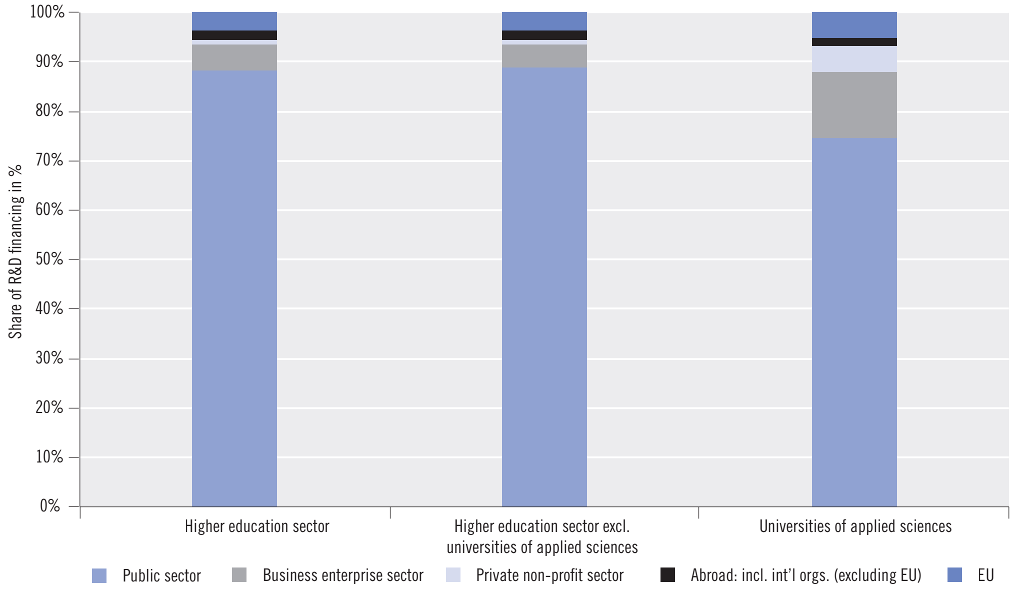
The specific significance of the UAS sector for firms becomes clearer if the R&D financing structure for the higher education sector and for the UAS sector is considered (Fig. 35). The business enterprise sector financed EUR 109 million of R&D in the higher education sector in 2011. The universities of applied sciences accounted for EUR 10 million or 9% of this in 2011. This corresponds with a tenfold increase in R&D financing from the higher education sector in the period between 2002 and 2011, while R&D financing from the business enterprise sector in the overall higher education sector merely doubled in the same period: The universities of applied sciences were therefore able to raise EUR 9 million (16%) from the EUR 58 million of additional funds from the business enterprise sector in the higher education sector in 2011 compared

Fig. 34: Share of universities of applied sciences of R&D expenditure in the higher education sector according to research type (in %), 2002–2011



Source: Statistics Austria. Calculations: AIT.

Fig. 35: Share of financing areas in R&D expenditure by the higher education sector (overall, plus excluding universities of applied sciences) and by universities of applied sciences (in %), 2011

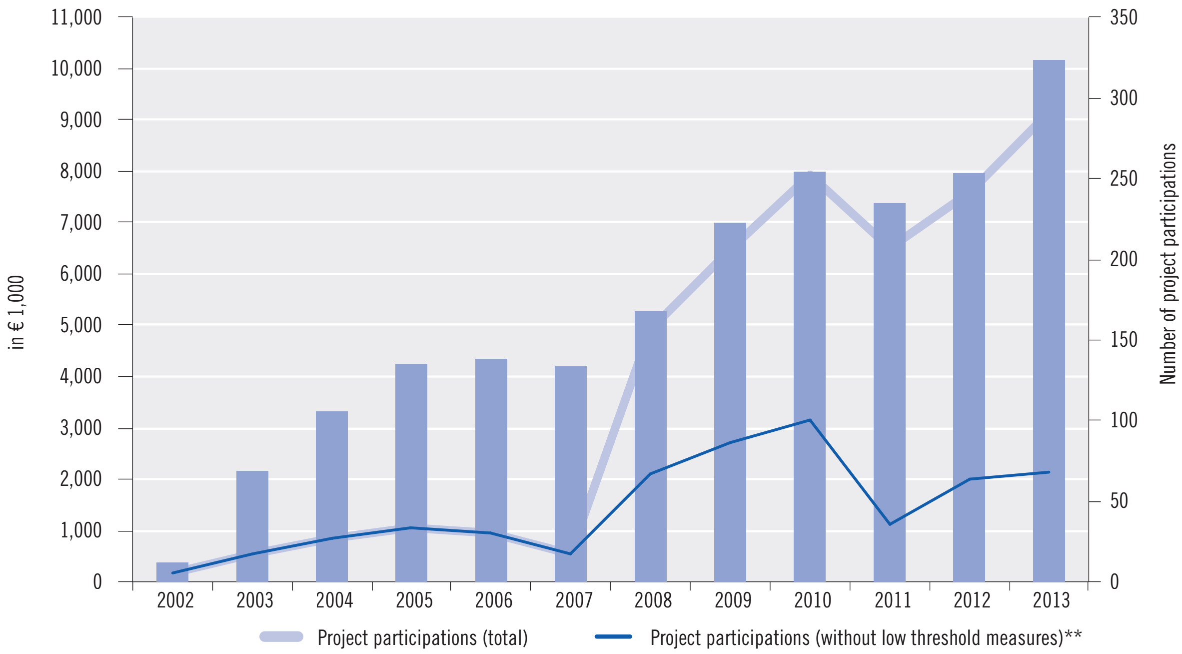


Source: Statistics Austria. Calculations: AIT.

with 2002. The business enterprise sector thereby finances over 13% of the R&D expenditure of the universities of applied sciences, while the corresponding value for the higher education sector as a whole is just under 5%.

The universities of applied sciences also boast a share in overall R&D financing which is slightly above the average in relation to financing by the EU. Around 5% of EU funds for financing R&D in the higher education sector are

Fig. 36: Development of the Austrian Research Promotion Agency (FFG) cash values* for the Austrian universities of applied sciences, 2002–2013



* In order to avoid distortions in the values presented the cash values were distributed proportionately over the lifetime of the project.
** Innovation Voucher, research expertise for industry plus Talents.

Source: Austrian Research Promotion Agency (FFG) database Calculations: AIT.

accounted for by the universities of applied sciences, with these funds also thereby contributing 5% to the overall R&D expenditure of the universities of applied sciences.

Participation of the university of applied sciences sector in national funding programmes in the period between 2002–2013

The status and increased significance of the UAS sector for the national R&D scene can finally be demonstrated through the participation of the universities of applied sciences in the cooperative and application-oriented national funding programmes (see Fig. 36). While just 15 projects in total from the universities of applied sciences were recorded as having been part of the national funding programmes of the Austrian Research Promotion Agency (FFG) between 2000 and 2003, the Austrian universities of applied sciences were able to increase both the number of project participations as well as the corresponding subsidy volume, not least as a result of specific structural programmes such as FH*plus* and COIN. For instance the number of projects by the Austrian Research Promotion Agency (FFG) with participation from the universities of applied sciences rose from less than 25 projects per annum in the period between 2002 and 2007 to just under 300 projects in 2013.

The increase in participation is in particular attributable to the below-threshold programmes "Innovation Voucher", "Research expertise for industry" as well as "Talents", which were created specifically for SMEs, which are generally operating in a regional environment. Excluding these programmes, between 36 and 100 subsidy agreements were entered into with participation from universities of applied sciences between 2007 and 2013.

The subsidy cash value generated annually of the universities of applied sciences increased from just under EUR 2 million in 2003 to more than EUR 10 million in 2013. In total the Austrian universities of applied sciences attracted funds amounting to EUR 82.7 million in the period between 2000 and 2013. 22% of this was attributable to the FH*plus* subsidy programme, while a further 34% was attributable to the COIN – Cooperation and Innovation programme. In total these two UAS-specific funding programmes therefore represent the most significant funding programmes for the UAS sector.

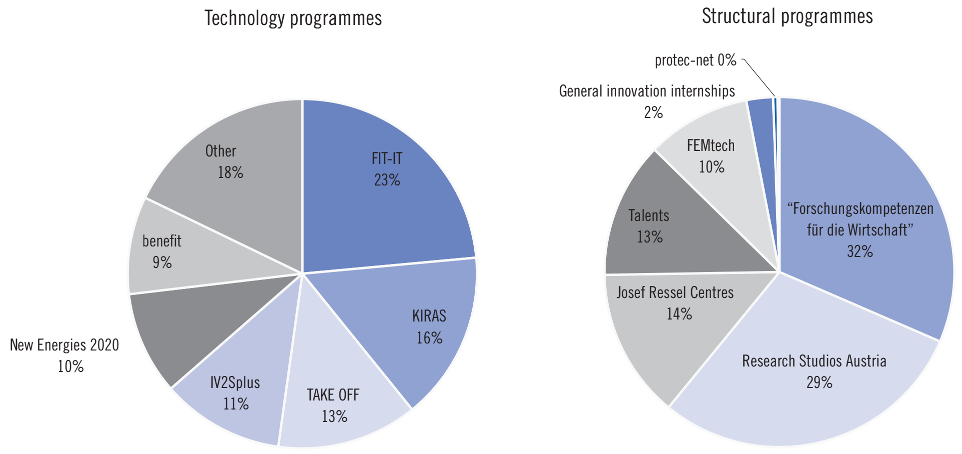
However, the universities of applied sciences also successfully took part in other programmes in addition to becoming established in FHplus and COIN. Across the entire UAS sector, 25% of the funds obtained come from the area of topical programmes. A further 7% come from structural programmes, 6% from the general programmes and 5% from the Innovation Voucher and Innovation Voucher plus funding systems.

Within the area of "Thematic programmes", the ICT subsidy programme FIT-IT represents the most significant programme in terms of participation from universities of applied science (see Fig. 37), followed by the KIRAS (security research), Take-Off (aerospace), IV2Splus (intelligent traffic systems) and Neue Energien 2020 (energy) funding programmes.

Two thematic focal points for university of applied sciences participation can be demonstrated with the area of "structural programmes" (see Fig. 37):

1. *The educational role of universities of applied sciences for the regional economy via participation in the research expertise programmes for industry (FoKo) and Talents:* The "Research expertise for industry" programme encourages firms (primarily SMEs) to systematically expand their existing research and innovation staff and increase their qualifications, and enshrines company-related research priorities at Austrian universities and universities of applied sciences.[124] The universities of applied sciences are acting both as leaders of more short-term qualification seminars and of more long-term qualification net-

Fig. 37: Participation of the universities of applied sciences in the Austrian Research Promotion Agency (FFG) support areas technology and structural programmes, 2002–2013



Source: Austrian Research Promotion Agency (FFG) database. Calculations: AIT.

124 See https://www.ffg.at/Forschungskompetenzen.

works, where the intention is for innovative expertise in firms to be increased in fields of technology which are relevant to the future in cooperation with universities and the universities of applied sciences. The universities of applied sciences implemented a large number of research internships for pupils in particular as part of the Talents programme.

2. *The establishment of research and teaching expertise at universities of applied sciences via the pilot action of the Josef-Ressel Centres as well as via the Research Studios Austria programme:* The Research Studios Austria introduced in 2008 by the Federal Ministry of Science, Research and Economy (BMWFW) promote the use and implementation of research results from basic research at the forefront of corporate research in Austria. Between 2008 and 2013, the first three Josef-Ressel Centres were also supported by the Austrian Research Promotion Agency (FFG) as part of a pilot action at the universities of applied sciences in Upper Austria, Vorarlberg and Burgenland. The objective of the Josef Ressel Centres is to use the acquired research results to develop or continue the development of products, procedures and services. It should therefore be the role of firms to make economic use of the results, while the universities of applied sciences should exploit the results by using them for teaching and for further R&D activities.

An evaluation[125] of the pilot action confirmed the signal and appeal through the Josef Ressel Centres in priority-setting at universities of applied sciences and in interlinking the research with the teaching. Following the end of the pilot action at the Austrian Research Promotion Agency (FFG), an independent support programme was established for Josef Ressel Centres in the research company Christian Doppler Forschungsgesellschaft (CDG), which is geared towards the established cooperation model for CD laboratories. The support is specifically focused in the area of applied research at a high level and will be in place for five years. The annual budget is set at up to EUR 400,000. There were four new Josef Ressel Centres already active (universities of applied sciences in Upper Austria/Hagenberg Campus, Salzburg, Technikum Wien and Vorarlberg) as of January 2014. Up to 15 new Josef Ressel Centres are planned for the full programme supported by the Federal Ministry of Science, Research and Economy (BMWFW).

In addition to the participation in the thematic programmes and structural programmes within the Austrian Research Promotion Agency (FFG) or subsequently the CDG as stated above, the high level of participation by the universities of applied sciences in the Innovation Voucher programme is also worthy of note: *"The Innovation Voucher is a type of funding offered to small and medium-sized enterprises in Austria aimed at allowing them to start up ongoing research and innovation activities. With the Innovation Voucher, firms are able to approach research institutions (non-university research institutions, universities of applied sciences and universities) and, depending on their need, pay for their eligible services up to a maximum amount of EUR 5,000 using the Voucher, or for up to EUR 10,000 if they make a personal contribution of 50% (Innovation Voucher plus). This should therefore make it easier for SMEs to overcome the obstacles to cooperation with research institutions"*.[126] Since the introduction of the Innovation Voucher in 2007/2008, Austrian universities of applied sciences have carried out around 765 R&D projects for SMEs. Based on the results of the interim assessment of the Innovation Voucher subsidy, it can be seen that Austrian universities of applied sciences were involved in around 20% of Innovation Voucher transactions for SMEs in the period between 2007–2011.

125 Gerhardter, Gruber (2010).
126 See https://www.ffg.at/innovationsscheck.

The Austrian universities of applied sciences also reported their participation in national competency centre programmes (K-programmes). The universities of applied sciences recorded a total of five cases in the years 2000–2006 where they participated in the K_Ind competency centre programme for manufacturing. Since the start of the COMET programme there have been 13 instances of participation in K1 centres, seven in K2 centres and nine in K-projects. The universities of applied sciences involved were able to attract a subsidy cash value of around one million euros in the K-projects. No subsidy cash values are stated for participation at the centres.

The Austrian universities of applied sciences have been involved in a total of 3,571 publicly funded cooperation partnerships with other organisations between 2000 and 2013. 70% of the partnerships are attributable to the business enterprise sector, 16% to universities, 6% to non-university research institutions and 7% to other establishments. The COMET competency centre programme accounts for the (potentially) highest number of cooperation partnerships on account of the networking character of the programme with a large number of network partners, followed by Innovation Voucher, the technology programmes and the structural programmes.

A location-specific analysis of the cooperation partners of universities of applied sciences reveals that Austria's universities of applied sciences to a large extent cooperate with local organisations in their home state (Table 33). In addition to the home states, neighbouring regional governments as well as Vienna represent the most significant cooperation partners of Austrian universities of applied sciences. The high level of participation in below-threshold R&D support tools, coupled with a high number of cooperation partners from the same federal state, suggests that Austria's universities of applied sciences specifically engage in R&D activities which are geared towards the demand structures in the regional environment.

Summary

In summary, it can be confirmed that there has been a significant increase in R&D expenditure for the university of applied sciences sector since 2002. Both the proportion of overall Austrian R&D expenditure as well as of the R&D expenditure of the higher education sector increased considerably with this.

In terms of the direction for R&D in the universities of applied sciences (FH), applied research and experimental development are, as expected, of higher average importance than they are in the higher education sector, while basic research plays a subordinate role in the UAS sector. The importance of the UAS sector for regional firms in particular can be seen from

Table 33: Cooperation partners of the universities of applied sciences by location (Austrian regional governments)

Partner UAS location	Burgen-land	Carin-thia	Lower Austria	Upper Austria	Salzburg	Styria	Tyrol	Vorarl-berg	Vienna	Abroad
Burgenland	22%	3%	15%	8%	3%	19%	4%	4%	19%	2%
Carinthia	0%	51%	2%	4%	4%	10%	2%	1%	22%	4%
Lower Austria	0%	1%	36%	14%	2%	7%	2%	2%	36%	0%
Upper Austria	0%	1%	8%	58%	4%	8%	2%	1%	15%	2%
Salzburg	1%	1%	5%	28%	38%	8%	3%	1%	14%	3%
Styria	0%	5%	5%	5%	1%	60%	2%	1%	20%	2%
Tyrol	1%	3%	6%	3%	5%	6%	44%	11%	20%	2%
Vorarlberg	0%	0%	11%	12%	0%	6%	8%	37%	22%	2%
Vienna	1%	2%	14%	7%	2%	11%	4%	2%	56%	1%

Source: Austrian Research Promotion Agency (FFG) database Calculations: AIT.

the participation by the universities of applied sciences in the application-based national funding programmes of the Austrian Research Promotion Agency (FFG). The UAS sector was able to build up certain research infrastructures and sustainable expertise through participation in specific research programmes for universities of applied sciences, in particular FH*plus* and COIN as well as the Josef-Ressel Centres. Against this background, application-based R&D projects are implemented in particular in the UAS sector with firms in a predominantly regional environment. The subsidies which are particularly significant are those that are structurally geared towards the needs of SMEs, such as "Innovation Voucher" and "Research expertise for industry", where universities of applied sciences frequently operate as partners in innovation and knowledge transfer for firms.

3.6 New social media and its significance for scientific research

The availability of new information technology and social media changes the scientific production process. This can be seen for instance in the availability of large quantities of data, the involvement of citizens in the research process, the establishment of new online publication formats and effective cooperation between different stakeholders at the global level. Digital technologies and the codification of knowledge have generated multiple diverse opportunities for producing, accumulating and distributing knowledge. Global access to large and complex quantities of data ("big data") has enabled new types of cooperation and usage, and changed the scientific process together with the methods used in this. A number of scientific and innovation researchers have recently started to characterise and examine these types of phenomena: concepts such as Science 2.0, Cyberscience and E-Science are making their way into the discussion in this context.[127] Some of these developments are discussed and the challenges for research agendas are outlined below.[128]

Big Data and Open Data

The quantity of data produced in science, society and industry is increasing exponentially. Data that is collected by sensors in mobile telephones and cars can also be listed here as well as data saved in social networks or financial transactions. Current studies show that 1.2 zettabytes of electronic data are generated annually *"…. by everything from underground physics experiments and telescopes to retail transactions and Twitter posts"*.[129] This trend, which is also known as big data, is considered to be a huge potential in science for the purposes of addressing new types of research queries, and industry for developing innovative products and services. Up until now research has not only been primarily concerned with the issue of how the huge heterogeneous quantities of data can be analysed, but also of how they can be archived, transferred and used by innovative technologies and applications over the long term. A series of projects and initiatives can be listed for instance in the areas of bioscience and medicine which attempt to combine and manage data and make it available for various applications worldwide.[130] This goes hand in hand with innovative distributed computer architectures and systems such as grid computing, a type of distributed computer which allows the computing capacities of multiple computers to be used simultaneously. The use and treatment of this data, e.g. through identification of unexpected correlations in the data structures, the interpretation of empirical findings and the formulation of new types of research questions is considered to be a central challenge with this for public and

127 See Nentwich, König (2012); Schroeder (2008); Breivik et al. (2009).
128 Based primarily on the results of the project Research and Innovation Futures (RIF) 2030. See: Schaper-Rinkel et al. (2012) pages 9–27.
129 See Mervis (2012).
130 See Howe et al. (2008).

private research.[131] At the same time it can also be stated that in business in particular, big data does not necessarily mean data that is made generally available (open data). Firms are currently developing many applications where data is not disclosed. These include the linking and evaluation of complex customer data.

The US is a significant pioneer in the development of big data. The Office of Science and Technology Policy at the White House started the *"Big Data Research and Development Initiative"* in 2012. The aim of this project is to facilitate the development of technologies in cooperation with various public stakeholders which will allow data to be generated, saved, managed, analysed and shared. It is assumed here that the private sector in particular should play a leading role in developing big data systems. At the same time, the government is promoting the corresponding research and development. It is also setting the regulatory framework, particularly in relation to data protection and guarantees of privacy. The National Science Foundation and the National Institute of Health have recently started to promote some initial interdisciplinary projects, and are also planning to support the universities in establishing interdisciplinary graduate programmes for big data in future. The Virtual Laboratory can also be stated here: this is a tool which allows scientists to exchange their molecular modelling globally for the purposes of developing new medications on a uniform data network.[132] The "Whole Brain Catalogue" also shows how different stakeholders are able to cooperate in the research and innovation process.[133] This open platform for brain research was developed by a team from the University of San Diego. Anyone who is interested in this research can take part, and not just a few privileged researchers from other partner universities. The global community that has developed in this fashion in recent years works both on fundamental research questions as well as on tangible medical applications and procedures.

The European Commission wants to promote big data with Horizon 2020, and has for instance published its own priorities for funding big data in the first call for the information and communication technologies programme line. The European Grid Infrastructure Initiative can be mentioned here.[134] The European Commission supported the setting up of this e-infrastructure, which links European researchers through a common data and computer structure. While the current discussion around big data is generally centred around the analysis of unstructured data, large quantities of structured data are also of central importance in research. The Large Hadron Collider (LHC) at CERN is an example here which, in line with the principle of open data, has been providing large quantities of data to the research community since 2009. The LHC Computing Grid (LCG) provides a distributed computer and storage network infrastructure for the experiments on the Large Hadron Collider.

One Austrian example is the establishment of the European bio-database at the Medical University of Graz. In total, there are 16 electronic databases present at Austrian universities according to assessments from the research infrastructure database of the Federal Ministry of Science, Research and Economy (BMWFW), which collects different categories of research infrastructure from the Austrian universities.[135] However, these are only provided to third parties to a limited extent (Open for Collaboration). The European e-infrastructure OpenAIRE which the University of Vienna also takes part in can also be noted here.[136] The aim of this research

131 See Frankel, Reid (2008).
132 See Buyya, Abramson (2003).
133 http://wholebraincatalog.org/.
134 http://www.egi.eu/.
135 See Heller-Schuh and Leitner (2012).
136 http://openaire.univie.ac.at/.

infrastructure is to create free-of-charge public access across Europe to quality-checked scientific articles via a central electronic portal. The Centre for Digital Humanities (ZDG) at the Austrian Academy of Sciences or the research infrastructure CLARIN and DARIAH run by the University of Graz aimed at developing specific basic services, repositories and digital research methods for research in the humanities can be mentioned here.[137] Big data projects have also been encouraged in Austria by the Austrian Research Promotion Agency (FFG) since 2013 under the "ICT of the future" programme umbrella. The internet portal data.gv.at also offers a catalogue of open data records and services from public administration (Open Government Data). This data can be used freely, both for personal information as well as for commercial purposes.

The term *Open Notebook Science* as defined by a US chemist can also be referenced in this context. *Open Notebook Science* means making the data generated within the scope of research projects directly available on the internet. This way scientific data is made freely available within a few hours, even before the actual publications are created by the researchers involved – something which can take a few years in the case of peer-reviewed publications. An increasing number of scientists have adopted this strategy, placing the notebooks as used in laboratories online. Jean-Claude Bradley defines *Open Notebook Science* as *"the practice of making the entirety of one's laboratory notebook and all associated raw data public in as close to real time as possible"*.[138] The aim is for this transparent approach also to make data available to the scientific community which is not traditionally published, for the purposes of publishing failed or unverified experiments or those which are of limited significance.

Data-driven research methods

Making displaced large and complex quantities of data usable for research involves a development process which is known as a data-driven research method in the literature.[139] Researchers postulate with this that traditional hypothesis and theory-driven research will be replaced by data-driven research methods in some fields in future.[140] Wired Magazine writes for instance of the end of traditional science in this context and states: *"The quest for knowledge used to begin with grand theories. Now it begins with massive amounts of data"*.[141] Some scientists see a particular potential here in combining the traditional hypothesis-driven approach to research with the data-driven approach for the same project in the laboratory.[142] Information technology infrastructures including databases acquire an increasingly major role against this background in terms of identifying correlations and patterns in the data, as well as in driving experimental research.

As part of big data development, sensory participative data collection (*Participatory Sensing*) is an additional important development channel which specifies that individuals and communities collect and save events, patterns and infrastructures in a wide variety of fields from health to culture using their personal mobile phones and web services. The champions of this development see major opportunities for acquiring scientific knowledge through citizens and communities of citizens not only generating and documenting data collectively, but also being involved in interpreting and developing research issues.[143]

137 www.clarin-dariah.at.
138 Quoted in (Stafford, 2010).
139 See Schaper-Rinkel et al. (2012) page 14.
140 See Burgelmann et al. (2011); ICSU (2011).
141 http://www.wired.com/images/press/pdf/1607cover.pdf.
142 See O'Malley, Soyer (2012).
143 See Goldmann et al. (2009).

New forms of communication and publication

New forms of information technology and social media create diverse opportunities for research results to be communicated and published, and are on the brink of transforming the scientific research process. In addition to traditional forms of publication in newspapers and books, multimedia presentation and publication options on the internet are increasingly being used, ranging from presentations and videos and animations embedded in publications through to discussions on internet blogs.

Reference can also be made to open access in this context, i.e. the efforts to make peer-reviewed scientific publications freely available on the internet. This development was already discussed in detail in the Austrian Research and Technology Report 2013, to which reference should be made here.

The online encyclopaedia Wikipedia has become an important online reference in recent years. While the quality, validity and scope of Wikipedia entries is a controversial issue, the entries made there often provide a starting point for further research into a topic by researchers.[144] The initiative started in 2008 whereby findings from peer-reviewed articles in Wikipedia are replicated can be mentioned here as an example in the area of biology and RNA research.[145] The success of Facebook has also encouraged the scientific community to increase presentations and cooperation by and between scientists. Websites such as ResearchGate, Academia.edu and Mendeley[146] allow research results and data to be published and shared and discussed with others. Yet social networks such as LinkedIn and XING also provide a place for scientists for networking, discussion and presentation of their research work. The messaging service Twitter is also an essential asset which as well as being suitable for distributing research results, also specifically acts as a "filter". A large number of journals, research organisations and individuals tweet news about their scientific work. Users receive the posts that are interesting to them in their Twitter channel. Instruments and platforms for joint use of data and options for setting up blogs and Wiki articles on the net are relatively easy for scientists and institutions to use and also speed up the application and distribution process. New forms of rapid (pre-) publication and of fast feedback from the community are also growing.[147]

New types of web and software-based options for communication and cooperation between scientists go hand in hand with strategies aimed at common use and integration of data which are already a central component in many areas of any research work in chemistry and medicine today. These include applications whereby properties of molecules are modelled on the net in a cooperative manner.[148] The success of the Human Genome Project (HGP), where the principle of making data available to third parties prior to actual publication has been in place for some years, is probably one of the best known and most important examples which can be stated at this point.

The use of new technologies and media thereby accelerates the research process, consolidates cooperation and interaction at the global level and enables a high degree of inclusion of citizens and society – frequently even in real time.[149] The technologies and applications described are not only used within specific research communities and networks – they have encouraged interaction and cooperation between different institutions and scientific disciplines, and have thereby also facilitated the car-

144 See Giles (2005).
145 See Daub et al. (2008)
146 http://www.mendeley.com, http://www.researchgate.net/.
147 See Mandavilli (2011).
148 See Williams (2008).
149 See Schroeder (2008); Shneiderman (2008).

rying out of interdisciplinary and transdisciplinary research. At the same time, questions arise in relation to scientific quality assurance, work distribution and the status of researchers in scientific activities which are increasingly dominated by social media and their conventions.

The developments described here thereby support the "Open Science" paradigm, i.e. the demand first made by Robert Merton that the objective of scientists is to justify the priority of a scientific discovery by first revealing progress in knowledge.[150] New social media and information technology support this demand and allow all data generated within the scope of research work to be made public (sometimes in real time). In relation to the challenge and dynamics, this development has a high level of affinity with the development of open innovation as increasingly demanded within the framework of the description of commercial innovation activities (see also chapter 4.3.1). Both developments go hand in hand and open up, digitise and link the overall research and innovation process, from basic research through to applications in industry and society.

Challenges for for the research agenda

There are a large number of policy challenges which arise against this background of digitalisation and exchange of data between various disciplines, organisations and nations, which go beyond pure research and innovation policy and also include fields such as safety and security, warranties, copyright and data protection and which thereby also touch upon many social areas. The issues as to how data can be saved and protected, access secured and user-friendliness increased on a sustainable basis are important topics on the development and policy agenda. Some researchers also warn against a new type of digital divide potentially opening up in this context, characterised by *"the big data rich and the big data poor"*.[151]

Science 2.0 requires new investments in data infrastructures (e-infrastructures) and new capabilities and skills on the part of scientists in order for them to be able to participate successfully in the process. The need and level of these types of investment must be taken into account accordingly by universities and research institutions in their financing and facility decisions. However, there is still little comparable information overall at the international level on the distribution, participation and use of Austrian scientists and institutions in the new research methods and strategies described here.

There are also challenges regarding the issue of how public access to data and information can be secured for as many stakeholders as possible – including for the purposes of the open science and open access postulate – if universities and research institutions are at the same time in competition for third-party funding and commissioned projects. They could achieve an advantage in the short term in individual cases where they keep data and findings secret or provide them exclusively to the client. This conflict of priorities will become more acute in some cases in future, for instance those involving the acquisition of R&D for manufacturing, where the research institutions wish to finance their investments in databases and electronic infrastructures through projects or scientific publishing houses have to find new business models. Issues around data protection and privacy in particular are a factor in this that could potentially limit the spread of the phenomena described here.

150 See Merton (1973).
151 See Boyd, Crawford (2012).

4 Research and Innovation in the Business Enterprise Sector

4.1 International orientation is key when it comes to technological competitiveness

4.1.1 Austria's position in the global value chain

Given the increasing globalisation and integration of the world economy, domestic output in Austria has become more international over the past several years. The successive dismantling of international trade barriers, which has been accelerated by the work of the World Trade Organisation (WTO), founded in 1995, has been essential in this development. In 2001 China joined the WTO and the country has since become a central actor in the world economy. European integration and the realisation of a common market was given strong impetus by the 1992 founding of the European Union following the signing of the Maastricht Treaty.

Structural changes are evident in the specialisation of certain products, and these changes are also accompanied by an increasing fragmentation of production processes. One vital prerequisite for this specialisation, amongst others, is a comparative cost advantage, which means that a country specialises in the production of goods that are produced cheaper than in other countries. This development leads to fundamental changes in the way the global economy functions, especially with respect to the division of labour in the production process. Firms that previously integrated all aspects of their work internally now spread these functions across a number of companies and countries, with the result that international delivery networks – and relationships of dependence amongst various countries – have grown dramatically.[152] And since information and communication technologies (ICT) are constantly being improved, the outsourcing of work to companies abroad is no longer limited to just some parts of the production process, such as accounting and support services.

These trends have a significant impact on Austria as a business location, too. Given its tight integration in import-export networks, Austria is now characterised by a steadily growing participation in global markets as well as a resultant dependence on foreign suppliers and markets, which affects Austria to a greater degree than larger economies. For that reason, the impact of changes in the global trade network is far greater for Austria than for larger economies.

Global value chains

Today products cross a number of international borders as they make their way to consumers, which is well illustrated by production networks and value chains. Global value chains describe the full range of activities required to bring a product or service from conception via the intermediate phases of production to delivery to consumers and final disposal after use.[153]

The concept of global value chains has gained in international importance in the past few years, especially as a result of the availability of

152 See Linden et al. (2009); Hummels, Ishii (2001); Johnson, Noguera (2012).
153 See Gereffi, Fernandez-Stark (2011).

global, multi-regional data that portrays the input-output relationships between countries. Examples include the World-Input-Output-Database (WIOD)[154] and the Global Trade Analysis Project (GTAP). The central indicator in the analysis of global value chains is the determination of the proportion of the value added contributed by other countries to one's own exports and, conversely, the proportion of the value it adds to the exports of other countries.[155] This indicator enables the consideration of indirect relationships in the production process ("imports for exports"), whereas standard foreign trade statistics depict data only in gross terms, which do not allow for any conclusions regarding the location along the value chain (upstream or downstream). The absence of indirect relationships in foreign trade statistics leads to the value of a country's exports being overestimated. This is especially true for emerging economies, which tend to focus on the labour-intensive assembly of imported intermediate goods, which contributes only a small amount to the finished product's value added. Apple's iPhone is a prominent example. Chinese manufacturers are responsible only for the assembly of individual components and therefore contribute only 1.8% to the total value added of the final product. When discussed in terms of gross value, though, the entire value of the iPhone is attributed to China's exports.[156]

Value added in exports

A country's position in global value chains and the competitiveness of that country in terms of international trade can be determined on the basis of developments of it's domestic content of value added in exports as well as its indirectly exported value added. By means of the Network-Value-Added-Index (NWI), which illustrates the share of value added by country "r" in the exports of country "s" for any pair of countries in the network.[157]

Countries that lead globally in the export of manufactured products and industrial goods include Germany (DEU), the US (USA) and China (CHN), which are all tightly integrated into the global trade network. Germany creates a large portion of the value added of the exports of European countries and therefore dominates the European market for manufactured goods and services. Comparing the global trade network in 1995 with that in 2011, we find that the large economies of Russia (RUS), the US and Germany were still the strongest and most central players on the market, but the situation changed remarkably by 2011. First, China has clearly grown in significance. Germany and especially Russia have lost in importance. Furthermore it is clear that the degree of integration, measured by the number and strength of relationships, has grown significantly in the past decade.

An examination of Austria's position in the global trade networks demonstrates that the size of an economy matters. Austria's position in the global market, however, has remained stable since 1995. Austria is generally well integrated in European trade, especially in Eastern Europe. The country contributes a considerable share of value added to the exports of neighbouring countries such as Hungary and Slovenia. Austria's own exports are strongly dependent on value added imports from Germany, Italy, China and the US.

Austrian value added in a global context

Fig. 38 shows the development of Austria's gross exports as well as its domestic and foreign content of value added. One can see that gross exports continually rose between 1995 and 2008,

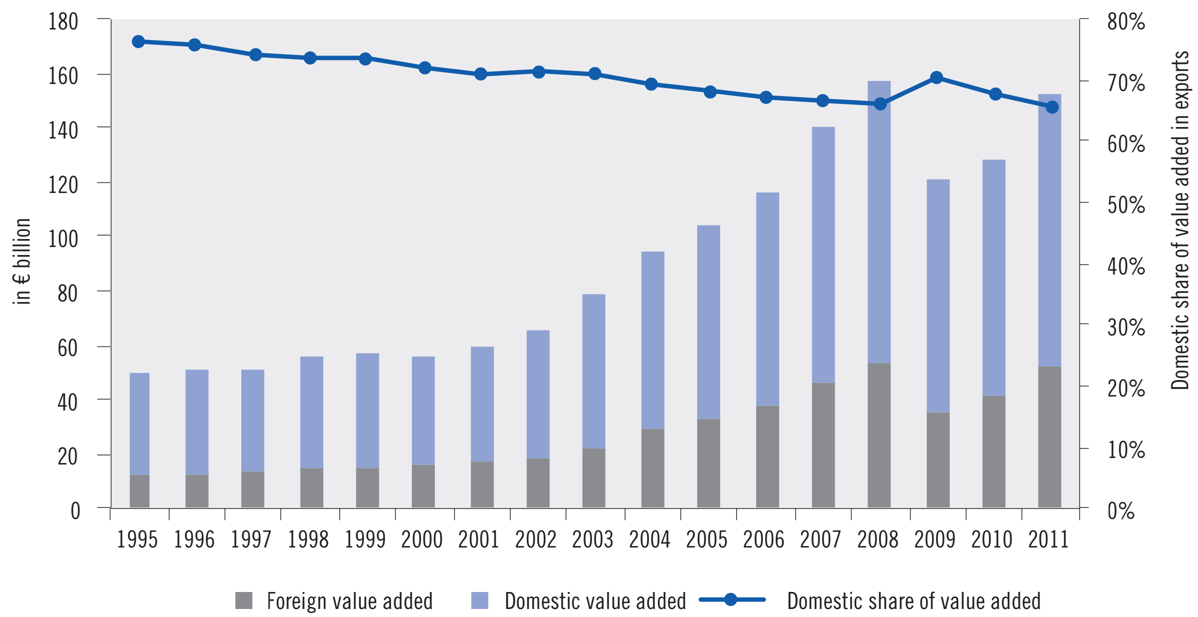
154 Timmer et al. provides a detailed methodological description of the WIOD database (2012).
155 See Johnson, Noguera (2012); Dedrick et al. (2010); Hummels et al. (2001).
156 See Kraemer et al. (2011).
157 See Fig. 60 in Annex.

but that they noticeably declined in 2009 as a result of the global economic crisis. Recovery began in 2011, during which gross exports were nearly able to reach pre-crisis levels. The share of domestic value added steadily declined between 1995 and 2011 as a result of progressive internationalisation (from 76% in 1995 to 66% in 2011).

The proportion of foreign value added to a country's gross exports depends on the size of that country's economy and the degree of specialisation. The share of foreign value added in Austria is relatively high in global comparison (2011: around 34%). Countries with large economies, such as the US, Russia and Japan, produce a large portion of the necessary intermediate products themselves and are therefore less dependent on foreign imports. The domestic contribution to value added is therefore also significantly higher. This was over 85% in 2011 for the US, Russia and Japan. Domestic contributions to value added are equally high in those countries, such as Australia, that are rich in natural resources since the processes related to the discovery and extraction of natural resources are only dependent on intermediate products to an insignificant degree.[158]

Given the growing share of foreign value added in Austrian gross exports, it is natural to ask which countries contribute most to this development. As depicted in Fig. 39, the largest share of foreign value added comes from Germany (DEU), followed by the remaining EU-12 countries (RoEU-12), especially Italy and France, as well as south-eastern Europe (SEE), with the Czech Republic leading the way. A comparison over time reveals that Germany's share has slightly decreased but still remains the largest amongst the countries compared. It should additionally be noted that the portion of value added contributed by the remaining EU-12 countries declined (from 25% to 19%), whilst that from south-eastern Europe has risen significantly.

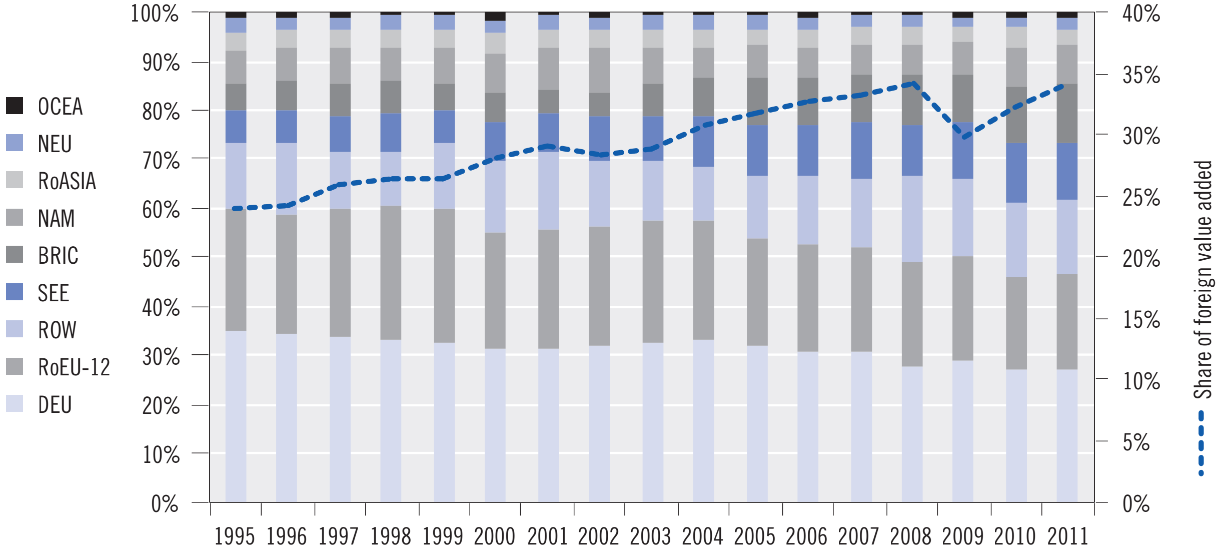
Fig. 38: Developments in gross exports, sorted into domestic and foreign share of value added (in € billions)



Source: WIOD (2013). Presentation: JOANNEUM RESEARCH (2014).

