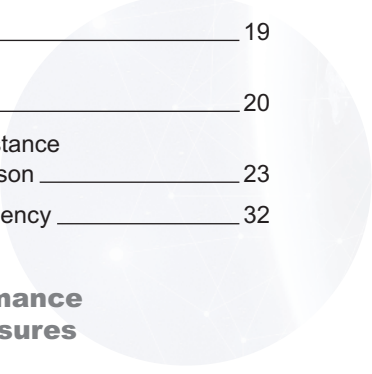


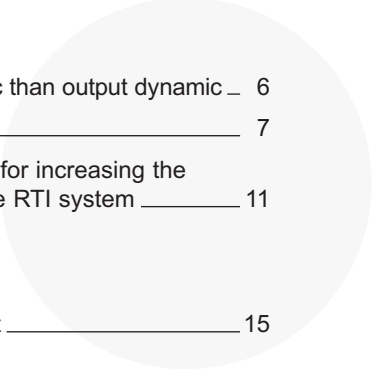
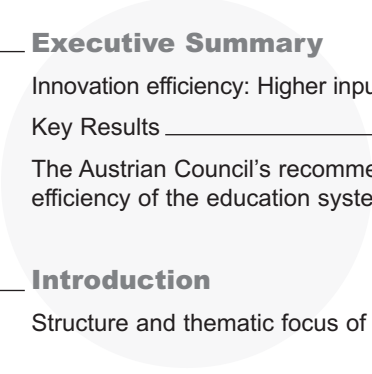







Report on Austria's Scientific  
and Technological Capability  
**2018**



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preamble

With the start of the 25th legislature period and the inauguration of the new Federal Government, rather positive signals can be seen for the research, technology and innovation areas. At the request of the Austrian Council, all parties represented on the National Council have stressed the importance of these key political areas of the future. And the new Federal Government has also set itself quite ambitious goals for its RTI policy.

The 2017–2022 government programme includes a series of important pointers to continue pursuing the goal of making Austria one of the leading innovation nations. The Austrian Council welcomes the overriding strategic objectives of expanding the science location and achieving innovation leadership in Europe, presented in the respective preambles to the “Science” and “Innovation and Digitalisation” chapters of the government programme. The Austrian Council also believes the detailed goals and measure packages anchored in said chapters are extremely positive. The expectation that the actual implementation will be swift and in particular that secure financing will be provided is therefore correspondingly high with both the Austrian Council and in the RTI community.

Consequently the financing of the measures anchored in the government programme is particularly important, because the actual importance that the RTI policy takes on in setting policy priorities is measured on it. The Science and Re-

search chapters of the Federal Government’s estimated budget presented on 21 March 2018 are insofar an expression of this setting of priorities, as in contrast to almost all other policy areas of the RTI area, budget cuts were excluded. According to the Austrian Council’s calculations, the fixed increases in R&D expenditure will nevertheless be insufficient to achieve the funding goals set by the government itself.

The Austrian Council believes the Federal Government’s intention to work out a new research and innovation strategy for Austria within the context of an overall strategy procedure is particularly relevant. The current RTI Strategy from 2011 is now approaching its time limit and has, as the Austrian Council showed in its annual reports on Austria’s scientific and technological capability, scarcely any realistic prospects of achieving the goals by 2020.

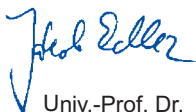
A new strategy and a more coordinated implementation process controlled from the highest political level are therefore key. Primarily important here are all the various types of preparatory work, which are already under way and deliver a detailed analysis of that already achieved and the status quo of Austrian innovation performance. The Austrian Council also sees its Report on Austria’s Scientific and Technological Capability as a building block in this respect. The Austrian Council offers the Federal Government its expertise and active support for the forthcoming preparation of the strategic guidelines and their subsequent implementation.



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## executive summary

Austria has developed rather well in the last two decades with regard to research, technology and innovation (RTI). The performance of the Austrian RTI system is well above the average in the international comparison. Austria occupies a position in the forward midfield in most international rankings. This shows that the efforts to join the innovation leaders and consequently ensure economic development, prosperity, quality of life and environmental protection have certainly had effects and triggered a positive dynamic in a number of areas. On the other hand, however, it is also clear that on the whole the dynamic has not developed sufficiently to catch up with that of the leading countries. Austrian performance has stagnated compared with the leading innovation nations, Denmark, Germany, Finland, the UK, the Netherlands, Sweden and Switzerland in particular. From today's point of view the majority of the RTI Strategy objectives are therefore not achievable by 2020. A series of efficiency barriers in the RTI

system and imbalances in the distribution of funds could primarily play an important role here.

The Austrian research quota, that is, the gross domestic expenditure for R&D relative to the gross domestic product, is actually now one of the highest in the comparison of countries, but output remains clearly below the level of the innovation leaders. An increasing number of analyses therefore confirm the insufficient efficiency of the Austrian research, technology and innovation system.