158 See OECD-WTO (2012), OECD (2013).

Fig. 39: Breakdown of foreign share of value added of Austrian gross exports by country



Source: WIOD (2013). Presentation: JOANNEUM RESEARCH (2014). (See Annex I for country abbreviations).

The BRIC countries, with China leading amongst them, have also gained in influence.

In addition to the size of a country's economy, the level of foreign value added is also dependent on the country's economic structure (degree of specialisation, mix of industries) and the composition of gross exports by sectors. Empirical studies have demonstrated that the degree of global networking at the level of industry or economic sector can deviate widely.[159] The international fragmentation of a production process depends on the product's technical characteristics and is far more prevalent in manufacturing and assembly than in the services sector.

This correlation is also reflected in the breakdown of Austrian gross exports by industry. As is evident in Fig. 40, the share of foreign value added is greatest in the manufacturing industry, which is dependent on imported primary goods and raw materials. The share of foreign value added in the metal industry, for example, amounted to 46%. It is furthermore evident that these industries account for a large portion of Austria's total gross exports. In contrast, gross exports in the healthcare, education and housing industries are small, as is to be expected. Their share of domestic value added, however, is large by comparison.

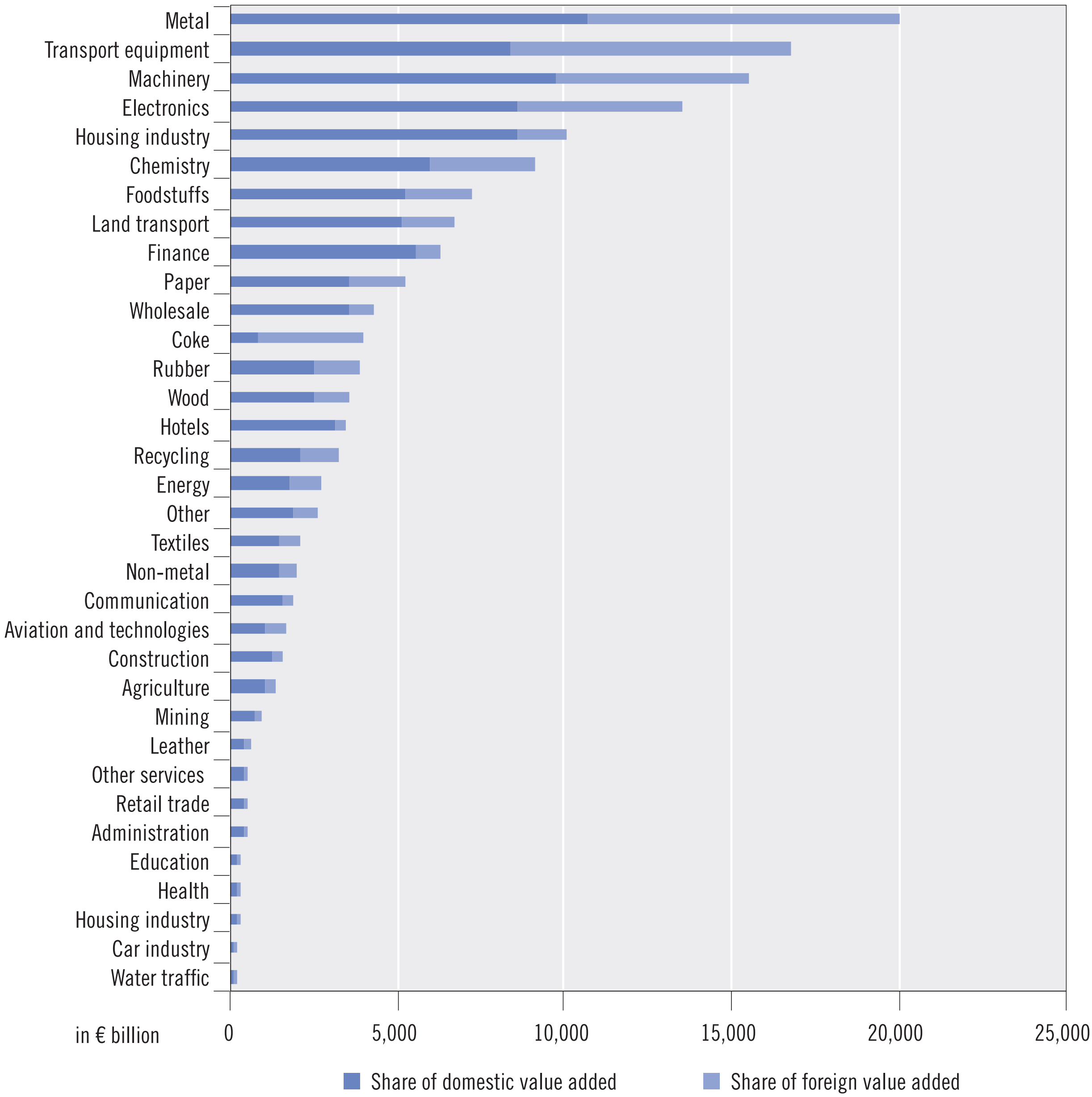
The fragmentation of production processes is of central importance especially for products built in a modular fashion in the high-tech industries. This takes the form of parts and components produced in a variety of countries to be exported to other countries, the so-called assembly countries, where a product is assembled into its final form. The internationalisation of modular products has had an impact especially on the following industries: electrical machinery and equipment; radio, television and telecommunications equipment; transport devices; and the automobile industry. The highest levels of foreign value added are in the production of transport devices (foreign value added at 50%),

159 See Ferraini (2011); Gereffi et al. (2005).

machinery (38%) and electronics (36%), which are also Austria's strongest export industries.

The counterpart to foreign contributions to Austrian exports is the Austrian contribution to other countries' exports, which is often defined as indirectly exported value added. This demonstrates above all which countries regard Austria as an important supplier of products. This indirect value added amounted to around €37 billion in 2011, from a total of around €170 billion

Fig. 40: Gross exports by industry, sorted into domestic and foreign share of value added, 2011



Source: WIOD (2013). Presentation: JOANNEUM RESEARCH (2014).

in direct exports (Fig. 41). In comparison, foreign producers added around €52 billion of value to Austria's exports. The share of value added contributed by Austria to gross exports by other countries has noticeably risen in exactly the same way as the share of value added contributed by other countries to Austria's gross exports. Annual growth between 1995 and 2011 averaged about 7% (and about 11% in the previous period 2000–2008).

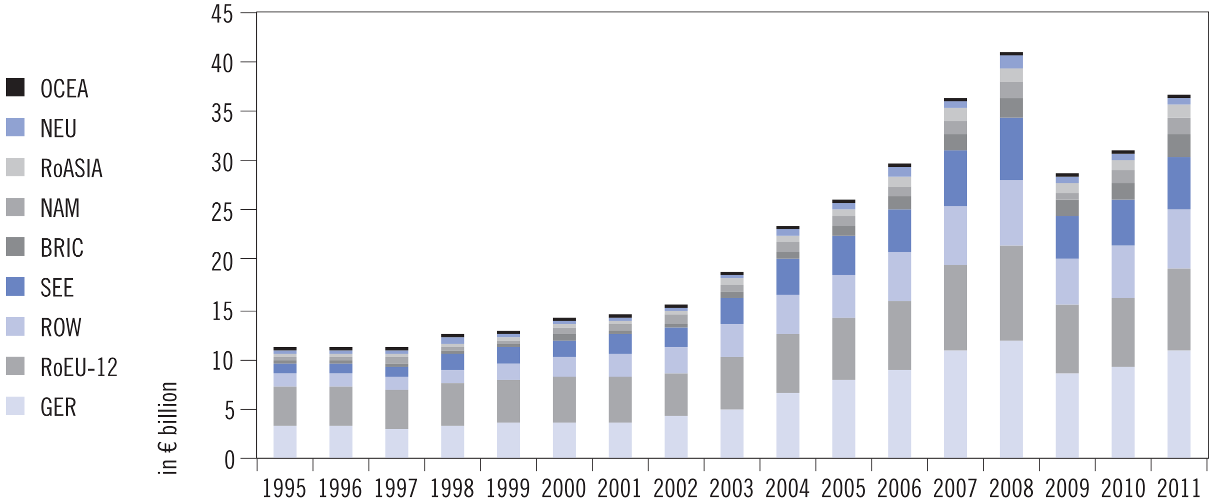
As indicated by more detailed analyses,[160] Austria plays a role via third party countries in exports to the US, China and Mexico. These are all countries that can not necessarily be directly connected to Austria's gross value added. Analysing the indirect value added contributed by Austria to gross exports on the level of individual countries, we find that a significant portion (around 25% in 2011) can be attributed to Germany (DEU), which is Austria's most important trading partner. It should be noted that south-eastern Europe has become an important market for Austria, with Hungary, Slovenia and Poland as central trading partners. An amount that is certainly not insignificant from the Austrian perspective goes to the BRIC countries.

Austria's participation in the global market

When both indicators are taken into account together – the foreign share of value added in a country's gross exports and that country's share of value added to the gross exports of third party countries – a clearer picture arises of the complex connections that characterise foreign trade in the global market. Fig. 42 shows values for 2011, with the foreign share of value added in domestic gross exports on the vertical axis and the share of indirect value added on the horizontal axis.

A country has a high degree of participation or integration in the world market when it has both a relatively high share of indirect value added and a high share of foreign value added in

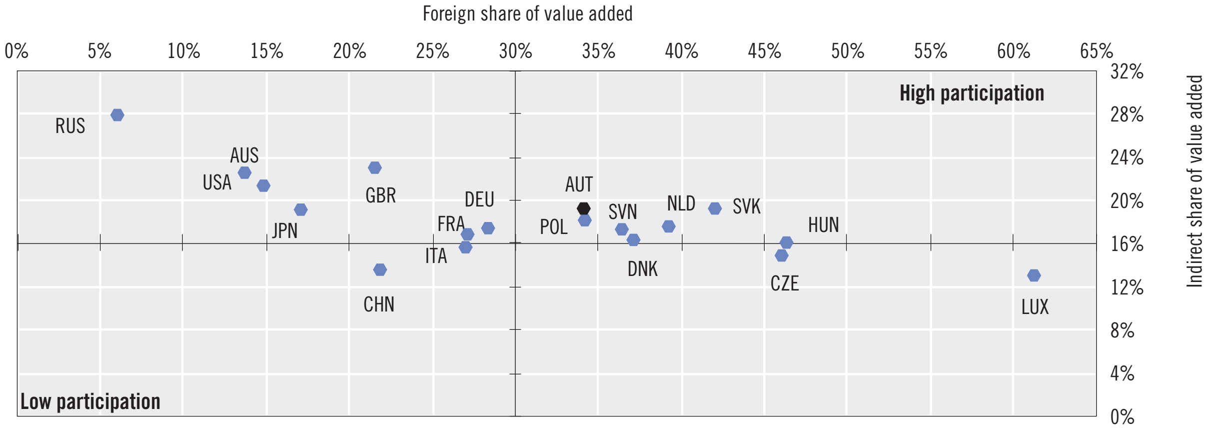
Fig. 41: Indirect value added for Austria by region (in € billions)



Source: WIOD (2013), Presentation: JOANNEUM RESEARCH (2014). (See Annex I for country abbreviations).

160 See Fig. 6 1 in Annex.

Fig. 42: Level of participation in the global market



Source: WIOD (2013), Presentation: JOANNEUM RESEARCH (2014).

domestic products.[161] Of course, the size of a country's economy plays a role in determining its participation in the world market. But because the value chain works in both directions, this effect does not have as great of an impact.

It is apparent that Austria and other small economies (such as the Netherlands and Slovakia) are more tightly integrated into the world market than the large economies of the US, Russia and China. On the one hand, Austrian firms use a number of foreign products in their own production processes and, on the other, Austria produces a variety of products that are used in the global value chain.[162]

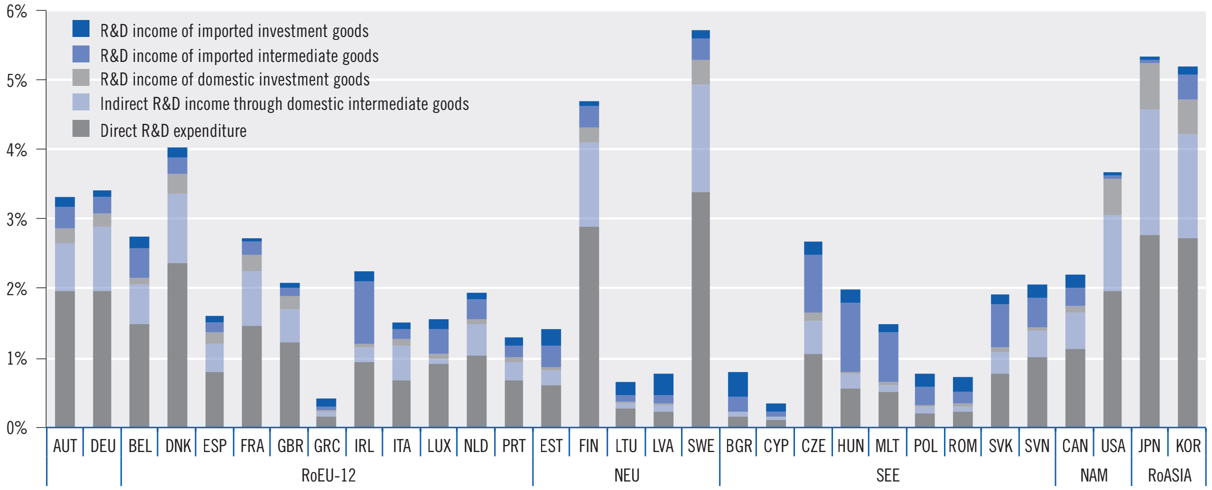
Importing R&D via the acquisition of goods and services

The intensity of R&D activity and the use of external sources of technology are an important aspect in an industry's position in global value chains. Whilst innovation activities in some industries (the pharmaceutical industry, for example) is driven especially by R&D internal to that industry, other industries primarily secure technology and know-how from sources external to that industry via the purchasing of products and services, both domestically and from foreign suppliers. The same can be witnessed at the macroeconomic level: whilst large, highly developed economies can overwhelmingly rely on domestic research and technology, smaller or less developed countries find themselves dependent on technologies that have been developed abroad. It is evident, however, that small countries can become leading producers of specialist technologies, that new technologies are generally developed and introduced by small enterprises, and that researchers' international mobility is a primary vector for the spread of technology.[163]

Current firm-specific figures related to R&D do not allow us to identify which countries and industries profit the most, and to which degree they profit, from specific R&D activities conducted at particular points in the economic system. Total R&D income is central to new studies[164] that aim to quantify the total R&D-related

161 See Johnson, Noguera (2012); Koopman et al. (2011); OECD (2013).
162 See Grossman, Helpman (1993); OECD (2013).
163 See OECD (2013).
164 See Hauknes, Knell (2008); Hutschenreiter, Kaniovski (1999); Papaconstantinou et al. (1996).

Fig. 43: Structure of total research and development income of the industries, share of value added (in %)



Source: WIOD (2013). Presentation: JOANNEUM RESEARCH (2014).

income generated by output streams. This includes not only direct expenditure for R&D, but also R&D-related income from intermediate goods and capital goods, both domestic and imported, and is therefore in many cases a meaningful measure of the level of technological advancement.

The role of technology imports in international comparison

Fig. 43 depicts the structure of the total R&D-related income from aggregated outputs (all goods and services) compared internationally.[165] Total technology intensity[166] is in many respects a far more suitable measure of the technological level of production in a country (or industry) than direct R&D intensity. Total technology intensity may be significantly higher than direct R&D intensity, especially in small and less developed countries. International comparisons based on direct R&D intensity, therefore, may very likely underestimate the level of technology involved in production systems located in those types of countries.

Half of the total R&D income resulting from aggregated outputs in Austria in 2007 were accounted for by direct R&D expenditure. The most important components of "indirect R&D" are imported and domestic intermediate products.

Direct R&D expenditure are highest, relatively speaking, in large, research-intensive countries such as Finland and Sweden in Europe and in the US and Japan internationally. The ratio of indirect to direct R&D expenditure in these countries is approximately 1:3. As would be expected of a small, open economy, the ratio of R&D income from imported intermediate and capital goods to direct R&D expenditure in Austria is higher than in larger economies (around 1:1 in 2007).

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165 The study by Hauknes, Knell (2008) follows the method used here to quantify total R&D income of material good and services in the Austrian economy. EUROSTAT as well as the OECD ANBERD database and the World Input Output Database (WIOD) for 2007 provide the basis for data.
166 Defined as the ratio of total R&D income to gross value added of the aggregated output.

As in the analysis of global value chains, Germany here too plays a central role for the Austrian economy as a supplier of R&D in the form of intermediate goods and an even more important role as a supplier of R&D that is delivered in the form of capital goods. The R&D income from intermediate goods imported from Germany amounted to €447.23 million in 2007. Austria's second most important partner from this perspective (excluding the remaining EU-12 countries[167]) is the US (€53.27 million).

In each and every year examined, Germany features as the most important supplier of indirect R&D in all ten economic sub-sectors with the largest contributions of indirect R&D to total technology intensity. The remaining EU-12 countries are the second biggest supplier, followed by the US and Japan. The R&D income related to imported intermediate goods for these countries lies between 0.1% and 0.9%. The significance of the US as a country of origin reflects the structure of American exports to Austria as well as the high intensity of R&D related to manufacturing in the US.

Whilst an industry's "R&D performance" is straightforwardly derived from its direct R&D expenditure, the acquisition of related technology – mediated through the structure of the inter-sector streams of intermediate and capital goods – depends on the R&D intensity of the upstream industries (domestically and abroad). Fig. 44 illustrates the total R&D income for the relevant industries.

The spread of indirect R&D across various industries is markedly different from that of direct R&D expenditure (performance of R&D). Those industries that perform substantial amounts of R&D activities are generally not the same as those which acquire indirect R&D by means of intermediate and capital goods. Agriculture, the food industry, the construction industry or the recycling sector acquire up to 50% of indirect R&D via their intermediate and capital goods.

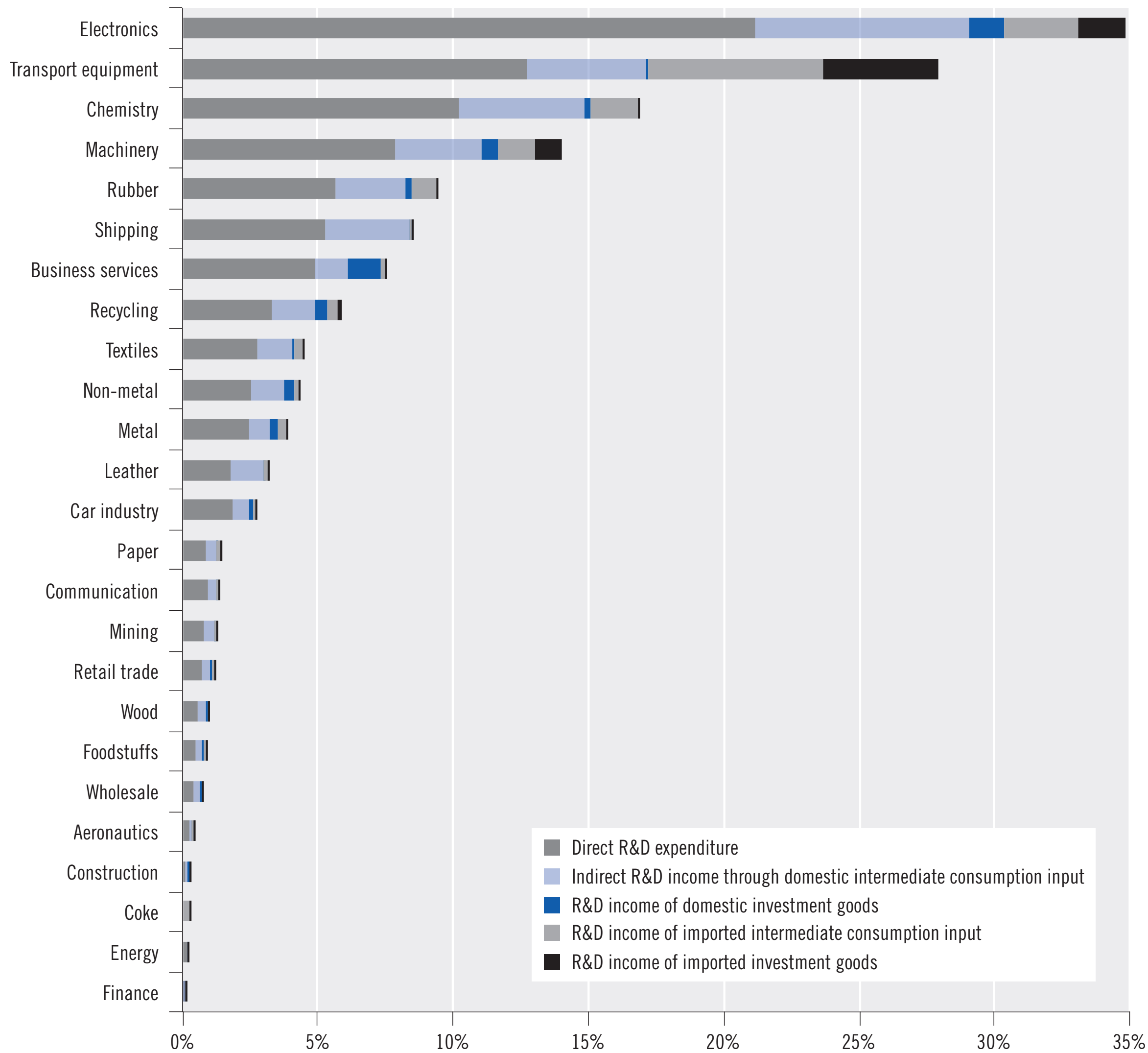
Summary

There is a steady increase in cooperation in the production of goods in the form of intensifying import-export relationships. Products pass numerous national borders on their way to consumers, either in the form of intermediate products that are used in the production process or as finalised products that are sold to the public. The share of foreign value added in gross exports is in direct relation to the size of an economy and its degree of specialisation. For this reason, the Austrian share of foreign value added is relatively high compared internationally. As a result of progressively growing internationalisation, the share of domestic value added in gross exports between 1995 and 2011 declined from 76% to 66%.

Austria has strong connections with other European countries, especially those in Eastern Europe, and contributes a significant share of value added to the exports of its neighbouring countries (Hungary, Slovenia). At the same time, Austrian exports are heavily reliant on value added imports from Germany, Italy, China and the US. The largest share of foreign value added in Austrian exports can be attributed to Germany (DEU), followed by the remaining EU-12 countries (RoEU-12) and south-eastern Europe (SEE). Foreign contributions to Austrian exports vary according to the industry. The highest levels of foreign value added are to be found in the production of transport devices (foreign value added at 50%), machinery (38%) and electronics (36%), which are also Austria's strongest export industries.

167 The "EU 12 country" group of countries includes: Belgium (BEL), Denmark (DNK), Germany (DEU), France (FRA), Greece (GRC), Ireland (IRL), Italy (ITA), Luxembourg (LUX), Netherlands (NLD), Portugal (PRT), Spain (ESP) and the United Kingdom (GBR)

Fig. 44: Contribution of indirect research and development to overall technological intensity of Austrian manufacturing branches.



Source: WIOD (2013). Presentation: JOANNEUM RESEARCH (2014).

The concept of global value chains can be expanded to include the analysis of direct and indirect R&D relationships via the provision of goods. Whilst innovation activities in some industries (the pharmaceutical industry, for example) is driven especially by R&D internal to that industry, other industries primarily secure technology and know-how from sources external to that industry via the purchasing of products and services, both domestically and from foreign suppliers. Total technology intensity may be calculated as the sum of direct and indirect R&D intensity. Direct R&D expenditure are highest, relatively speaking, in large, research-intensive countries such as Finland and Sweden in Europe and in the US and Japan internationally. The ratio of "indirect R&D expenditure" to direct R&D expenditure in these countries is approximately 1:3. As would be expected of a small, open economy, the ratio of R&D income from imported intermediate and capital goods to direct R&D expenditure in Austria is higher than in larger countries (around 1:1 in 2007).

4.1.2 International R&D cooperation by Austrian firms: findings based on patent statistics

A number of factors drive the internationalisation of firms' R&D processes. One significant component is winning and securing markets abroad for the sale of a firm's products. Firms are continually faced with new product requirements in foreign markets. These may include technical requirements for the product to be placed on the market or specific preferences on the part of consumers. Products must thus regularly be technologically adapted to a number of different markets if exportability and market access are to be ensured. Another factor is the access to sources of know-how that complement in-house competences. Finally, costs may also play a role in the internationalisation of R&D. This internationalisation of R&D can take several forms. One is the establishment of a new R&D location abroad, whilst another is participation in or the take-over of foreign firms with their own R&D capacities. A third form is cooperation with foreign partners on R&D projects.

One means of measuring Austrian firms' involvement in international cooperation in R&D is provided by patent statistics. As part of the patent application process, firms must provide the names of people who were involved in developing the invention. This includes the provision of these individuals' home addresses. The locations where the inventors are active can be approximately determined from this information. The regional distribution of inventors should correspond to a great degree with the regional distribution of locations in which R&D activities take place since employees tend to live near their place of employment. Patents that list inventors from a number of different countries illustrate the international cooperation involved in R&D processes.[168]

The following analysis draws on information contained in the EPO's PATSTAT database. This database contains all patent applications from nearly all patent offices worldwide. All patent applications by applicants from Austria were identified in the database.[169] The institutional sector (business enterprise sector, university, government and cooperative research institutions, public administration and private individuals) was identified, as was the location in Austria in which the inventor works or where the R&D activity primarily took place. In addition, the industry (2-digit NACE), the size (in the categories SMEs with fewer than 250 employees and large firms with 250 or more employees) and membership in corporate groups with headquarters abroad were identified for all firms.[170] Patent applications were grouped together into patent families,[171] and the locations (by country) of all of the inventors were identified for each patent family. Patent applications by foreign subsidiaries were not included in the analysis since applications submitted only by foreign subsidiaries of Austrian firms[172] (and not

168 Inaccuracies also have to be taken into account, since inventors may move between the time of the invention and the patent application and inventors in areas close to borders may have their place of residence abroad but work in Austria.

169 The applicant's country ID "AT" was used for this. However, since Austrian applicants constantly appear incorrectly under the country ID "AU" (Australia) or "ST" (for applicants from Styria), a name search was used (whereby all applicant names with "AT" were searched under all other applicant names) in an attempt to capture these Austrian applicants also. At the same time non-Austrian (in particular Australian) applicants which were captured under the country ID "AT" were excluded from the analysis.

170 This information was captured through reconciliation of the corporate applicants with the Creditreform Austria database and through additional research.

171 A patent family covers all applications to different patent offices which relate to the same invention. The term "patent" is used below for patent families.

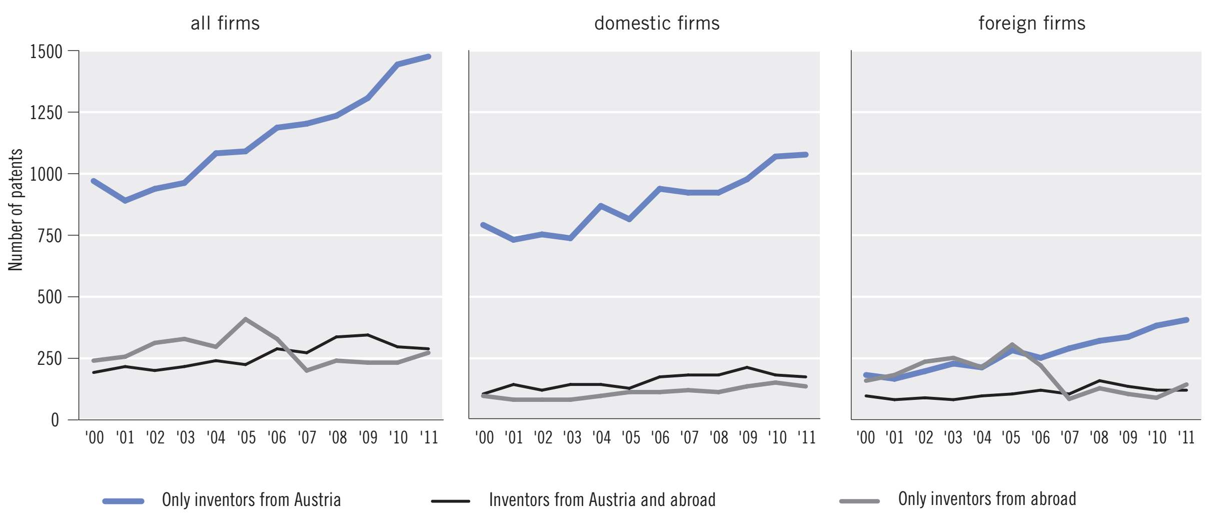
172 "Domestic firms" below refers to those firms whose headquarters are in Austria. "Foreign firms" are accordingly subsidiaries or branches in Austria with the firm's headquarters located abroad.

by the Austrian parent company) are a sign that the patent was to be exploited solely in the foreign location. Were the Austrian parent company also intended to exploit the patent, the application would generally have been filed by (or along with) the Austrian parent company. The analysis covered the period from 2000 to 2011, and patents were organised according to the priority year of the first patent application within a patent family.

Firms in Austria submitted over 20,400 patent applications worldwide between 2000 and 2011. Almost 13,800 patents were registered by firms headquartered in Austria, and more then 6,600 were registered by firms active in Austria but with headquarters abroad.[173] The number of patents increased continuously from 2001 (Fig. 41). The rise was attributable equally to increased patent activity by domestic and foreign firms. If controlled for the inventor's location, then the rise is primarily due to the increased number of patents registered by inventors located in Austria. Foreign firms have profoundly increased the number of patents that feature only inventors located in Austria (Table 34). This indicates that personnel in Austrian locations have been increasingly central to activities undertaken by foreign firms in Austria leading to new inventions, whilst cooperative work on inventions with foreign locations or external partners abroad has relatively declined in importance. This may be interpreted as a sign that Austria is now a stronger location for R&D, which implies further that Austrian subsidiaries are increasingly working independently on R&D.

The number of patents registered by domestic firms with inventors located in Austria and abroad ("international cooperative patents") experienced a disproportionate rise. The number

Fig. 45: Number of patents of firms in Austria 2000–2011 by inventor location



Patents: number of patent family applications, years allocated based on the earliest priority year.
All firms: domestic plus foreign firms; domestic firms: firms with their headquarters in Austria; foreign firms: Austrian subsidiaries of foreign firms.

Source: EPO: PATSTAT. Calculations: ZEW.

173 For foreign firms only those patents are taken into account which have been registered by the Austrian subsidiaries (where applicable incl. patents which at the same time have been registered abroad by the parent company or affiliated company).

Table 34: Change in the number of patents of firms in Austria between 2000 and 2011 by inventor location

Change 2000–2011 in %	Only inventors from Austria	Inventors from Austria and abroad	Only inventors from abroad	Total
Domestic firms	36	71	48	40
Foreign firms	124	30	-8	54
All firms in Austria	52	51	12	44

Source: EPO: PATSTAT. Calculations: ZEW.

of these patents rose by 71% between 2000 and 2011, compared with a rise of just 40% for patent activity in total. The number of patents registered by Austrian firms but with inventors who reside abroad increased only by 12%. Domestic firms experienced a disproportionate rise of 48%, whilst there were 8% fewer patents in 2011 than in 2000 registered by foreign firms in which the named inventors reside outside of Austria. This development can be attributed to a small number of international firms which up until 2006 used their Austrian subsidiaries to register a large number of patents developed abroad; this strategy changed in 2007.

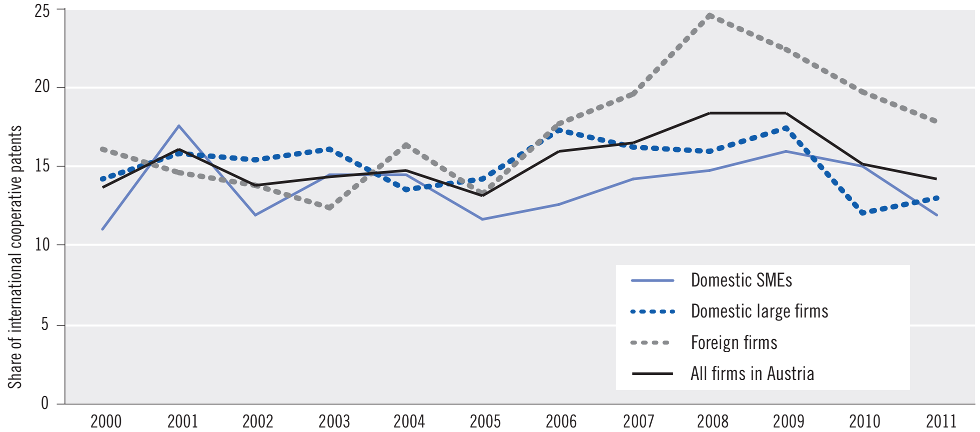
The number of international cooperative patents grew up until 2009. The rate of growth was particularly strong amongst foreign firms, which is in part due to the limited number of patent applications in which all of the listed inventors reside abroad. International cooperative patents represented 18% of patent applications filed by domestic firms in 2009 (2000: 14%). This figure returned to 14% for both 2010 and 2011 (Fig. 46). This decline was experienced equally by domestic as well as foreign firms. Amongst domestic firms, SMEs and large firms registered similar numbers of international cooperative patents, and these figures largely developed in parallel over the past twelve years.

The number of international cooperative patents registered by domestic firms is highest in the chemical and pharmaceutical industries and lowest in the services segments (with the exception of engineering/R&D) (Fig. 47). Foreign firms in the metal industry and in engineering/R&D registered an especially high number of international cooperative patents. The chemical, pharmaceutical and electronics industries are responsible for the registration of significant numbers of international cooperative patents by foreign firms which list only inventors who reside abroad.

A differentiation by federal state (in which firms are assigned to federal states not according to the location of their legal headquarters, but rather the location in which the largest portion of their R&D activities takes place) shows few differences in terms of the number of registered international cooperative patents (Table 35). The highest numbers amongst domestic firms were in Vorarlberg and Vienna with shares of 18% and 17% respectively. The high share in Vorarlberg may be partially attributable to workers who commute from Switzerland, Liechtenstein and Germany. The numbers of international cooperative patents registered by foreign firms are above average in the states of Lower Austria, Salzburg and Upper Austria. There were no significant differences amongst the federal states overall.

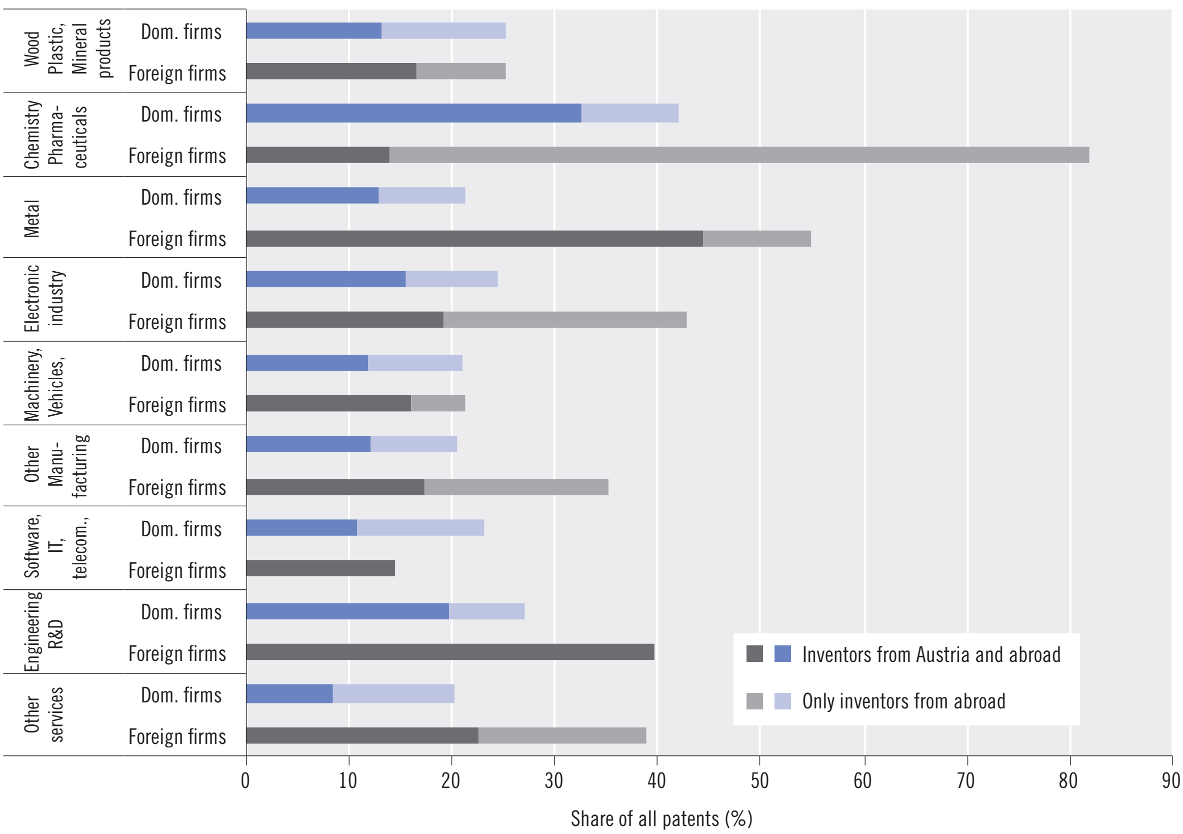
The largest number of inventors resident abroad who were involved in the development of patents registered by Austrian firms come from Germany. Amongst those working for domestic firms, 60% of the inventors with non-Austrian addresses are resident in Germany. However, Germany is home to only a third of those who work for foreign firms. The proportion of inventors resident in Germany amongst all of the inventors with residences abroad is

Fig. 46: Share of international cooperative patents of firms from Austria, 2000–2011



International cooperative patents: patents with inventors from Austria and abroad
SMEs: firms with less than 250 employees.
Source: EPO: PATSTAT. Calculations: ZEW.

Fig. 47: Share of patents of firms from Austria with inventors from abroad, average 2000–2011



ÖNACE codes of industry groups: wood, plastic, mineral products: 16, 22, 23; chemistry, pharmaceuticals: 19, 20, 21; metals: 24, 25; electronics industry: 26, 27; machinery, vehicles: 28, 29, 30; other manufacturing: 5-15, 17-18, 31-33, 35-39, 41-43; software, IT, telecommunications: 61, 62, 63; engineering, R&D: 71, 72; other services: 45-60, 64-70, 73-96.

Source: EPO: PATSTAT. Calculations: ZEW.

Table 35: Inventor location of patent firms in Austria, by federal state, average 2000–2011

Share of all patents in %	Domestic firms			Foreign firms			All firms		
	Only AT inventors	AT + foreign inventors	Only foreign inventors	Only AT inventors	AT + foreign inventors	Only foreign inventors	Only AT inventors	AT + foreign inventors	Only foreign inventors
Vienna	74	17	9	81	15	5	76	16	8
Lower Austria	78	12	10	47	27	26	64	19	17
Upper Austria	82	12	6	56	25	19	79	14	8
Salzburg	83	13	5	68	26	6	79	16	5
Tyrol	76	13	11	80	13	7	76	13	11
Vorarlberg	69	18	13	24	10	66	49	15	36
Burgenland	74	15	11	100	0	0	75	14	11
Styria	77	13	11	79	18	4	77	14	9
Carinthia	75	16	9	34	21	45	48	19	32

Allocation of patents to federal states based on the location for R&D activity.

Source: EPO: PATSTAT. Calculations: ZEW.

45% (Table 36) for all firms taken together. Switzerland and the US are the places of residence for the next greatest share of inventors with foreign addresses, with 13% each. Another 5% of inventors resident abroad are located in neighbouring countries (Italy, Czech Republic, Slovakia, Hungary, Slovenia). Amongst EU member states, Great Britain and France follow Germany as the most prominent countries of residence for those inventors who are not resident in Austria (5% each). Asia plays a minor role as home to inventors not resident in Austria, with a total share of just 3%.

The analysis of the home locations of inventors provides a good indication of the level of international cooperation in the development of new technologies and new products. Between 2000 and 2011, 15% of all patents registered by business enterprises in Austria were developed in cooperation with international partners, which means that the underlying invention was developed jointly by people in Austria and abroad. This figure was 13% for companies headquartered in Austria and 19% for the Austrian subsidiaries of foreign firms. The share of international cooperative patents increased up until 2009, but declined again in 2010 and 2011. Growth in the number of international cooperative patents was stronger for domestic firms than for foreign firms. The largest number of inventors located abroad who were involved in the development of patents registered by Austrian firms came from Germany (60%), Switzerland (8%) and the US (6%). This analysis demonstrates a trend towards stronger international cooperation in R&D, particularly within Europe.

4.2 Corporate innovation in transition

4.2.1 Open Innovation as the new innovation paradigm

The concept of "Open Innovation" has increasingly become part of innovation policy over recent years. The concept introduced by US innovation researcher Henry Chesbrough in 2003 denotes the trend which can be observed empirically for firms to cooperate more frequently with customers, research institutions, suppliers, competitors, etc. for the purposes of developing and implementing innovation. Open Innovation is defined as followed in the literature: *"Open Innovation is a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as the firms look to ad-*

Table 36: Regional breakdown of inventors from abroad who were involved in the development of patents registered by Austrian firms, average 2000–2011

Proportion of all patents with inventors from abroad in %	domestic firms	foreign firms	all firms
Germany	60	34	45
Switzerland, Liechtenstein	8	17	13
Italy	3	2	3
Czech Republic, Slovakia, Hungary, Slovenia	3	2	2
United Kingdom	4	5	5
France	2	8	5
Sweden	1	2	2
Other EU countries	5	7	6
Other European countries	2	1	1
USA	6	18	13
Other American countries	1	1	1
Asia	4	3	3
Africa, Oceania	0	0	0

Allocation of patents to federal states using the location for the R&D activity.

Source: EPO: PATSTAT. Calculations: ZEW.

vance their technology".[174] Open innovation is therefore aimed on the one hand at using as many external sources of information as possible, with interaction and cooperation with customers playing a particularly important role here. This form of Open Innovation is also known as an inside-out strategy. On the other hand, Open Innovation means commercialisation of as many ideas and technologies developed with the scope of R&D activities as possible, with different external sources, stakeholders and channels used in this process: this is also known in the literature as an outside-in strategy. With this Chesbrough specifically advocates the funding of spin-off companies, licensing of patents and the formation of joint ventures.

The Open Innovation model can be contrasted with the "Closed Innovation" model here. The Closed Innovation model follows the sequential introduction of business innovation, in which firms generate technical knowledge in relatively isolated R&D departments, and then commercialise this knowledge in the form of improved production processes and new products on the market. The ability to maintain a focus on the market and to absorb information on customer needs is comparatively weak in this model. The Open Innovation paradigm is quite different: the postulate here is that firms generate profitable ideas internally or acquire them externally, and then commercialise the products built upon these ideas either themselves, in cooperative efforts with third parties, or through licensing in the marketplace.

The idea of open networked innovation is not a new one: significant importance was already being attached to the integration of and cooperation with customers, suppliers, universities and competitors for successful R&D and innovation activities in the 1980s.[175] In his model, however, Chesbrough specifically illustrates the interplay between a company's internal development and

174 See Chesbrough (2003, xxiv).
175 See for instance Rosenberg (1982), von Hippel (1986) or Lundvall (1988).

the internal use of external knowledge, between in-house commercialisation and alternative exploitation strategies. In the age of Open Innovation firms are compelled to access external resources as soon as possible, and to press ahead with their R&D efforts in constant interaction with the environment. Information technology, the internet, new social media and the creation of knowledge markets are the particular drivers and characteristics of Open Innovation.

A series of forms and strategies have become established in recent years, all of which can be designated as different forms of Open Innovation. The concept of "User Innovation" has been in use for some years in connection with active customer involvement. User innovation is more than the conventional customer focus, e.g. through customer surveys in traditional marketing and market research, as it means all those examples where customers or users themselves become innovators and develop products independently. The development of software products in open source communities can be stated as a very familiar example in this regard. The traditional image of the innovative firm is increasingly being replaced by a model which sees the innovation process as a network between different stakeholders. The lead user approach is an additional method discussed in this context.[176] Lead users or pioneer users involve the small group of customers who anticipate market needs and provide important momentum for innovation. Firms attempt to identify these in a targeted manner and to actively include them in the product development process. As such the customers are not merely receivers of the value, they are actually involved in creating the value.[177] Companies often also use specific software products in this context which are frequently known as "Toolkits for User Innovation", which the companies use to provide an interactive platform to customers which gives the customers the opportunity of creating new products or product versions based on their requirements.

One promising strategy for implementing approaches to Open Innovation is Crowdsourcing.[178] Based on the term outsourcing this involves outsourcing working and creative processes to a number of volunteers (the "crowd"), e.g. via the internet,[179]. Often referred to as "swarm intelligence", this crowd is used for the purposes of gathering product innovations or suggestions for improvements for existing products. One well-known example is crowdtesting, where internet users are invited to test web applications, apps or other (mobile) web solutions and to share their experiences with the firm. Participants usually receive financial remuneration with this or some other form of compensation, and the firm then generally implements the most suitable ideas. The internet, software solutions and new social media have enabled these and similar innovation models and strategies and have encouraged the opening-up of the innovation process.

Empirical findings

The first empirical studies on opening up the innovation process and using Open Innovation strategies have been published in the last few years. In accordance with the major focus on customer integration, a large number of these studies are concerned with the degree of interaction and the various roles played by customers in the innovation process. For instance studies have found that between around 10 and 20% of users in the software area develop their own solutions.[180] In some industries, the majority of

176 See von Hippel (1986).
177 See Prahalad, Ramaswamy (2004).
178 See Howe (2006).
179 See Wikipedia.
180 See Lüthje, Herstatt (2004).

new product ideas actually come from users. Examples include the medical engineering sector and the development of tools in the semiconductor industry. An analysis of the providers of computer-assisted planning and manufacturing tools (CAD/CAM) have likewise shown that users frequently put process innovations into practice. Nevertheless, the significance of customers as idea suppliers or innovators has also been noted in low-tech industries such as construction.[181] However, the significance of different partners depends on certain specific features in the sector: for example, universities are the most important source of innovation in the field of biotechnology, while users dominate in the development of scientific measurement instruments.[182]

A more recent study on the prevalence of Open Innovation at US and European firms with more than 1,000 employees concluded that Open Innovation strategies are applied in particular by technology-intensive companies, with the focus placed on the outside-in process.[183] Around 80% of companies which use Open Innovation rely on the integration of external knowledge and joint development of innovation with a wide variety of partners. Yet only 20% of the companies surveyed use the inside-out process, where internal capabilities and knowledge are used in external markets or in-house patents are licensed. A further study at 159 German-speaking firms of all sizes examined the motives behind the implementation of Open Innovation. According to these the most significant motives are faster product development, cost savings, access to new markets and the use of synergy effects.[184] Joint development with customers and/or suppliers represents the most significant form of Open Innovation, with this used by more than 44% of the firms. On the other hand, web-based Open Innovation strategies such as crowdsourcing and solution platforms are pursued by just a few firms; the application potential for these is also dependent on the industry.

The extent to which interaction and cooperation with external partners increased at firms in Austria was examined for the first time in 2009 based on the CIS surveys between 1994 and 2006.[185] The data shows an increasing appreciation of different external innovation sources, with the significance of customers, suppliers, and competitors growing in greater proportion compared to other sources, such as universities and research institutions. The percentage of cooperating innovators remained unchanged for a long time, and has been clearly increasing only since 2002/04. Within the group of cooperating enterprises an increase primarily in cooperation with customers and principals as well as suppliers can be observed. The following section includes a detailed analysis on innovation cooperation programmes based on current CIS data. Initial works have also recently been published on the importance and experience of crowdsourcing by Austrian firms.[186] Telekom Austria and 3M Austria have implemented projects of this type for example.

Challenges for innovation policy

Open Innovation was originally discussed as a concept and strategy in company innovation literature and management theory, but is now also increasingly making its way into discussions on innovation policy. The change in orientation towards more Open Innovation processes is a welcome development from the perspective of poli-

181 See Slaughter (1993).
182 See Zucker et al. (1998); Riggs, von Hippel (1996).
183 See Chesbrough, Brunswicker (2013).
184 See Enkel (2011).
185 See Dachs, Leitner (2009).
186 See Sundic, Leitner (2012).

cy, as initial studies show that business enterprises which pursue these strategies have a higher success rate in product developments, develop more new products for the market, and have a measurably positive influence on corporate success.[187] However, at the same time there are also potential negative effects with this development, such as when the corporate risk is transferred to individuals, without these individuals being remunerated accordingly. In addition the implementation of Open Innovation strategies does not encourage sustainable development, and may also result in research and development activities no longer being carried out by firms in Austria. New challenges arise through this both for firms as well as for RTI policy.

The importance of new types of innovation and of wider support measures can be found in the current innovation policy of the European Commission, the Europe 2020 strategy, as well as lead initiative Innovation Union, which state: *"While some conduct R&D and develop new technologies, many base their innovations on existing technologies or develop new business models or services driven by users and suppliers, or within clusters or networks. Policies must therefore be designed to support all forms of innovation, not only technological innovation. … As the problems grow more complex, and the costs of innovation increase, firms are increasingly being driven to collaborate. … They sometimes co-innovate with users and consumers in order to better satisfy their needs or create new routes to market. This trend is being fuelled by social networking and cloud, mobile and collaborative computing and is spreading across manufacturing and service sectors"*.[188] The issue of user innovation was already referred to in the Aho Report on "Creating an Innovative Europe".[189] Furthermore the EU Lead Market Initiative builds on insights from user innovation, as do the OECD project on "Globalisation and Open Innovation" and the Dutch "Advisory Report on Open Innovation".[190]

In relation to Open Innovation a report financed by the EU has examined the implications of Open Innovation for innovation policy.[191] For this the authors investigated European and national policies for their potential in promoting Open Innovation. Among other things they demand that policy should support user innovation, venture capital markets, the founding of spin-off companies and open innovation and crowdsourcing concepts more intensively for public procurement which promotes innovation.

Open Innovation also raises the question as to whether intellectual property rights (IPR) are an incentive for innovation activities or in fact represent an obstacle to the exchange of knowledge instead. A better understanding is required in relation to the areas in which IPRs make sense and the areas in which they have negative effects on economic welfare. Measures which promote innovation policy should also support customer integration more than has previously been the case, and should promote awareness among customers that they can bring about innovation themselves. At the same time the public sector can itself act as an innovative user, for instance by co-developing and encouraging innovations through public procurement and specific product specifications.[192]

The first observations on increased opening-up of the innovation process and associated prevalence of new types of innovation can also

187 See von Hippel (2005), Laursen, Salter (2006).
188 See European Commission (2010) p. 18.
189 See Aho et al. (2006).
190 See EU (2005), AWT 2006, OECD (2008).
191 See de Jong et al. (2008).
192 See Leitner (2012).

be found in Austrian national RTI strategy. The Austrian government's current strategy states the following in relation to promoting innovation: *"We must adopt a broad approach to innovation that not only includes technological, research-driven and non-technological innovations in manufacturing and in the service sector but also ecological and social innovations and innovations in the public sector."* It then explicitly mentions the importance of users and consumers in developing innovative products and services. Although no more concrete objectives and actions are stated for funding non-technological innovations, it is undoubtedly still possible to detect a greater awareness of new innovation models, accompanied by a broader understanding of innovation. As such the federal government aims overall to avoid focusing unilaterally on pure financial support for science and technology, and to take a comprehensive approach to innovation policy which includes organisational measures in the fields of training, regulation and procurement[193] Research is still required overall at the international as well as the national levels for the purposes of better understanding the many positive as well as negative effects on business and society and of formulating appropriate political strategies and actions.

4.2.2 Open Innovation in Austria: empirical findings based on the Community Innovation Survey

The extent to which opening up the innovation process can also be validated empirically is analysed below in relation to Open Innovation. The development and importance of innovation cooperation for innovation over the last decade are portrayed for this purpose using the Community Innovation Surveys (CIS).

In addition to developments in the importance of innovation cooperation in the business enterprise sector over the period, the innovation cooperation initiatives are also looked at in greater detail below broken down into cooperation partners. A distinction is made for these purposes between the type of cooperation partner on the one hand and their location on the other. As the literature on cooperation[194] within business as well as between business and science shows that there are major differences in the cooperation trends according to industries and sizes, particular focus is placed on a differentiated consideration between the manufacturing and the services sector, and a distinction is made between small and medium-sized enterprises.

The Community Innovation Survey (CIS)

The CIS surveys the innovation behaviour of firms in the European Union, and is organised jointly by EUROSTAT and the national statistical offices. Results from the Community Innovation Survey for Austria are available for six different time periods: 1994–1996 (CIS2), 1998–2000 (CIS3), 2002–2004 (CIS4), 2004–2006 (CIS2006), 2006–2008 (CIS2008) and 2008–2010 (CIS2010).

The sample for the CIS covers the business enterprise sector, incl. mining, manufacturing, energy and water supply, wholesale trade, transportation, information and communication, financial and insurance services as well as selected business-related services. A representative sample of enterprises with ten employees or more were questioned as part of the survey.

The individual surveys in the CIS are based upon common definitions, and can therefore be compared with one another in principle. Nevertheless there are still differences between the individual rounds of the CIS. For instance CIS4 uses a slightly different definition of innovation

193 See RTI Strategy (2011). Page 11.
194 See Schartinger et al. (2002); Abramovsky et al. (2009); Srholec (2011).

cooperation. The sample also changed over time. CIS2 (1994/96) had a significantly stronger focus on manufacturing than did later surveys, which was one reason for the strong decline in the innovator ratio (proportion of firms active in innovation out of all firms) between CIS2 and CIS3 (1998/00).[195]

Furthermore, when interpreting the results one must not forget that more than 14 years passed between the first and last survey. During this time, awareness of the importance of innovation increased significantly due to the presence of this topic in public discussion, and this could have led to a change in answer behaviour. There are also large differences between the individual surveys in terms of the economic environment: the average growth rate in real GDP was 3.5% for 1998/2000, whereas the comparable value for 2002/2004 is only 1.1%, and there was even a drop of 1.8% recorded for the period 2008/2010. Firms adapt their innovation plans to future prospects over the course of the economic cycle.

Development in cooperation trends in the business enterprise sector

Despite major attention from policymakers, the trend towards cooperation - measured as the proportion of firms with innovation cooperation initiatives in place out of all companies - has changed very little over the long term in Austria (see Table 37). The percentage of cooperating enterprises consistently accounts for around 10% of all firms between 1994/96 and 2002/04. The lowest value was in the period of 2002/04; weak economic growth and uncertain expectations for the future during these years may have reduced the willingness to cooperate. A significant increase in the trend towards cooperation can be observed only in the time period of 2004/06, and this increased even further by the period covering 2008/10. Only firms with more than 250 employees showed a constant increase in innovation cooperation throughout the entire time period. Smaller and medium-sized enterprises exhibit greater fluctuations in the trend towards cooperation, with a trend that is sharply upward from the period 2004/06.

According to the last available figures from the 2008/10 survey, 22% of all Austrian firms enter into innovation cooperation. This corresponds with 51% of Austrian innovating firms, and as such half of all innovating firms in Austrian cooperate in relation to innovation.

In relation to the overall number of firms in manufacturing, the trend towards cooperation is slightly higher than in the services sector, and this increases considerably with the size of the firm. Large firms have relatively larger capacities in terms of searching for partners and maintaining and monitoring cooperation, and have

Table 37: Firms with innovation cooperation as a proportion of all firms

	1994/96	1998/00	2002/04	2004/06	2006/08	2008/10
Total	11.6%	10.3%	9.1%	19.7%	16.6%	22.4%
Manufacturing	13.1%	9.9%	10.8%	20.2%	18.4%	25.5%
Services	9.7%	10.4%	7.6%	19.2%	15.1%	19.8%
10–49 employees	8.6%	7.4%	6.6%	15.2%	11.8%	16.9%
50–249 employees	17.4%	14.1%	12.6%	30.3%	26.5%	35.7%
250 and more employees	34.6%	34.7%	40.2%	55.1%	54.7%	61.3%

Source: Statistics Austria.

195 See Falk, Leo (2004), p. 12.

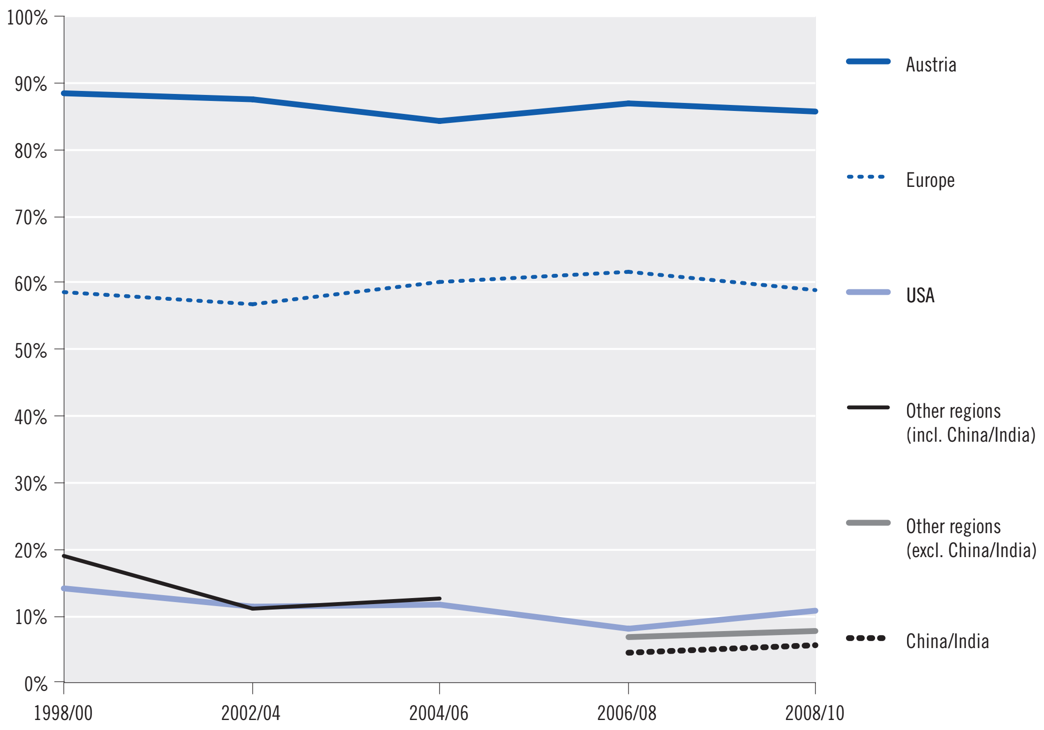
higher absorptive capacities for incorporating external knowledge and therefore also a greater trend towards cooperation. If one looks solely at innovating companies, then the difference in the trend towards cooperation between manufacturing and the services sector disappears. Innovating service providers cooperate just as frequently as firms involved in manufacturing .

The importance of cooperation partners over time

In addition to the prevalence of innovation cooperation over time described previously, an analysis of the importance of different cooperation partners is also enlightening in terms of an empirical validation of the opening-up of the innovation process in Austria. A distinction can first of all be made between national and international cooperation initiatives. Fig. 48 below shows the development of company cooperation initiatives according to the head office of the cooperation partner over the last five CIS (as of CIS3, or the years 1998/00). For this the number of cooperating firms according to partners was related to the total number of cooperating firms.

It is clear that the rise in the trend towards cooperation described above can be attributed primarily to a consistently high proportion of cooperation initiatives within Austria and to a slightly lesser extent within Europe. On the other hand, the proportion of firms with non-European cooperation partners remains stagnant at a very low level. As such distance between the partners remains a significant limiting factor for innovation cooperation. Over 85% of firms also cooperate with at least one national partner, and around 60% have at least one European cooperation partner. Firms from the USA, the most im-

Fig. 48: Proportions according to registered office of the cooperation partner, 1998–2010



Note: Europe includes the EU Member States (not including Austria), the EU candidate countries of Croatia, Macedonia and Turkey and the EFTA countries (Iceland, Liechtenstein, Norway and Switzerland). Multiples allowed.

Source: Statistics Austria.

Table 38: Proportions according to type of the firm's cooperation partner with innovation cooperation

	1994/96	1998/00	2002/04	2004/06	2006/08	2008/10
Suppliers[1]	38.8%	54.8%	43.0%	58.6%	56.6%	53.5%
Customers[2]	40.5%	43.7%	44.8%	59.8%	41.9%	43.3%
Competitors[3]	22.6%	48.5%	22.5%	36.0%	23.8%	21.5%
Consultants[4]			41.8%	37.1%	37.8%	36.6%
Universities[5]	42.1%	45.0%	57.6%	41.5%	50.5%	42.6%
Other public research institutions[6]	21.5%	20.7%	30.1%	23.8%	18.7%	18.1%

Multiples allowed.
1 suppliers of equipment, raw materials, primary products or software; 2 contractors or customers; 3 competitors or other firms from the same sector; 4 consultants, commercial laboratories or private R&D facilities; 5 universities, universities of applied sciences or other tertiary centres of education; 6 other government or public-sector research facilities.

Source: Statistics Austria.

portant cooperation partner country outside of Europe, are only stated by around 10% of firms.

In addition to the distinction according to the registered office of the cooperation, a distinction can also be made according to the type of cooperation partner (see Table 38). Here too there are only minor changes apparent over time, with certain fluctuations between the individual surveys in the CIS. Around a half of all cooperating firms were cooperating in each case with suppliers, customers and universities in the last surveys. Another third cooperated most recently with consultancy firms, the importance of competitors and other public research institutions is the lowest with around 20% in each case. While these proportions of all cooperating firms remain relatively stable, the absolute number of cooperation initiatives and the number according to registered location of the cooperation partner rose for all types of cooperation as a result of the general rise in the trend towards cooperation (see Table 38).

The above analysis of the trend towards cooperation according to economic sector and category of size on the one hand and according to registered location and type of cooperation partner on the other can also be combined in a final step, thereby allowing examination of the interaction between company features and types of cooperation (Table 39).

Table 39: Firms with innovation cooperation as a proportion of all innovating firms

	Total	within the group of firms	Suppliers[1]	Customers[2]	Competitors[3]	Consultants[4]	Universities[5)]	other public research institutions[6]
Total	51%	22%	27%	22%	11%	19%	22%	9%
Manufacturing	51%	21%	30%	23%	8%	20%	25%	12%
Services	51%	23%	24%	21%	13%	17%	18%	6%
10–49 employees	45%	15%	23%	19%	10%	15%	15%	6%
50–249 employees	59%	30%	33%	23%	10%	22%	30%	12%
250 and more employees	77%	57%	48%	40%	18%	40%	55%	25%

Multiples allowed.
1 suppliers of equipment, raw materials, primary products or software; 2 contractors or customers; 3 competitors or other firms from the same sector; 4 consultants, commercial laboratories or private R&D facilities; 5 universities, universities of applied sciences or other tertiary centres of education; 6 other government or public-sector research facilities

Source: Statistics Austria.

Firms involved in manufacturing cooperate more frequently with suppliers, universities and other public research institutions than firms in the services sector, while service providers co-operate far more frequently with competitors. Like the trend towards cooperation as a whole, the trend towards cooperation within the group of companies, with customers and with consultancy firms in manufacturing is around the same level as it is in the services sector.

The rise in the trend towards cooperation in line with the size of the firm can be seen across all cooperation partners. However, differences can be seen in the relative importance of the co-operation partners for the relevant category of size. For firms with less than 50 employees, the proportion of cooperation with suppliers is less significant at 23% than at larger firms, but is the most important form of cooperation overall at the smaller firms. Cooperation with customers is the second most important form of cooperation for these small firms. For small firms therefore cooperation primarily takes place along the value chain.

This cooperation along the value chain is also of major importance for the medium-sized firms with between 50 and 249 employees. However the importance of cooperation within the group of companies and with universities is also increasing significantly as compared with small firms.

Cooperation within the group of companies and with universities is particularly important for the large firms with more than 250 employees. More than half of the large firms use both these types of cooperation. Cooperation with science replaces cooperation along the value chain as the most important type of cooperation here. While customers, suppliers and consultancy firms have similar importance as cooperation partners for large firms and are used as partners by just under half of the firms, one in four large firms cooperates with public research institutions outside of the higher education sector. Cooperation with competitors is also less important for large firms, with only one in six of these firms using this type of cooperation.

If a similar distinction is made according to the registered location of the cooperation partner between manufacturing and the services sector (Table 40), then no significant differences can be seen: cooperation within Austria or with partners in Europe is the dominant type of cooperation in each case. However, considerable differences can be seen with the distinction according to category of company size. The trend towards cooperation does indeed increase in all cases in line with the company size, but it is also clear that the heavy focus on cooperation partners ascertained in Austria or Europe is particularly pronounced with small and medium-sized enterprises. Cooperation with part-

Table 40: Firms with innovation cooperation as a proportion of all innovating firms according to region

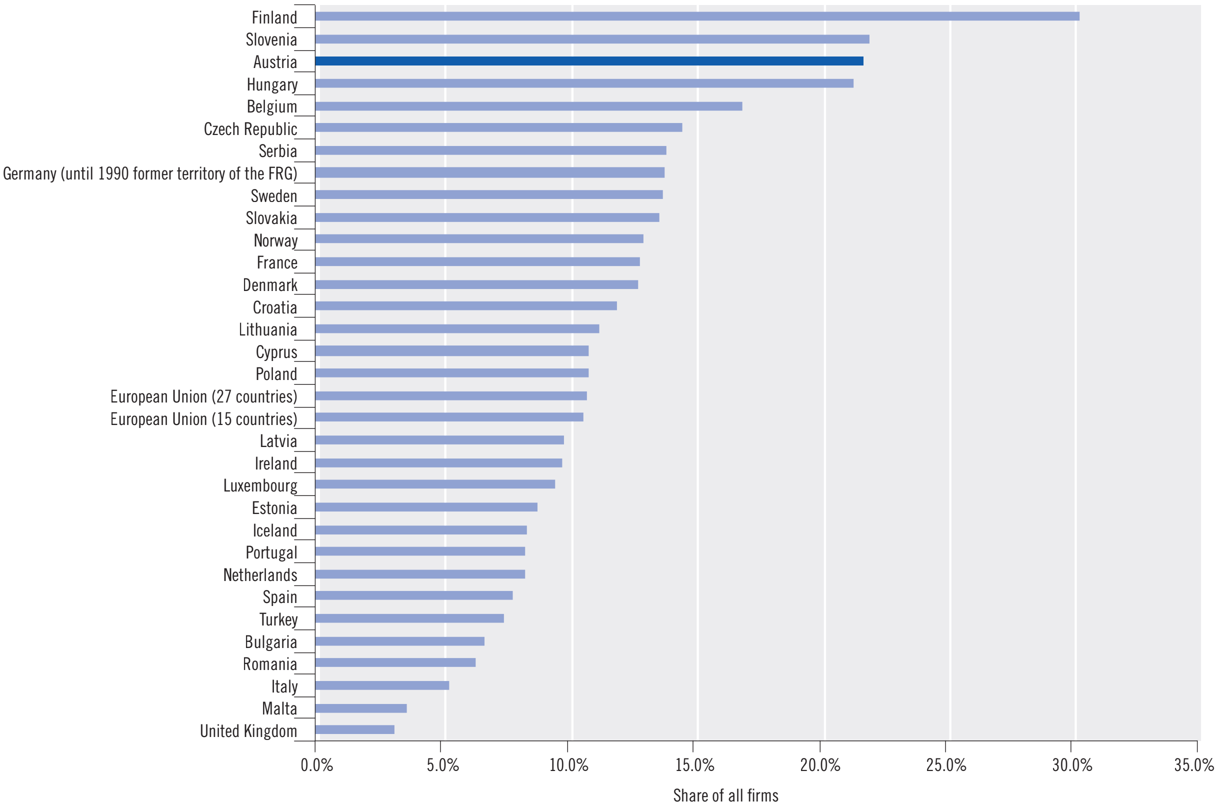
	Total	Austria	Europe[1]	USA	China/India	other regions
Total	51%	44%	30%	5%	3%	4%
Manufacturing	51%	44%	32%	5%	3%	3%
Services	51%	43%	28%	6%	3%	5%
10–49 employees	45%	37%	24%	4%	2%	3%
50–249 employees	59%	52%	36%	7%	3%	5%
250 and more employees	77%	70%	63%	18%	10%	11%

Multiples allowed.

[1] Europe includes the EU Member States (not including Austria), the EU candidate countries of Croatia, Macedonia and Turkey and the EFTA countries (Iceland, Liechtenstein, Norway and Switzerland).

Source: Statistics Austria.

Fig. 49: Innovation cooperation between firms and the higher education sector, various countries, 2008/10



Source: EUROSTAT, CIS 2010.

ners outside of Europe is only of certain importance for large companies with 250 or more employees. For instance around one in five large firms cooperates with a partner in the USA and one in ten large firms with a partner in China or India.

Cooperation behaviour in an international comparison

In terms of the trend with firms towards cooperation with the higher education sector, Austria is one of the leaders in this area at well above the EU average. Austria is one of the leading countries in Europe for cooperation between science and business.

This above-average placing for Austria in an international comparison is also confirmed from the point of view of the firms (Fig. 49). As the country comparison shows, Austrian firms cooperate with the higher education sector more frequently than the average level. As such Austria is in the top group together with Finland, Slovenia, Hungary and Belgium. From this grouping it may be presumed that cooperation between science and industry arises comparatively more easily in small countries, since the number of stakeholders in a field of science is more manageable and therefore existing relationships and networks are easier to use.

Summary

The number of Austrian firms with innovation cooperation initiatives has almost doubled in the last two decades to almost a quarter of all firms, thereby providing empirical evidence of the increasing interaction and opening-up of the innovation process in the domestic economic sector. No essential difference can be seen between manufacturing and the services sector in the prevalence of innovation cooperation. However, very clear differences can be seen in relation to the size of the firm: The trend towards cooperation rises considerably in line with company size. However, larger firms are not only inclined to be engaged in more frequent innovation cooperation overall, the relevant importance of the cooperation partner can also be distinguished according to company size: SMEs cooperate primarily with partners in Austria and Europe, with partners along the value chain particular important here. In contrast, cooperation partners outside of Europe also have greater importance for large firms, with greater cooperation also taking place with partners from science. Cooperation with competitors remain the exception, irrespective of the company size. While half of all Austrian firms were cooperating most recently in some way for innovation activities, this only applied to one in ten firms in terms of cooperation with competitors. Furthermore the results from the CIS reveal above-average performance in an international comparison: according to this Austria is one of the leading countries in terms of cooperation between industry and universities.

4.2.3 Crowdfunding in Austria

While the knowledge, creativity and working power of the crowd is at the forefront with crowdsourcing, crowdfunding aims to attract the crowd as a provider of funding for business ideas.[196] The restrictions on access to bank loans as a result of the economic and financial crisis along with new requirements as a result of Basel II and Basel III make this type of financing particularly interesting to start-ups and young firms. Mediation between initiators and the community generally takes place via online portals known as crowdfunding platforms. The idea is presented to a wide audience ("campaign"), which is used at the same time for marketing and public relations (PR) purposes. If the required amount is achieved within a specific period of time then the project is implemented. If it is not achieved then the initiators usually receive no money from the supporters.

A distinction can generally be made between four business models[197] with crowdfunding, with mixed forms being frequent and transitions fluid (Table 41).

The difference between crowdfunding in general and crowdinvesting in particular is based on the fact that with crowdfunding there are no shares in the business assigned to (the many) funders. The consideration consists of small courtesies such as acknowledgments, special

Table 41: Overview of crowdfunding business models

Form	Description
Donations	Campaigns for donations on the internet, often supplemented by non-monetary incentives such as sponsorship.
Pre-sale	The fund providers are asked to pre-order (planned) products or services and therefore to provide (advance) financing. The firm also gets a first overview of the demand structure and target group.
Loan	Similar to a bank loan, generally with collateral provided. The amount contributed will be repaid (incl. interest) if the case is successful.
Equity investment (crowdinvesting)	"Traditional investment" in the enterprise value and profits. Providers of funds become private investors and share in the enterprise risk following their contribution.

196 EFI (2013).
197 Ibid.

conditions, the possibility of advance orders or exclusive access to the product. By comparison crowdinvesting, such as via venture or general risk financing, involves concrete economic interests. The crowd is supposed to finance a firm which promises a return for providing the capital. The opportunities and risks must be considered with crowdfunding in the same way as with risk investments. There may be a threat of total loss in a worst-case scenario following a sale or cessation of the business or insolvency.

The growing interest in this type of financing is reflected by its disproportionately high market growth. While according to estimates for 2011 around US$1.5 billion were provided via crowdfunding, for 2012 this figure had already risen to US$2.8 billion (+ 81%).[198] North America accounted for around US$1.6 billion and Europe for around US$1 billion. Experts expect an increase of more than US$5 billion for 2013. Capital is predominantly raised via donations and gratuitous models for crowdfunding. Around a third of all crowdfunding platforms are concentrated on the Anglo-American area. In Europe high start-up dynamics can be seen for platforms in the United Kingdom, Netherlands, France and Germany. Transregional competition between platforms is constantly increasing.

Between 2011 and mid-2013, around €6 million were raised in Germany via crowdfunding[199]. Of the 2,758 projects 1,350 (approx. 49%) were successful in receiving financing. In the case of crowdfunding *Startnext is the market leader with a share of around 90%. Using crowdinvesting*[200] around €20 million were raised since the end of 2011; 66 projects were implemented in 2013 alone with capital raised of around €15 million. The market leader in the crowdinvesting area is *seedmatch*. Dynamic development is expected for both areas in 2014. The platform bergfürst.de which is active using a licence from banking supervision authority Bafin is subject to particular observation. The difference between crowdinvesting and the provision of venture capital noticeably disappears in such cases.

Crowdfunding is not very widespread in Austria. The first German-speaking crowdfunding platform was founded in Vienna in 2010 by the *Respekt.net* association. It is focused on social, charitable and voluntary projects. Supporters are able to contribute resources to projects such as time or knowledge and skills in addition to monetary amounts. Donations/investments can be made from the sum of €10. In April 2014 the investment volume for the platform came to around €660,000. *inject-power.at.* is dedicated to the issue of research sponsorship. Amounts from €20 can be invested in scientific projects since September 2013. The Ludwig Boltzmann Gesellschaft (LBG), the Natural History Museum Vienna (NHM), the Austrian Archaeological Institute (ÖAI), the Institute of Molecular Biotechnology (IMBA) and DEBRA Austria (aid for children with epidermolysis bullosa) have been acquired as partners to the platform.

Crowdinvesting is also offered in Austria by *conda.at*, *1000x1000.at* and *Greenrocket.at*. Table 42 offers an overview.

In addition to the acceptance criteria and the testing processes which are somewhat comprehensive in some cases, the following must also be noted in Austria on account of the current legal situation related to crowdfunding and investing: firms are allowed to raise a maximum of €250,000 of private equity per project without having to submit an investor's prospectus approved externally. This limit was amended by parliament in July 2013 (previously: €100,000). Raising higher amounts is not generally pursued since the provision is cost-intensive and not cost-effective at this scale. Whether and the extent to which crowdinvesting can be brought in line with the definition of "deposit business"

198 Ibid. 2013CF (2013).
199 Crowdfunding monitor of Für-Gründer.de (www.fuer-gruender.de).
200 Ibid.

Table 42: Crowdfunding platforms in Austria – as at April 2014

	1000x1000.at	Conda.at	GreenRocket.at
Active since	April 2012	March 2013	October 2013
Investment in legal form	Participation certificates	Participation certificates	Participation certificates
Amount of investment	€ 100 to 5,000	€ 100 to 3,000	€ 250 to 10,000
Investment sum	max. € 250,000	min. € 50,000 (max. € 250,000)	max. € 249,990
Financing term	Freely selectable	Freely selectable	Freely selectable, min. 30 days
Financed successfully[1]	Three projects (around € 290,000)	Five projects (around € 560,000)	3 projects (around € 440,000)
Comments	Crowdfunding possible	-	Focus on projects in the fields of energy, environment, mobility and health

1 Crowdinvesting only.

for the purposes of the Banking Act is also the subject of fierce discussion. Commercial deposit business currently requires a banking permit. No money can therefore be offered for providing capital via the crowd.

There are currently no uniform regulations regarding crowdfunding/investing at the European level. As a result a consultation has been held by the European Commission for the purposes of examining whether a European Regulation on crowdfunding is required. The submissions and considerations of the Commission became part of a communication which was published on 27 March 2014.[201] Some provisions which indirectly affect crowdfunding are planned or are currently being implemented, including the Prospectus Directive and the Alternative Investment Fund Manager (AIFM) Directive[202] in Austria by late July 2013 in the form of the Alternative Investment Fund Manager Act (AIMFG)[203]. Developments such as those in the USA where in 2012 individual provisions on crowdfunding were eased as part of the Jumpstart Our Business Startups (JOBS) Act[204] are also possibilities for Europe going forward.

In summary crowdfunding/investing in Austria are at an early stage of development, increasingly becoming an alternative for innovation financing in a restrictive environment shaped by traditional forms of financing and an underdeveloped venture capital market[205], at least for the purposes of closing existing financing gaps. Things are at an early stage and the number of successful financing initiatives has so far been modest.. It is little surprise that no firm has yet raised the maximum amount of € 250,000 via any of the domestic crowdinvesting platforms. It will probably take some time before the platforms are cost-effective. Similar high levels of growth can be expected in Austria based on the developments in Germany. Competition, in particular between platforms in different countries, is on the rise.

Clarification is required regarding issues of regulation and the protection of investors. Possible solutions are being discussed, for instance in relation to the permitted investment volume which can be raised using crowdfunding and a simple yet purposeful obligation to provide information. The developments with *inject-power.at* could provide some initial indications for funding research. The public sector could also

201 Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Unleashing the potential of Crowdfunding in the European Union.
202 See EFI (2013).
203 See ECN (2013).
204 Firms may raise a maximum of USD 1 million per year using crowdfunding. Certifications for crowdfunding platforms as well as statutory regulations related to the capital invested per person, which should depend on the relevant income, are used in addition.
205 See Improveo et al. (2012).

expand its role as a promoter in order to increase awareness of (supported) projects, and as a network and hub, for example through events with crowdfunding platforms and investors.

4.2.4 Service innovations

Increasing tertiarisation and the growing relevance of the service sector for economic development and the growth in employment raises growing scientific and political interest in service innovations. This can be seen in the recommendations of the Austrian Council for Research and Technology Development for the use of funds from the National RTD Foundation for 2014 or the "Innovation with services" R&D programme of the Federal Ministry of Education and Research in Germany among other things. For instance the Austrian Council for Research and Technology Development suggests embracing the important trend for service innovations and providing support for founders in this sector through a necessary reinforcement of venture capital.[206]

Service innovations have been underestimated for some time, particularly in terms of their importance for technological innovations. The main reasons for this are the fact that the original understanding of innovation was heavily characterised by the perception of technological innovation in the industrial environment on the one hand. On the other, this was caused by the fact that the influences of services for technological innovation are very difficult to quantify, primarily due to the heterogeneity of the services sector. This has also now become part of the political indicators through the increasing link between industrial production and innovation with services and service innovations.[207]

The Seventh Community Innovation Survey (CIS7) from 2012 provides an insight into the multiple ways that services influence innovation. A distinction is made in the CIS7 between technological (product and process innovations) and non-technological innovations (organisational and marketing innovations). Technological innovations include innovative services both within as well as outside of the process innovations, while non-technological innovations are understood to be (supporting) service innovations per se. Around 57% of all firms were able to show innovation activities in Austria between 2008 and 2010. Around 77% of innovating firms have implemented non-technological innovations and thereby provided innovative services, and just under 23% of innovative companies have also exclusively implemented technological innovations, with a significant portion of these also representing services.

Just under half of those firms which has implemented product innovations[208] between 2008 and 2010 generated a new service product. A new innovation in goods was also developed at the same time in two-thirds of these cases. Service innovations take up a significant proportion of product innovations in the material goods sector, particularly in the manufacture of transport equipment. 25.7% of all firms in the sector implemented service innovations between 2008 and 2010.

Table 43 shows the proportions for services aggregated within technological innovations and according to the economic sectors with the highest proportions of services.[209] It is clear here that service innovations also play a role in the area of process innovations[210].