The Austrian Council has consequently set itself the goal of focusing more on this imbalance. The topic of innovation efficiency correspondingly forms the focus point of this report. Using different methodical approaches, the input-output ratio in the various areas of the RTI system is calculated in comparison with that of the leading innovation nations. This will illustrate how efficient Austria is in converting its available input into scientific, technological and economic output relative to the leading countries.

### **Innovation efficiency: Higher input dynamic than output dynamic**

In its RTI Strategy, the Austrian Government set itself the goal of increasing the research quota by 2020 in order to join the European leaders. This goal and the European target value of an R&D quota of three percent were achieved in 2014. Over the years Austria has therefore continuously worked its way up into the top league in an impressive catch-up process. With a research quota of 3.15 percent for 2016 (the most recent year with EU comparative data),<sup>1</sup> in the EU Austria is in second place behind Sweden, by more than one percentage point higher than the EU 28 average (2 percent), and worldwide

among the five best-placed countries. Only Israel and South Korea with an R&D quota of approximately 4.2 percent, Japan (4 percent) and Sweden (3.3 percent) are ahead of Austria.

By contrast, Austria's position in the most important international rankings for innovation performance, competitiveness, etc., most of the time is at best in the forward midfield, which runs contrary to the lead position in the area of R&D expenditure. If we also consider the development over recent years, on the whole we can see a stagnating or even declining trend.

The European Innovation Scoreboard (EIS), on

<sup>1</sup> According to Statistik Austria's global estimate, the R&D quota in 2018 will rise to 3.19 percent.

which the RTI Strategy and its overriding objective are oriented, illustrates this well. According to the EIS, Austria is currently ranked number 7 in the EU (or 9 when non-EU members such as Switzerland and Iceland are also included), and therefore recently once again took the lead in the “Strong Innovators” group. With its return to the head of the chasing pack, Austria is however at exactly the same position it was ranked at nine years ago when the RTI Strategy was being worked out. In these nine years it has evidently not succeeded in getting closer to the strategic objective and securing places, let alone moving up into the group of leading innovation nations, as planned in the RTI Strat-

## Key Results

### **Austria’s RTI system is not among the most efficient countries in any area**

The statistical efficiency analysis shows that Austria is not among the efficient countries in any area of the RTI system, but nor is it in the bottom third in any area. It was considered here that a trend of declining R&D productivity was observed in many countries, that is, that the marginal return per euro used falls. In detail the results show Austria’s known strengths and weaknesses and those of the comparison countries. In the science area the USA, the UK and Switzerland are the leading countries, whereby they not only achieve high outputs, but rather also use their inputs relatively efficiently for this. Austria only ranks number 17 with this consideration, with the known structure and governance problems in particular contributing to this. In the areas of technology and innovation it is the patent-intensive, strong exporting countries, Japan, Germany and again Switzerland, which take the top places among the leading innovation nations with regard to an efficient conversion of input to output. In the technology area Austria is ranked 13; with innovation 18. There is therefore considerable potential in all three areas to increase efficiency.

If it did succeed in using its inputs in a similarly efficient way to those of the countries de-

egy. The gap to the innovation leaders today, following years of decline or stagnation, is once again at the 2009 level.

To analyse the innovation efficiency in detail, including the possible time delay with which increased inputs have an effect on outputs, the Austrian Council commissioned the Austrian Institute of Economic Research with an evidence-based efficiency analysis. On the basis of a differentiated set of indicators, Austria was compared here with the leading countries to determine the relative efficiency of the respective RTI systems in the areas of science, technology and innovation.

efined as efficient (among the leading innovation nations these are Germany and Switzerland in particular), Austria could increase its outputs (essentially the quantity and quality of scientific publications) with the same inputs by 16 percent. In the technology area Austria could even increase its outputs, that is, quantity and quality of inventions protected by patent law, by 37 percent; in the innovation area (dynamic and export strengths in knowledge-intensive areas) by 17 percent. Austria therefore has room for manoeuvre in all areas, to achieve more output with the given resources. This result does not, however, justify any funding cuts, because on one hand these send negative location signals, and on the other hand Austria still has catch-up requirements with its outputs compared with the leading innovation countries, with scientific publications, patents and knowledge-intensive start-ups, for example.

The analysis also shows that in very general terms Switzerland and Germany in particular, as well as Ireland in science and the Netherlands in technology, can be considered reference countries for Austria. These are the efficient countries that Austria is closest to with regard to its input-output combination, and whose RTI systems are easiest to compare with Austria’s, which makes them realistic benchmarks.

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summary

**Efficiency barriers in the education,  
university, start-up and research area**

The detailed analysis of the individual elements of the RTI system identifies some of the known areas under construction, whose completion could contribute to increasing the efficiency of the Austria science and innovation location.

They are in the education area, in the education sector, especially the universities, and basic research, in the area of start-up activities and in the area of research funding. The Austrian Council has repeatedly pointed out that structural reforms to increase efficiency will be required in all these areas.

Added to this, however, an accentuated reallocation of resources is also required. The universities are under-funded in comparison with those of the leading countries. The funding of basic research, at least that awarded in competition, has stagnated for years at a low level relative to the innovation leaders, and from an international point of view there is still too little funding available for start-up activities. A revision of the appropriate use of funding in the RTI system will therefore be unavoidable.

In the **education** area the problem of education inheritance, the high social selectivity and the insufficient expansion of all-day education in particular are serious efficiency and performance barriers. At the same time considerably poorer performances are yielded with high financial inputs compared with the leading innovation nations. On the whole this contributes to the input-output ratio in the education system having significant improvement potential, which could be exploited with structural reforms.

In the **universities and basic research** area, in addition to the insufficient funding situation relative to the leading countries, problems in the area of governance at the universities and uncontrolled student flows in particular present an obstacle to increased performance. The imbalance connected with student access to universities and technical colleges in particular obstructs improved performance. Added to this, the low awarding of funds in competition compared to the leading countries for basic research is in par-

ticular one of the major efficiency barriers of the Austrian RTI system.

In the area of **innovative start-ups**, above all the adverse bureaucratic, regulatory and taxation framework conditions and the insufficient availability of private financing through risk capital or crowdfunding can be identified as key efficiency barriers. Along with the familiar and serious problems of the Austrian capital market, costs and the times it takes to set up a limited company (GmbH) and its legal structure must in particular be emphasized here. Despite some improvements in recent years, the lack of funding options and insufficient start-up regulations in Austria effectively continue to create detrimental framework conditions for start-ups and the growth of young companies.

An extremely complex system of how federal funding flows from the ministries via the agencies down to the individual research institutes has established itself in the area of **research funding**. It exhibits signs of over-regulation, fragmentation, unclear responsibilities and a complicated, non-harmonised set of rules for individual mechanisms, which together generate high friction losses and obstruct an efficient distribution of resources for research funding. However, due to the restrictive data situation in Austria, there is a lack of information on how to improve the efficiency of the entire research funding system, and in particular also the interaction between mechanisms of sharply increased tax incentives for research funding and direct research funding. A focus on efficiency in the RTI area should, however, always be made while also considering all other federal funding and its efficiency. Of all direct federal funding in Austria, only just over 13 percent flows into the RTI area. This is definitely not in the interests of the frequently requested future orientation of government spending.

A further efficiency barrier can be observed in the context of the **R&D financing** area. Although Austria is in an excellent position worldwide in this respect with one of the highest research quotas, there are obvious imbalances in the distribution of funds, which in the interests of increased efficiency in the entire RTI system,

must be urgently corrected. The private sector share of all R&D financing, despite a notable closing of the gap compared with the leading countries, is still below the level intended by the RTI Strategy, which requires continuous compensation by the public sector. With public sector R&D funds on the other hand, especially with those for universities and basic research, an increasing imbalance between basic funding and funds awarded in competition is evident, and should be revised in the interests of closing the gap with the leading innovation nations.

### **Conclusion**

With an estimated R&D quota in 2018 of 3.19 percent, Austria invests an above average high amount in its RTI system in the international comparison. At the same time, however, this only generates comparably moderate output. These findings apply to most areas of the RTI system. It has obviously not been possible to convert the high R&D expenditures into performance that is appropriate for Austria's advanced science and innovation level. At best we could say that, despite Austria's high input, performance in the areas of science, research, technology and innovation is stagnating compared with the leading countries in Europe. If we compare the high (in particular financial) input with the output or outcome generated from it, it becomes evident that the Austrian RTI system suffers from considerable inefficiencies compared with the leading countries.

Austria does actually achieve top values in economic output, especially with per capita GDP, compared with the leading innovation countries. However this economic performance benefits from special factors, such as the high tourism share (31 percent of service exports in Austria vs. 12 percent in the innovation leaders' average) or the geographic location in the middle of Europe, for example. And the still very pronounced competitiveness of big industrial companies and many SMEs, especially of quite a few globally successful "hidden champions", must also be emphasized in this respect. In view of current global challenges, these existing

strengths alone do not make the country sufficiently future-proof.

The order of the day is therefore to get the Austrian RTI system fit to meet these challenges, as is also specified in the government programme. To do this efficiency barriers must be systematically removed, and available funds must be used more efficiently and effectively than before to then generate increased top performances. How this could work is demonstrated by the leading innovation nations, especially Switzerland and Germany, from whom Austria could learn quite a bit when it comes to innovation efficiency.

A number of measures included in the government programme can contribute to an increase in the input-output ratio. It remains to be seen here, however, if and with what intensity the Federal Government will also actually implement these measures. It also remains to be seen what significance the new RTI Strategy planned by the Federal Government will afford the increase in efficiency of the Austrian RTI system and the boosting of the effectiveness of science and research funding.

For successful governance of the RTI system, finding consensus on the main bottlenecks that could impede Austria's scientific and technological performance and its innovation efficiency is key in any case. On this basis the various players in the RTI system must target common goals, structural changes must be made and the available resources must be consistently reallocated where required. To achieve these goals, the annual RTI summit of the Federal Government anchored in the government programme should be used to initiate an active and comprehensive RTI policy reform process to decisively drive forward the implementation of the new RTI Strategy.