The CIS7 also allows an assessment to be made of the service innovations within product and process innovations according to developer.

206 See Austrian Council for Research and Technology Development (2013).
207 See Schienstock et al. (2010); Boden, Miles (2000); Leiponen (2003).
208 A product innovation is defined as the market launch of a new or significantly improved product (incl. service products) (OECD 2005).
209 See Statistics Austria (2013).
210 The Oslo Manual views a process innovation as the introduction of a new or significantly improved process for providing services or for selling products (OECD 2005).

It can be seen here that service innovations take place to a large extent within the same firm. Services which accompany products are very often developed together with new goods. The proportion of service innovations developed with the same company tends to be higher in companies active in manufacturing than it is in service companies, where this occurs more frequently in cooperation with other firms or institutions.

Among the business-related services, *knowledge intensive business services* (in short: KIBS) play an exceptionally important role in the innovation process. They make a big contribution to the production, recombination and diffusion of knowledge and to the development of innovations in other sectors, particularly in the material goods area.[211] This is also clear from the data from the area of research and experimental development. 13.3% of all employees in KIBS firms were active in research and experimental development in 2011. By comparison this is only true of 4.9% of employees in the material goods sector and 0.7% of employees in the services sector. Both the proportion as well as the growth rate of research staff are very high. The level of R&D employees in KIBS firms grew by 32.4% between 2007 and 2011.[212]

Knowledge intensive business services can take on a role as a knowledge broker in association with innovation processes and be seen as a co-contributor of a "second" (informal) knowledge infrastructure which supplement the more heavily institutionalised public institutions of the *"first knowledge infrastructure"* (while also competing with these). In addition to the knowledge transfer adapted to customer needs, knowledge intensive business services also make an essential contribution to growth and structural change by creating highly qualified jobs.[213] Knowledge intensive business services are particularly relevant for higher corporate roles. However, it can be seen that in relation to headquarters, geographical proximity to this KIBS is less important than this in turn influences the location decision of KIBS firms.[214]

Table 43: Proportion of services within technological innovations, 2008–2010

Economic sectors (ÖNACE 2008)	Product innovations				Process innovations			
		of which				of which		
	in % of all firms	both new goods as well as services	new goods only	new services only	in % of all firms	with new/improved methods for producing goods or services	with new/improved logistics processes, delivery or sales and distribution methods	with new/improved support activities for their processes and procedures
Total	32.0%	9.5%	16.6%	5.8%	31.2%	17.8%	11.4%	21.8%
Manufacturing	38.0%	9.1%	27.4%	1.4%	35.1%	26.4%	10.8%	21.4%
26-27 Computers, electr. and optical products; electr. equipment	73.3%	19.8%	52.4%	1.0%	59.0%	44.8%	18.1%	39.2%
29-30 Vehicles and parts, other manufacture of transport equipment	64.1%	18.6%	38.5%	7.1%	60.3%	51.9%	21.2%	41.0%
46-71 Services	27.9%	9.9%	8.9%	9.0%	27.7%	10.9%	11.5%	21.9%
61-63 Provisioning of information technology services; information services	62.7%	30.4%	17.7%	14.6%	53.8%	27.7%	16.7%	42.9%

Source: Statistics Austria (2013).

211 See Muller, Doloreux (2009).
212 See Statistics Austria (2013a).
213 See Schnabl, Zenker (2013).
214 See Wood (2002); Jakobsen, Aslesen (2004).

The area of knowledge intensive business-related services is defined differently at the industry level. Not all industries included in a more recent analysis by Schnabl and Zenker (2013) are covered by the CIS7.[215] The following consideration of innovation trends and behaviour includes information services (Nace 62), information technology services (Nace 63) and architectural and engineering offices (Nace 71).

The studies show that the economic categories under consideration feature a comparatively high trend towards innovation which is above the average. In those sectors assigned to knowledge intensive business services (KIBS), 67.6% of firms carried out innovation activities between 2008–2010, which is also above the value for the aggregated material goods sector which was already high (60.6%). Furthermore an exceptionally high proportion of KIBS firms feature innovation activities both for technological as well as non-technological firms, and for product and/or process innovations (see Table 44).

The data from the CIS7 also shows that firms from KIBS sectors enter into innovation cooperation considerably more frequently than is the case in the area of other services or the production of goods. While 33.6% of these companies were able to show innovation cooperation between 2008–2010, this was only true for 22.4% of all firms, or 25.5% of firms in manufacturing and 19.8% of all service providers. KIBS firms with innovation cooperation initiatives in place cooperate very frequently with clients or customers or with universities, universities of applied sciences or other institutes of higher education. For instance 51.5% of these firms were engaged in innovation cooperation with clients or customers (all firms: 43.3%) and 60.8% with universities, universities of applied sciences or other institutes of higher education (all firms: 42.6%).

The studies in this section provide the reasons behind the increasing interest in service innovations and the growing awareness in relation to the suitability of funding for research and innovation in the area of service products and processes. These make an essential contribution to technological innovations, both in the material goods and the services sector, and considerably influence the innovative capacity in the material goods sector. The results of the assessments of the CIS 2010 also show that knowledge intensive business service firms are highly innovative and make an essential contribution to the distribution of knowledge across all sectors through their intensive cooperation activities.

4.2.5 Corporate culture and innovation

The trend towards Open Innovation also involves changes in corporate cultures and structures. New forms of innovation and networking processes are finding their way into the company environment, which also frequently involves

Table 44: Proportion of KIBS firms in innovation activities, 2008–2010

Economic sectors (ÖNACE 2008)	Innovation active firms	Technological innovations	Non-technological innovations	Product innovations	Process innovations
	(in % of all firms)				
Total	56.5%	43.9%	43.9%	32.0%	31.2%
10-33 Manufacturing	60.6%	50.4%	45.1%	38.0%	35.1%
46-71 Services	53.4%	38.9%	43.6%	27.9%	27.7%
KIBS (62, 63, 71)	67.6%	56.4%	51.3%	47.2%	44.4%

Source: Statistics Austria (2013).

215 In study cited the NACE rev. 2 classes 62, 63, 69, 70, 71, 72 and 73 are allocated with knowledge-intensive corporate services.

opening the organisation up to external influences. People speak of organisational innovations whenever new management practices are developed, propagated and implemented in a firm on a sustainable basis. Organisational innovations can be seen both in the firm's internal processes as well as in its external cooperation initiatives: examples in *internal* work processes include the creation of a culture of recognition through personal wellbeing, optimisation of innovative research teams or organisational innovations through greater participation by employees in the decision-making processes. Examples of organisational innovations in external cooperation initiatives include innovative networking and outsourcing strategies as well as new organisational forms in care for the elderly.[216]

According to Steiber[217] organisational innovations feature the following characteristics as compared with technological innovations: (i) They are more difficult to observe and define and based on their type and the system limits are less easily distinguishable. (ii) Markets do not emerge in the traditional sense, but emerge instead through shifts in position between firms, user networks and advice services. (iii) More commitment is required from top management to push forward with change processes.

Impetus for the introduction of organisational innovations comes from new markets or from knowledge transfer, internal company experience or from economic crises. Their implementation in firms requires different steps in the decision-making process which follow a circular implementation path. Steiber[218] has identified five typical ideal steps for this:

- The desire for organisational change on the part of central stakeholders in the firms
- A conviction on their part that the innovation is feasible in the firm
- A "first trial", i.e. a pilot run and subsequent evaluation of the organisational innovation
- Application of the organisational innovation in parts of the firm at least
- A focus on sustainable implementation, so that organisational innovations become part of the firm's regular operations, work organisation or external relations.

These steps are influenced by the nature of the innovation per se, the firms internal management culture, the firm's external environment and the different diffusion mechanisms. Current activities are outlined below which provide more precise insights into organisational innovations and which discuss central intangible factors on firms' innovation performance. Crucial importance for the innovation behaviour of the employees[219] is attached to the work environment and the corporate culture[220].

Benchmarking results are provided e.g. by the European Manufacturing Survey (EMS)[221], which measures innovations in human resource management *of producing* firms. In the last survey from 2012 it was observed that regular work meetings represent the most frequent form of innovation in the creative search for new ideas. Half of the Austrian firms surveyed feature this form. The other organisational innovations, i.e. instruments for keeping older employees and their knowledge in the company, specific leeway for creativity and innovation during working hours, talent promotion programmes and pro-

216 See Döös, Wilhelmson (2009).
217 See Steiber (2012), p. 12f.
218 Ibid., p. 14.
219 See Amabile et al. (1996).
220 See Kaiser et al. (2012).
221 The EMS records the use of technical and organisational innovations in production and the improvements in performance achieved with this in manufacturing. There is now data available from four survey rounds, with the last survey taking place in 2012 (companies involved in manufacturing with more than 20 employees, for 2012 there were 250 companies in Austria; representative of the base population).

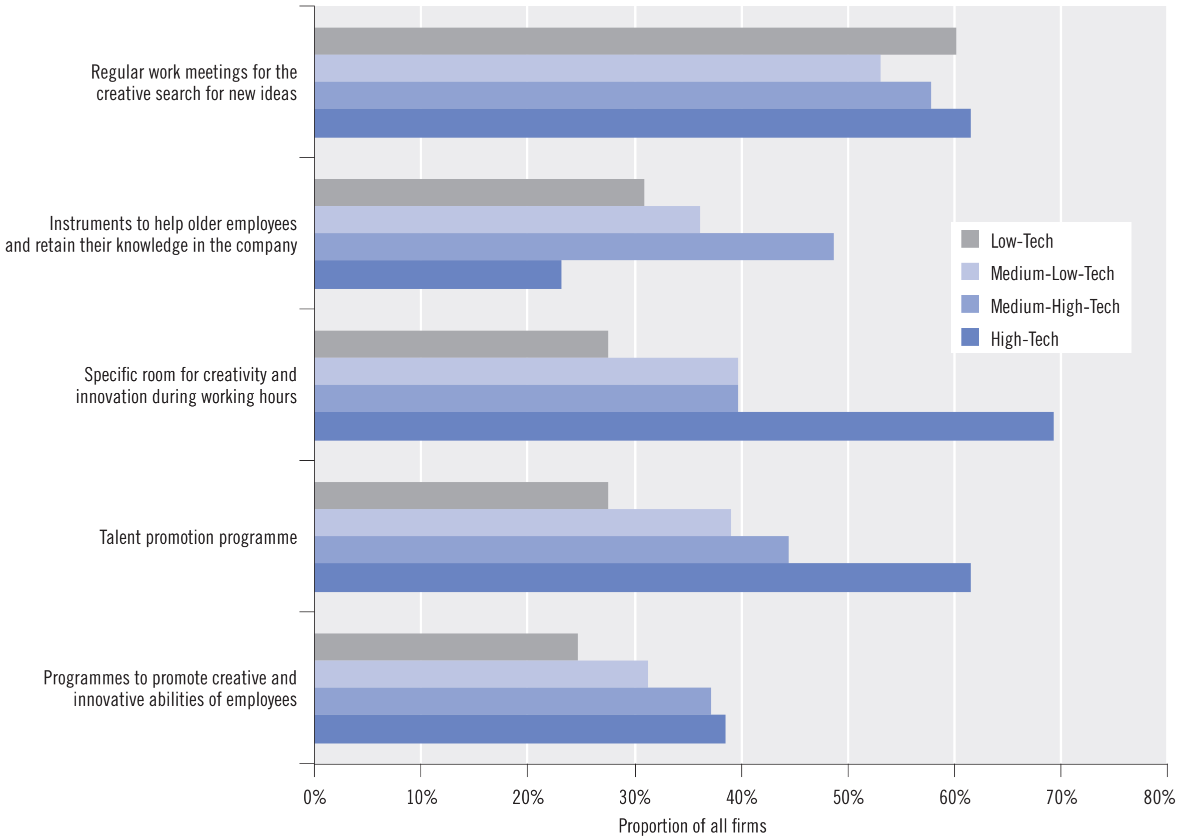
grammes aimed at encouraging creative and innovation-based skills of employees can be found at around a third of firms.

It was also possible to determine that greater product complexity increases the diffusion of all innovations surveyed. Firms active in R&D have considerably higher specific leeway for creativity, talent promotion programmes and programmes aimed at encouraging creativity. As Fig. 50 shows, the proliferation of these three organisational innovations rises with the technological intensity in the sector.

With the exception of regular work meetings, the implementation of all types of organisational innovation rises significantly in line with company size (Fig. 51). The difference with the employee promotion programmes is especially clear, with these implemented in each case by around two-thirds of large companies but by just one in five small companies.

Efforts to improve innovation behaviour by changing corporate culture can also be seen in relation to research promotion: the Laura Bassi Centres of Expertise[222] (LBC) stimulus programme is targeted at changing the organisational and management culture in research institutions. Requirements in this regard are set out in the proposal for the programme. Central elements include a clear definition of which criteria are actually crucial for the assessment,

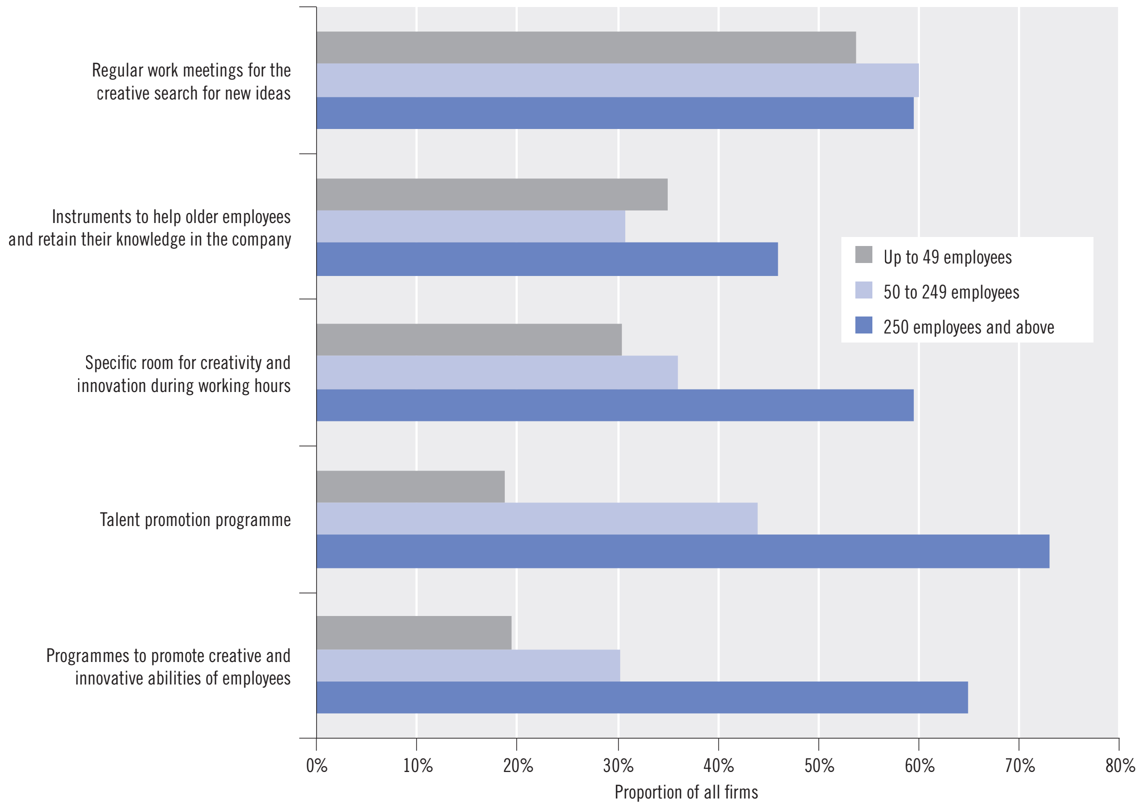
Fig. 50: Organisational innovations according to technology intensity



Source: AIT.

222 See also Chap. 5 Evaluations for a description of the support programme.

Fig. 51: Organisational innovations according to size of the firm (number of employees)



Source: AIT.

a change in the performance assessment, which is based around the future development potential of the management personnel and not around the CV or track record of the researchers. Different factors are assessed accordingly using newly developed analyses of future potential:

- since a management culture is required which is based around management standards, the skills related to management and career progression need to be evidenced to the centres in the application process[223] and during the interim evaluations.
- The management skills were focused on establishing appropriate structures, knowledge transfer and economic exploitation of the research results, as well as on developing team potential.
-

The changes to the management culture are supposed to be expressed in responsibility for the career options of the researchers employed, which need to be made visible both in the team as well as on an individual basis. Team culture is fostered and career development options set out for the employees using personal development plans. The experiences from this programme which can be seen as organisational innovations should be extended to other funding programmes in order to encourage organisa-

223 See programme document (BMWA 2008, p. 24f.).

tional innovations also in research institutions and firms. The following factors were identified as being transferrable:[224]

- The composition of the jury is considered to be relevant. Management and personnel development qualities must be assessed in hearings in addition to scientific excellence.
- Targeted environmental management, i.e. confirmation of the expectations of the relevant environments, as well as management of the cooperation with the partner organisations were also set out as further essential requirements as part of the interim evaluations by the centres.
- Finally the future direction also needs to be considered, including the establishment of successful structures for knowledge management and transfer.

A study recently carried out among Austrian research institutions in cooperative research[225] on cooperation, competition, success and leadership based on qualitative and quantitative assessments found that management skills are barely seen as a separate qualification in cooperative research but are generally justified based on scientific reputation or contextual expertise. Accordingly there is a shortfall in increased professionalism among the management personnel, with employee motivation and staff development only of marginal importance as a consequence.

Efforts to establish quality standards across Europe for "good HR management in the public research sector" find expression in the "Human resources strategy for researchers"[226]. Research institutions and support organisations receive support with actual implementation of the Charter and Code in four areas using this tool (ethical and professional aspects, recruiting, working conditions and advanced training). These establishments are honoured as attractive employers and promoters with a "stimulating and pleasant working environment under the slogan "HR Excellence in Research".

The *Human Resources Strategy for Researchers* (HRS4R) needs to be seen in the ERA context as a contribution to the change in organisational culture in research and support institutions at the overall European level.

4.2.6 The importance of intangible assets for the national economy

Compared with tangible capital assets, intangible assests receive increasing attention, for instance as part of corporate valuations and financing questions. In addition to expenditure for research and development (R&D) and information and communication technologies (ICT), these include in particular the development of human and organisational capital, the brand value and physical appearance (design) of products and the knowledge contained in databases and IT processes. Intangible assets make an essential contribution to strengthening a business location by increasing the innovative potential and competitiveness of firms.

Intellectual property rights (IPR), such as such as patents, utility models and trademarks are important components of intangible assets. Companies, and to a growing extent also universities and research organisations, are using IPRs not only to protect monopolies in competition, but also for the targeted commercialisation of innovations. Development of the legal instrument into a strategic tool opens up new opportunities, for instance trade and direct marketing of intellectual property using licensing mecha-

224 See Dörflinger, Heckl (2013).
225 See Schiffbänker et al. (2013).
226 See Technopolis Group (2014).

nisms. IPRs are increasingly playing a more significant role in the context of open innovation and crowdsourcing. The creation of the European Union patent should benefit small and medium-sized enterprises (SMEs) in particular at the European level, for instance by reducing the costs of fees and translations associated with comprehensive patent protection.

Overall economic importance

Intangible assets are also highly significant in Austria in relation to economic growth and the increase in national economic productivity.[227] The growth contribution to labour productivity averaged 0.5% in Austria between 1995 and 2007, and between 0.2% (Italy) and 0.9% (USA) internationally. Looking back, high investment rates above the average could be determined until 2008 in Austria for intangible investments. Further development slowed slightly with the onset of the economic and financial crisis. In 2010 with a share of around 6% of GDP, Austria was at the European average, roughly equal to Germany. The countries with the highest investments include the United Kingdom (8%), France (9%) and the USA (11.4%). Expenditure for software and databases, R&D, advanced training and organisational capital are particularly important in Austria. The above-average R&D investments compared internationally are contrasted with growth potential in software, design and market research.

In relation to industrial structures, significant importance is attached to intangible assets in the areas of manufacturing and business-related services in particular. However, catching-up processes can be ascertained in other industries in this regard. The trend towards the "scientification of industry" also essentially contributed in Austria to the fact that firms and therefore the entire national economy are increasingly geared towards and accordingly investing in intangible assets, particularly IPRs. The focus on intangible assets had positive effects on Austria's journey through the economic and financial crisis.

A positive trend can also be identified both for patents applied for and issued for Austria in international comparisons. Patent statistics show that international patent applications by Austrian firms abroad have undergone dynamic development since 2005. The overwhelming proportion of patents are submitted by private individuals in Austria, which may point to the fact that a large number of innovations take place in start-ups and small businesses. The photovoltaic example shows that care is needed with a simple count of patents, for instance based on the lack of any accounting for technological relevance or the portfolio strength. While Austria is ranked eighth in the photovoltaic area in terms of patent counts, it is ranked fifth when technical quality is taken into account, and is even third within Europe.[228] This is evidence of the existence of leading edge research in Austria, but also points to gaps in international protection and in the implementation of effective commercialisation strategies.

IPRs in firms

Innovation protection such as patents allows firms to achieve monopoly gains for limited periods and to reduce the uncertainties of investments in R&D. The development of a patent and/or IPR strategy which defines the strategic scope of technical and non-technical intangible property rights and which is closely aligned to the R&D and/or corporate strategy is of central

227 The following statements are based on the results of the study by ITEM-HSG (2013).
228 The technical quality was measured using the St. Galler Patent Index™ in this example. With this the Index takes into account factors such as the strength of the patent portfolio, the market strength of the patent and the relevance of the patent.

importance here. Patents do not by any means need to be the best possible tool for market success and competitiveness. The trade-off between the protection from patents and aggressive dispersal of an innovation not protected by patent can differ depending on the firm and the industry. Protective mechanisms such as confidentiality, market leadership and technical complexity may be a more effective approach.

Only few Austrian companies are aware of this trade off, and they rarely consider it in strategical conisderations. A similar thing applies to Open Innovation, where the innovation process usually works based on clear regulations and the use of IPR concepts. Against this background a need for catching-up on IPRs can be stated for SMEs and the start-up area in Austria, particularly in the area of IPR management. Altough there is more is more capacity and corresponding knowledge and skills in medium and large firms, there appear to be opportunities for improving the development of international IPR strategies.

IPRs barely play a role in financing decisions at private institutions in Austria. While licence payments are considered, the main priority lies on material collateralisation. IPRs are acknowledged as a soft factor at larger firms in certain cases. The high assessment costs and the difficulties with the handling IPRs are the main reasons against any increased consideration of IPRs. A number of support measures and activities are provided at multiple levels (national and state) by different institutions (e.g. the Austrian Research Promotion Agency (FFG), aws, the Austrian Science Fund, regional providers) in several forms which to some extent build upon each other. IPRs can also be used as collateral at aws upon approval of funding or grants.

Outline for a national IP strategy

Starting points for changes are the creation of awareness and knowledge and skills in relation to intangible assets in society ("innovation and IP culture"). Institutions from research and science must also be supported in addition to firms when establishing patent and IP strategies. In particular, the lack of specific IP stakeholders and transaction intermediaries has to be considered. The existing support measures in Austria must be coordinated more effectively, particularly from the aspects of clearer and target group-based structuring and communication. The centralisation of (initial) advice at a cross-regional institution would be conceivable. Support and consultation for companies when developing international IP strategies and commercialisation is needed. Deregulation measures, such as a reduction in administrative obstacles for start-ups and in the barriers to trade and investments could be implemented as accompanying support measures. Over the long term, considerations could be made related to the creation of an IPR market place which could simplify transactions for IPRs, in particular patents.

The development of an overall Austrian strategy for intellectual property is essential for sustainable increase in the importance of IPRs, a project which is in the working programme for the Austrian federal government for 2013 to 2018 and which has already been implemented successfully in other countries. The cornerstones to any national IP strategy include a clear formulation of objectives (e.g. "top 3 ranking in Europe in terms of quality of the IPRs generated in future industries"), the selection and definition of corresponding focus industries, targeted funding for firms at the start-up and growth stage, for internationalisation projects and for the development of new business models that link to IPR issues ("modular sytem"), and a target group-based communication concept including all key stakeholders.

One challenge in developing an Austrian IP strategy will be in linking this closely to the country's economic policy strategies, in particular the RTI strategy. Clarity towards the measurement of key figures related to IPR is the basis for any productive analysis and assessment.

4.3 Measuring the economic effects of innovation activities

Evidence-based research, technology and innovation policy requires indicators to understand the development of innovation activities over time. The international use of indicators to measure RTI activities, by the OECD and the U.S. National Science Foundation (NSF) for example, can be divided into two periods.[229] Up until the 1970s, RTI policy was dominated by efforts to develop research potentials and capacity. The focus was placed accordingly on input indicators, such as expenditure for research and development. The slowdown in growth and the economic crises associated with oil shocks in the 1970s led to a shift in RTI policy towards the distribution of scarce resources. Relatively stagnant budgets for RTI activities, combined with the simultaneously increasing importance of RTI for economic development, led to the development of output indicators by the USA and then the OECD, the latter of which published three initial indicators for measuring the impact of innovation: patent statistics, the technology balance of payment flows, and trade in high-tech products.

The Lisbon Strategy initially prescribed a pure input target in the form of a 3% R&D intensity at the EU level. This target is now supplemented by an output indicator in the Europe 2020 Strategy. The Innovation Union Scoreboard (IUS) however has long included an "economic effects" group of indicators. Output indicators will assume even greater significant in RTI policy debates as the trends described here intensify further in the coming years: budget consolidation applies to Austria's efforts to break into the top group of Innovation Leaders. In the face of scarce resources, considerations about impact, efficiency and efficacy will all become increasingly important. It is all the more important to have high-quality impact indicators that represent the economic effects of innovation activities as completely as possible and that do not entail a distorted depiction of impact effects that could for example negatively influence the allocation of public resources for RTI activities.

This section will first define what is meant by the impact of innovation activities. Then the IUS will be used to assess the economic effects of innovation activities in Austria. We first analyse at a conceptual level the recognition of the economic effects of innovation in the IUS before proposing a series of additional and alternative indicators. These indicators are used to recalculate the IUS and represent Austria's position. In addition to economic effects, there is of course a series of further important effects of innovation, for example in the fields of health and the environment. A description of these effects lies beyond the scope of this work.

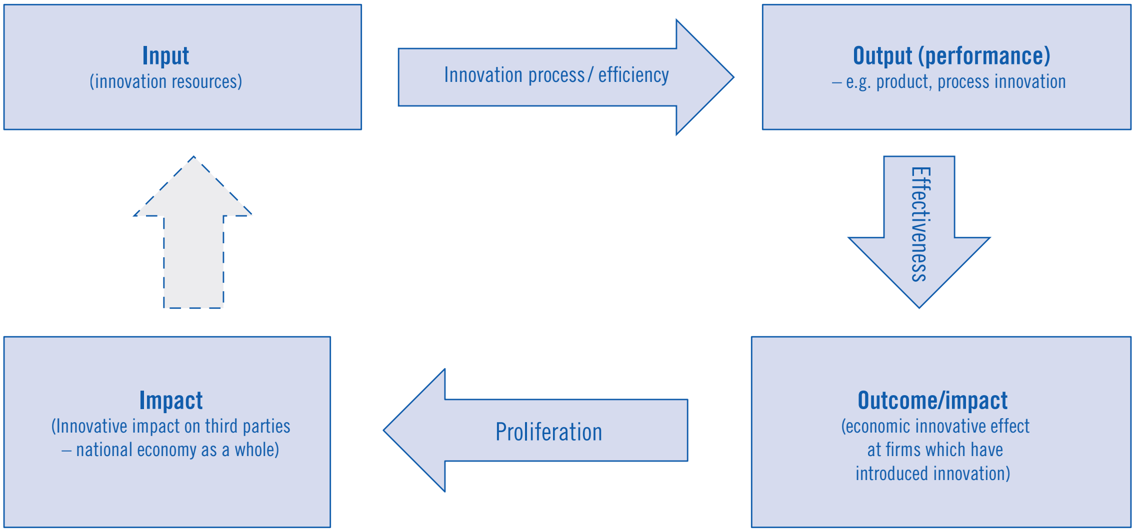
4.3.1 Innovation along the chain of effects: measurement options

A chain of effects[230] can illuminate the measurement of innovation activities in the fields of input and (innovation) resources, (innovation) processes, output and services, outcome and effect, or impact and effect on third parties (Fig. 52). The EU's Innovation Union Scoreboard is constructed in principle according to an impact model; the survey for the Community Innovation Survey (CIS) also enquires into innovation inputs, processes, results, and impacts. Both however do not deal with the impact of innovation (see below).

Input indicators describe the required resources for innovation activities: the "raw materials", meaning staff, monetary and physical resources, such as the number of researchers, R&D and innovation expenditure, and research

229 See Godin (2013).
230 See Jaffe (2011); McLaughlin, Jordan (1999); Webber (2004).

Fig. 52: Innovation along the chain of effects



Source: Austrian Institute of Economic Research (WIFO)

infrastructure. Process indicators provide information about the transformation of resources into services and typically correlate two input indicators; for example, innovation expenditure relative to human resources. Indicators on the progress of innovation processes, such as cooperation with external partners such as universities or other firms, are conceivable.

Output indicators and innovation patterns

Output indicators represent the results of the innovation process, for example in the form of new or improved products or production processes, or organisational and marketing innovations. The relationship between resources and results is termed efficiency. The degree of expression and the forms of innovation are fundamentally diverse. There is a basic distinction made between, on one hand, small and continuous improvements of existing products and processes along technology paths or within existing industries, and on the other hand, fundamentally new products that could for example lead to the emergence of new markets.[231] The ongoing incremental innovation in the context of existing products is also described as a quality ladder that can lead to major economic effects over the long term.[232] This kind of innovation is typically the dominant pattern for innovation.[233] "Radical" innovations or innovations that lead to disruptive changes can lead to the emergence of completely new industries and fields of activity, thereby unleashing very significant economic effects. Such innovations tend to occur rather seldom.

The frequency at which these patterns of innovation appear vary between industries.[234] Some industries are influenced typically by cumulative, incremental innovation (i.e., automobile and mechanical engineering), while others exhibit major leaps in innovation (i.e., pharmaceuticals and software). Both patterns of innova-

231 See Darby, Zucker (2003); Kline, Rosenberg (1986); Pavitt (2005); Smith (2005).
232 Smith (2005), Grossman, Helpman (1991).
233 See Smith (2005), Pavitt (2005), Harberger (1998).
234 See Malerba, Orsenigo (1997).

tion surface everywhere and can also be associated with an industry's life cycle. At the creation of a new industry, such as the manufacture of smartphones, major innovations emerge that disrupt existing markets; afterwards, however, products tend to develop in a more incremental way (for example, the succession of improved yet not fundamentally different smartphones from Apple, Samsung, etc.).

Examples for innovation performance and output indicators are those that were produced with the aid of the CIS: the proportion of firms that have introduced an innovation. However, there is no information about the quality of innovation, meaning whether incremental or comprehensive improvement is taking place. Patent statistics are always used as output indicators although patents actually only represent a preliminary stage of a potential innovation; indeed, many patents never lead to innovations.

Impact indicators

Impact indicators express the economic effect that innovation has on those firms that have introduced an innovation. The impact of the various aforementioned forms of innovation can be divided into two groups. First, economically successful innovations can initiate a shift in creation of value added and employment towards knowledge-intensive sectors, such as those with higher intensities of research or education, extending through an entire country's creation of value added or employment, as the IUS shows in the form of classical structural change indicators. Second, innovation triggers an increase in knowledge intensity in individual sectors that can lead for example to improved product quality or more cost-effective production processes, that then lead in turn to increased creation of value added or exports without industry shifts ("sectoral upgrading"). Indicators for this include the share of revenue from innovation as reported for example in the CIS.

This focus on economic effects such as turnover, creation of value added, etc. enables us to compare innovations in terms of their effects among countries and between technologies. More radical innovations need not necessarily, in purely statistical terms, lead to structural change; they can also lead to incremental innovations: incremental improvements to the iPhone, for example, which are very successful commercially, therefore lead to faster growth in corresponding industries in the USA, while for example the introduction of breathable waterproof clothing does not lead to a shift towards knowledge-intensive industries. It is important however to capture both effects - structural change and upgrading - for impact indicators; this is also relevant in terms of the fact that sectoral knowledge intensity typically coincides with the formation of an international average. The computer sector is classified as high-tech in all countries, although many countries probably are not conducting any research in this sector; instead, they merely acquire existing innovations. Structural change indicators do not measure actual innovation activity. This is why upgrading indicators, which record actual innovation activity, are an important supplement to the structural change indicators. It is more difficult to construct upgrading indicators, however, which is why there are fewer of them and why they are applied less often. Other problems in ascribing impact to innovations come from international spillover (the impact of the innovation also benefits other countries) and temporal delays in an innovation's effects, which sometimes can take a few years.

The impact of innovation at the economic level

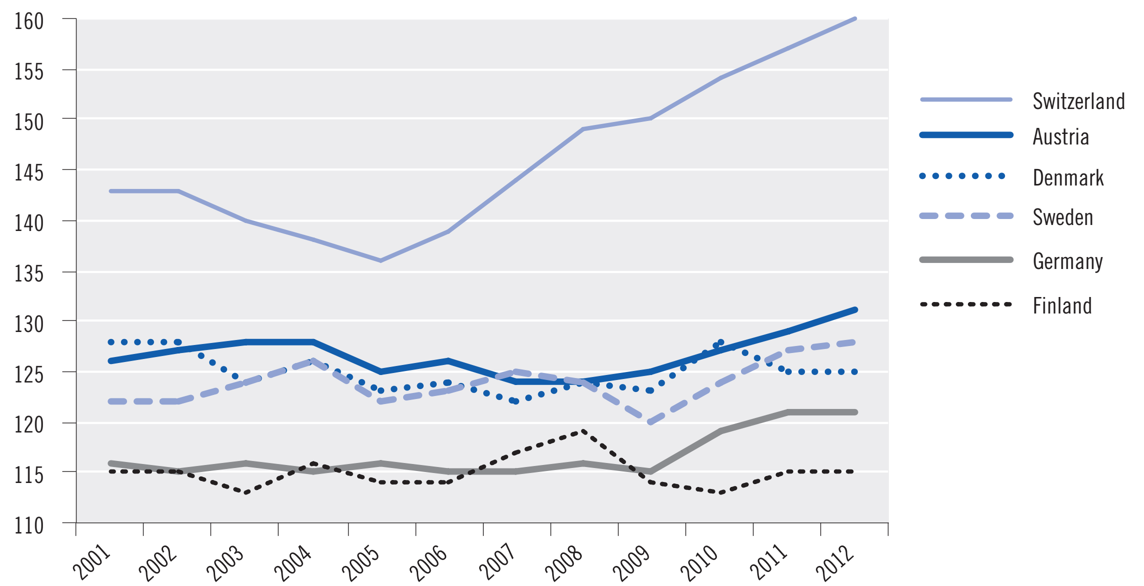
Impact studies go one or more steps further than impact indicators by attempting to determine the effect of innovation on the economy. This effect occurs at a broad level only with the diffusion of an innovation from a successful innovator to other firms or to customers. From an economic perspective, the economic effect of innovation is typically associated with a rise in hourly productivity or overall productivity. This attribution of impact is however often not possible with the aid of simple descriptive statistics, according to which developments in productivity are determined by various factors. In order to examine the effect of innovation on productivity while excluding these factors, econometric analyses that typically combine data from many countries over many years are necessary.[235] The result of such analyses is often a single number (such as the elasticity of productivity on R&D expenditure, which serves as a *proxy* for innovation) that provides a general view of several countries over time. This approach is therefore not appropriate for indicators. However, assessments of productivity at the sectoral level show that most of the growth in productivity stems from improvements within industries and not from a shift towards industries with higher growth in productivity.[236]

Fig. 52 shows these elements of the chain of effects. The arrow from the "impact" area to resources clearly shows that these effects are not monocausal or one-sided; instead, economic effects influence available innovation resources. Business enterprises will only continue to allocate resources for innovation if these innovations result in profits that are reasonable for the market. The public financing of RTI activities depends on the success of these activities, for example through rising tax revenues, which alleviates the competition for funds with other government remits such as healthcare and pensions.

4.3.2 The economic effects of innovation: Austria in international comparison

Fig. 53 shows Austria's positive economic development, measured in GDP per capita in purchasing power parity. Austria has distinguished itself not just against the EU-27 average, but also in comparison to Innovation Leaders such as Germany, Denmark, Finland and Sweden. Only

Fig. 53: GDP per capita of purchasing power parities in an international comparison (EU-27=100)



Source: Eurostat.

235 See Crepon et al. (1998), Griliches (1979), Mairesse, Mohnen (2010), Falk, Hake (2008).
236 See Peneder (2003).

Switzerland ranked significantly above all of the other countries. This positive economic development can only be attributed however to a small portion of innovation activities, if we take Austria's performance in the IUS "Economic effects of innovation" sub-group as a yardstick, which is contrasted with Austria's overall ranking in Fig. 54: while Austria held the 10th position across all the indicators (7th place without group economic effects), it only reached 17th place in innovation impact. This means that a solid portion of Austria's positive performance is based on other factors such as tourism and wage flexibility.[237] This kind of evaluation would lead in the medium term to scrutiny of significant increases of public R&D funding.

Fig. 55 shows Austria's R&D ratio in international comparison, which has far exceeded the EU and OECD average since 1995. If we believe the IUS impact indicators, then these higher inputs for R&D and innovation have not found adequate expression in economic effects. In this context, we would be able to describe Austria's position as having higher R&D inputs, lower innovation outputs, and good overall economic performance.

4.3.3 Impact measurement in the IUS

The "economic effects" group of the IUS includes the following indicators:

- Employment in knowledge-intensive sectors
- Contribution of medium-high and high technology intensity products to the balance of trade
- Exports of knowledge-intensive services
- Revenue share from innovations that are new for the firm and new for the market
- Licensing and patent income from abroad.

The first three indicators are classic indicators of structural change: the knowledge-intensive sectors in the first indicator are determined by the international average of the proportion of university graduates in each sector (those with more than 33% qualify as knowledge-intensive). This average is only calculated once and then remains stable over a longer period of time. Country-specific variations are caused by the different proportions held by these sectors in employment in each country. As described above, this creates a problem, namely that some countries have high proportions of sectors that qualify statistically as knowledge-intensive without actually having a high share of university graduates.

The technological character of export products in the second indicator is also determined not by actual metrics but by the calculation of international averages; this is also the case for exports of knowledge-intensive services. The latter is affected by a major problem: exports are calculated as the share of all service exports, which means that countries such as Austria and France, which have a high proportion of tourism, are massively disadvantaged in structural terms.

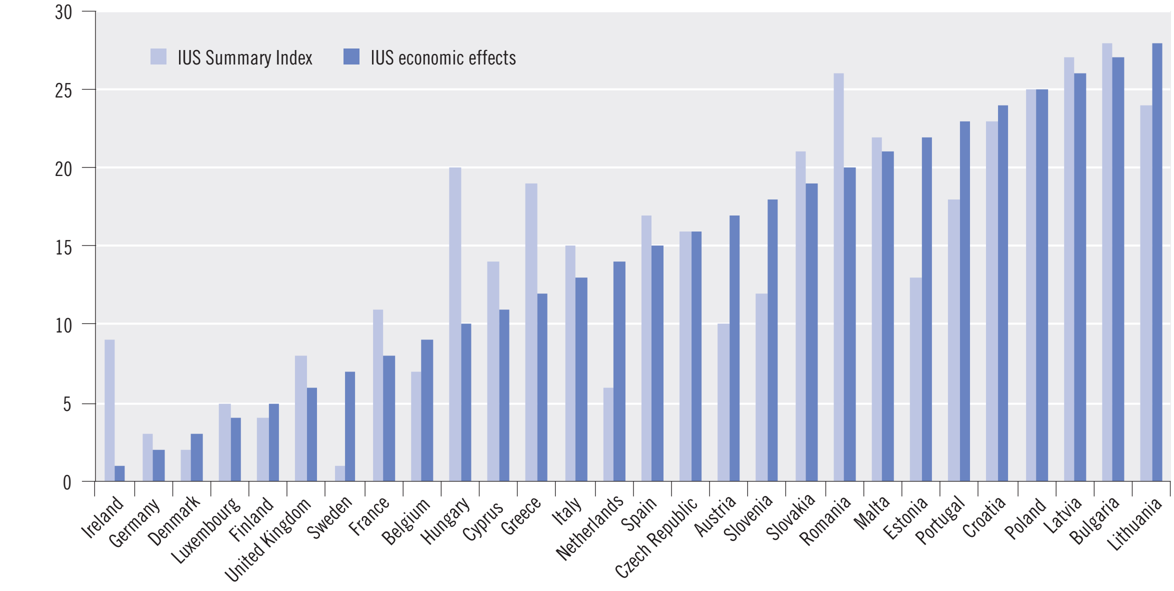
The fourth indicator captures in principle actual innovation activity in all sectors and can therefore be classified as an "upgrading" indicator. It is based however on the CIS and therefore on a subject assessment by firms of what is "new to the market". It is scarcely possible to use this for objective comparisons of impact among countries.[238] Calculations of the average volatility of the IUS indicators also show that CIS-based indicators swing the most by far, along with the oscillating spectrum of subjective evaluations of what is new.[239]

The fifth indicator also tends to be an upgrading indicator, even if industries differ structurally in terms of their technology payment flows, depending on the role that codifiable technologies play in the creation of competitive advantages. The problem with this indicator is its geo-

237 See Ederer, Janger (2010) for a picture of Austria's economic strengths and weaknesses.
238 See Smith (2005).
239 See Janger (2012).

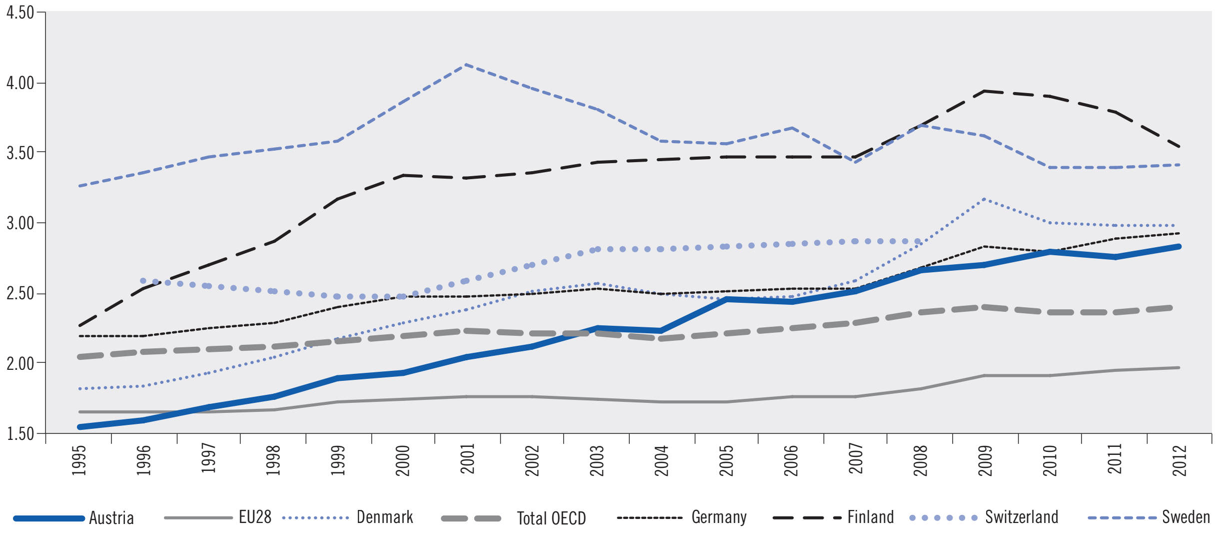
graphical categorisation of actual innovation activity. It captures framework conditions, such as the taxation of companies where headquarters are located, as actual innovation activity; as a result, countries such as Ireland and the Netherlands are way ahead for this indicator.

Fig. 54: Comparison of rankings for IUS overall indicator vs. IUS sub-indicator "economic effects", 2014



Source: Innovation Union Scoreboard 2014.

Fig. 55: R&D ratio for Austria in an international comparison



Note: missing values substitutes using average values; no values for Switzerland as of 2008.

Source: OECD, Austrian Institute of Economic Research (WIFO).

Overall, the IUS provides a highly insufficient image of the upgrading components of innovation impacts, or those components that are actually dominant in contrast to structural change effects. Even the structural change indicators, especially the service indicator, are plagued by major problems. The next section therefore proposed supplemental indicators that will allow a more comprehensive assessment of innovation impact and a recalculation corresponding to the IUS.

4.3.4 Alternative impact indicators and recalculation of the IUS

Indicators have been developed in recent years to gain a more comprehensive view of upgrading components for innovation impact. These include in particular export quality indicators[240], structurally adjusted R&D intensity of the business enterprise sector[241], and patent statistics.[242] The following briefly explains these indicators and then applies them to recalculate the IUS "economic effects" group of indicators.

Export quality indicators

It is obvious that innovation efforts that lead to enhanced product quality are also expressed in export quality. Improvements in export quality within the same industry can also be interpreted as an upgrade to the position of "quality leader" in an industry sector. The export quality of products is determined on the basis of the distribution of unit prices *(unit values)* for export products, which are classified at a very refined level as six-digit NACE units.[243] Three thresholds are formed on the basis of distribution, which results in three price segments (low: less than 33.3%, medium: between 33.3% and 66.7%, and high: above 66.7%). There is an inherent assumption here that higher prices mean higher quality: a higher proportion of exports in the high-price segment is interpreted as an indicator for high product quality.

An analysis of this product quality shows that the recent development of the Austrian export market was shaped less by diversification of geographical markets or industries than it was by an increase in quality among quality leaders within the industries.[244] This report used the inverted share of the lowest price segment in technology-oriented industries as an indicator, that is to say, the share of the high and medium price segment in all exports from technology-oriented industries. Technology orientation is measured in terms of R&D intensity at the three-digit NACE level[245]; the association between export product quality and innovation is supposed to be especially high in these industries. Table 45 presents the normalised and updated value for Austria's share; it is significantly higher than the values for the five IUS "economic effects" indicators.

Structurally adjusted R&D intensity

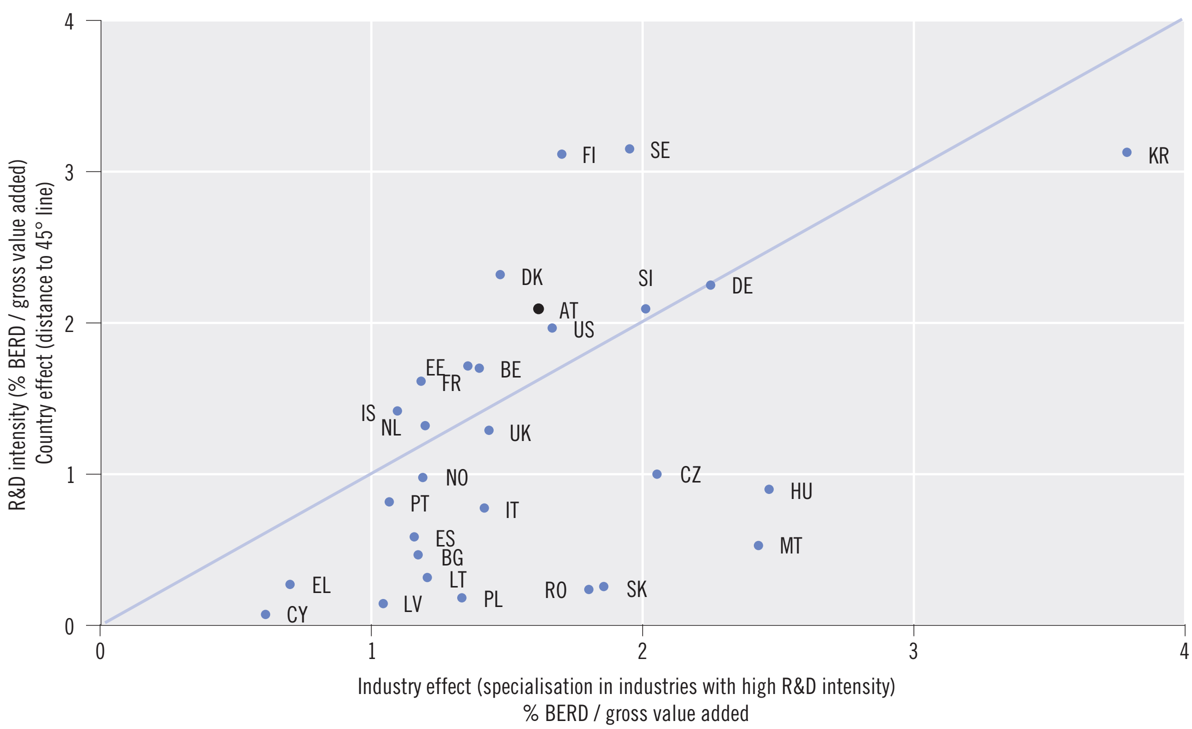
Different industry sectors exhibit various R&D intensities. The pharmaceutical industry requires a much higher R&D intensity to remain internationally competitive than does the metal construction industry, for example. The comparison of R&D intensities in the business enterprise sector therefore says little about knowledge intensity and competitiveness: a country with specialisation in high-tech sectors tends to have higher aggregated R&D intensities than countries, like Austria, that specialise in medi-

240 See Reinstaller, Sieber (2012).
241 See Reinstaller, Unterlass (2012a, 2012b).
242 See Unterlass et al. (2013a).
243 NACE is a classification system for economic activities.
244 See Reinstaller, Sieber (2012), p. 657.
245 See Peneder (2002).

um-tech sectors. Countries can however specialise in very knowledge-intensive segments of particular industries, thereby assuming a highly knowledge-intensive position. This is why R&D intensity for the business enterprise sector was calculated in a way that adjusts for these sectoral effects and represents a weighted version of the aforementioned IUS structural change indicators. This indicator provides a more realistic assessment of countries like Hungary that specialise strongly in rather research-intensive sectors, yet actually perform little of their own research and innovation there.

Fig. 56 shows the results of this computation. The horizontal axis shows the expected R&D intensity based on industry structure. This is determined by the average of leading R&D countries. Countries with strong high-tech industries are located at the far right. The vertical axis represents actual R&D intensity. Countries with a higher than expected R&D intensity are located above the 45° line, which means that they have a positive "country effect" that is an actual measure of knowledge intensity. The evaluation showed that a country such as Hungary has a sectoral high-tech structure due to its integration in international value chains (and therefore has a good ranking in the IUS structural change indicators). However, there is only a limited amount of R&D and innovation carried out in Hungary; the country primarily hosts the production side of creation of value chains. In contrast, Austria has a medium-tech economic structure with clear sectoral positioning in the knowledge-intensive segments, even if Austria is significantly behind the Scandinavian countries in this regard. The normalised values for country effect intensity are presented in Table 45 and again show a much higher value than the IUS indicators.

Fig. 56: R&D intensity in an international comparison adjusted for structure, 2011



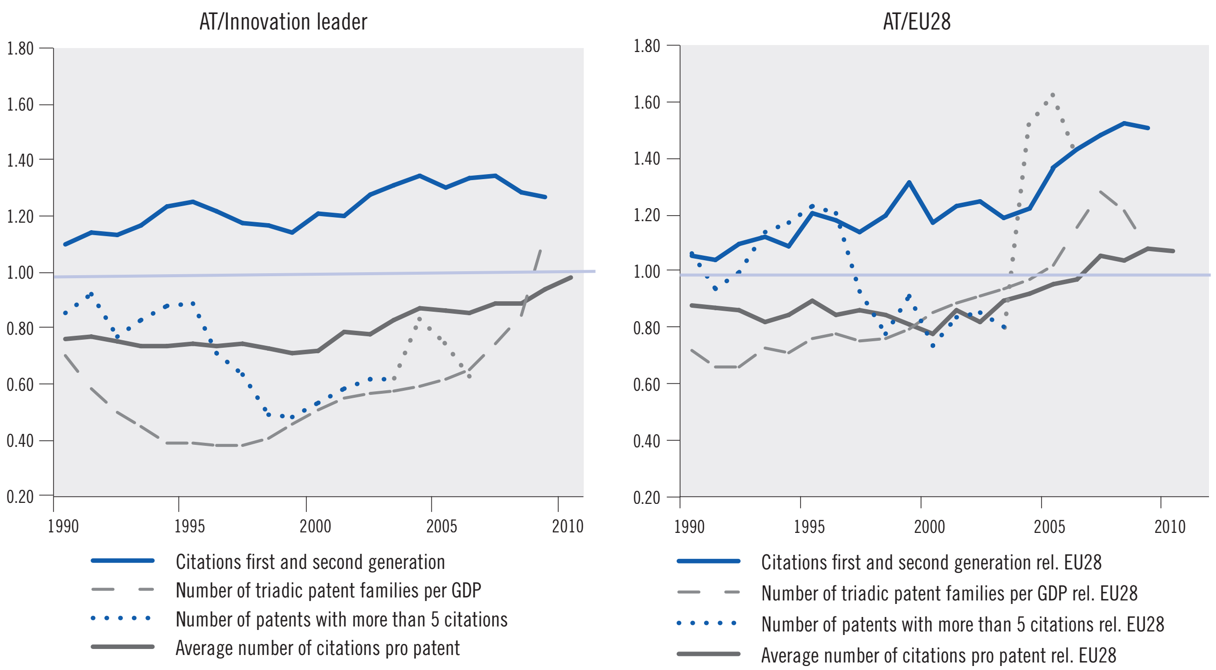
Source: OECD, Eurostat, Austrian Institute of Economic Research (WIFO) calculations.

Patent statistics

As stated above, patent statistics are not impact indicators because they only represent one preliminary stage of an innovation. Nonetheless, the consideration of patent citations (i.e., citations of patents in other, newer patents) has improved conventional patent statistics in terms of their significance for assessing the quality of inventions. Similar to scholarship in the sciences, oft-cited patents can be interpreted as an indicator for the quality of an invention, which should at least facilitate an economically successful innovation. Fig. 57 shows three indicators constructed with the help of citations, and supplements them by the number of triadic patent families relative to GDP (meaning the number of patents filed with the three major patent offices: the EPO, USPTO, and JPO). With the exception of one indicator, a comparison with the Innovation Leaders yields below-average but rising values; these figures are above average in comparison to recent performance in the EU-28. Table 45 shows the normalised value for the "Average number of citations per patent" indicator, in which Austria has a value that is significantly above the IUS impact indicators.

The three groups of indicators introduced here suggest overall a positive and above-average innovation effect. Austria is positioned in the knowledge-intensive and high-quality segments of industries which have experienced a significant rise in invention quality in the last 15 years. Austria has delivered solid performance for impact indicators that represent improvement within industries, along technology paths, and within niches. This finding corresponds with numerous analyses of Austria's innovation activi-

Fig. 57: Patent indicators for measuring invention quality, 1990–2010

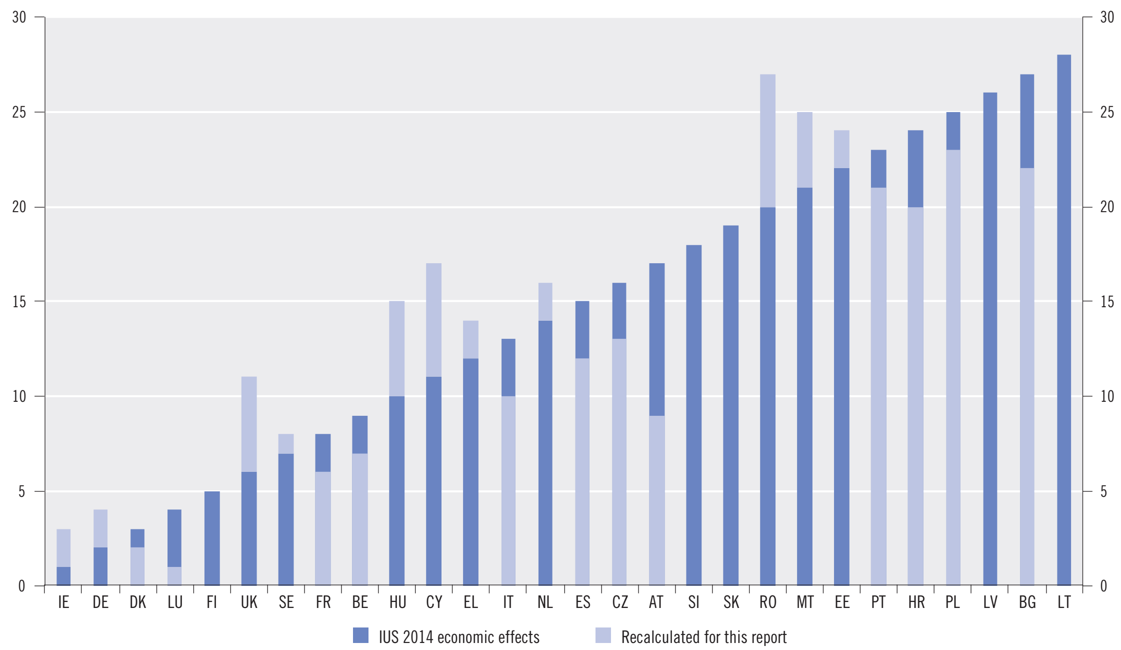


Source: OECD, Regpat database, January 2014, OECD Citation database, January 2014, OECD Triadic Patent Families database, January 2014, World Bank, Austrian Institute of Economic Research (WIFO) calculation. Note: Innovation Leader: average of DE, DK, FI, SE=1.0. Citations from first and second generation, number of patents with more than 5 citations, average Number of citations per patent: indicators have been adjusted for families. Proportion of patents with more than 5 citations: the last years from 2006 (grey line) must be interpreted with caution for the indicator on account of an outlier caused by a low falling number with the comparison countries.

ties.[246] Like the IUS indicators, all three indicators also demonstrate weaknesses, thereby suggesting that interpretation must be done carefully and in combination with other indicators. They do however offer additional important information for evaluating the economic effects of innovation. The indicator values are normalised in a way similar to the IUS and are added to the "economic effects" group in the IUS (figures in Table 45). The IUS indicator 3.2.3 is also rendered more meaningful with the removal of tourism and shipping services from the overall total of service exports. Both of these service sectors depend heavily on geographic idiosyncrasies and should therefore not reduce the proportion of knowledge-intensive services (for the sake of comparison, Austrian tourism accounts for 35% of service exports, while tourism makes up 13% of service exports for the Innovation Leaders).

Fig. 58 shows the resulting changes in the country rankings. Austria improves its position by eight rankings, from 17th to ninth place. This leads to an improvement in the IUS Summary Index by three rankings to seventh place, moving past the Netherlands, the United Kingdom, and Ireland (Fig. 59). If we also remove the highly problematic indicator 3.2.5 from the IUS (licensing and patent revenue), Austria's position in the assessment of the economic effects of innovation improves even more to sixth place, and sixth place in the overall index as well. Austria remains however below the Innovation Leaders in all cases, including the upgrading indicators introduced here. Even if the recalculation of impact is only one of many, and even if the proposed indicators have their weaknesses, the highly essential upgrading components of innovation impact are represented in a

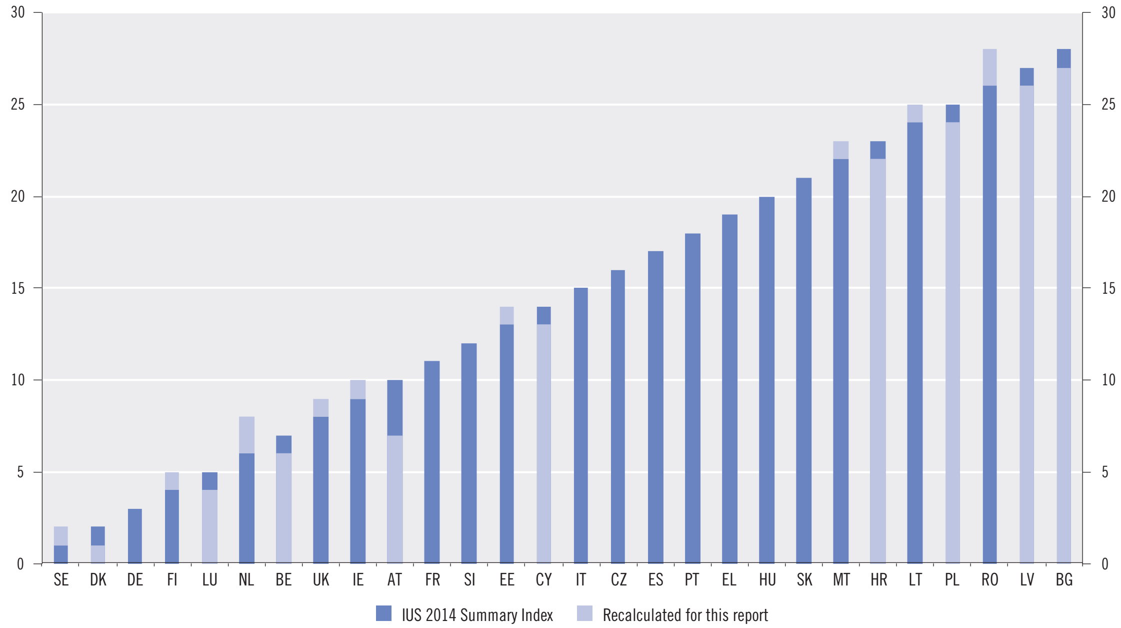
Fig. 58: Positions of the countries in the IUS 2014 in the "Economic Effects" group vs. position following new calculation (incl. additional impact indicators)



Source: Innovation Union Scoreboard 2014. Austrian Institute of Economic Research (WIFO) calculations.

246 See System Evaluation Summary Report on performance determination for the Austrian innovation system (Aiginger et al., 2009; Leitner, 2003).

Fig. 59: Changes to ranking Summary Index IUS 2014 based on new impact calculation



Source: Innovation Union Scoreboard 2014, Austrian Institute of Economic Research (WIFO) calculations.

much more comprehensive way in comparison with the IUS. Different combinations of indicators may locate Austria somewhere between 17th and fifth or sixth place, but the country still does not attain the level of an Innovation Leader.

Summary

The current measurement of impact in the IUS and in the Commission's new output indicator captures only a relatively small part of the economic effects of innovation, primarily that part that is visible in the structural change towards more knowledge-intensive activities. Its significance for policy-making is therefore reduced in such a way that no decisions about resource allocation should be taken on the basis of these indicators. A more comprehensive consideration of innovation impacts includes both the effects of structural change and quality improvements within industries. The use of such quality indicators to enhance the IUS leads to a significantly more positive image of the effects generated by innovation efforts in Austria. Even with this more comprehensive assessment of impact, however, Austria continues to lag behind the Innovation Leaders. The gap between Austria and the Innovation Leaders however is no longer so large as to suggest that Austria cannot join the ranks of the leading countries by 2020, which is the explicit aim of the RTI Strategy 2020. This section therefore has arrived at an assessment similar to that of the report of the Council for RTD on the implementation of Austria's RTI strategy: The weaknesses in the IUS[247] include the number of university graduates and innovation risk financing (venture capital). Both are significant drivers of structural change, not least because of their significance for innovation-intensive, fast-growing start-up company formation, thereby reinforcing the

247 See Austrian Council for Research and Technology Development (2013b).

conclusion that Austria has delivered medium performance for the structural change indicators. In the context of the further development of the Austrian innovation system, special attention should be paid in the coming years to those components that drive forward structural change, since sectoral upgrading functions comparatively well. This renewed focus could set Austria on a trajectory to improve its position, which has not been the case since 2010.

Table 45: Impact indicators from the IUS 2014, supplemented by additional indicators (scaled values)

	3.2.1 Employment in knowledge-intensive sectors	3.2.2 Contribution of medium-high and high technology intensity products to the balance of trade	3.2.3 Exports of knowledge-intensive services (not incl. tourism / forwarding)	3.2.4 Revenue share from innovations that are new for the firm and new for the market	3.2.5 Licence and patent income from abroad	Average number of citations of patents	Structurally adjusted R&D intensity	export quality
EU-28	0.58	0.55	0.69[a]	0.66	0.57	0.50	0.48[b]	0.83[c]
BE	0.66	0.60	0.59	0.52	0.56	0.75	0.66	0.88
BG	0.23	0.25	0.74	0.19	0.16	0.77	0.35	0.46
CZ	0.49	0.67	0.76	0.72	0.24	1.00	0.25	0.34
DK	0.68	0.34	0.83	0.70	0.66	0.94	0.82	0.98
DE	0.70	0.93	0.72	0.74	0.47	0.72	0.57	1.00
EE	0.39	0.35	0.81	0.52	0.18	0.00	0.68	0.00
IE	0.97	0.59	0.80	0.31	1.00	0.43	0.00	1.00
EL	0.48	0.24	0.90	1.00	0.13	0.34	0.44	0.52
ES	0.46	0.65	0.73	0.98	0.23	0.78	0.40	0.35
FR	0.61	0.74	0.61	0.69	0.52	0.54	0.70	0.85
HR	0.36	0.54	0.00	0.40	0.17	0.69	0.00	0.00
IT	0.54	0.72	0.67	0.70	0.33	0.95	0.38	0.61
CY	0.77	0.61	0.81	0.69	0.08	0.00	0.41	0.55
LV	0.35	0.26	0.86	0.00	0.12	0.00	0.30	0.83
LT	0.28	0.45	0.37	0.13	0.08	0.00	0.30	0.52
LU	1.00	0.28	0.80	0.24	0.80	1.96	0.00	0.98
HU	0.49	0.76	0.48	0.62	0.70	0.49	0.10	0.70
MT	0.78	0.65	0.38	0.18	0.37	0.00	0.00	0.86
NL	0.66	0.54	0.41	0.39	0.60	0.38	0.61	0.80
AT	0.60	0.66	0.60	0.49	0.34	0.75	0.72	0.87
PL	0.32	0.52	0.67	0.22	0.16	0.66	0.00	0.23
PT	0.27	0.48	0.78	0.66	0.11	0.17	0.50	0.40
RO	0.11	0.51	0.79	0.66	0.28	0.00	0.10	0.11
SI	0.59	0.80	0.66	0.41	0.32	0.26	0.60	0.24
SK	0.34	0.68	0.52	1.00	0.06	0.46	0.08	0.58
FI	0.68	0.55	0.53	0.73	0.90	0.39	1.00	0.99
SE	0.82	0.58	0.54	0.25	0.85	0.29	0.93	0.98
UK	0.83	0.69	0.81	0.17	0.50	0.29	0.53	0.92

a EU-27 (not incl. HR), b EU-24 (not incl. IE, HR, PL, LU), c EU-27 (not incl. HR).

Source: Innovation Union Scoreboard; Eurostat, Patstat, OECD, WIFO calculations.

5 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. The relevant statutory foundations are provided by a series of laws in Austria, including 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 standards: sections 6–9), and guidelines for research funding[248] based on these laws and for the promotion of economic-technical research and technology development, the so-called "RTD guidelines".[249] The FTF-G (section 15, para. 2) in particular creates a legal standard for the principals of evaluation, stipulating a set of minimum requirements 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*".[250]

This statutory basis has played no small part in the fact that nearly all research and technology programmes use evaluations in their programme planning (ex-ante evaluations), programme implementation (monitoring and interim evaluations) and programme conclusion (ex-post evaluation), and it is seen as essential to providing direction to the further strategic development of Austria's research funding portfolio.

The following section will provide an overview of the evaluative activities of Austrian research funding programmes. These have been selected according to the following criteria:

- The evaluations are primarily relevant to federal policy.
- There is an approved report of the evaluation available.
- The evaluation report is available to the public, which essentially means that the report has been published on the Austrian Platform for Research & Technology Policy Evaluation's homepage.[251]

The results of some of the evaluations commissioned by the Federal Ministry are presented in summary below. They are the accompanying evaluations of the "Laura Bassi Centres of Expertise", 2014 Final Report (on behalf of the Federal Ministry of Economy, Family and Youth (BMWFJ); the ex-post evaluation of the K-plus and K-ind/K-net programmes for competence centres (on behalf of the Federal Ministry for Transport, Innovation and Technology (BMVIT) and the Federal Ministry of Economy, Family

248 Federal government guidelines on granting and executing funding pursuant to sections 10–12 of the Research Organisation Act (FOG), Federal Law Gazette No. 341/1981.
249 Guidelines for the funding of economic-technical research and technology development (RTD Guidelines) pursuant to section 11 (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).
250 See RTD Guidelines, section 2.2., p. 4.
251 www.fteval.at.

and Youth [BMWFJ]); FOR-AUS, an international comparison of criteria applied to organisations that fund research (on behalf of the Federal Ministry for Transport, Innovation and Technology [BMVIT]); the evaluation of research cooperation resulting from bilateral treaties and agreements (on behalf of the Federal Ministry of Science and Research [BMWF]); and the ex-post evaluation of the Austrian genome research programme, GEN-AU (on behalf of the Federal Ministry of Science and Research [BMWF]).

5.1 Evaluation of the "Laura Bassi Centres of Expertise" campaign 2014 Final Report

Objective of the evaluation

The accompanying evaluation of the "Laura Bassi Centres of Expertise (LBC)" programme was commissioned in 2009 shortly after the programme started, aiming to provide strategic monitoring with a focus on drawing appropriate lessons and creating feedback loops as well as clear recommendations for the programme's management. To this end, a progress report was produced annually to document and discuss progress and preliminary results. The report for 2010 focused on an analysis of the selection process, evaluation criteria and general awareness of the programme.[252] The 2011 report emphasised the programme's unique aspects through the inclusion of direct target groups; it also outlined early activities related to the category "Transfer of knowledge" and discussed opportunities for such transfers.[253] The third year's report emphasised the way in which the LBC function and methods of increasing awareness.[254] The final report, which is now available,[255] summarises the primary results from the work accomplished, supplemented by new findings from evaluation activities undertaken in 2013.

Programme objectives and key information

The "Laura Bassi Centres of Expertise" is a programme organised under the auspices of the Federal Ministry of Economy, Family and Youth (BMWFJ) (now the Federal Ministry of Science, Research and Economy, BMWFW) which establishes excellence centres led by female researchers. The development and implementation of the programme are a response to the low number of female directors of research centres focused on applied science research in cooperative research fields. The programme's objectives are:

- to improve the visibility of the research work undertaken and results achieved by highly qualified women in a way that addresses research, management and careers
- to work as a learning and teaching instrument to contribute to increased equality of opportunity in Europe's scientific landscape.

From this perspective, the programme is also meant to serve as an example for future initiatives in developing transparent and sustainable procedures (selection and evaluation procedures) and aims to increase the level of gender competence in research management.

After comprehensive preparatory work and analyses of the conditions necessary for supporting the work of female researchers, a selection procedure was initiated in 2009, the result of which was the establishment of eight LB centres. There was a two-stage selection process (preliminary and full proposals), in which the evaluative focus was on the candidates' research performance, with consideration given especially to their future potential, and their ideas regarding management, team leadership and ca-

252 See Mayer et al. (2010).
253 Dörflinger, Heckl (2011).
254 Dörflinger, Heckl (2013).
255 Dörflinger, Heckl (2014).

reer planning. The funded centres began operations towards the end of 2009. The federal ministry contributes €15 million of the total €25 million budget. Each centre has access to a maximum amount of €320,000 per year. The Austrian Research Promotion Agency (FFG) was charged with the responsibility of implementing the Laura Bassi Centres of Expertise.

An international peer review process that followed the first LBC funding period (2010-2013) recommended a second period of funding (2013-2016) for all of the centres. The output of the LBC was quite considerable:[256] By the spring of 2013 the eight centres produced 230 publications, 21 dissertations, 41 bachelor's and master's theses, two patents and two licenses. Some 90 researchers, in addition to the eight directors, were active at the centres.

Results of the evaluation

Having spent four years strategically monitoring the programme, the evaluation team has given the LBC positive marks for both its initial stages and the effects the programme has. All of the participants praised the selection process, which has consisted of two stages. In particular the focus on academic excellence, equality and management aspects were described as unique. Given the centres' innovative features and the overall potential displayed by all of the participants, evaluators judged the significant effort involved in the programme to be worthwhile.

The centres, located on the boundary between science and industry, are characterised by a distinctive, open culture of communication and a focus on teamwork as vital components of research performance, without creating any disadvantages for any individual team member's personal career development. Traditional research organisation and culture is placed under critical examination, not only to create new possibilities for female researchers, but also to rethink the concept of research as a whole. A fully integrated interdisciplinarity and ongoing engagement with the topics of management and careers, which is a fundamental aspect of the programme and the individual centres, contributes in a profound way to this objective. The selection process specific to the programme is considered the central element in its targeted objective of helping women to reach top leadership positions at the centres. Funding works to support the centres' research performance and allows for an ongoing expansion of competences and a thorough engagement with the specific themes of the research, from the creation of the proper basis for research activity through to the development of marketable products.

Programme evaluators expressed the opinion that those aspects identified in previous progress reports related to creating and sustaining a more broad sensitivity towards and awareness about gender in the research community will require a certain set of conditions before sustainable change can be realised throughout the system as a whole. These include, in particular, a receptive audience, the inclusion of appropriate themes in research institutions' agendas, the formulation and implementation of relevant ongoing activities, supportive lobbying and the creation of a critical mass of female researchers in leadership roles who can act as role models.

In summary, the key aspects of management, leadership, human resources development and interdisciplinarity must play an explicit role in developing future structures and measures in line with the stated goals. A focus on future potential during the selection process, the thematisation of gender during the entire selection process and the implementation of ongoing support measures for centre directors are all proven measures. To ensure equal opportunity in the research sector and to promote and strengthen the potential of individual researchers, the eval-

256 See Laura Bassi brochure, available at: https://www.ffg.at/sites/default/files/downloads/131011_laura_bassi_broschuere_final.pdf; last accessed on 10 April 2014.

uators recommend a dual approach that includes incorporating these programme elements into mainstream processes and continuing the specific (adapted) LBC programme.

5.2 Ex-post evaluation of the K-plus and K-ind/K-net Programmes for Competence Centres

Objective of the evaluation

The objective of the evaluation was to investigate the integration of the K-plus and K-ind/K-net Programmes for Competence Centres in the Austrian innovation system and to assess what effects these programmes have had.[257] A final evaluation of the K-programmes was produced and recommendations for future funding measures were formulated. It must be noted that the COMET programme is a direct successor to the K-programmes, which represents a significant challenge for ex-post evaluations of the majority of centres.

Programme objectives and key information

The K-plus and K-ind/K-net competence centre programmes, which have been coordinated at the federal level since 1998, were created as instruments to support research cooperation between academia and industry. The programmes aimed to improve the culture of cooperation between industry and science through the establishment of competence centres and competence networks as well as to accelerate the accumulation of shared research competences and the commercialisation of these.

Integrated into fixed-term research institutions, the K-plus centres placed a central focus on cooperative, scientifically ambitious research and the specialised professional development of young researchers and engineers within the context of bridge-building between scientific and industrial research. K-plus centres were primarily housed in publicly funded research institutions. The K-plus centres thus allowed for a so-called non-K-area, which enabled the centres to additionally focus on R&D and service activities separate from their core partners' cooperative research activities.

The programme specifications for the industrial competence centres (K-ind) and competence networks (K-net) were more clearly aligned with the research agendas developed by the industrial partners. They were considered complementary instruments in the founding of industry competence centres, networks or 'clusters' and tended to operate under the aegis of industrial firms or consortiums.

K-plus centres were established following a competitive, two-stage peer review selection process. K-ind and K-net centres were the result of applications to the federal ministry (Federal Ministry of Economics and Labour (BMWA), later the Austrian Research Promotion Agency [FFG]); successful applications were chosen in a one-stage process. Each programme was entitled to public funds to cover up to a maximum of 60% of its budget.

The number of centres fluctuated over time. In 2013 around 1,500 researchers from scientific institutions and the private sector were actively working in 35 projects across 21 centres under the umbrella of the COMET programme. The centres' research orientations areheterogeneous, including information and communication technology (ICT) and mobility to energy, the environment and life sciences. Over the course of the entire lifespan of the programme (1998-2009), €432 million was made available for K-plus and €399 million for K-ind/K-net.

Results of the evaluation

The evaluators affirm that the K-programmes have made a substantial contribution to the

257 See Schibany et al. (2013).

readiness of Austrian firms and research institutions to engage in cooperations. Evaluators especially stressed the regional importance of the centres as innovation drivers and regional platforms for R&D. As the first Austrian initiative to provide structural funding for cooperation between science and industry, the K-programmes have been recognised internationally for their contributions to 'best practice'.

It has been found that the firms that made use of the K-programmes were those that already demonstrated a high level of R&D intensity and propensity for cooperation. Even before taking part in the programme, 88% of the K-plus firms and 75% of the K-ind/K-net firms had already engaged in cooperative R&D work with other firms. They also had already undertaken and completed similar R&D projects. The K-programmes stimulated more intense cooperation, which was reflected in innovation performance. Around 62% of the K-plus firms (72% of the K-ind/K-net firms) that were asked confirmed that their participation in the programme contributed to their abilities to produce significant product or process innovations.

Of the 144 higher education institutions that took part in the K programmes, the majority were technical universities. The long-term budgets for cooperative research activity and the high concentration of experts in the teams were both named as primary reasons for taking part in the programme. Concerns were raised regarding excessive influence on the part of manufacturing partners, which were party overcome, an achievement that is seen as one of the K-programmes' key effects. The K-programmes also enabled the addition of new projects, to existing cooperative endeavours as well as impetus for new lines of inquiry. The internal intensity of cooperation between institutes and departments was also improved. The K-programmes have been praised for the valuable contributions they have made to the strategy and priority-setting of technical universities

The majority of the staff at the centres participated with an eye to attaining new qualifications and/or with specific career advancement in mind. Cooperation between science and industry was perceived as an asset in the K-plus centres, especially as the majority of the researchers already had experience in science-industry cooperation. Similarly to the business enterprise sector, the K programmes' contribution was to augment and expand existing cooperative efforts. Complex cooperative relationships, which demanded a greater amount of effort to coordinate, came in for criticism. In addition, there appears to be a need for greater clarification regarding the high turnover amongst those working in R&D.

In sum, the existence of the K-programmes has not only contributed over the past several years to making the national framework for innovation more dynamic, they have also played a major role in setting up modern structures for programme management. This is especially true with respect to the clear division of responsibilities amongst various stakeholders. Consideration should be given in future to the development of a comprehensive monitoring system, especially with respect to an impact-oriented research policy. Finally, care must be taken that the quasi-permanent nature of the COMET programme does not cause a "crowding out of new challenges".

5.3 An international comparison of the selection procedures of research funders (FOR-AUS)

Objective of the evaluation

This evaluation sought to analyse the procedures used by international research funders for selecting the projects they support.[258] The roles of various stakeholders in these selection procedures

258 See Bieglebauer, Palfinger (2013).

and their relationships with one another were key focuses. Funding agencies considered by the analysis were the Danish Agency for Science, Technology and Innovation (DASTI), the Research Council for Technology and Innovation and the Council for Strategic Research in Denmark, the Research Council of Norway (RCN) in Norway, the Verket för innovationssystem (Vinnova) in Sweden, Teknologian Kehittämiskeskus (Tekes) in Finland, and the German Project funders Jülich (PTJ), Technischer Überwachungsverein Rheinland (PT TÜV Rheinland), Verein Deutscher Ingenieure-Technologiezentrum (PT VDI-TZ) and the Verein Deutscher Ingenieure/Verein Deutscher Elektrotechniker-Innovation und Technik (PT VDI/VDE-IT).

Results of the evaluation

There is a noticeable trend towards a standardisation of selection procedures amongst research funding agencies, especially those in the Scandinavian countries. For example, Tekes and RCN have already standardised their internal processes to a significant degree, and Vinnova and DASTI are planning to align their existing selection procedures. In Germany, processes can sometimes vary to significant degrees within individual organisations, whilst some units have already defined standards. The development experienced by German project funders differs from their Scandinavian counterparts because of their longer histories, diverse budget structures and selection procedures as well as their supposedly greater dependence on government ministries.

The use of external evaluators in the project selection process is increasing. Evaluations undertaken for the Swedish Vinnova will be completed in future primarily by external evaluators. The Danish Council for Technology and Innovation and the German PT Jülich are both planning to move in this direction. These organisations are making increasing attempts to create more objective selection processes. Measures that have been implemented include the use of multi-stage, criteria-driven selection procedures that are spread across the entire organisation (RCN), new combinations of evaluators and the use of programme committees (Vinnova, PT Jülich).