Austria has, according to the results of the analyses for this report, rather high potential in all examined areas of the RTI system to increase its efficiency and, similar to the leading countries, improve its input-output ratio. Austria usually ranks in the midfield of the comparison countries, so efficiency is therefore not very low. For a country that operates close to the scientific,

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technological and innovation frontier, however, the Austrian Council believes this is not sufficient. The Austrian Council believes in any case that the following areas under construction of the Austrian RTI system must be priori-

tised in order to increase innovation efficiency. Otherwise the obvious efficiency barriers threaten to continue impeding the country's success, whereby Austria runs the risk of stagnating in the midfield in the future, or even falling further back.

## The Austrian Council's recommendations for increasing the efficiency of the education system and the RTI system

The recommendations that the Austrian Council believes are the most important to increase the efficiency of the education system and the RTI system are summarized in the following. For details and more specific measure proposals see the recommendations in the respective chapters of the report, the underlying individual recommendations and the comprehensive "Recommendation on the way to the forefront of innovation".<sup>2</sup>

### Education System

To increase the efficiency of the education system, the Austrian Council recommends the problem of education inheritance and (across the board) excessive social selectivity be prioritised. In this respect the Austrian Council once again recommends a commitment to comprehensive schools for 10 to 14-year-olds and the expansion of all-day schools.

Specific measures must be defined here to further raise the achieved performance level across the board. In this context the Austrian Council welcomes the commitment included in the government programme to quality primary school teaching, but also recommends a significant increase in the number of qualified teachers, and multi-lingual teachers in particular. Instead of a scattergun approach, the Austrian Council recommends better financial and human resources (keyword: support staff) for those schools that are confronted with special challenges, especially with regard to the socio-economic structure of their students (so-called "hotspot schools").

### Universities and basic research

To increase the efficiency of the university area, the Austrian Council recommends the swift and consistent implementation of the measures anchored in the government programme for the structural further development of the higher education area and to improve the governance

structures of the universities, the study conditions and the control of student flows. In addition to the structural reforms planned by the government, it also recommends an increase in the university expenditure rate to two percent of GDP, to be able to finance the required upgrades. This also requires an increase in the private sector financing share. To remove one of the major efficiency barriers of the RTI system, the Austrian Council urgently recommends the continued increase in the funds awarded in competition for funding basic research to the level of the leading countries.

### Innovative start-ups

To increase innovation efficiency the Austrian Council recommends the administrative and financial hurdles for start-ups be specifically removed. To do this all the adverse bureaucratic, regulatory and taxation framework conditions must primarily be improved, in particular to make it easier for innovative start-ups with regard to expenses, costs and set-up time. The familiar problem of the insufficient availability of private financing through risk capital or crowd-funding must also be addressed. In addition to funding by banks, the Austrian Council also recommends developing funding options for innovative young entrepreneurs and SMEs. A suitable framework is required to increase equity capital intensity from the private side, such as appropriate legislative and taxation framework conditions for private equity, an improvement in the quality of the Austrian capital market and assessment stipulations of pension and insurance funds, for example.

### R&D financing and research funding

With respect to the coming funding period of the EU, and wherever else applicable, the Austrian Council recommends the domestic re-

2 Austrian Council (2017): Recommendation on the way to the forefront of innovation of 30 November 2017.

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## executive summary

search funding offers be adjusted so that on one hand a complementary offer for the European framework programmes is made, and on the other hand the funding logic is also harmonised and simplified. The Austrian Council generally recommends that excessive administration and piecemeal and unclear funding offers be avoided in research funding. An increase in the efficiency of research funding should be afforded greater attention in the future than it has been to date. Existing structures must be critically scrutinised here and incentive effects must be increased with specific funding. The Austrian Council welcomes the research funding act anchored in the government programme, which will secure the medium to long-term stability of RTI funding in Austria. In this context the Austrian Council recommends a revision of the appropriate use of funding in the Austrian RTI system, to correct existing imbalances in funding distribution. In the universities

and basic research area the ratio between core financed and public sector funds awarded in competition must in particular shift in favour of the competitive share. To increase innovation efficiency the Austrian Council also recommends concentrating public sector funding and mechanisms on increasing the private sector financing share of corporate research spending, which is still too low compared with the leading countries. Better data access could enable meaningful analyses on the effect of the overall system and on the interaction of sharply increased tax-based and direct funding in particular. As only 13.4 percent of all direct federal funding in Austria flows into R&D, the Austrian Council also recommends a revision of the budgetary prioritisation in the international comparison as well. The goal should be to make state spending considerably more future-oriented. Special focus on increasing the funding awarded in competition, especially for basic research, is also required here.