This includes ongoing process development on the basis of experiential knowledge, process monitoring and standardised evaluation procedures that can be activated and utilised at any point during the measure's life-span (Vinnova, RCN, DASTI). Debriefing meetings, human resources development activities in the form of workshops and drawing on reflective knowledge produced by (system) evaluations and ongoing studies are amongst the concrete instruments that can be used.

The following observations were made with regard to organisational practices:

- The criteria connected to the selection process must be clear, transparent and appropriately communicated to the various stakeholders, including applicants, evaluators and employees of the funding body. Quantitative schemata should be supplemented with more qualitative descriptions of the assessments.
- When processes involve internal and external evaluators, due consideration should be given to the specific functions of each group, which may vary depending on the particular circumstances and organisation. External evaluators are incorporated especially in proposals in which the science involved is highly specialised. Internal evaluators contribute to the process through formal assessments.
- Because the first stage of the two-stage evaluation process sorts the applications into those that are outstanding and those that are less promising, more time is available in the second stage to analyse and discuss those applications that have passed through the first stage but are unclear in terms of promise ("intermediate").
- Comparative evaluations of project applications are increasingly being used to provide a better calibration of the evaluation process. This takes the form of on-site discussions by panels or programme committees.

5.4 Evaluation of research cooperation under the framework of the bilateral Science and Technology Cooperation agreements (WTZ)

Objective of the evaluation

The evaluation sought to assess the existing bilateral agreements reached between Austria and various partner countries both in and outside of Europe under the framework of the Science and Technology Cooperation programme (WTZ).[259] The examination focused on the development and presentation of the WTZ's current circumstances and was primarily concerned with measures of efficiency and effectiveness. Concluding summaries and recommendations for future development were produced based on the evaluation's findings.

Programme objectives and key information

The WTZ aims to support researcher mobility by means of bilateral and multilateral research projects organised on the basis of agreements at the state level to support scientific-technical cooperation. Austria negotiates these agreements with partner countries on an individual basis. The WTZ programme can also act as a starting point for multilateral cooperative efforts that can be carried out under the aegis of European funding and support programmes (e.g. international ERA-NETs).

The agreements seek to intensify cooperation between Austrian researchers and researchers in partner countries. Agreements concluded as part of the WTZ also aim to strengthen diplomatic relations and improve international understanding. The so-called 'Mixed Commissions' are meant to allow for exchange about current RTI policy in the respective participating countries. WTZ is funded by the Federal Ministry of Science and Research (BMWF) and the programme is implemented partly in cooperation with the Federal Ministry for European and International Affairs (BMeiA). Currently there are active agreements with 23 countries.[260] The project is managed by the ICM-Centre for International Cooperation & Mobility at the Austrian Agency for International Cooperation in Education and Research (OeAD).

Researchers at universities and universities of applied sciences as well as other publicly funded scientific and research institutions that fall under the Federal Ministry of Science and Research's area of responsibility are eligible for funding. Applications must feature concrete, cooperative scientific projects. The funding covers travel and expenses for research stays up to ten days or for longer stays up to a maximum of three months within the duration of the granted project, which is usually two years.

Results of the evaluation

The evaluators confirmed that the WTZ had a considerable mobility effect, according to them, 2,529 Austrian project leaders[261] between 2003 and 2013 and 3,729 Austrian project employees[262] between 1997 und 2013 received funding. An average of 150 new WTZ projects are implemented each year and funding for project mobility averaged around €3,000 per WTZ project and year. A total of around €5.2 million was provided between 2002 and 2012.

Because of the resulting gains in mobility, the WTZ agreements may be considered cost-effec-

259 See Schuch et al. (2013).
260 15 active agreements between countries: Albania, Bulgaria, China, France, India, Croatia, Macedonia, Montenegro, Rumania, Russian Federation, Serbia, Slovakia, Slovenia, Ukraine and Hungary. 2 non-active agreements between countries: Israel and Spain; 2 active agreements in connection with cultural agreements: Poland and the Czech Republic; 1 non-active agreement in connection with a cultural agreement: Italy; 3 other agreements such as MoUs: Argentina, South Korea, Vietnam.
261 In this context, "Austrian" means that the project coordinators and project staff are working at Austrian institutions in Austria, but it does not necessarily mean that they are Austrian citizens.
262 Ibid.

tive, although they seem a bit piecemeal, in particular concerning the financing, the size of the participating teams, institutional effects and the separation of the funded projects without any umbrella framework to connect them. The WTZ's relevance was judged to be high, whilst awareness of the programme in individuals' professional circles was rated as fair. Projects overwhelmingly contributed to fostering international partnerships that already existed as well as initiating new cooperative relationships. The focus was set on preparing and finalising publications. Contact amongst participants tended to remain intact after the funding period was over, and in more than half of the cases, follow-up projects and additional publications resulted.

The majority of WTZ coordinators are men, working at a university, especially in the natural sciences, and are, from the perspectives of their age and careers, well established. There was little evidence of increased mobility for female scientists connected to WTZ projects. Researchers, when asked, generally rated the OeAD's administrative work and supervision positively. Starting points for recommendations include the structure of feedback as part of project evaluations, the general use of budgets and the networking of thematically related WTZ projects. For WTZ projects to serve specifically as a form of support for young researchers and female scientists, newly developed, additional measures in line with WTZ's global objectives would need to be developed.

Additional recommendations focused on the composition of the participant pool and the choice of countries. The creation of a "programme leader" role was suggested as a means of supporting further internationalisation, given the general lack of international project funding in Austria. WTZ agreements provide a starting point, but European or international programmes (e.g. HORIZON 2020, EUREKA) should be the targeted end result. According to the evaluators, this approach is consistent with the objectives outlined in the AG 7a policy paper entitled "Internationalisation and RTI-related foreign policy" produced by the inter-ministerial RTI Task Force charged with implementing the federal government's RTI strategy. Future development will, however, depend on budgetary circumstances and will require the agreement of the countries with whom bilateral programmes have been established.

5.5 Ex-post evaluation of the Austrian genome research programme (GEN-AU)

Objective of the evaluation

The Austrian genome research programme (GENome Research in Austria – GEN-AU) underwent a comprehensive ex-post evaluation after a total programme length of 10 years.[263] The evaluation aims to assess in a detailed, systematic manner the programme's effects on the national research landscape in the life sciences, to outline this field's development in Austria and internationally as well as to evaluate the activities of the GEN-AU programme office, which is housed in the Austrian Research Promotion Agency (FFG). The results are intended to provide a basis for assessing the state of life sciences research in Austria and internationally.

Programme objectives and key information

GEN-AU not necessarily mean in September 2001 with the intention of supporting and strengthening the fields of genome research and systems biology, both of which were underrepresented in Austria in spite of their importance as future-oriented areas of research. The programme aimed to connect research capacities,

263 See Warta et al. (2014).

open up new research fields and translate research results into usable knowledge through technology transfer measures. The programme was organised in three distinct phases. Funding was distributed according to different project types that were distinguished from one another in terms of their objectives, the number of project partners, their duration and funding volume. GEN-AU comprised of comprehensive, interdisciplinary cooperative projects (joint and network projects) flanked by smaller project formats (associated projects, pilot projects, transnational projects) and a series of projects focused on the social sciences and the arts and humanities (ELSA). Measures accompanying these projects included funding for specific individuals (mobility fellowships, funding specifically targeted at women), publicity materials targeted at particular groups and support for patents, amongst others.

Originally provided by the Federal Ministry of Science and Research (BMWF), the GEN-AU office, which manages the programme, was moved during the second phase of the programme to the Austrian Research Promotion Agency (FFG). A scientific advisory board assisted the ministry in its preparation of funding recommendations throughout the duration of the programme. With a total funding volume of around €85 million, GEN-AU was the Federal Ministry of Science and Research's largest thematically organised research programme.

Results of the evaluation

According to the evaluators, GEN-AU was successful in offering sustainable support to genome research in Austria, putting the country on the map internationally as a prime location for research in the life sciences thanks to a series of simultaneous measures, especially the establishment of the Austrian Academy of Sciences' Excellence Institutes and the IST Austria. The high number of ERC grants in this area of research is one indicator, amongst others, that underlines this positive development. GEN-AU projects provided room to experiment with design, allowing researchers to choose riskier research paths. A large number of researchers took concrete steps in terms of career advancement and secured new qualifications as a result of working on these projects.

Cooperation networks were established in a broad manner as part of GEN-AU, with only a few central clusters in Vienna, Graz and Innsbruck. Sharing the same location was especially important in establishing cooperative relationships. Spatial proximity, which sometimes included the shared use of infrastructure, helped to firmly establish cooperative efforts in a sustainable fashion.

With the aim of increasing and expanding public discussions about and public engagement with the relevance of genome research to society in general, publicity efforts were conceived broadly, designed to be subject-specific and distributed through various channels (website, newsletter, press releases, etc.). Certain activities won as great a deal of attention as these public relations efforts, such as the ELSA programme, which benefited from its expertise in interdisciplinary research between life sciences and social sciences, as well as the GEN-AU Summer School for school pupils.

GEN-AU's programme results were negligible from an economic as well as health policy perspective. It was noted that the programme's goals were very ambitious from the start, too broadly defined given the programme's framework and, especially with respect to health policy, defined with insufficient attention to actually existing circumstances. Firms were hardly represented at all in the programme, and a planned platform for manufacturing partners was not realised given the lack of interest. Evaluators identified insufficient coordination with other existing measures and (political) stakeholders, which was due in part to the high level of complexity involved in GEN-AU and the general dynamic of growth and recover during the 2000s, during which coordination was deemed to be less urgent.

The evaluation of GEN-AU provided evidence for the evaluators' finding that the consistent application of the "excellence" concept during the 2000s resulted on the one hand in the creation of top research institutions, which have had a very positive effect for Austria as a location for top-level research, but that – in the shadow of this success – the university entities might fall behind. The "new institutions", which operated from a clear system of objectives and benefited from efficient management and decision-making structures, were able to make much better use, in relation to their size, of the opportunities provided through GEN-AU than were the majority of university-based research units. The latter were less able to act and react in an efficient manner given their tradition-bound structures and pre-existing arrangements. In times of shrinking budgets and increased competition, universities may find it more difficult to secure sufficient third-party funding. To the extent that as these types of structural factors are not given consideration in future funding decisions, an "institutional divide" may well arise between non-university research institutions and classic universities.

Future considerations regarding research funding should pay particular attention to continuing to provide space for high-risk research projects. It is undoubtedly reasonable to continue to use selected accompanying measures in future. An ongoing engagement with the problem of an "institutional divide" between universities and non-university research institutions is recommended. Finally, research funding should always be considered within a context of other instruments and measures. This means, particularly with respect to "policy ownership", that coordinating and securing agreements with other (political) stakeholders are of especial importance.

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7 Annex I

7.1 Country codes

Codes	Country/region
AUS	Australia
AUT	Austria
BEL	Belgium
BGR	Bulgaria
BRA	Brazil
CAN	Canada
CHN	China
CYP	Cyprus
CZE	Czech Republic
DEU	Germany
DNK	Denmark
ESP	Spain
EST	Estonia
FIN	Finland
FRA	France
GBR	United Kingdom
GRC	Greece
HUN	Hungary
IDN	Indonesia
IND	India
IRL	Ireland
ITA	Italy
JPN	Japan
KOR	South Korea
LTU	Lithuania
LUX	Luxembourg
LVA	Latvia
MEX	Mexico
MLT	Malta
NLD	Netherlands
POL	Poland
PRT	Portugal
ROM	Romania
ROW	Rest of the world
RUS	Russia
SVK	Slovakia
SVN	Slovenia
SWE	Sweden
USA	USA
TUR	Turkey
TWN	Taiwan

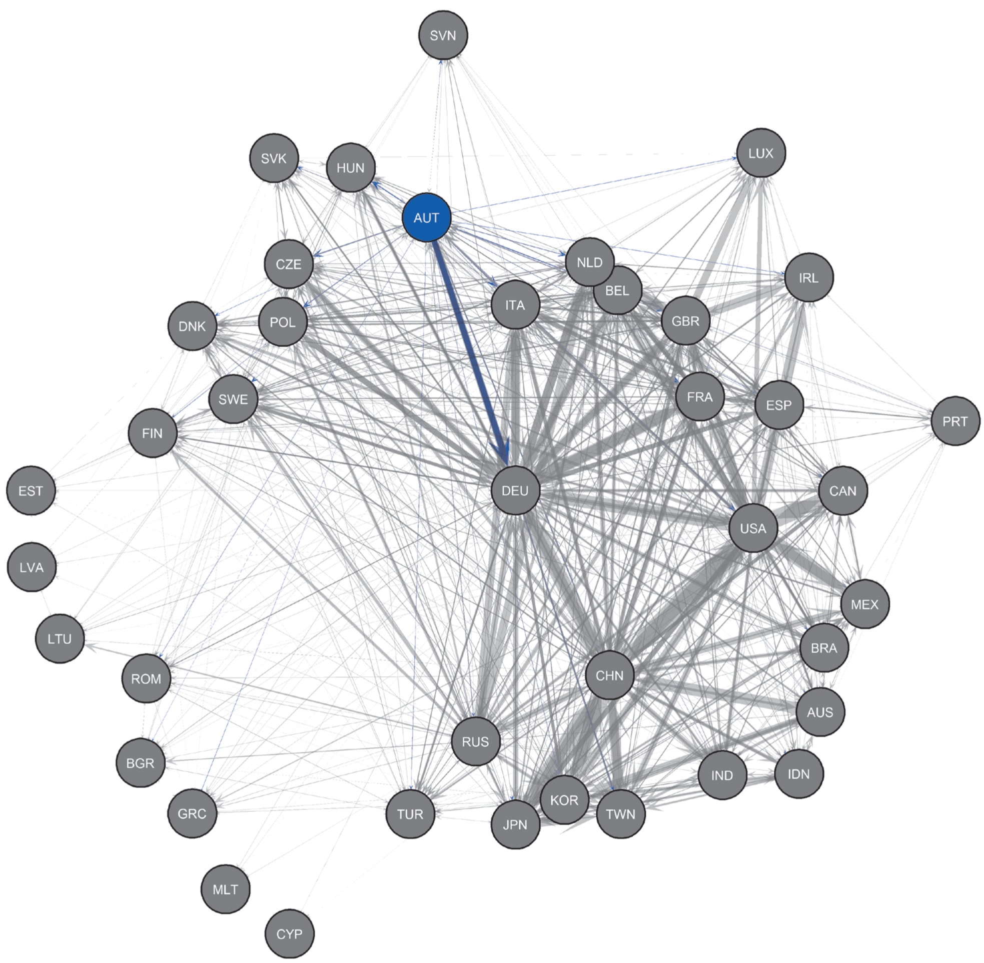
Country groups	Country codes
BRIC	BRA, RUS, IND, CHN
NAM	CAN, MEX, USA
NEW	EST, FIN, LTU, LVA, SWE
OCEA	AUS, IDN
RoASIA	JPN, KOR, TWN, TUR
RoEU-12	BEL, DNK, ESP, FRA, GBR, GRC, IRL, ITA, LUX, NLD, PRT
SEE	BGR, CYP, CZE, HUN, MLT, POL, ROM, SVK, SVN

7.2 List of the European Commission's H2020 fact sheets

Horizon 2020 official standard presentation. The New EU Framework Programme for Research and Innovation 2014-2020. [http://ec.europa.eu/research/horizon2020/pdf/press/horizon2020-presentation.pdf]
Fact sheet on industrial participation [http://ec.europa.eu/programmes/horizon2020/sites/horizon2020/files/Factsheet_Industrial%20participation.pdf]
Fact sheet: Gender Equality in Horizon 2020 [https://ec.europa.eu/programmes/horizon2020/sites/horizon2020/files/FactSheet_Gender_091213_final_2.pdf]
Fact sheet: Horizon 2020 budget [https://ec.europa.eu/programmes/horizon2020/sites/horizon2020/files/Factsheet_budget_H2020_0.pdf]
Fact sheet: International Participation in Horizon 2020 [http://ec.europa.eu/programmes/horizon2020/sites/horizon2020/files/Factsheet_international_participation.pdf]
Fact sheet: Rules under Horizon 2020 [http://ec.europa.eu/programmes/horizon2020/sites/horizon2020/files/Fact %20sheet_Rules_of_participation.pdf]
Fact sheet: Science with and for Society in Horizon 2020 [https://ec.europa.eu/programmes/horizon2020/sites/horizon2020/files/FactSheet_Science_with_and_for_Society.pdf]
Fact sheet: SMEs in Horizon 2020 [http://ec.europa.eu/programmes/horizon2020/sites/horizon2020/files/Facsheet_SME_H2020.pdf]
Fact sheet: Spreading Excellence and Widening Participation [http://ec.europa.eu/programmes/horizon2020/sites/horizon2020/files/Factsheet_widening_participation.pdf]
History of Horizon 2020 [http://ec.europa.eu/programmes/horizon2020/en/history-horizon-2020]
Horizon 2020 – The EU Framework Programme for Research and Innovation Experts [http://ec.europa.eu/programmes/horizon2020/en/experts]

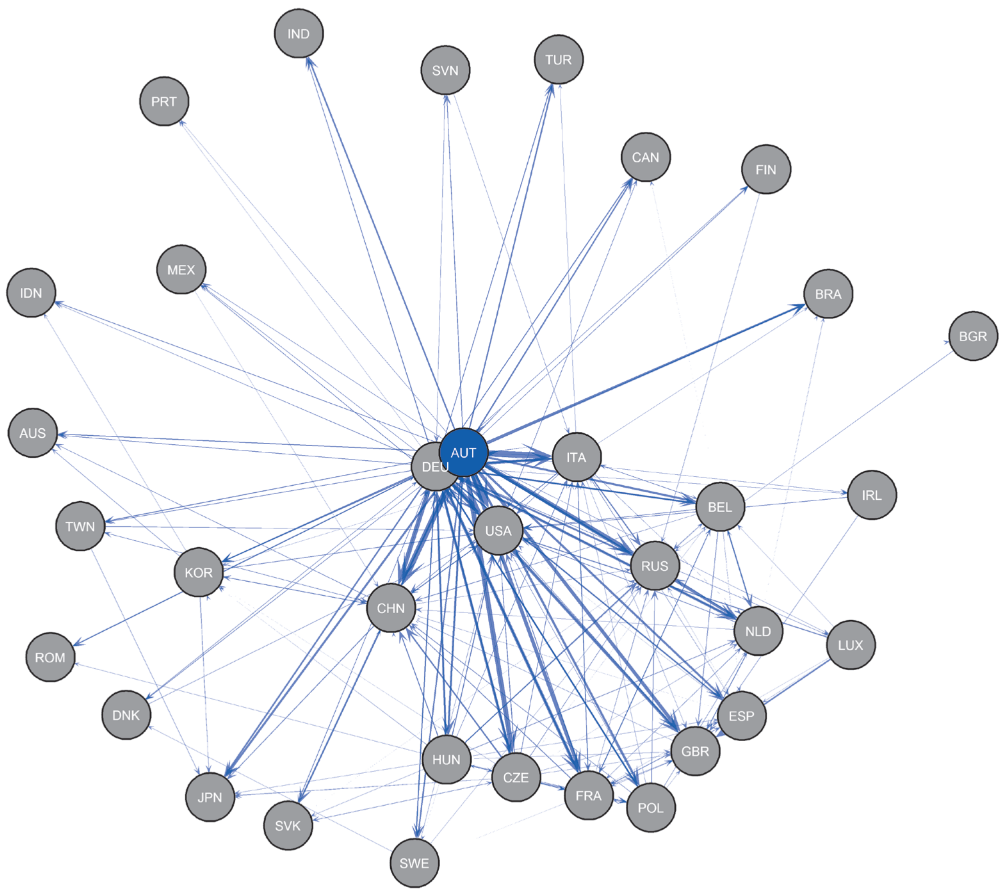
7.3 Austria's position in the global trade network

Fig. 60: Value added in exports: global trade network, 2011



Source: WIOD (2013). Graphic: JOANNEUM RESEARCH.

Fig. 61: The spread of Austrian gross value added, 2011



Source: WIOD (2013). Graphic: JOANNEUM RESEARCH.

7.4 Overview of Austria's ESFRI participations

ESFRI Roadmap - projects in which Austrian companies are participating, 2014

Category	Biosciences & medical research	Physics & engineering			ICT/e-infrastructure
	BBMRI	**ESRF**	**ILL 20/20**	E-ELT	**PRACE**
Project	**B**iobanking & **B**io**m**olecular **R**esources Research **I**nfrastructure	**E**uropean **S**ynchrotron **R**adiation **F**acility Upgrade	**I**nstitute **L**aue **L**angevin Upgrade	**E**uropean **E**xtremely **L**arge **T**elescope for Optical Astronomy	Partnership for Advanced Computing in Europe
Information	www.bbmri.eu	www.esrf.eu/AboutUs/Upgrade	http://www.ill.eu/?id=3732	http://www.eso.org/public/teles-instr/e-elt/	http://www.prace-project.eu
Project contents	• Pan-European network of existing biobanks & biological sample collections and those that are being built up	• Development and expansion of existing infrastructure for producing high-energy synchrotron radiation for structure research	• Development and expansion of existing infrastructure for producing slow ("cold") neutrons for examining condensed matter	• Construction of the largest optical telescope for the near infrared range in the world	• Pan-European HPC infrastructure in the highest performance category
	• Further development of standards and methods for sample collection, sample security and data collection and data security	• Construction of new research laboratories	• Increase in performance and quality	• Enabling of new astro-physical findings	• Currently 4 computer centres in the petaflop/s category (6 in 2013)
		• Increase in performance and quality as well as expansion of capacity	• Expansion of capacity	•Further development of technology	• Association of national, regional to local computer centres according to a pyramid performance model
Benefit to Austria	• Strengthening and int'l. networking of Austrian biobanks and data collections	• Access to new and improved research areas	• Access to new and improved research areas	• Access to new and globally unique tele-scope facilities for the nation's astronomers	• PRACE provides access to EU-wide HPC computer and data management resources
	• Access to standardised and comprehensive sample collections	• Further improvement of excellence in the area of structure research	• Further improvement of excellence in diverse areas of matter research	• Further improvement of excellence	• Access through peer review for members
	• Expansion of the research areas and questions by increasing the available number of samples	• Expansion of research areas	• Expansion of research areas	• Expansion of research areas	• Strengthen the research base for all areas that need computer calculations
Organisation & Austrian participation	12 members, 5 observers	19 member states	14 member states	14 member states	21 members, 2 types of membership; Univ. of Linz (regional partner)
	including Austria	Austria ESRF member since 2002	Austria ILL member since 1990	Austria ESO member since 2009	
Coordination	AT	ESRF	ILL	ESO	F/D/I/E – Headquarters: B
Status	ERIC founded	Operation; ongoing implementation acc. to timetable: 2009 – 2018	In operation	Planning phase	Implementation phase 2010-2012
	Operative start 2014				
Total costs	Operative Phase: ~ €2 million / a	Build-up: ~ €241 million	Build-up: ~ €171 million	Construction: ~ €1,000 million	€100 million each (for 5 years) per country
Financing AT	Membership fee: €170k-200 k/a	ESRF membership fee: ~ €1.3 million /a	ILL membership fee: ~ €1.7 million /a	€600 k/a until completion	€60 k/a (University of Linz)

Category	Humanities & social sciences				
	CESSDA	**CLARIN**	**DARIAH**	**SHARE**	**ESS**
Project	**C**ouncil of **E**uropean **S**ocial **S**cience **D**ata-**A**rchives	**C**ommon **La**nguage **R**esources and Technology **In**frastructure	**D**igit**a**l **R**esearch **I**nfrastructure for the **A**rts and the **H**umanities	**S**urvey on **H**ealth, **A**geing and **R**etirement in **E**urope	**E**uropean **S**ocial **S**urvey
Information	www.cessda.org	www.clarin.eu	www.dariah.eu	www.share-project.org	www.europeansocialsurvey.org
Project contents	• Coordination of existing national and international databases, data analysis	• Standardisation/ coordination of research for the provisioning of language resources and language technologies.	• Standardisation/ coordination of digital resources and technologies for image, sound and text analysis in the arts and humanities	• Creation of a comprehensive, long-term European database for health, aging and pensions in Europe	• Creation of a comprehensive, long-term European database for attitudes, behaviour and living conditions in Europe
	• Tool development for monitoring				
	• Educational and training activities				
Benefit to Austria	• Strengthening of the qualitative and quantitative data base in social sciences	• Strengthening of the technological foundation for the development of methods, tools and instruments to work with language resources	• Strengthening of the digital humanities data base and methods and technologies for analysis	• Strengthening, standardising the domestic and European data base on health, aging, employment, pensions	• Strengthening, standardising the domestic and European social science data base on social and political values and social change
	• Development and implementation of shared standards, tools, archiving instruments	• Simple and lasting access to digital language resources such as text and language collections, encyclopaedias, glossaries, thesauri, etc.	• Standardisation of and access to instruments, methods, state-of-the-art software, etc. for the digital humanities	• Access to uniformly prepared international data	• Access to uniformly prepared international data
	• Training on using the databases	• Creation of technologies to process language resources	• Generically generated basic services and specialised, virtual research environments	• Worldwide distribution and application of the European standards through a cooperation with the US.	
Organisation & Austrian participation	13 founding members	9 founding members	Declaration of intent from 15 members, including Austria	10 members, 5 observers, 6 participants	13 founding members
	including Austria	including Austria		Austria is a founding member	including Austria
Coordination	NO	NL	DE, ERIC headquarters: F	DE	UK
Status	Established as a legal entity	ERIC founded	MoU and statutes signed, ERIC status 08/2014	ERIC founded	ERIC founded
	Domestic implementation and preparation phase	Domestic implementation phase	Domestic implementation phase	Preparation of the 6th survey wave.	Preparation of the 7th survey wave.
Total costs	~ €2 m /a	~ €1 m /a	~ €1 m /a	~ €2 m /a	~ €1 m /a
Financing AT	~ €600 k /a incl. ~ €20 k membership fee	~ €250 k /a incl. ~ €45 k membership fee	~ €250 k /a incl. ~ €28 k membership fee	~ €600 k /a incl. €10 k membership fee	€200 k /a incl. €40 k membership fee

8 Annex II

Research funding and research contracts of the federal government according to the federal research database

Figures 62 to 65 provide an overview of R&D funding and contracts recorded in the federal research data base B_f.dat by the ministries in 2013. The database for recording research funding and contracts (B_f.dat) for the federal government has been in place since 1975, and was set up as a " documentation of facts by the federal government" in the then Federal Ministry of Science and Research. The mandatory reporting of the ministries to the relevant Science Minister is recorded in the Research Organisation Act (FOG), Federal Law Gazette No. 341/1981, last amended to Federal Law Gazette I No. 74/2002. The last adaptation took place in 2008 with the migration to a database to which all ministries have access and in which they all enter their research-related funding and contracts independently. The B_f.dat database is not used for recording payments made. Instead, it is a documentation database which also records contextual information on the R&D projects.

With regard to the relevant reporting year the database makes a distinction between ongoing and completed R&D projects, their overall funding volume and actual funds paid in the reporting year, thereby providing a current picture of the number of projects and of project financing. In addition, the new approved projects can also be assessed in their various forms. The major global financing for the Austrian Science Fund, the Austrian Research Promotion Agency (FFG), LBG, ÖAW, AIT and IST-Austria is excluded from all these assessments.

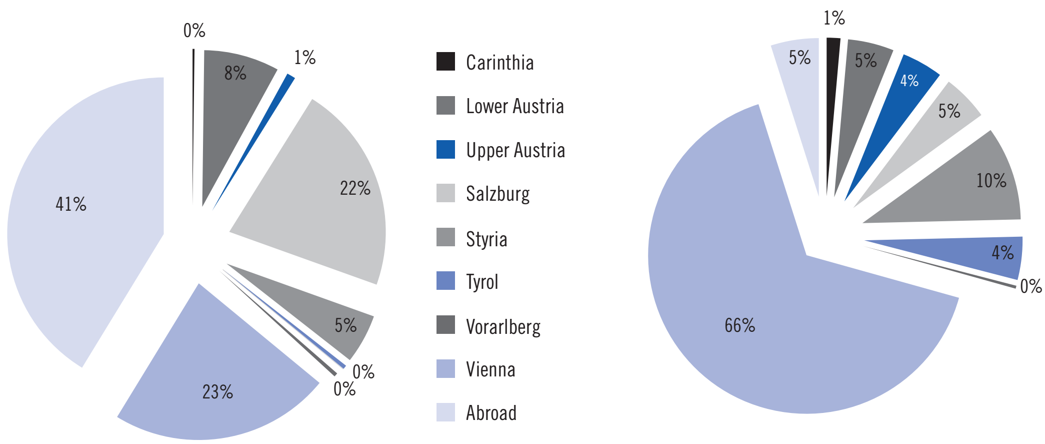
For 2013 a total of 759 ongoing or completed R&D projects can be found in the B_f.dat with an overall funding volume of around €344 million. Thereof, €75 million were paid out by all ministries in 2013. 51% of projects and approximately 64% of the R&D funding came from the Federal Ministry of Science and Research (BMWF). At the federal state level it can be seen that around 2/3 of projects feature a contractor with Vienna as their headquarters. A different picture emerges if a distinction is made according to the overall amount of R&D funds paid: 41% goes abroad, primarily in the form of membership contributions in international organisations. No project was allocated to the federal state of Burgenland in 2013.

With an overall funding volume of more than €17 million, universities funding a total of 240 of the projects ongoing or completed in 2013. Thereof, around €3 million were paid out for 148 projects, i.e. approximately 25% of the overall projects or around 4% of total R&D funds.

Differentiation by fields of science shows that socio-economic projects are dominant in terms of the numbers: Around 46% of the ongoing and completed projects can be ascribed to this area of knowledge. In contrast, projects from the natural science segment feature higher funding totals: more than 50% of the R&D funds paid in 2013 are attributable to the natural sciences.

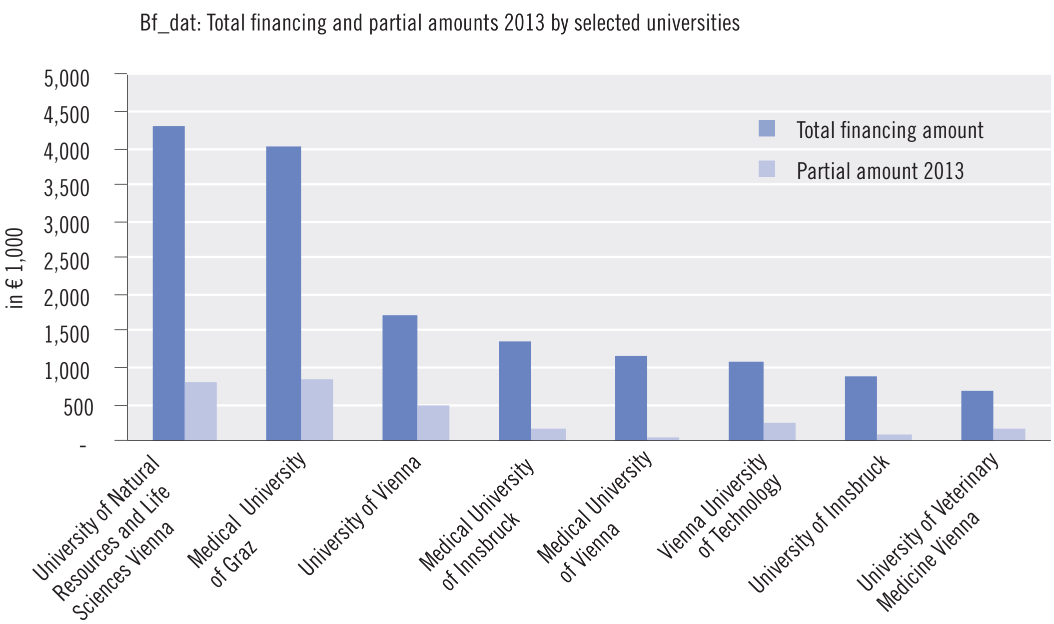
A total of 224 R&D-related projects were funded by the federal ministries in the reporting year of 2013 with a funding volume of around €37.7 million newly approved, with three quarters of the funds already paid out. The Federal Ministry for Science and Research approved around 45% of the projects, followed by BMASK at 15%. Broken down into the total sum of projects approved the following picture emerges as can be seen from Fig. 65: almost 86% of the funding totals approved are attributable to the Federal Ministry of Science and Research and the Federal Ministry

Fig. 62: Share of R&D projects and partial amounts in 2013 by contractor's main location (in %)



Source: Federal Ministry of Science, Research and Economy (BMWFW), Federal research database B_f.dat. As at 8 April 2014

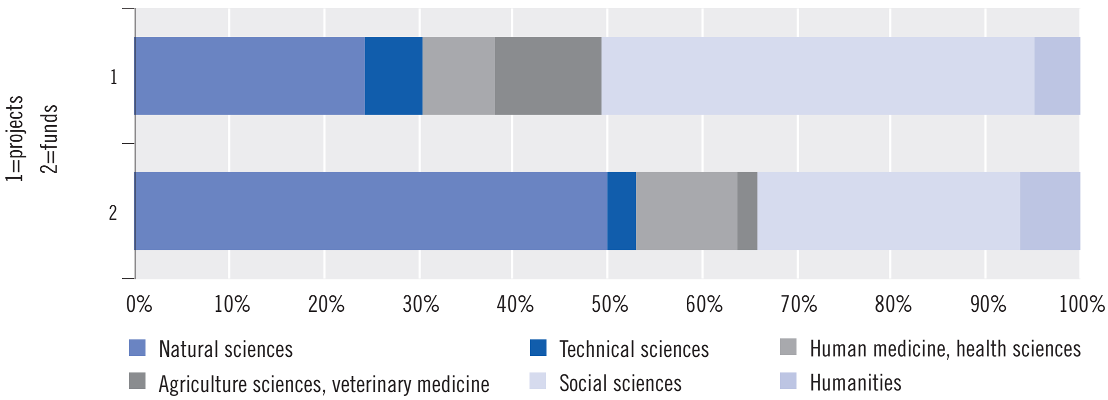
Fig. 63: Total financing volume and partial amounts in 2013 by selected universities (in € 1,000)



Source: Federal Ministry of Science, Research and Economy (BMWFW), Federal research database B_f.dat. As at 8 April 2014 of Education, Arts and Culture. The Federal Ministry for Transport, Innovation and Technology (BMVIT) features a low percentage due to the fact that the processing for the majority of R&D funds for the BMVIT is outsourced (e.g. to the Austrian Research Promotion Agency [FFG]).

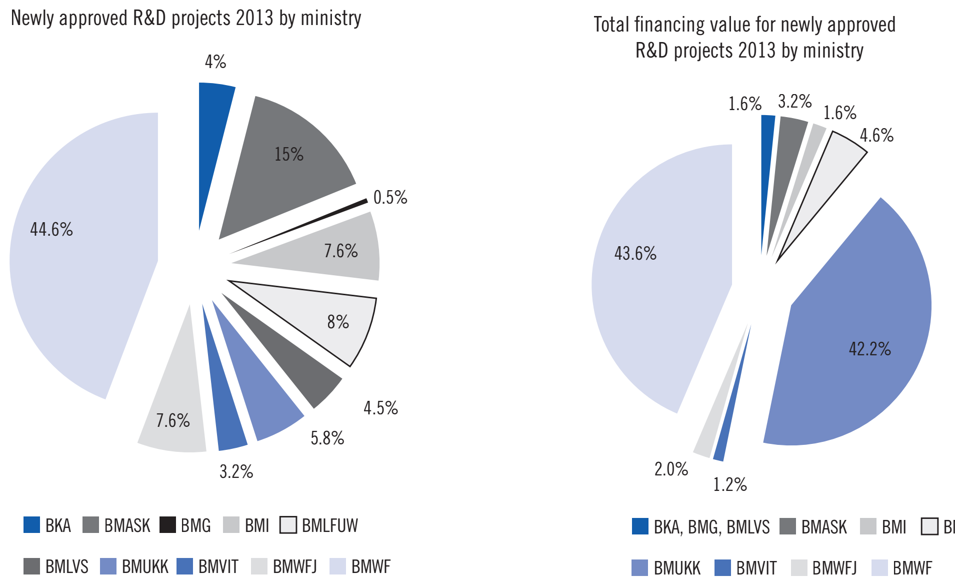
An overview of the data from B_f.dat on the research funding and research contracts by the federal government showing the projects in the reporting year which have been newly awarded or are ongoing or completed, with the titles, contractors, funding contributions, scientific classifications, contract and completion dates classified according to the awarding part can be found on the Federal Ministry of Science, Research and Economy's website at: http://wissenschaft.bmwfw.gv.at/bmwfw/ministerium/veranstaltungenpublikationen/publikationen/forschung/berichte/forschungsfoerd-und-forschungsauftraege-des-bundes/

Fig. 64: Number of R&D projects and their shares in 2013 by fields of science (in %)



Source: Federal Ministry of Science, Research and Economy (BMWFW), Federal research database B_f.dat. As at 8 April 2014

Fig. 65: New approvals in 2013 by number and total financing amounts by ministry (in %)



Source: Federal Ministry of Science, Research and Economy (BMWFW), Federal research database B_f.dat. As at 8 April 2014

9 Statistics

1. Financing of gross domestic expenditure on R&D and research intensity in Austria[264] 2014

According to an estimate by Statistics Austria, more than €9.32 billion in gross domestic expenditure are expected to be spent in Austria in 2014 on research and experimental development (R&D). This corresponds to a research intensity of 2.88% as a ratio of gross domestic product (GDP). Compared with 2013, the total amount of Austrian R&D expenditure will increase by an estimated 2.7%. This increase is somewhat higher than the one between 2012 and 2013 when 1.8% more was spent on R&D. The estimated increase in total Austrian R&D expenditure was 7.7% from 2011 to 2012.

The public sector will finance 38.7% of the total forecast for research expenditure in 2014 (around €3.61 billion). The federal government is the most significant source of R&D funding for this with around €3.06 billion (32.8% of total R&D expenditure). The regional governments contribute around €440 million, with other public institutions (local government authorities, chambers, social security institutions) providing €110 million of research financing. An estimated €4.15 billion (44.5% of total gross domestic expenditure on R&D) is financed by domestic firms. As such the business enterprise sector continues to be the most significant national economic sector for financing research and development in Austria in terms of quantities. 16.4% of R&D funding (around €1.53 billion) comes from abroad, with foreign firms representing the most significant sources of funding. Multinational corporations whose Austrian subsidiaries conduct R&D represent a large proportion in particular. The returns from the EU Framework Programmes are also included in the foreign funding. The private non-profit sector features the lowest funding volume with around €42.5 million (0.5% of total R&D expenditure).

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 but only to a minor extent (from 2012 to 2013: 0.3%; from 2013 to 2014: 2.0%).

The research intensity as a central measurement for the funds allocated for R&D has increased significantly over the last two decades in Austria, including during the latest financial crisis. Gross domestic expenditure on R&D increased to 2.90% of GDP by 2012. The research intensity remained the same in the following

264 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 budget 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).

year, and is expected to drop slightly to 2.88% in 2014 according to the information currently available. The level of research intensity depends in particular on developments with gross domestic product. For instance there was an increase in research intensity of 0.04 percentage points from 2008 to 2009, despite a decline in overall Austrian R&D expenditure, since nominal GDP also dropped in the same period.

In an EU comparison for 2012 (the last year for which international comparative figures are available for national research intensity) Austria is behind Finland, Sweden, Denmark and Germany, but is ahead of all other EU countries and is well above the average for the EU-28 of 2.06%.

The budget appropriations and outlays of the federal government and the regional governments, current economic data and the results of the last R&D survey for the reporting year 2011 were taken into account in estimating the Austrian gross domestic expenditure on R&D in 2014.