## introduction

Austria has developed rather well in the last two decades with regard to research, technology and innovation (RTI). Today it is a research-intensive country, well positioned in the international comparison with regard to science and research funding. Following the crisis years, which also left their mark on research, positive signals and significant advances are now clearly visible. With a research quota of 3.15 percent in 2016 (most recent year with EU comparative data), Austria is now second in the EU after Sweden. According to Statistik Austria's global estimate, overall spending for R&D in 2018 will increase to well over EUR 12 billion and therefore reach a new record level. The public sector funded research in Austria in 2017 with approximately EUR 4.2 billion. This is a peak value in proportion to the number of inhabitants, and pro rata relative to the gross domestic product it is even one of the highest in the world.<sup>3</sup>

Added to these impressive actual values in the financing area are positive announcements from the political arena, as, at the request of the Austrian Council, all parties represented on the National Council submitted positive declarations of intent with the National Council vote of 15 October 2017 with regard to the funding of science, research and innovation. There is broad cross-party consensus on the strengthening of the RTI location Austria, deemed to be necessary.<sup>4</sup> The current 2017–2022 government programme also includes a series of important measures, with which the goal of making Austria an innovation leader continues to be pursued.<sup>5</sup>

This welcome news is, however, faced with some

development barriers, which put the nascent success in some doubt. Because even without the radical upheavals and changes of the world at the beginning of the 21st century penetrating Austria from without, there is still a whole range of home-made problems that impede progress in the country, block its innovation dynamic, and further reduce competitiveness year by year. While leading innovation nations such as Denmark, Germany, Sweden and Switzerland in particular continue to expand their position in international rankings, Austria continuously falls back or stagnates, with the odd exception. This of course also affects science and research. It is these future areas in particular that, in addition to a solid and modern education foundation that meets the requirements of the age, decide in our world as it is today on success or failure in meeting future challenges. Because there is nothing to be gained from recourse to supposed solutions of the past – creativity, unconventional approaches, new ideas and innovations, both technological and social, are what are really needed.

These stagnating or negative trend developments in international rankings are astonishing insofar as the starting position is anything but bad. If, in fact, we compare the relatively high financial input with the output or outcome generated from it – which is moderate in comparison with the leading innovation nations –, it quickly becomes clear that inefficiencies block the performance of the Austrian RTI system. Obviously there has only been an insufficient conversion in Austria of the high input into corresponding scientific and technological output or into marketable innovations and business success result-

<sup>3</sup> For this, see also Bundesregierung (2017): Österreichischer Forschungs- und Technologiebericht 2017. Vienna, p. 15.

<sup>4</sup> Austrian Council (2017): 7 Questions to politicians; online at: <http://www.rat-fte.at/news-reader/items/id-7-fragen-an-die-politik.html>

<sup>5</sup> Bundesregierung (2017): Zusammen. Für unser Österreich. Regierungsprogramm 2017–2022. Vienna, pp. 68 ff. and pp. 75 ff.

ing from them. The question therefore is: Why it is not possible in one of the richest countries of the world to increase its capability accordingly and converge its performance in the areas of science, research and innovation with that of the global leading countries? Evidently it is inefficient structures and the friction losses they

cause that thwart Austria in general and in the important future areas in particular. Above all the lacking efficiency of the Austrian research, technology and innovation system threatens to become a success inhibitor.<sup>6</sup>

## introduction

### Structure and thematic focus of the report

This Report on Austria's Scientific and Technological Capability 2018 primarily focuses on the discrepancy between innovation input and output and analyses the efficiency of Austrian innovation activities compared with the leading countries in detail. Innovation efficiency can be calculated as part of a statistical efficiency analysis, by comparing key input indicators with the relevant output or outcome indicators. The basis for this is provided by an appropriate study by the Austrian Institute of Economic Research, as commissioned by the Austrian Council.<sup>7</sup> The key results of the study are summarized in the "Analysis of the Efficiency of the Austrian RTI System" chapter.

An overview of Austria's performance with regard to the goals and measures of the RTI Strategy is presented in the subsequent chapter. The important developments in the areas of, "RTI Strategy priority objectives", "Education system (without tertiary area)", "Tertiary education system", "Research at universities and non-university research institutions", "Research and innovation in the corporate sector", "RTI governance" and "Financing of the RTI system" are roughly outlined here and a summative evalua-

tion of the performance of the Austrian RTI system in relation to the leading innovation nations is provided. After this, the prospects of achieving the goals of the RTI Strategy are evaluated. Finally the report also includes the Austrian Council's Global Innovation Monitor, which compares Austria's innovation performance with that of the leading countries outside of the EU on the basis of selected key performance indicators.

It should be noted that the group of innovation leaders is composed slightly differently with the European Innovation Scoreboard (EIS) 2017. The UK recently also joined the existing innovation leaders, Denmark, Germany, Finland, the Netherlands and Sweden. For the Report on Austria's Scientific and Technological Capability 2018, all data points of the UK were therefore also incorporated into the calculation for all indicators since 2010. Compared with previous years, this produces a rather different view of the details in some areas. The effects on the overall result must, however, be ignored and therefore are not specifically emphasised. It should also be noted that, in the context of innovation efficiency in particular, Switzerland has been increasing-

6 For this, see also Tichy, G. (2017): Mangelnde Effizienz als Erfolgsbremse. In: WIFO-Monatsberichte, 2017, 90(9), pp. 677–699, pp. 685 ff., pp. 688 ff.

7 Janger, J. / Kügler, A. (2018): Innovationseffizienz, Österreich im internationalen Vergleich. Study commissioned by the Austrian Council. WIFO, Vienna.



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ly used for the comparison as global innovation leader.

This report follows the same methodology as previous reports. Details can be found in the appendix and on the Austrian Council's website under the menu item "Performance Reports".<sup>8</sup> Besides in-

formation about the report and a range of download options, the site also offers an interactive depiction of the indicator sets, which makes it possible to retrieve detailed information about the status quo and recent developments and relevant trends in individual areas interactively.

<sup>8</sup> <http://www.rat-fte.at/leistungsberichte.html>





**efficiency analysis**

The Report on Austria's Scientific and Technological Capability 2017 established an imbalance in the domestic research, technology and innovation system, which generates a comparably moderate output with an above average high innovation input.<sup>9</sup> The Austrian Council has therefore set itself the goal of focusing more on this imbalance in its work programme. The topic logically also forms the focus point of this report.

The innovation efficiency of the Austria science and innovation location is analysed in detail in this chapter. The input-output ratio in the various areas of the RTI system is calculated in comparison with that of the leading innovation nations. This will illustrate how efficient Austria is in converting the available input into scientific, technological and economic output. Firstly there is a basic review of the status quo. This is then followed by a statistical efficiency analysis.

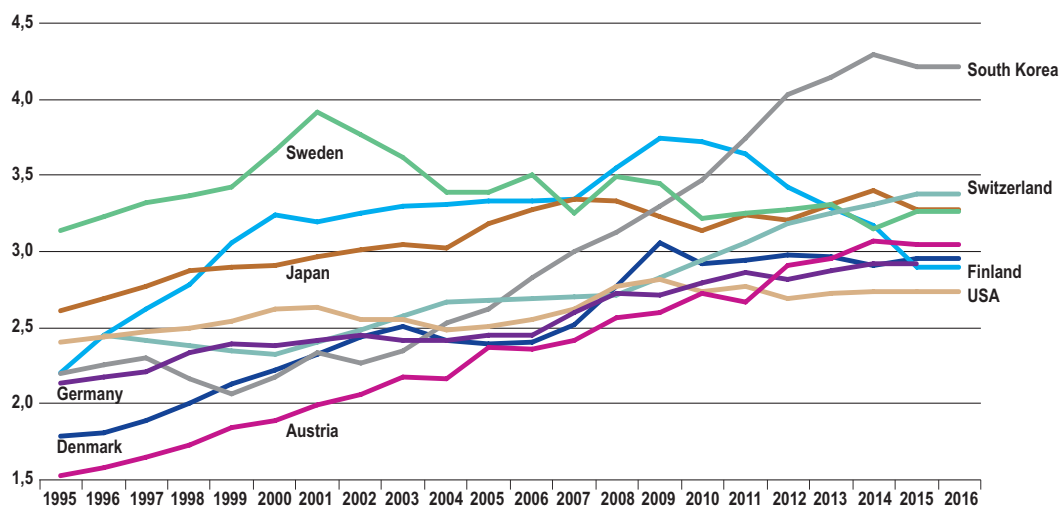
<sup>9</sup> See Austrian Council (2017): Report on Austria's Scientific and Technological Capability 2017. Vienna, pp. 39 ff.

### RTI funding: Spending at record level

In advanced economies such as Austria's, innovation activities form an important basis for economic, social and ecological developments. They are the most important element of corporate strategies, both to safeguard competitiveness against emerging economies with wage cost advantages and for the development of further growth prospects.<sup>10</sup> Equally, they are also key levers in meeting major social challenges, such

as climate change, resource scarcity or increasing population ageing.<sup>11</sup> With the adoption of the Research, Technology and Innovation Strategy (RTI Strategy), Austria set itself the goal in 2011 of joining the group of leading innovation countries in the EU.<sup>12</sup> This goal is to be achieved, among other things, with an increase in research and development spending to

Figure 1: R&D quotas of selected countries, 1995 to 2016



Source: OECD MSTI, WIFO calculations; missing values have been given average values or the average annual growth rate.

10 See, inter alia, Austrian Council (2015): Designing the Future: Economic, Societal and Political Dimensions of Innovation. Ecomedia Verlag, Vienna; Aghion, P. / Howitt, P. (2006): Joseph Schumpeter Lecture Appropriate Growth Policy: A Unifying Framework. In: Journal of the European Economic Association, 4(2-3), pp. 269-314; Hölzl, W. / Friesenbichler, K. S. / Kügler, A. / Peneder, M. / Reinstaller, A. (2017): Österreich 2025 – Wettbewerbsfähigkeit, Standortfaktoren, Markt- und Produktstrategien österreichischer Unternehmen und die Positionierung in der internationalen Wertschöpfungskette. In: WIFO-Monatsberichte 2017, 90(3), pp. 219-228.

11 See Aghion, P. / Hemous, D. / Veugelers, R. (2009): No green growth without innovation. In: Bruegel Policy Briefs, Issue 2009/7; Aiginger, K. (2016): New dynamics for Europe: Reaping the benefits of socio-ecological transition. WWWforEurope Synthesis Report. Vienna/Brussels.