2. Federal R&D expenditure in 2014

2.1. The federal expenditure shown in Table 1 for R&D carried out in Austria in 2014 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 the preliminary version of Annex T according to the budget drafted for 2014. The estimate also includes the funds from the National Foundation for Research, Technology, and Development available for 2014, based on the currently available information, as well as the estimates of the 2014 payout for research premiums.[265]

2.2. In addition to its expenditures for R&D in Austria, in 2014 the federal government will pay contributions to international organisations aimed at research and the promotion of research amounting to €98.9 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 "Federal expenditure on research and research promotion." These correspond to what is called the "GBAORD" concept[266] that is used by the OECD and the EU on the basis of the Frascati Manual, referring 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 2014 the following socio-economic objectives will receive the largest portions of federal expenditure on research and research promotion:

- Promotion of general advancement of knowledge: 32.4%
- Promotion of industrial production and industry: 24.8%
- Promotion of health:20.3%
- Promotion of social and socio-economic development: 4.7%
- Promotion of exploration and exploration of earth and space: 4.1%
- Promotion of environmental protection: 3.2%

265 Source: BMF.
266 GBAORD: Government Budget Appropriations or Outlays for R&D = (official EU translation).

3. R&D expenditure by the Austrian regional governments

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 expenditure of the regional hospitals is estimated annually by Statistics Austria by a methodology agreed on with the regional governments.

4. 2011 Comprehensive R&D survey

In addition to the observations in Chap. 1.2, Tables 13 to 19 provide an overview of the amount of funding and personnel devoted to research and experimental development (R&D) that was recorded by Statistics Austria among all institutions in all economic sectors that conduct R&D, in the course of the comprehensive 2011 survey.

5. An international comparison of 2011 R&D expenditure

Table 20 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.[267]

6. Austria's participation in the European Framework Programmes

Tables 21 through 23 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.

7. Research funding by the Austrian Science Fund (FWF)

Tables 24 through 26 provide detailed information about funding and the number of projects in Austrian Science Fund (FWF) projects.

8. Funding by the Austrian Research Promotion Agency (FFG)

Tables 27 and 28 provide detailed information on 2012 funding approvals by the Austrian Research Promotion Agency (FFG).

9. The aws technology programmes

Table 29 shows an overview of disbursed funding under the auspices of the aws technology programme.

10. Christian Doppler Society

Tables 30 to 32 depict the status and historical development of the CD laboratories and the "Josef Ressel Centres (JR-Centres)" support programme for universities of applied sciences that was set up in 2013.

267 Source: OECD, MSTI 2013-2.

List of Tables in the Statistical Annex

Table 1: Global estimate for 2014: Gross domestic expenditure on R&D financing of research and experimental development carried out in Austria in 1993–2014

Financing	1993	1994	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1. Gross domestic expenditure on R&D (in € millions)	**2,303.31**	**2,550.73**	**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**	**8,066.44**	**8,276.34**	**8,912.99**	**9,074.23**	**9,322.26**
of which financed by:																			
Federal government[1)]	957.12	1,075.14	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	2,614.29	2,986.87	2,996.62	3,055.58
Regional governments[2)]	129.67	158.69	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	298.71	416.31	441.64	439.94
Business enterprise sector[3)]	1,128.40	1,179.42	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	3,639.35	3,820.90	3,922.92	4,003.34	4,147.06
Abroad [4)]	59.69	106.52	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	1,297.63	1,401.67	1,442.32	1,484.15	1,527.19
Other[5)]	28.42	30.96	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	140.77	144.57	148.48	152.49
2. Nominal GDP [6)] (in € billions)	159.27	167.22	191.91	199.27	208.47	214.20	220.53	225.00	234.71	245.24	259.03	274.02	282.74	276.23	285.17	299.24	307.00	313.20	324.14
3. Gross domestic expenditure on R&D as a % of GDP	***1.45***	***1.53***	***1.77***	***1.89***	***1.93***	***2.05***	***2.12***	***2.24***	***2.24***	***2.46***	***2.44***	***2.51***	***2.67***	***2.71***	***2.83***	***2.77***	***2.90***	***2.90***	***2.88***

Status: 7 May 2014
Source: Statistics Austria (Bundesanstalt Statistik Österreich)

1) 1993, 1998, 2002, 2004, 2006, 2007, 2009, 2011: Survey results (federal government including the Austrian Science Fund, the two research promotion funds (FFF/FFG) and in 1993, 1998 and 2002 also including ITF).
1994, 1999-2001, 2003, 2005, 2008 and 2010: Annex T/Part b of the Auxiliary Document for the Federal Finances Act (in each case: outlays).
2012-2014: Preliminary draft of Annex T/Part b based on the draft budget 2014.
2005: Additionally €84.4 million National Foundation for Research, Technology and Development and €121.3 million research premiums paid out.
2008: Additionally €91.0 million National Foundation for Research, Technology and Development and €340.6 million research premiums paid out.
2010: Additionally €74.6 million National Foundation for Research, Technology and Development and €328.8 million research premiums paid out.
2012: Additionally €53.9 million National Foundation for Research, Technology and Development and €574.1 million research premiums paid out.
2013: Additionally €92.8 million National Foundation for Research, Technology and Development and €378.3 million research premiums paid out.
2014: Additionally €38.7 million National Foundation for Research, Technology and Development, as well as € 375.0 million for research premiums expected to be paid out (source: BMF estimate, April 2014).

2) 1993, 1998, 2002, 2004, 2006, 2007, 2009, 2011: survey results. 1994, 1999-2001, 2003, 2005, 2008, 2010, 2012-2014: Based on the estimates of R&D expenditure reported by the state government offices.

3) Funding by business.
1993, 1998, 2002, 2004, 2006, 2007, 2009, 2011: survey results. 1994, 1999-2001, 2003, 2005, 2008, 2010, 2012-2014: Estimates made by Statistics Austria.

4) 1993, 1998, 2002, 2004, 2006, 2007, 2009, 2011: survey results. 1994, 1999-2001, 2003, 2005, 2008, 2010, 2012-2014: 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, 2009, 2011: survey results. 1994, 1999-2001, 2003, 2005, 2008 , 2010, 2012-2014: Estimates made by Statistics Austria.

6) 1993-2012: Statistics Austria. 2013: Austrian Institute of Economic Research (WIFO) on behalf of Statistics Austria. 2014: Austrian Institute of Economic Research (WIFO), economic forecast March 2014.

Table 2: Global estimate for 2014: Gross domestic expenditure on R&D financing of research and experimental development carried out in Austria in 1993–2014 (in % of GDP)

Financing	1993	1994	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1. Gross domestic expenditure on R&D (in % of GDP)	***1.45***	***1.53***	***1.77***	***1.89***	***1.93***	***2.05***	***2.12***	***2.24***	***2.24***	***2.46***	***2.44***	***2.51***	***2.67***	***2.71***	***2.83***	***2.77***	***2.90***	***2.90***	***2.88***
of which financed by:																			
Federal government[1)]	0.60	0.64	0.57	0.60	0.59	0.63	0.62	0.62	0.62	0.72	0.68	0.70	0.83	0.83	0.91	0.87	0.97	0.96	0.94
Regional governments[2)]	0.08	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	0.10	0.14	0.14	0.14
Business enterprise sector[3)]	0.71	0.71	0.74	0.78	0.81	0.86	0.95	1.01	1.05	1.12	1.18	1.22	1.23	1.27	1.28	1.28	1.28	1.28	1.28
Abroad [4)]	0.04	0.06	0.36	0.37	0.38	0.40	0.45	0.45	0.43	0.44	0.45	0.45	0.44	0.45	0.46	0.47	0.47	0.47	0.47
Other[5)]	0.02	0.02	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	0.05
2. Nominal GDP [6)](in € billions)	159.27	167.22	191.91	199.27	208.47	214.20	220.53	225.00	234.71	245.24	259.03	274.02	282.74	276.23	285.17	299.24	307.00	313.20	324.14

Status: 7 May 2014
Source: Statistics Austria (Bundesanstalt Statistik Österreich)

Footnotes cf. Table 1.

Table 3: Federal expenditure on research and research promotion, 2011 to 2014
Breakdown of Annex T of the Auxiliary Document for the Federal Finances Act 2013 and preliminary draft of Annex T according to the draft budget for 2014 (Financing proposal, Part a and Part b, respectively)

Ministries [1]	Outlays				Budget appropriation			
	2011[2]		2012[3]		2013[3]		2014[3]	
	€ million	%	€ million	%	€ million	%	€ million	%
Federal Chancellery (BKA)[4]	1.898	*0.1*	2.125	*0.1*	2.856	*0.1*	33.518	*1.2*
Federal Ministry of the Interior (BMI)	0.801	*0.0*	0.790	*0.0*	0.911	*0.0*	1.067	*0.0*
Federal Ministry for Education, Arts and Culture (BMUKK)	70.046	*2.9*	73.446	*3.0*	71.409	*2.7*	.	.
Federal Ministry for Education and Women's Affairs	.	.	.	.	.	.	48.372	*1.8*
Federal Ministry of Science and Research (BMWF)	1,752.624	*72.2*	1,780.922	*72.6*	1,886.096	*72.2*	.	.
Federal Ministry of Science, Research and Economy	.	.	.	.	.	.	2,080.394	*75.9*
Federal Ministry for Labour, Social Affairs and Consumer Protection (BMASK)	2.735	*0.1*	6.450	*0.3*	6.031	*0.2*	5.649	*0.2*
Federal Ministry for Health (BMG)	5.083	*0.2*	7.068	*0.3*	7.617	*0.3*	7.577	*0.3*
Federal Ministry for European and International Affairs (BMEIA)	2.260	*0.1*	2.536	*0.1*	2.386	*0.1*	.	.
Federal Ministry for Europe, Integration and Foreign Affairs	.	.	.	.	.	.	2.234	*0.1*
Federal Ministry of Justice (BMJ)	0.098	*0.0*	0.125	*0.0*	0.130	*0.0*	0.130	*0.0*
Federal Ministry of Defence and Sports (BMLVS)	1.030	*0.0*	1.185	*0.0*	1.169	*0.0*	1.174	*0.0*
Federal Ministry of Finance (BMF)	33.971	*1.4*	31.720	*1.3*	34.621	*1.3*	31.799	*1.2*
Federal Ministry for Agriculture, Forestry, Environment and Water Management (BMLFUW)	80.205	*3.3*	78.410	*3.2*	78.785	*3.0*	87.677	*3.2*
Federal Ministry of Economy, Family and Youth	110.488	*4.6*	114.230	*4.7*	100.725	*3.8*	.	.
Federal Ministry for Family and Youth	.	.	.	.	.	.	1.654	*0.1*
Federal Ministry for Transport, Innovation and Technology (BMVIT)	366.904	*15.1*	353.948	*14.4*	428.513	*16.3*	439.521	*16.0*
Total	**2,428.143**	***100.0***	**2,452.955**	***100.0***	**2,621.249**	***100.0***	**2,740.766**	***100.0***

Status: April 2014
Source: Statistics Austria (Bundesanstalt Statistik Österreich)

[1]) In accordance with the applicable version of the Act Governing Federal Ministries of 1986 (2011, 2012, 2013: Federal Law Gazette I No. 3/2009); 2014: Federal Law Gazette I No. 11/2014). - [2]) Auxiliary Document for the Federal Finances Act of 2013. Revised data - [3]) Preliminary version of Annex T based on the budget drafted for 2014 (financing proposal). - [4]) Including the highest executive bodies.

Table 4: Preliminary version of Annex T based on the budget drafted for 2014 (financing proposal)

Federal expenditure on research from 2012 – 2014

Annex T of the Auxiliary Document for the Federal Finances Act is broken down in each case according to

- Contributions from federal funds paid to international organisations which (i.a.) aim at research and research promotion (Part a) and
- Other federal expenditure on research and research promotion (Part b, federal research budget)

This list of expenditures is made primarily with a view to the research impact, which is based on the research concept as used by the OECD's Frascati Manual and is also applied by Statistics Austria in its research and experimental development (R&D) surveys.

Annex T 2014	Budget appropriation 2014		Budget appropriation 2013		Outlays 2012	
	Total	Research	Total	Research	Total	Research
	€ millions					
Part a [1])	113.604	98.888	110.971	95.775	108.847	94.035
Part b [2])	6,165.857	2,641.878	6,615.327	2,525.474	6,240.082	2,358.920
Total	**6,279.461**	**2,740.766**	**6,726.298**	**2,621.249**	**6,348.929**	**2,452.955**

As of: April 2014 Source: Federal Ministry of Finance

[1]) Contributions to international organisations which aim at (i.a.) research and research promotion.

[2]) Federal expenditures on research and research promotion (federal research budget).

Table 5: Federal expenditure in 1997 to 2014 on research and research promotion by socio-economic objectives
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												
			Promotion of exploration and exploitation of earth and space:	Promotion of agriculture and forestry	Promotion of industrial production and industry	Promotion of energy production, storage and distribution	Promotion of transport, traffic and communica-tions	Promotion of education	Promotion of health	Promotion of social and socio-economic development	Promotion of environmental protection	Promotion of urban and rural planning	Promotion of defence	Promotion of other objectives	Promotion of general advancement of knowledge
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	2,428,143	107,277	63,063	613,692	41,294	54,043	59,479	510,359	115,792	77,578	20,170	99	-	765,297
	in %	*100.0*	*4.4*	*2.6*	*25.3*	*1.7*	*2.2*	*2.4*	*21.0*	*4.8*	*3.2*	*0.8*	*0.0*	-	*31.6*
2012[16)]	in € 1,000	2,452,955	103,432	60,609	607,920	55,396	47,934	65,537	499,833	121,570	86,776	20,338	120	-	783,490
	in %	*100.0*	*4.2*	*2.5*	*24.8*	*2.3*	*2.0*	*2.7*	*20.4*	*5.0*	*3.5*	*0.8*	*0.0*	-	*31.8*
2013[17)]	in € 1,000	2,621,249	110,007	64,125	671,784	65,658	51,670	64,969	530,822	130,378	92,089	22,229	90	-	817,428
	in %	*100.0*	*4.2*	*2.4*	*25.6*	*2.5*	*2.0*	*2.5*	*20.3*	*5.0*	*3.5*	*0.8*	*0.0*	-	*31.2*
2014[17)]	in € 1,000	2,740,766	113,042	76,931	679,570	62,414	51,336	75,282	555,032	129,496	88,785	21,707	83	-	887,088
	in %	*100.0*	*4.1*	*2.8*	*24.8*	*2.3*	*1.9*	*2.7*	*20.3*	*4.7*	*3.2*	*0.8*	*0.0*	-	*32.4*

Status: April 2014
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 (budget appropriation), outlays Revised data - [16]) Preliminary version of Annex T based on the budget drafted for 2014 (financing proposal), outlays. - [17]) Preliminary draft of Annex T based on the budget drafted for 2014 (financing proposal), budget appropriation. - Rounding differences not compensated for.

Table 6: Federal expenditure on research and research promotion by socio-economic objectives and ministries, 2012[1)]

Ministries		Total federal expenditure for R&D	of which											
			Promotion of exploration and exploitation of earth and space:	Promotion of agriculture and forestry	Promotion of industrial production and industry	Promotion of energy production, storage and distribution	Promotion of transport, traffic and communica-tions	Promotion of education	Promotion of health	Promotion of social and socio-economic development	Promotion of environmental protection	Promotion of urban and rural planning	Promotion of defence	Promotion of other objectives	Promotion of general advancement of knowledge
BKA[2)]	in € 1,000	2,125	-	-	-	46	1	-	-	1,353	-	567	-	-	158
	in %	*100.0*	-	-	-	*2.2*	*0.0*	-	-	*63.7*	-	*26.7*	-	-	*7.4*
BMI	in € 1,000	790	-	-	-	-	-	-	-	790	-	-	-	-	-
	in %	*100.0*	-	-	-	-	-	-	-	*100.0*	-	-	-	-	-
BMUKK	in € 1,000	73,446	5,456	-	319	-	-	34,992	-	5,775	-	-	-	-	26,904
	in %	*100.0*	*7.4*	-	*0.4*	-	-	*47.7*	-	*7.9*	-	-	-	-	*36.6*
BMWF	in € 1,000	1,780,922	72,144	21,622	298,981	9,585	22,974	29,856	460,657	92,290	29,856	19,392	72	-	723,493
	in %	*100.0*	*4.1*	*1.2*	*16.8*	*0.5*	*1.3*	*1.7*	*25.9*	*5.2*	*1.7*	*1.1*	*0.0*	-	*40.5*
BMASK	in € 1,000	6,450	-	-	-	-	-	-	190	6,260	-	-	-	-	-
	in %	*100.0*	-	-	-	-	-	-	*2.9*	*97.1*	-	-	-	-	-
BMG	in € 1,000	7,068	-	65	-	-	-	-	7,003	-	-	-	-	-	-
	in %	*100.0*	-	*0.9*	-	-	-	-	*99.1*	-	-	-	-	-	-
BMEIA	in € 1,000	2,536	-	-	-	1,142	-	-	-	1,388	-	-	-	-	6
	in %	*100.0*	-	-	-	*45.0*	-	-	-	*54.8*	-	-	-	-	*0.2*
BMJ	in € 1,000	125	-	-	-	-	-	-	-	125	-	-	-	-	-
	in %	*100.0*	-	-	-	-	-	-	-	*100.0*	-	-	-	-	-
BMLVS	in € 1,000	1,185	-	-	-	-	-	-	-	-	-	-	48	-	1,137
	in %	*100.0*	-	-	-	-	-	-	-	-	-	-	*4.1*	-	*95.9*
BMF	in € 1,000	31,720	976	569	5,204	163	461	542	7,020	6,241	542	379	-	-	9,623
	in %	*100.0*	*3.1*	*1.8*	*16.4*	*0.5*	*1.5*	*1.7*	*22.1*	*19.7*	*1.7*	*1.2*	-	-	*30.3*
BML-FUW	in € 1,000	78,410	1,211	36,883	304	-	-	109	-	1,723	37,866	-	-	-	314
	in %	*100.0*	*1.5*	*47.0*	*0.4*	-	-	*0.1*	-	*2.2*	*48.4*	-	-	-	*0.4*
BMWFJ	in € 1,000	114,230	-	-	112,765	-	-	-	-	1,465	-	-	-	-	-
	in %	*100.0*	-	-	*98.7*	-	-	-	-	*1.3*	-	-	-	-	-
BMVIT	in € 1,000	353,948	23,645	1,470	190,347	44,460	24,498	38	24,963	4,160	18,512	-	-	-	21,855
	in %	*100.0*	*6.7*	*0.4*	*53.7*	*12.6*	*6.9*	*0.0*	*7.1*	*1.2*	*5.2*	-	-	-	*6.2*
Total	**in € 1,000**	**2,452,955**	**103,432**	**60,609**	**607,920**	**55,396**	**47,934**	**65,537**	**499,833**	**121,570**	**86,776**	**20,338**	**120**	**-**	**783,490**
	in %	***100.0***	***4.2***	***2.5***	***24.8***	***2.3***	***2.0***	***2.7***	***20.4***	***5.0***	***3.5***	***0.8***	***0.0***	**-**	***31.8***

Status: April 2014
Source: Statistics Austria

[1)] Outlays. Preliminary version of Annex T based on the budget drafted for 2014 (financing proposal; Part a and Part b). - [2)] Including the highest executive bodies.

Table 7: Federal expenditure on research and research promotion by socio-economic objectives and ministries, 2013[1)]

Ministries		Total federal expenditure for R&D	of which											
			Promotion of exploration and exploitation of earth and space:	Promotion of agriculture and forestry	Promotion of industrial production and industry	Promotion of energy production, storage and distribution	Promotion of transport, traffic and communica-tions	Promotion of education	Promotion of health	Promotion of social and socio-economic development	Promotion of environmental protection	Promotion of urban and rural planning	Promotion of defence	Promotion of other objectives	Promotion of general advancement of knowledge
BKA[2)]	in € 1,000	2,856	-	-	-	48	2	-	-	2,056	-	591	-	-	159
	in %	*100.0*	-	-	-	*1.7*	*0.1*	-	-	*71.9*	-	*20.7*	-	-	*5.6*
BMI	in € 1,000	911	-	-	-	-	-	-	-	911	-	-	-	-	-
	in %	*100.0*	-	-	-	-	-	-	-	*100.0*	-	-	-	-	-
BMUKK	in € 1,000	71,409	5,545	-	319	-	-	32,031	-	6,218	-	-	-	-	27,296
	in %	*100.0*	*7.8*	-	*0.4*	-	-	*44.9*	-	*8.7*	-	-	-	-	*38.2*
BMWF	in € 1,000	1,886,096	76,713	23,746	325,274	9,924	25,230	32,186	487,166	99,291	32,186	21,221	74	-	753,085
	in %	*100.0*	*4.1*	*1.3*	*17.2*	*0.5*	*1.3*	*1.7*	*25.8*	*5.3*	*1.7*	*1.1*	*0.0*	-	*40.0*
BMASK	in € 1,000	6,031	-	-	-	-	-	-	184	5,847	-	-	-	-	-
	in %	*100.0*	-	-	-	-	-	-	*3.1*	*96.9*	-	-	-	-	-
BMG	in € 1,000	7,617	-	71	-	-	-	-	7,542	4	-	-	-	-	-
	in %	*100.0*	-	*0.9*	-	-	-	-	*99.0*	*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	1,169	-	-	-	-	-	-	-	-	-	-	16	-	1,153
	in %	*100.0*	-	-	-	-	-	-	-	-	-	-	*1.4*	-	*98.6*
BMF	in € 1,000	34,621	1,073	626	5,720	179	506	596	7,716	6,616	596	417	-	-	10,576
	in %	*100.0*	*3.1*	*1.8*	*16.5*	*0.5*	*1.5*	*1.7*	*22.3*	*19.1*	*1.7*	*1.2*	-	-	*30.6*
BMLFUW	in € 1,000	78,785	1,496	37,872	324	-	-	109	-	1,674	36,972	-	-	-	338
	in %	*100.0*	*1.9*	*48.2*	*0.4*	-	-	*0.1*	-	*2.1*	*46.9*	-	-	-	*0.4*
BMWFJ	in € 1,000	100,725	-	-	99,043	-	-	-	-	1,682	-	-	-	-	-
	in %	*100.0*	-	-	*98.3*	-	-	-	-	*1.7*	-	-	-	-	-
BMVIT	in € 1,000	428,513	25,180	1,810	241,104	54,352	25,932	47	28,214	4,727	22,335	-	-	-	24,812
	in %	*100.0*	*5.9*	*0.4*	*56.2*	*12.7*	*6.1*	*0.0*	*6.6*	*1.1*	*5.2*	-	-	-	*5.8*
Total	**in € 1,000**	**2,621,249**	**110,007**	**64,125**	**671,784**	**65,658**	**51,670**	**64,969**	**530,822**	**130,378**	**92,089**	**22,229**	**90**	**-**	**817,428**
	in %	***100.0***	***4.2***	***2.4***	***25.6***	***2.5***	***2.0***	***2.5***	***20.3***	***5.0***	***3.5***	***0.8***	***0.0***	**-**	***31.2***

Status: April 2014
Source: Statistics Austria (Bundesanstalt Statistik Österreich)

[1)] Budget appropriation. Preliminary version of Annex T based on the budget drafted for 2014 (financing proposal; Part a and Part b). - [2)] Including the highest executive bodies.

Table 8: Federal expenditure on research and research promotion by socio-economic objectives and ministries, 2014[1)]

Ministries		Total federal expenditure for R&D	of which											
			Promotion of exploration and exploitation of earth and space:	Promotion of agriculture and forestry	Promotion of industrial production and industry	Promotion of energy production, storage and distribution	Promotion of transport, traffic and communica-tions	Promotion of education	Promotion of health	Promotion of social and socio-economic development	Promotion of environmental protection	Promotion of urban and rural planning	Promotion of defence	Promotion of other objectives	Promotion of general advancement of knowledge
BKA[2)]	in € 1,000	33,518	4,404	-	-	48	1	-	-	6,700	-	678	-	-	21,687
	in %	*100.0*	*13.1*	-	-	*0.1*	*0.0*	-	-	*20.0*	-	*2.0*	-	-	*64.8*
BMI	in € 1,000	1,067	-	-	-	-	-	-	-	1,067	-	-	-	-	-
	in %	*100.0*	-	-	-	-	-	-	-	*100.0*	-	-	-	-	-
BMBF	in € 1,000	48,372	924	-	-	-	-	42,347	-	1,036	-	-	-	-	4,065
	in %	*100.0*	*1.9*	-	-	-	-	*87.6*	-	*2.1*	-	-	-	-	*8.4*
BMWFW*	in € 1,000	2,080,394	79,765	23,079	421,696	10,594	24,521	32,231	510,615	99,079	32,231	20,650	77	-	825,856
	in %	*100.0*	*3.8*	*1.1*	*20.3*	*0.5*	*1.2*	*1.5*	*24.5*	*4.8*	*1.5*	*1.0*	*0.0*	-	*39.8*
BMASK	in € 1,000	5,649	-	-	-	-	-	-	-	5,649	-	-	-	-	-
	in %	*100.0*	-	-	-	-	-	-	-	*100.0*	-	-	-	-	-
BMG	in € 1,000	7,577	-	71	-	-	-	-	7,504	2	-	-	-	-	-
	in %	*100.0*	-	*0.9*	-	-	-	-	*99.1*	*0.0*	-	-	-	-	-
BMEIA	in € 1,000	2,234	-	-	-	1,120	-	-	-	1,105	-	-	-	-	9
	in %	*100.0*	-	-	-	*50.1*	-	-	-	*49.5*	-	-	-	-	*0.4*
BMJ	in € 1,000	130	-	-	-	-	-	-	-	130	-	-	-	-	-
	in %	*100.0*	-	-	-	-	-	-	-	*100.0*	-	-	-	-	-
BMLVS	in € 1,000	1,174	-	-	-	-	-	-	-	-	-	-	6	-	1,168
	in %	*100.0*	-	-	-	-	-	-	-	-	-	-	*0.5*	-	*99.5*
BMF	in € 1,000	31,799	976	569	5,204	163	461	542	7,020	6,320	542	379	-	-	9,623
	in %	*100.0*	*3.1*	*1.8*	*16.4*	*0.5*	*1.4*	*1.7*	*22.1*	*19.9*	*1.7*	*1.2*	-	-	*30.2*
BMLFUW	in € 1,000	87,677	1,496	51,273	503	-	-	125	-	1,740	32,202	-	-	-	338
	in %	*100.0*	*1.7*	*58.5*	*0.6*	-	-	*0.1*	-	*2.0*	*36.7*	-	-	-	*0.4*
BMFJ	in € 1,000	1,654	-	-	-	-	-	-	-	1,654	-	-	-	-	-
	in %	*100.0*	-	-	-	-	-	-	-	*100.0*	-	-	-	-	-
BMVIT	in € 1,000	439,521	25,477	1,939	252,167	50,489	26,353	37	29,893	5,014	23,810	-	-	-	24,342
	in %	*100.0*	*5.8*	*0.4*	*57.5*	*11.5*	*6.0*	*0.0*	*6.8*	*1.1*	*5.4*	-	-	-	*5.5*
Total	**in € 1,000**	**2,740,766**	**113,042**	**76,931**	**679,570**	**62,414**	**51,336**	**75,282**	**555,032**	**129,496**	**88,785**	**21,707**	**83**	**-**	**887,088**
	in %	***100.0***	***4.1***	***2.8***	***24.8***	***2.3***	***1.9***	***2.7***	***20.3***	***4.7***	***3.2***	***0.8***	***0.0***	**-**	***32.4***

Status: April 2014
Source: Statistics Austria (Bundesanstalt Statistik Österreich)

1) Budget appropriation. Preliminary version of Annex T based on the budget drafted for 2014 (financing proposal; Part a and Part b). - 2) Including the highest executive bodies.

* Federal Ministry of Science, Research and Economy

Table 9: General research-related university expenditure by the federal government[1] (General University Funds), 1999 – 2014

Years	General university expenditure	
	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	1,236.757
2010	2,777.698	1,310.745
2011	2,791.094	1,388.546
2012	2,871.833	1,395.130
2013	3,162.488	1,544.772
2014	3,093.322	1,499.782

Status: April 2014
Source: Statistics Austria (Bundesanstalt Statistik Österreich)

[1]) 1999–2011: Assessments of Annex T of the Auxiliary Document for the Federal Finances Act. 2012-2014: Assessment of the preliminary version of Annex T based on the budget drafted for 2014.

Table 10: Research promotion schemes and contracts awarded by the federal government in 2012, 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 2012	of which awarded to																						
		Higher education sector							Government sector						Private non-profit sector			Business enterprise sector						
		Universities (including teaching 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	Largely publicly financed private non-profit institutions	Ludwig Boltzmann Gesellschaft	Total	private non-profit institutions	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)	Österreichische Forschungs-förderungsgesellschaft mbH	Abroad
	in €	in %																						
BKA	288,797	13.3	-	-	-	-	-	13.3	3.2	-	-	36.1	-	39.3	2.6	-	2.6	-	-	36.8	36.8	-	-	8.0
BMEIA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BMASK	3,811,475	8.7	-	-	-	-	-	8.7	47.9	-	-	32.9	-	80.8	1.8	0.5	2.3	1.4	-	5.5	6.9	-	-	1.3
BMF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BMG	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BMI	833,844	29.2	0.6	1.5	3.9	-	-	35.2	6.1	-	-	25.0	-	31.1	2.5	-	2.5	14.0	-	17.2	31.2	-	-	-
BMJ	191,325	-	-	-	-	-	-	-	-	-	-	100.0	-	100.0	-	-	-	-	-	-	-	-	-	-
BMLVS	203,018	20.4	-	-	9.9	-	-	30.3	4.0	-	-	2.5	-	6.5	2.3	21.1	23.4	-	16.3	23.5	39.8	-	-	-
BMLFUW	2,589,466	48.8	-	-	-	-	-	48.8	17.6	-	-	12.5	-	30.1	6.4	-	6.4	0.8	3.1	3.0	6.9	-	3.9	3.9
BMUKK	15,032,717	0.6	-	-	-	-	-	0.6	97.3	-	-	0.9	0.7	98.9	0.1	0.3	0.4	-	-	-	-	-	-	0.1
BMVIT	3,586,244	-	-	-	-	-	-	-	-	-	-	18.5	-	18.5	9.7	-	9.7	66.5	-	5.3	71.8	-	-	-
BMWFJ	1,625,913	1.3	-	-	-	-	-	1.3	34.4	-	-	19.6	-	54.0	1.4	-	1.4	4.4	3.2	5.8	13.4	-	29.9	-
BMWF	62,000,723	1.4	-	0.1	0.0	-	-	1.5	0.4	-	-	13.6	3.3	17.3	0.9	0.1	1.0	0.5	0.2	25.5	26.2	-	6.0	48.0
Total	**90,163,522**	**3.1**	**0.0**	**0.1**	**0.1**	**-**	**-**	**3.3**	**19.7**	**-**	**-**	**13.0**	**2.4**	**35.1**	**1.3**	**0.2**	**1.5**	**3.3**	**0.3**	**18.5**	**22.1**	**-**	**4.8**	**33.2**

Status: April 2014
Source: STATISTICS AUSTRIA (Bundesanstalt Statistik Österreich)

[1]) Formerly facts documentation of the federal offices; as of November 2013.

[2]) i.e. excluding global financing for Austrian Science Fund (FWF), Austrian Research Promotion Agency (FFG), Ludwig Boltzmann Gesellschaft, Austrian Academy of Sciences, AIT Austrian Institute of Technology GmbH.

Table 11: Research promotion schemes and contracts awarded by the federal government in 2012, broken down by socio-economic objectives and awarding ministries
Analysis of the federal research database[1] without "major" global financing[2]

Ministries		Partial amounts 2012	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 knowledge advancement
BKA	in €	288,797	-	9,297	-	-	-	-	-	207,070	-	31,730	-	40,700
	in %	*100.0*	-	*3.2*	-	-	-	-	-	*71.7*	-	*11.0*	-	*14.1*
BMEIA	in €	-	-	-	-	-	-	-	-	-	-	-	-	-
	in %	-	-	-	-	-	-	-	-	-	-	-	-	-
BMASK	in €	3,811,475	-	-	-	2,000	-	-	2,990	3,794,865	-	-	-	11,620
	in %	*100.0*	-	-	-	*0.1*	-	-	*0.1*	*99.5*	-	-	-	*0.3*
BMF	in €	-	-	-	-	-	-	-	-	-	-	-	-	-
	in %	-	-	-	-	-	-	-	-	-	-	-	-	-
BMG	in €	-	-	-	-	-	-	-	-	-	-	-	-	-
	in %	-	-	-	-	-	-	-	-	-	-	-	-	-
BMI	in €	833,844	-	-	-	-	-	-	-	701,084	-	-	-	132,760
	in %	*100.0*	-	-	-	-	-	-	-	*84.1*	-	-	-	*15.9*
BMJ	in €	191,325	-	-	-	-	-	-	-	191,325	-	-	-	-
	in %	*100.0*	-	-	-	-	-	-	-	*100.0*	-	-	-	-
BMLVS	in €	203,018	-	-	8,500	-	-	-	33,000	45,312	5,000	-	12,950	98,256
	in %	*100.0*	-	-	*4.2*	-	-	-	*16.3*	*22.3*	*2.5*	-	*6.4*	*48.3*
BMLFUW	in €	2,589,466	279,046	1,803,544	19,442	99,361	-	-	172,204	5,000	165,369	-	-	45,500
	in %	*100.0*	*10.8*	*69.5*	*0.8*	*3.8*	-	-	*6.7*	*0.2*	*6.4*	-	-	*1.8*
BMUKK	in €	15,032,717	-	-	-	-	-	14,607,480	100,000	215,987	-	-	-	109,250
	in %	*100.0*	-	-	-	-	-	*97.2*	*0.7*	*1.4*	-	-	-	*0.7*
BMVIT	in €	3,586,244	142,083	-	2,357,275	71,000	5,963	-	-	406,529	-	15,000	-	588,394
	in %	*100.0*	*4.0*	-	*65.7*	*2.0*	*0.2*	-	-	*11.3*	-	*0.4*	-	*16.4*
BMWFJ	in €	1,625,913	-	-	-	67,449	-	-	30,984	686,095	-	-	-	841,385
	in %	*100.0*	-	-	-	*4.1*	-	-	*1.9*	*42.2*	-	-	-	*51.8*
BMWF	in €	62,000,723	6,081,048	-	86,224	15,500	240	281,236	20,990,953	2,579,741	67,787	12,775	-	31,885,219
	in %	*100.0*	*9.8*	-	*0.1*	*0.0*	*0.0*	*0.5*	*33.9*	*4.2*	*0.1*	*0.0*	-	*51.4*
Total	in €	**90,163,522**	**6,502,177**	**1,812,841**	**2,471,441**	**255,310**	**6,203**	**14,888,716**	**21,330,131**	**8,833,008**	**238,156**	**59,505**	**12,950**	**33,753,084**
	in %	***100.0***	***7.2***	***2.0***	***2.7***	***0.3***	***0.0***	***16.5***	***23.7***	***9.8***	***0.3***	***0.1***	***0.0***	***37.4***

Status: April 2014
Source: STATISTICS AUSTRIA (Bundesanstalt Statistik Österreich)

[1]) Formerly facts documentation of the federal offices; as of November 2013.

[2]) i.e. excluding global financing for Austrian Science Fund (FWF), Austrian Research Promotion Agency (FFG), Ludwig Boltzmann Gesellschaft, Austrian Academy of Sciences, AIT Austrian Institute of Technology GmbH.

Table 12: Research funding and research contracts of the federal offices in 2012 by fields of sciences and awarding ministries.
Analysis of the federal research database[1)] without "major" global financing[2)]

Ministries		Partial amounts 2012	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 €	288,797	22,296	-	-	-	266,501	-
	in %	*100.0*	*7.7*	-	-	-	*92.3*	-
BMEIA	in €	-	-	-	-	-	-	-
	in %	-	-	-	-	-	-	-
BMASK	in €	3,811,475	-	2,000	101,930	-	3,707,545	-
	in %	*100.0*	-	*0.1*	*2.7*	-	*97.2*	-
BMF	in €	-	-	-	-	-	-	-
	in %	-	-	-	-	-	-	-
BMG	in €	-	-	-	-	-	-	-
	in %	-	-	-	-	-	-	-
BMI	in €	833,844	-	-	-	-	733,296	100,548
	in %	*100.0*	-	-	-	-	*87.9*	*12.1*
BMJ	in €	191,325	-	-	-	-	191,325	-
	in %	*100.0*	-	-	-	-	*100.0*	-
BMLVS	in €	203,018	78,340	15,468	33,000	-	76,210	-
	in %	*100.0*	*38.6*	*7.6*	*16.3*	-	*37.5*	-
BMLFUW	in €	2,589,466	607,290	100,000	40,000	1,731,117	111,059	-
	in %	*100.0*	*23.5*	*3.9*	*1.5*	*66.8*	*4.3*	-
BMUKK	in €	15,032,717	-	-	100,000	-	14,932,717	-
	in %	*100.0*	-	-	*0.7*	-	*99.3*	-
BMVIT	in €	3,586,244	383,083	2,629,238	-	-	559,423	14,500
	in %	*100.0*	*10.7*	*73.3*	-	-	*15.6*	*0.4*
BMWFJ	in €	1,625,913	222,946	57,449	35,670	-	1,278,348	31,500
	in %	*100.0*	*13.7*	*3.5*	*2.2*	-	*78.7*	*1.9*
BMWF	in €	62,000,723	52,350,564	1,314,275	3,077,754	22,278	4,618,506	617,346
	in %	*100.0*	*84.5*	*2.1*	*5.0*	*0.0*	*7.4*	*1.0*
Total	**in €**	**90,163,522**	**53,664,519**	**4,118,430**	**3,388,354**	**1,753,395**	**26,474,930**	**763,894**
	in %	***100.0***	***59.5***	***4.6***	***3.8***	***1.9***	***29.4***	***0.8***

Status: April 2014
Source: STATISTICS AUSTRIA (Bundesanstalt Statistik Österreich)

1) Formerly facts documentation of the federal offices; as of November 2013.

2) i.e. excluding global financing for Austrian Science Fund (FWF), Austrian Research Promotion Agency (FFG), Ludwig Boltzmann Gesellschaft, Austrian Academy of Sciences, AIT Austrian Institute of Technology GmbH.

Table 13: Expenditure on research and experimental development (R&D), broken down by sectors of performance and sources of funds, 2002 to 2011

Sectors	2002		2004		2006		2007		2009		2011	
	€ 1,000	%	€ 1,000	%	€ 1,000	%	€ 1,000	%	€ 1,000	%	€ 1,000	%
Sectors of performance												
Total	**4,684,313**	**100.0**	**5,249,546**	**100.0**	**6,318,587**	**100.0**	**6,867,815**	**100.0**	**7,479,745**	**100.0**	**8,276,335**	**100.0**
Higher education sector [1]	1,266,104	27.0	1,401,649	26.7	1,523,160	24.1	1,637,277	23.8	1,951,845	26.1	2,117,553	25.6
Government sector[2]	266,428	5.7	269,832	5.1	330,232	5.2	367,300	5.3	399,093	5.3	425,222	5.1
Private non-profit sector[3]	20,897	0.4	21,586	0.4	16,519	0.3	17,377	0.3	35,905	0.5	40,719	0.5
Business enterprise sector	3,130,884	66.9	3,556,479	67.8	4,448,676	70.4	4,845,861	70.6	5,092,902	68.1	5,692,841	68.8
of which:												
Institutes' sub-sector ("kooperativer Bereich")[4]	261,682	5.6	347,703	6.6	428,492	6.8	468,219	6.8	482,719	6.5	625,650	7.6
Company R&D sub-sector ("firmeneigener Bereich")	2,869,202	61.3	3,208,776	61.2	4,020,184	63.6	4,377,642	63.7	4,610,183	61.6	5,067,191	61.2
Sources of funds												
Total	**4,684,313**	**100.0**	**5,249,546**	**100.0**	**6,318,587**	**100.0**	**6,867,815**	**100.0**	**7,479,745**	**100.0**	**8,276,335**	**100.0**
Public sector	1,574,231	33.6	1,732,185	33.0	2,071,310	32.8	2,260,857	32.9	2,661,623	35.6	3,014,526	36.4
Business enterprise sector	2,090,626	44.6	2,475,549	47.1	3,056,999	48.4	3,344,400	48.7	3,520,016	47.0	3,820,904	46.2
Private non-profit sector	17,491	0.4	25,201	0.5	26,928	0.4	32,316	0.5	42,179	0.6	39,236	0.5
Abroad	1,001,965	21.4	1,016,611	19.4	1,163,350	18.4	1,230,242	17.9	1,255,927	16.8	1,401,669	16.9
of which EU	78,281	1.7	86,974	1.7	103,862	1.6	101,094	1.5	111,470	1.5	150,259	1.8

Source: Statistics Austria, Surveys by **Statistics Austria**. Compiled on: 14 Aug. 2013.