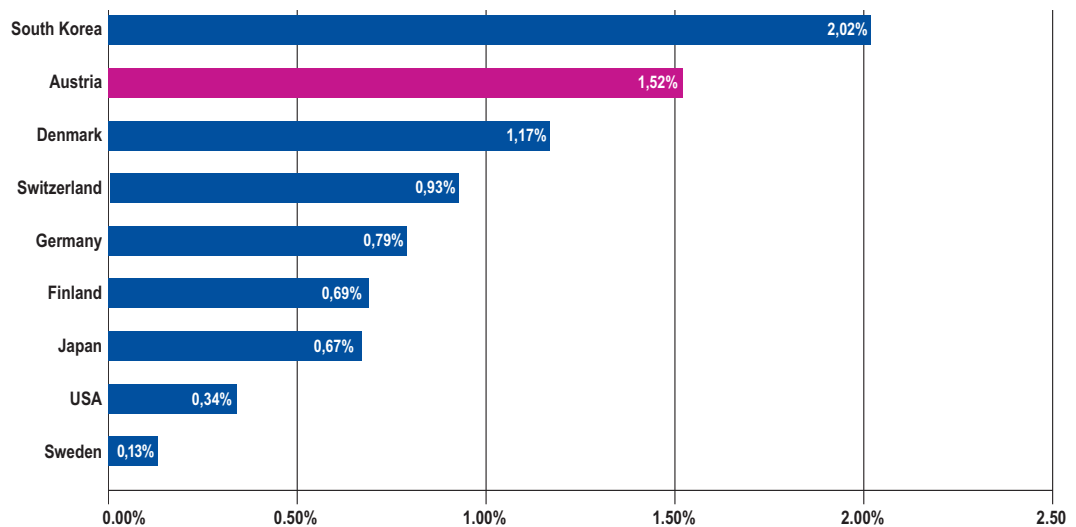
12 See Bundesregierung (2011): Auf dem Weg zum Innovation Leader – Strategie für Forschung, Technologie und Innovation. Vienna.

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a quota of 3.76 percent in 2020. R&D expenditures is one of the most important resources or inputs for innovation activities. Austria has increased its R&D quota from 1.4 percent in 1995 to 3.15 percent in 2016<sup>13</sup> (see figure 1). Statistik Austria's global estimate forecasts a further increase to 3.19 percent for 2018. Austria has consequently attained 2nd place

in the EU behind Sweden and 5th place worldwide (after Sweden, Japan, Switzerland and South Korea). From 1995 to 2015 only South Korea had a higher spending dynamic than Austria (see figure 2). According to Statistik Austria, the total spending for R&D also recently reached a new record level with well over EUR 12 billion.

Figure 2: R&D quota change in percentage points, 1995 to 2016



Source: OECD MSTI, WIFO calculations; missing values have been given average values or the average annual growth rate; for Switzerland the change was calculated from 1996 to 2015.

### Austria in international rankings: Stagnation to downward trend

R&D expenditures is, however, only one of the requirements for successful innovation activities. A country's innovation performance is generally also measured on the results of innovation activities, that is, on the outputs that are generated with the invested resources. Innovation performances are measured, for example, with the publications of scientific results, the protection

of inventions with patents, the growth dynamic of innovation-intensive young companies, the general structural change towards knowledge-intensive segments or the revenue share that companies achieve with innovations.

The apparent discrepancy between increasing spending for R&D and innovation performances increasing at a disproportionate rate has been

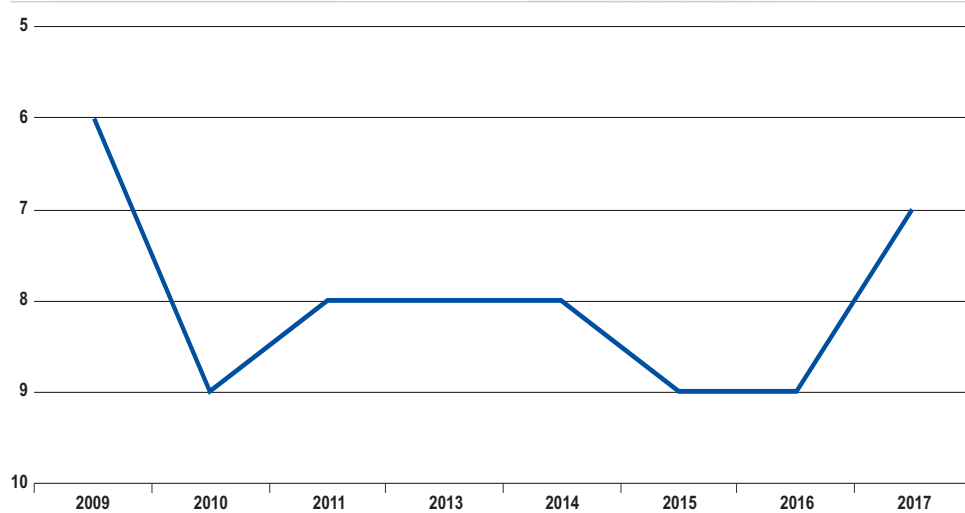
<sup>13</sup> 2016 is the most recent available year for which EU comparative data is available.

discussed in Austria for some years now. The Austrian Council has also addressed this topic in its previous reports on Austria's scientific and technological capability.<sup>14</sup> These findings are corroborated by the most diverse analyses and Austria's positions in international rankings, in particular the European Innovation Scoreboard (EIS), on which the RTI Strategy and its overriding objective<sup>15</sup> are oriented.