[1]) Universities including hospitals, art universities, the Austrian Academy of Sciences, testing institutes at technical federal colleges, universities of applied sciences, private universities and the University for Continuing Education Krems. Including pedagogical universities (since 2007). As of 2009 also includes other institutions attributable to the higher education sector. - [2]) Federal institutions (not including those combined in the higher education sector), state, local government and chamber institutions, R&D institutions of the social insurance carriers, public sector-financed and/or controlled private non-profit institutions as well as R&D institutions of the Ludwig Boltzmann-Gesellschaft; including regional hospitals.

The regional hospitals were not surveyed by questionnaire, but instead Statistics Austria prepared an estimate of their R&D expenditures based on the reports of the offices of the regional governments. - [3]) Private non-profit institutions whose status is predominantly private or under civil law, sectarian or other non-public. - [4]) Including The Austrian Institute of Technology GmbH and centres of excellence. - Rounding differences.

Table 14: Employees in research and experimental development (R&D), broken down by sectors of performance as well as survey areas, occupation category and gender, 2011

Sectors, areas	Survey units performing R&D	Total		of which					
				Researchers		Technicians and equivalent		Other supporting staff	
		male	female	male	female	male	female	male	female
Headcounts									
Total	**4,984**	**74,935**	**33,014**	**46,589**	**19,020**	**22,607**	**8,239**	**5,739**	**5,755**
1. Higher education sector	**1,304**	**22,884**	**19,407**	**19,544**	**12,464**	**2,050**	**4,049**	**1,290**	**2,894**
of which:									
1.1 Universities (without hospitals)[1]	1,043	17,105	13,519	14,434	8,583	1,551	2,862	1,120	2,074
1.2 University hospitals	88	2,549	3,194	2,289	1,886	159	670	101	638
1.3 Art universities	64	723	692	675	562	25	81	23	49
1.4 Academy of Sciences	59	891	686	734	501	155	175	2	10
1.5 Universities of applied sciences	22	1,133	840	979	564	123	203	31	73
1.6 Private universities	10	294	272	259	184	28	45	7	43
1.7 Pedagogical universities	14	85	147	82	138	3	7	-	2
1.8 Other higher education sector [2]	4	104	57	92	46	6	6	6	5
2. Government sector[3]	**252**	**3,165**	**3,020**	**1,870**	**1,467**	**525**	**574**	**770**	**979**
of which:									
2.1 Without the regional hospitals	252	3,165	3,020	1,870	1,467	525	574	770	979
2.2 regional hospitals	.	.	.	.	.	.	.	.	.
3. Private non-profit sector[4]	**44**	**385**	**445**	**300**	**230**	**42**	**140**	**43**	**75**
4. Business enterprise sector	**3,384**	**48,501**	**10,142**	**24,875**	**4,859**	**19,990**	**3,476**	**3,636**	**1,807**
of which:									
4.1 Institutes' sub-sector ("kooperativer Bereich")[5]	57	4,904	1,944	3,086	827	1,344	591	474	526
4.2 Company R&D sub-sector ("firmeneigener Bereich")	3,327	43,597	8,198	21,789	4,032	18,646	2,885	3,162	1,281
Full-time equivalents									
Total	**4,984**	**46,078.0**	**15,092.4**	**28,651.3**	**8,462.5**	**14,272.3**	**4,063.2**	**3,154.4**	**2,566.7**
1. Higher education sector	**1,304**	**9,249.3**	**6,846.9**	**8,010.4**	**4,188.8**	**756.5**	**1,590.4**	**482.4**	**1,067.7**
of which:									
1.1 Universities (without hospitals)[1]	1,043	7,279.8	5,017.2	6,255.9	3,011.2	586.0	1,150.2	438.0	855.7
1.2 University hospitals	88	640.4	870.6	556.8	454.5	60.2	259.7	23.3	156.5
1.3 Art universities	64	133.0	131.5	122.6	100.6	4.1	19.5	6.3	11.4
1.4 Academy of Sciences	59	571.8	373.2	508.1	293.4	62.2	72.9	1.6	6.9
1.5 Universities of applied sciences	22	466.7	320.3	421.9	224.8	36.3	73.1	8.5	22.5
1.6 Private universities	10	75.2	75.5	67.9	53.2	5.7	12.3	1.6	10.1
1.7 Pedagogical universities	14	18.4	26.6	18.1	25.9	0.3	0.4	-	0.3
1.8 Other higher education sector [2]	4	64.0	32.0	59.2	25.1	1.7	2.4	3.1	4.5
2. Government sector[3])	**252**	**1,402.2**	**1,165.0**	**889.3**	**621.8**	**176.6**	**187.8**	**336.3**	**355.5**
of which:									
2.1 Without the regional hospitals	252	1,402.2	1,165.0	889.3	621.8	176.6	187.8	336.3	355.5
2.2 regional hospitals	.	.	.	.	.	.	.	.	.
3. Private non-profit sector[4]	**44**	**195.0**	**214.6**	**155.1**	**110.8**	**20.1**	**74.0**	**19.7**	**29.8**
4. Business enterprise sector	**3,384**	**35,231.5**	**6,865.9**	**19,596.4**	**3,541.2**	**13,319.2**	**2,211.1**	**2,316.0**	**1,113.7**
of which:									
4.1 Institutes' sub-sector ("kooperativer Bereich")[5]	57	3,232.6	1,021.4	2,263.7	499.1	664.9	242.8	304.1	279.6
4.2 Company R&D sub-sector ("firmeneigener Bereich")	3,327	31,998.9	5,844.5	17,332.7	3,042.1	12,654.3	1,968.3	2,011.9	834.1

Source: Statistics Austria, Survey of research and experimental development in 2011. Compiled on: 30 July 2013.

[1]) Including the University for Continuing Education Krems. - [2]) Testing institutes at technical federal colleges as well as other programmes that can be attributed to the higher education sector (reported together to keep data confidential). - [3]) Federal institutions (not including those combined in the higher education sector), state, local government and chamber institutions, R&D institutions of the social insurance carriers, public sector-financed and/or controlled private non-profit institutions as well as R&D institutions of the Ludwig Boltzmann-Gesellschaft; without regional hospitals. The regional hospitals were not surveyed by questionnaire, but instead Statistics Austria prepared an estimate of the R&D expenditures based on the reports of the offices of the regional governments. For this reason there is no data about employees in R&D. -[4]) Private non-profit institutions whose status is predominantly private or under civil law, sectarian, or other non-public. [5]) Including The Austrian Institute of Technology GmbH and competence centres. - Rounding differences

Table 15: Employees in research and experimental development (R&D) (in full-time equivalents) in all of the areas surveyed [1]) 2011 broken down by state[2]) and occupation categories

States	Survey units performing R&D	Full-time equivalents in R&D			
		Total	of which		
			Researchers	Technicians and equivalent	Other supporting staff
Austria	**4,984**	**61,170.4**	**37,113.8**	**18,335.5**	**5,721.1**
Burgenland	84	573.6	295.7	189.3	88.6
Carinthia	237	3,048.5	2,006.8	915.8	125.9
Lower Austria	527	5,324.2	2,881.3	1,961.6	481.3
Upper Austria	886	10,027.8	5,053.8	3,920.0	1,054.0
Salzburg	284	2,560.9	1,572.3	843.8	144.8
Styria	913	12,128.5	7,193.0	3,621.2	1,314.3
Tyrol	406	5,019.4	3,136.8	1,393.1	489.5
Vorarlberg	160	1,770.6	844.5	854.0	72.1
Vienna	1,487	20,716.9	14,129.6	4,636.9	1,950.5

Source: Statistics Austria, Survey of research and experimental development in 2011. Compiled on: 30 July 2013.

1) The regional hospitals were not surveyed by questionnaire, but instead Statistics Austria prepared an estimate of the R&D expenditures based on the reports of the offices of the regional governments. For this reason there is no data about employees in R&D. - 2) R&D sub-sector ("firmeneigener Bereich"): Regional allocation by location of company head-quarters. - Rounding differences.

Table 16: Expenditure for research and experimental development (R&D) 2011 by sectors of performance/ survey areas and types of research

Sectors, areas	No. of survey units performing R&D	Total expenditure on R&D	Employees in R&D		
			Total	male	female
		in € 1,000	in full-time equivalents		
Total	**4,984[6]**	**8,276,335**	**61,170.4**	**46,078.0**	**15,092.4**
1. Higher education sector	**1,304**	**2,117,553**	**16,096.2**	**9,249.3**	**6,846.9**
of which:					
1.1 Universities (without hospitals)[1)]	1,043	1,644,055	12,297.0	7,279.8	5,017.2
1.2 University hospitals	88	207,890	1,511.0	640.4	870.6
1.3 Art universities	64	31,660	264.5	133.0	131.5
1.4 Academy of Sciences	59	117,142	945.0	571.8	373.2
1.5 Universities of applied sciences	22	77,412	787.1	466.7	320.3
1.6 Private universities	10	16,914	150.7	75.2	75.5
1.7 Pedagogical universities	14	4,848	45.0	18.4	26.6
1.8 Other higher education sector [2)]	4	17,632	96.0	64.1	32.0
2. Government sector[3])	**252[6]**	**425,222**	**2,567.2**	**1,402.2**	**1,165.0**
of which:					
2.1 Without the regional hospitals	252	274,567	2,567.2	1,402.2	1,165.0
2.2 regional hospitals	.	150,655	.	.	.
3. Private non-profit sector[4)]	**44**	**40,719**	**409.6**	**195.0**	**214.6**
4. Business enterprise sector	**3,384**	**5,692,841**	**42,097.4**	**35,231.5**	**6,865.9**
of which:					
4.1 Institutes' sub-sector ("kooperativer Bereich")[5)]	57	625,650	4,254.1	3,232.6	1,021.4
4.2 Company R&D sub-sector ("firmeneigener Bereich")	3,327	5,067,191	37,843.4	31,998.9	5,844.5

Source: Statistics Austria, Survey of research and experimental development in 2011. Compiled on: 14 Aug. 2013.

[1]) Including the University for Continuing Education Krems. - [2]) Testing institutes at technical federal colleges as well as other programmes that can be attributed to the higher education sector (reported together to keep data confidential). - [3]) Federal institutions (not including those combined in the higher education sector), regional government, local government and chamber institutions, R&D institutions of the social insurance carriers, public sector-financed and/or controlled private non-profit institutions as well as R&D institutions of the Ludwig Boltzmann-Gesellschaft.

The regional hospitals were not surveyed by questionnaire, but instead Statistics Austria prepared an estimate of the R&D expenditures based on the reports of the offices of the regional governments. For this reason there is no data about employees in R&D. - [4]) Private non-profit institutions whose status is predominantly private or under civil law, sectarian, or other non-public. - [5]) Including The Austrian Institute of Technology GmbH and competence centres. - 6) Number of survey units not including regional hospitals. - Rounding differences.

Table 17: Financing of expenditure for research and experimental development (R&D) in 2011 by sectors of performance/ survey areas and financing sectors

R&D performed in the sectors, areas	Survey units carrying out R&D	Total	Funding areas								
			Business enterprise sector	Public sector					Private non-profit sector	Abroad incl. international organisations (without EU)	EU
				Total	Federal government[1]	Regional governments[2]	Local governments[2]	Other [1]			
		in € 1,000									
Total	**4,984** [3]	**8,276,335**	**3,820,904**	**3,014,526**	**2,215,045**	**298,712**	**7,000**	**493,769**	**39,236**	**1,251,410**	**150,259**
1. Higher education sector	**1,304**	**2,117,553**	**109,122**	**1,870,264**	**1,571,617**	**49,336**	**2,462**	**246,849**	**19,082**	**41,426**	**77,659**
of which:											
1.1 Universities (without hospitals)[4]	1,043	1,644,055	82,581	1,467,623	1,239,034	24,831	1,086	202,672	8,431	28,378	57,042
1.2 University hospitals	88	207,890	11,436	183,920	160,049	2,109	17	21,745	614	7,724	4,196
1.3 Art universities	64	31,660	713	30,357	28,388	477	130	1,362	168	125	297
1.4 Academy of Sciences	59	117,142	781	105,444	94,749	1,134	27	9,534	824	1,805	8,288
1.5 Universities of applied sciences	22	77,412	10,280	57,839	33,261	14,380	1,172	9,026	4,143	1,096	4,054
1.6 Private universities	10	16,914	2,848	7,248	3	4,857	24	2,364	4,666	1,757	395
1.7 Pedagogical universities	14	4,848	124	4,416	3,960	304	6	146	170	-	138
1.8 Other higher education sector [5]	4	17,632	359	13,417	12,173	1,244	-	-	66	541	3,249
2. Government sector[6]	**252** [3]	**425,222**	**17,849**	**385,172**	**165,173**	**191,480**	**3,318**	**25,201**	**2,105**	**3,060**	**17,036**
of which:											
2.1 Without the regional hospitals	252	274,567	17,849	234,517	165,173	40,825	3,318	25,201	2,105	3,060	17,036
2.2 regional hospitals	.	150,655	.	150,655	.	150,655	.	.	.	.	.
3. Private non-profit sector[7]	**44**	**40,719**	**6,335**	**2,992**	**689**	**593**	**19**	**1,691**	**12,912**	**12,849**	**5,631**
4. Business enterprise sector	**3,384**	**5,692,841**	**3,687,598**	**756,098**	**477,566**	**57,303**	**1,201**	**220,028**	**5,137**	**1,194,075**	**49,933**
of which:											
4.1 Institutes' sub-sector ("kooperativer Bereich")[8]	57	625,650	115,179	174,421	85,000	40,181	651	48,589	178	318,195	17,677
4.2 Company R&D sub-sector ("firmeneigener Bereich")	3,327	5,067,191	3,572,419	581,677	392,566	17,122	550	171,439	4,959	875,880	32,256

Source: Statistics Austria, Survey of research and experimental development in 2011. Compiled on: 9 August 2013.

[1]) The funds from the Austrian Research Promotion Fund and the R&D financing by the higher education sector are included under "Other". - [2]) Regional governments including Vienna. Local governments without Vienna. - [3]) Number of survey units not including regional hospitals. - [4]) Including the University for Continuing Education Krems. - [5]) Testing institutes at technical federal colleges as well as other programmes that can be attributed to the higher education sector (reported together to keep data confidential). - [6]) Federal institutions (not including those combined in the higher education sector), state, local government and chamber institutions, R&D institutions of the social insurance carriers, public sector-financed and/or controlled private non-profit institutions as well as R&D institutions of the Ludwig Boltzmann-Gesellschaft; including regional hospitals. The regional hospitals were not surveyed by questionnaire, but instead Statistics Austria prepared an estimate of their R&D expenditures based on the reports of the offices of the regional governments. - [7]) Private non-profit institutions whose status is predominantly private or under civil law, sectarian or other non-public. - [8]) Including The Austrian Institute of Technology GmbH and centres of excellence.

Table 18: Financing of expenditure on research and experimental development (R&D) in all survey areas [1], in 2011, by regional governments[2] and financing sectors

States	Survey units carrying out R&D[3]	Total	Funding areas								
			Business enterprise sector	Public sector					Private non-profit sector	Abroad incl. international organisations (without EU)	EU
				Total	Federal government[4]	Regional governments[5]	Local governments[5]	Other [4]			
		in € 1,000									
Austria	**4,984**	**8,276,335**	**3,820,904**	**3,014,526**	**2,215,045**	**298,712**	**7,000**	**493,769**	**39,236**	**1,251,410**	**150,259**
Burgenland	84	56,846	41,792	9,745	4,743	3,031	88	1,883	-	4,818	491
Carinthia	237	480,133	195,202	99,206	63,814	17,535	1,136	16,721	702	179,671	5,352
Lower Austria	527	706,439	461,552	172,885	114,254	33,124	635	24,872	3,694	51,910	16,398
Upper Austria	886	1,295,914	952,101	269,919	176,340	28,184	1,420	63,975	3,053	59,247	11,594
Salzburg	284	287,664	151,820	123,285	82,971	10,940	1,009	28,365	1,586	5,564	5,409
Styria	913	1,646,956	584,981	595,863	410,458	75,979	1,567	107,859	1,898	436,403	27,811
Tyrol	406	728,795	302,510	324,131	251,877	32,022	300	39,932	4,757	84,186	13,211
Vorarlberg	160	202,836	159,461	37,232	17,832	10,375	53	8,972	59	5,123	961
Vienna	1,487	2,870,752	971,485	1,382,260	1,092,756	87,522	792	201,190	23,487	424,488	69,032

Source: Statistics Austria, Survey of research and experimental development in 2011. Compiled on: 22 July 2013.

[1]) Including R&D expenditure estimate for regional hospitals. - [2]) In the company R&D sector ("firmeneigener Bereich"), the standard evaluation was performed by location of company headquarters. - [3]) Number of survey units not including regional hospitals. - [4]) The funds from the Austrian Research Promotion Fund and the R&D financing by the higher education sector are included under "Other". - [5]) Regional governments including Vienna. Local governments without Vienna.

Table 19: Gross regional product (GRP), gross domestic expenditure on R&D and regional research intensity for 2011

Regions (NUTS 1, NUTS 2)	Gross regional product ("regional GDP")[1]	Gross domestic expenditure on R&D [2]	
	in € millions	in € millions	in % of GRP
Austria	**299,240**	**8,276.34**	**2.77**
Eastern Austria	**132,098**	**3,455.50**	**2.62**
Burgenland	6,829	51.68	0.76
Lower Austria	47,327	737.37	1.56
Vienna	77,942	2,666.45	3.42
Southern Austria	**54,349**	**2,201.90**	**4.05**
Carinthia	16,936	464.94	2.75
Styria	37,413	1,736.96	4.64
Western Austria	**112,679**	**2,618.96**	**2.32**
Upper Austria	50,677	1,372.89	2.71
Salzburg	21,857	316.28	1.45
Tyrol	26,095	722.18	2.77
Vorarlberg	14,050	207.61	1.48
Extra-Regio [3])	114	.	.

Source: Statistics Austria, Survey of research and experimental development in 2011. Compiled on: 17 January 2014.

[1]) Status: 20 Dec. 2013. Concept ESA 95, VGR revision date: July 2013. - [2]) Regional allocation by R&D location / the R&D locations of the survey units. - [3]) The "Extra-Regio" includes parts of the economic area which cannot be allocated directly to a region (embassies abroad). - Rounding differences.

Table 20: International comparison of research and experimental development (R&D) in 2011

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	Government sector	Private non-profit sector
		in %			as a % of gross domestic expenditure on R&D			
Belgium	2.21	23.4	60.2	62,895	68.7	22.3	8.1	0.9
Denmark	2.98	28.9	60.3	56,126	65.9	31.6	2.2	0.4
Germany	2.89	29.8	65.6	574,701	67.7	17.8	14.5[o)]	.[n)]
Finland	3.80	25.0[a)]	67.0	54,526[a)]	70.5	20.0	8.8	0.7
France	2.25	35.4	55.0	402,318	63.9	21.0	13.9	1.2
Greece [a)]	0.67[c)2)]	49.2[1]	32.7[1]	36,913[c)2)]	34.9[c)2)]	40.2[c)2)]	23.8[c)2)]	1.0[c)2)]
Ireland [c)]	1.66	30.3	48.4	21,560	69.0	26.1	4.9	.
Italy	1.25	41.9	45.1	228,094	54.6	28.6	13.4	3.3
Luxembourg [3)]	1.51	34.8	44.3	4,988	67.6	12.7	19.7	.
Netherlands [a)]	2.03	35.5[4]	49.9[4]	116,326	56.2	32.9	10.9[o)]	.[n)]
Austria [4)]	**2.77**	**36.4**	**46.2**	**61,170**	**68.8**	**25.6**	**5.1**	**0.5**
Portugal	1.52	41.8	44.0	55,612	46.7	37.7	7.4	8.1
Sweden	3.39	27.7	57.3	77,950[a)]	68.8	26.5	4.3	0.3[a)]
Spain	1.36	44.5	44.3	215,079	52.1	28.2	19.5	0.2
United Kingdom [c)]	1.78	30.5	45.9	356,258	63.6	26.0	8.6	1.8
EU 15 [b)]	**2.11**	**33.1**	**55.4**	**2,324,623**	**63.5**	**23.3**	**12.1**	**1.1**
Estonia	2.37	32.8	55.0	5,724	63.2	27.8	8.1	0.9
Poland	0.76	55.8	28.1	85,219	30.1	35.1	34.5	0.2
Slovak Republic	0.68	49.8	33.9	18,112	37.2	34.9	27.7[d)]	0.2
Slovenia [a)]	2.47	31.5	61.2	15,269	73.9	11.8	14.3	0.1
Czech Republic	1.64	41.7	37.7	55,697	55.3	24.4	19.8	0.6
Hungary	1.22	38.1	47.5	33,960	62.4[v]	20.2[v]	15.8[v]	.
Romania [a)]	0.50	49.1	37.4	29,749	36.0	22.9	40.7	0.4
EU-28 [b)]	**1.95**	**33.9**	**54.3**	**2,615,234**	**62.4**	**23.6**	**12.9**	**1.1**
Australia	2.20[c)z)3)]	34.6[2)]	61.9[2)]	137,489[3)]	58.4[c)3)]	26.6[c)3)]	12.4[c)3)]	3.0[c)3)]
Chile [3)]	0.42	37.3	35.4	11,491	38.7	30.6	8.4	22.3
Iceland [a)]	2.40[p)3)]	42.3[p)3)]	47.5[p)3)]	3,158[4]	52.6[p)3)]	26.5[p)3)]	17.8[p)3)]	3.0[p)3)]
Israel [d)]	4.21	12.2[3]	36.6[3]	68,175	84.0	13.0[g)]	1.9	1.1
Japan	3.39	16.4[e)]	76.5	869,825	77.0	13.2	8.4	1.5
Canada	1.79	34.8[c)]	48.0	228,970[p)]	52.0	37.9	9.7	0.4
Korea	4.04	24.9	73.7	361,374	76.5	10.1	11.7	1.6
Mexico	0.43	59.6	36.8	70,293[1)]	39.0	28.9	30.5	1.6
New Zealand	1.27	41.4	40.0	23,600	45.4	31.8	22.7	.
Norway	1.65	46.5[4]	44.2[4]	36,950	52.2	31.4	16.4	.
Switzerland [2)]	2.87	22.8	68.2	62,066	73.5	24.2	0.7[h)]	1.6
Turkey	0.86	29.2	45.8	92,801	43.2	45.5	11.3	.
United States [j)]	2.76[z]	31.2	58.6	.	68.5	14.6	12.7[h)]	4.3[c)]
OECD total [b)]	**2.37**	**29.8**	**59.9**	**.**	**67.3**	**18.4**	**11.8**	**2.5**

Source: OECD (MSTI 2013-2), **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. - g) Only natural science and technical research. - 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. - z) GDP according to System of National Accounts 2008.

1) 2007. - 2) 2008. - 3) 2010. - 4) Statistics Austria; Results of the 2011 survey on research and experimental development.

Full time equivalent = person year.

Table 21: 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 11/2013
Number of approved projects in which Austrian are participating	1,444	1,384	1,324	**2,291**
Number of approved Austrian participations	1,923	1,987	1,972	**3,180**
Number of approved projects coordinated by Austrian organisations	270	267	213	**352**
Funding for approved Austrian partner organisations and researchers for which a contract has been signed, in € millions	194	292	425	**949**
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%	**3.3%**
Austrian share of retrievable funds (returns indicator, RI)	1.99%	2.38%	2.56%	**2.65%**
Austrian share of retrievable funds (returns indicator, RI) measured against the contribution Austria makes to the EU budget (return ratio)	70%	104%	117%	**125%**

Data: European Commission, **processed and calculated by**: PROVISO, a project of the BMWF, BMVIT, BMWFJ and BMLFUW

Source: M. Ehardt-Schmiederer, J. Brücker, D. Milovanović, C. Kobel, F. Hackl, L. Schleicher, V. Postl, A. Antúnez, M. Zacharias: 7. EU Framework Programme for research, technological development and demonstration activities (2007–2013) PROVISO overview report autumn 2013, Vienna 2013

Table 22: 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	C	Lower Austria	Upper Austria	S	ST	T	V	VIE	n/A[2]
Projects	22,341	2,291	9	81	198	178	87	441	185	24	1,336	187
Participations	127,107	3,180	9	95	209	205	97	518	206	28	1,626	187
Universities, Higher education	*N/A*	*1,141*	*0*	*29*	*16*	*83*	*51*	*228*	*132*	*5*	*597*	*0*
Non-university research institutions	*N/A*	*680*	*0*	*3*	*53*	*22*	*20*	*116*	*3*	*0*	*463*	*0*
Large firms (over 250 employees)	*N/A*	*213*	*1*	*27*	*17*	*28*	*4*	*60*	*10*	*7*	*59*	*0*
Small and medium-sized enterprises (up to 249 employees)	*N/A*	*566*	*8*	*34*	*66*	*57*	*13*	*97*	*56*	*11*	*224*	*0*
Other categories	*N/A*	*580*	*0*	*2*	*57*	*15*	*9*	*17*	*5*	*5*	*283*	*187*
Coordinators [3]	10,624	352	0	22	12	19	13	69	22	0	195	0
Universities, Higher education	*N/A*	*136*	*0*	*0*	*3*	*11*	*6*	*25*	*18*	*0*	*73*	*0*
Non-university research institutions	*N/A*	*111*	*0*	*0*	*4*	*4*	*6*	*28*	*0*	*0*	*69*	*0*
Large firms (over 250 employees)	*N/A*	*16*	*0*	*3*	*0*	*1*	*0*	*11*	*0*	*0*	*1*	*0*
Small and medium-sized enterprises (up to 249 employees)	*N/A*	*56*	*0*	*18*	*4*	*0*	*1*	*4*	*4*	*0*	*25*	*0*
Other categories	*N/A*	*33*	*0*	*1*	*1*	*3*	*0*	*1*	*0*	*0*	*27*	*0*

Data: European Commission, **processed and calculated by:** PROVISO, a project of the BMWF, BMVIT, BMWFJ and BMLFUW

[1]) as at 11/2013 PROVISO only has partial information on the project negotiation results; 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 projects, 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: M. Ehardt-Schmiederer, J. Brücker, D. Milovanović, C. Kobel, F. Hackl, L. Schleicher, A. Antúnez, M. Zacharias: 7. EU Framework Programme for research, technological development and demonstration activities (2007–2013) PROVISO overview report autumn 2013, Vienna 2013

Table 23: Overview of projects and participations in the 7th EU Framework Programme for research, technological development and demonstration activities

	approved projects (total)	approved projects with AT participants	Percentage of approved projects (AT) of approved projects (as total)
Cooperation	6,625	1,416	21.4%
Ideas	4,187	147	3.5%
People	9,566	426	4.5%
Experts	1,963	302	15.4%
Total	**22,341**	**2,291**	**10.3%**

Data: European Commission, **processed and calculated by**: PROVISO, a project of the BMWF, BMVIT, BMWFJ and BMLFUW; **Data as per:** 11/2013

	approved participants (total)	approved participants (AT)	Percentage of approved participants (AT) of total approved participants
Cooperation	74,152	2,056	2.8%
Ideas	9,024	184	2.0%
People	25,234	524	2.1%
Experts	18,697	416	2.2%
Total	**127,107**	**3,180**	**2.5%**

Data: European Commission, **processed and calculated by**: PROVISO, a project of the BMWF, BMVIT, BMWFJ and BMLFUW; **Data as per:** 11/2013

Source: M. Ehardt-Schmiederer, J. Brücker, D. Milovanović, C. Kobel, F. Hackl, L. Schleicher, V. Postl, A. Antúnez, M. Zacharias: 7. EU Framework Programme for research, technological development and demonstration activities (2007–2013) PROVISO overview report autumn 2013, Vienna 2013

Note: According to the data of 11/2013, 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 24: FWF: Trend of funding of life sciences, 2011–2013

	2011		2012		2013	
	Total (in € millions)	Share in %	Total (in € millions)	Share in %	Total (in € millions)	Share in %
Biology, botany, zoology	43.1	22.1	39.3	20.0	46.9	23.2
Med. chemistry, med. physics, physiology	14.1	7.2	8.3	4.2	11.6	5.7
Hygiene, med. Microbiology	9.9	5.1	9.5	4.8	7.3	3.6
Clinical medicine	5.1	2.6	4.9	2.5	4.1	2.0
Other areas of human medicine	0.7	0.4	0.7	0.3	2.8	1.4
Anatomy, pathology	2.3	1.2	4.9	2.5	2.8	1.4
Psychiatry and neurology	3.1	1.6	2.0	1.0	2.3	1.1
Pharmacy, pharmacology, toxicology	3.7	1.9	3.1	1.6	1.5	0.7
Veterinary medicine	1.4	0.7	0.8	0.4	0.7	0.3
Surgery and anaesthesiology	0.3	0.2	0.3	0.1	0.2	0.1
Court medicine	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total life sciences	**83.7**	**42.9**	**73.8**	**37.6**	**80.2**	**39.6**
Total grants awarded	**195.2**	**100.0**	**196.4**	**100.0**	**202.6**	**100.0**

Table 25: FWF: Trend of funding in the natural sciences and engineering, 2011–2013

	2011		2012		2013	
	Total (in € millions)	Share in %	Total (in € millions)	Share in %	Total (in € millions)	Share in %
Mathematics, informatics	27.3	14.0	31.5	16.0	32.9	16.2
Physics, mechanics, astronomy	25.9	13.3	26.1	13.3	24.5	12.1
Chemistry	10.3	5.3	12.0	6.1	9.0	4.4
Geology, mineralogy	2.2	1.1	1.5	0.8	3.3	1.6
Hydrology, hydrography	0.7	0.4	0.7	0.4	3.3	1.6
Other natural sciences	2.1	1.1	1.7	0.9	2.2	1.1
Meteorology, climatology	1.0	0.5	2.2	1.1	1.9	1.0
Forestry	0.5	0.2	0.5	0.3	1.1	0.5
Electrical engineering/electronics	3.9	2.0	2.0	1.0	1.1	0.6
Geodetics, surveying	0.4	0.2	0.5	0.3	0.9	0.4
Other engineering sciences	0.9	0.5	1.8	0.9	0.5	0.3
Farming, plant cultivation and protection	0.2	0.1	0.5	0.2	0.4	0.2
Mechanical engineering, machinery, instruments	0.5	0.3	0.5	0.3	0.3	0.1
Mining, metallurgy	0.6	0.3	0.5	0.2	0.2	0.1
Technical chemistry, fuel and petroleum technology	0.4	0.2	0.4	0.2	0.3	0.1
Livestock breeding, animal production	0.3	0.1	0.3	0.2	0.2	0.1
Geography	0.7	0.3	1.2	0.6	0.2	0.1
Architecture	0.2	0.1	1.0	0.5	0.2	0.1
Traffic engineering, traffic planning	<0.1	<0.1	<0.1	<0.1	0.2	0.1
Construction engineering	0.1	0.1	0.9	0.4	0.2	0.1
Other areas of agriculture and forestry	0.1	0.1	0.9	0.5	<0.1	<0.1
Horticulture, orcharding	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total natural sciences and engineering	**78.2**	**40.1**	**86.9**	**44.2**	**82.8**	**40.8**
Total grants awarded	**195.2**	**100.0**	**196.4**	**100.0**	**202.6**	**100.0**

Table 26: FWF: Trend of funding of humanities and social sciences, 2011–2013

	2011		2012		2013	
	Total (in € millions)	Share in %	Total (in € millions)	Share in %	Total (in € millions)	Share in %
Historical sciences	8.5	4.4	8.5	4.3	9.4	4.6
Economics	3.5	1.8	1.9	1.0	4.9	2.4
Linguistics and literary studies	3.2	1.6	4.0	2.0	4.5	2.2
Art sciences	3.7	1.9	4.2	2.1	4.3	2.1
Other philological and culture sciences	4.1	2.1	2.7	1.4	3.5	1.7
Philosophy	1.3	0.7	2.1	1.1	3.5	1.7
Other social sciences	1.6	0.8	2.1	1.1	2.0	1.0
Theology	0.8	0.4	1.1	0.5	1.6	0.8
Psychology	2.0	1.0	1.6	0.8	1.5	0.7
Sociology	1.3	0.7	1.6	0.8	1.3	0.7
Political science	0.6	0.3	3.6	1.8	1.3	0.6
Jurisprudence	1.1	0.6	1.0	0.5	0.8	0.4
Other humanities	0.9	0.4	0.5	0.3	0.5	0.2
Applied statistics	0.2	0.1	0.1	0.1	0.3	0.1
Pedagogy, educational sciences	0.2	0.1	0.6	0.3	0.2	0.1
Physical planning	0.2	0.1	0.2	0.1	<0.1	<0.1
Total humanities and social sciences	**33.2**	**17.0**	**35.7**	**18.2**	**39.7**	**19.6**
Total grants awarded	**195.2**	**100.0**	**196.4**	**100.0**	**202.6**	**100.0**

Table 27: Austrian Research Promotion Agency (FFG): Funding by regional government, 2013

Regional government	Participations	Total funding [in €1,000]	Cash value [in €1,000]	Percentage of cash value [in %]
Burgenland	62	6,643	4,987	1.4
Carinthia	219	27,447	20,817	5.8
Lower Austria	589	39,150	31,961	8.8
Upper Austria	712	97,032	55,982	15.5
Salzburg	173	21,903	13,999	3.9
Styria	1132	114,848	90,605	25.0
Tyrol	277	28,548	22,375	6.2
Vorarlberg	119	13,242	8,900	2.5
Vienna	1544	133,994	108,832	30.1
Abroad	150	3,282	3,282	0.9
Total result	**4977**	**486,088**	**361,742**	**100**

Table 28: Austrian Research Promotion Agency (FFG): Project costs and funding by Subject Index Code, 2013

Subject Index Code	Total costs [in €1,000]	Total funding [in €1,000]	Cash value [in €1,000]
Advanced materials	95,140	47,601	35,878
Electronics, microelectronics	143,017	50,681	32,647
Industrial production	110,520	48,624	30,278
Surface transport and technologies	69,342	35,832	27,157
Information processing, information systems	72,862	32,224	27,009
ICT applications	66,464	33,811	26,661
Energy storage, conversion and transport	27,080	17,563	17,288
Energy savings	39,771	21,172	16,922
Unclassified	24,873	15,264	15,264
Medicine, health	30,988	17,772	12,050
Renewable energy sources	20,150	13,955	11,383
Biosciences	33,538	18,918	11,206
Sustainable development	17,914	10,539	10,250
Aviation and technologies	21,081	10,774	10,026
Construction engineering	23,393	11,628	9,583
Medical biotechnology	19,398	11,259	6,733
Measuring techniques	21,116	11,153	6,004
Waste management	12,801	7,393	5,876
Foodstuffs	14,103	5,642	4,798
Automation	20,292	12,060	4,756
Other technologies	12,254	7,142	4,471
Innovation, technology transfer	11,968	4,379	4,379
Space	4,645	3,903	3,903
Nanotechnologies and nanosciences	6,167	3,180	3,180
Economic aspects	3,782	2,666	2,550
Mathematics, statistics	4,387	2,728	2,471
Other energy topics	3,326	2,335	2,335
Business aspects	4,734	2,567	2,144
Telecommunications	7,650	2,624	2,016
Industrial biotechnology	3,500	2,089	1,721
Geosciences	3,750	1,604	1,604
Robotics	4,140	2,861	1,593
Information, media	2,349	1,535	1,304
Environment	3,353	2,252	1,230
Safety	1,826	1,176	1,176
Agricultural biotechnology	1,397	1,001	975
Network technologies	2,227	1,473	779
Research ethics	10,271	5,134	614
Agriculture	867	520	520
Research on climate change and the carbon cycle	559	440	393
Meteorology	350	210	210
Social aspects	280	206	206
Coordination, cooperation	139	139	139
Water resources and water management	68	60	60
Total result	**977,835**	**486,088**	**361,742**

Table 29: aws: Grants for technology funding, 2013

	Secured funding		Total project values [€ millions]	Funding [€ millions]	
	2013	%	2013	2013	%
PreSeed					
LISA PreSeed	10	1.2	2.2	1.9	5.4
PreSeed ICT & Physical Sciences	13	1.6	2.6	1.8	5.2
Seed financing					
LISA Seed	5	0.6	31.2	3.3	9.4
Seed financing ICT & Physical Sciences	21	2.6	78.3	12.1	34.6
Creative industries					
Creative industries (impulse XL, XS)	54	6.6	7.3	1.2	3.4
Creative industries (impulse LEAD)	4	0.5	1.6	3.0	8.6
Creative industry cheque	613	75.1	6.5	3.0	8.6
Start-up technology voucher	9	1.1	0.0	0.0	0.1
ProTRANS	86	10.5	26.1	8.5	24.3
Time management	1	0.1	0.1	0.1	0.3
Total	816	100.0	155.9	34.9	100.0

Table 30: CDG: CD laboratories by university/research institution and JR Centres by university of applied sciences, 2013

University/research institution	Number of CD laboratories	Budget[1] in €
University for Continuing Education Krems	1	219,333
Medical University of Graz	1	173,680
Medical University of Innsbruck	1	128,273
Medical University of Vienna	9	3,593,954
University of Leoben	6	2,322,375
Graz University of Technology	7	2,473,959
Vienna University of Technology	13	4,065,882
University of Natural Resources and Life Sciences, Vienna	8	3,002,224
University of Graz	2	422,381
University of Innsbruck	1	267,820
University of Linz	10	2,838,033
University of Salzburg	4	914,459
University of Vienna	1	221,050
University of Veterinary Medicine Vienna	3	421,952
Vienna University of Economics and Business	1	63,538
Austrian Academy of Sciences	1	347,197
Research Center for Non Destructive Testing GmbH	1	204,000
Max-Planck-Institut für Eisenforschung GmbH	1	458,000
Munich University of Technology	1	62,000
University of Bochum	1	459,517
University of Göttingen	1	347,000
University of Cambridge	1	348,579
Total	75	23,355,209

University of applied sciences	Number of JR Centres	Budget[1] in €
Fachhochschule Salzburg GmbH	1	135,000
University of Applied Sciences Technikum Wien	1	190,329
Fachhochschule Vorarlberg GmbH	1	26,479
FH OÖ Forschungs und Entwicklungs GmbH	1	261,749
Total	4	613,557

Note: The total amount of CD laboratories is 73; there are two CD laboratories with dual management at different universities.

[1]) Plan data as at 06.12.2013

Table 31: CDG: Development of the CDG from 1989 to 2013 and the JR Centres, 2012 to 2013

Year	Expenditures of the CD laboratories and JR Centres in €	Active CD laboratories	Active JR Centres	Active member companies
1989	247,088	5		
1990	1,274,682	7		
1991	2,150,389	11		
1992	3,362,572	16		
1993	2,789,910	17		
1994	3,101,677	18		
1995	2,991,214	14		
1996	2,503,325	15		6
1997	2,982,793	16		9
1998	3,108,913	17		13
1999	3,869,993	20		15
2000	3,624,963	18		14
2001	4,707,302	20		18
2002	7,295,957	31		40
2003	9,900,590	35		47
2004	10,711,822	37		63
2005	11,878,543	37		66
2006	12,840,466	41		79
2007	14,729,108	48		82
2008	17,911,784	58		99
2009	17,844,202	65		106
2010	19,768,684	61		110
2011	20,580,208	61		108
2012	22,167,259	64	1	114
2013[1)]	23,968,766	73	4	131

[1)] Plan data as at 06.12.2013

Table 32: CDG: CD laboratories according to thematic clusters, 2013

Thematic clusters	Number of CD laboratories and JR Centres	Budget[1] in €
Chemistry	12	4,034,746
Life Sciences and environment	13	4,164,026
Manufacture of machinery and equipment, instruments	4	1,578,021
Mathematics, informatics, electronics	19[2)]	5,830,762
Medicine	12	3,355,047
Metals and alloys	11	3,933,909
Non-metal materials	5 [3)]	1,008,717
Industry-, Social- und Jurisprudence	1	63,538
Total	77	23,968,766

[1]) Plan data as at 06.12.2013

[2]) incl. three JR Centres

[3]) incl. one JR Centre