The EIS uses 27 input and output indicators to measure countries' innovation performance.<sup>16</sup> The overall ranking is formed with a simple average of these 27 indicators and produces a sideways movement for Austria since 2009. Following the previous best ranking at number 6 in 2009 at the top of the chasing pack, Austria is now ranked 7 and once again

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**Figure 3: Austria's position in the European Innovation Scoreboard (EIS), 2009–2017**



Source: European Innovation Scoreboard, 2009–2017. The EIS was changed in 2013 from EIS (t-1) to EIS (t), which means 2012 (=2013) is omitted.

<sup>14</sup> See, inter alia, Austrian Council (2015): Report on Austria's Scientific and Technological Capability 2015. Vienna, pp. 23 ff.; idem (2017): Report on Austria's Scientific and Technological Capability 2017. Vienna, pp. 34 ff.

<sup>15</sup> Bundesregierung (2011): Auf dem Weg zum Innovation Leader – Strategie für Forschung, Technologie und Innovation. Vienna, p. 4. The Austrian Council has repeatedly criticised the fact that the EIS at least partially gives a distorted view of Austria's innovation performance. In its reports on Austria's scientific and technological performance, the Austrian Council therefore assesses on the basis of a wider and more appropriate set of indicators. However, due to the importance of the EIS for the RTI Strategy and evaluating the achievement of the overriding goal of "Innovation Leader", the positioning in the EIS remains the frame of reference. See, inter alia, the statements in: Austrian Council for Research and Technology Development (2014): Report on Austria's Scientific and Technological Capability 2014. Vienna, pp. 15 ff. It should be noted that the indicators of the EIS have been changed several times since 2009, which is why the positioning can only be compared with caution.

<sup>16</sup> [http://ec.europa.eu/growth/industry/innovation/facts-figures/scoreboards\\_de](http://ec.europa.eu/growth/industry/innovation/facts-figures/scoreboards_de)

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at the head of the “strong innovators”. With its return to the top of the chasing pack Austria is, however, now at exactly the same position it was at when the RTI Strategy was being worked out (see figure 3).<sup>17</sup>

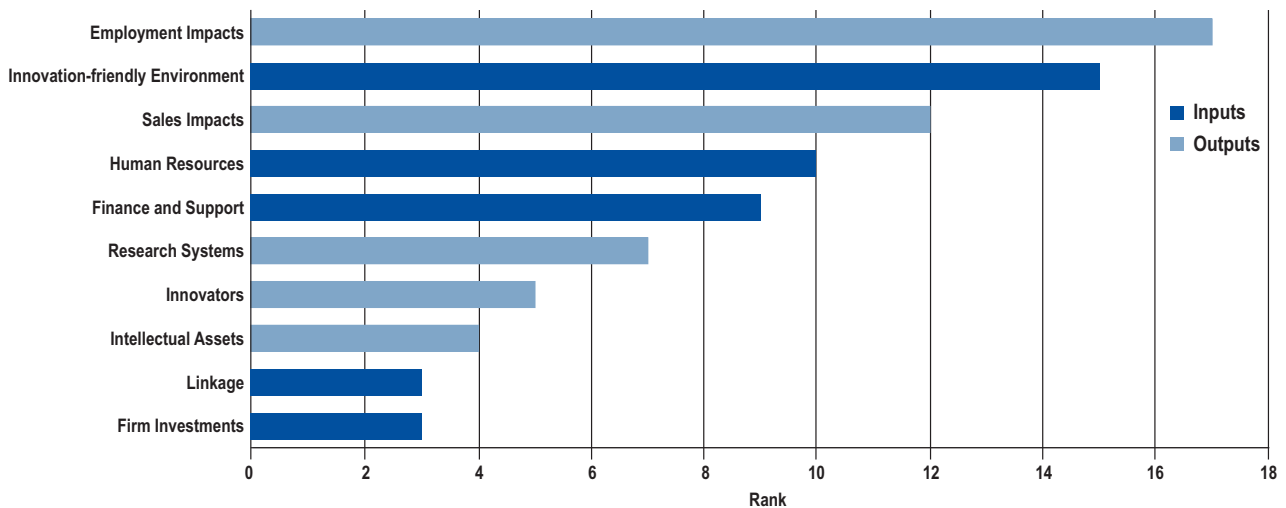
The development of the overall performance covers the performance in the 10 sub-performance areas (see figure 4), of which 5 inputs each (dark blue bars) and 5 outputs each (bright blue bars) must be allocated. This shows that Austria scores relatively well with some input categories; within the “Firm Investments” group Austria is at the top of the EU countries, with “R&D Expenditure in the Business Sector” for example, even ahead of Switzerland. Austria also scores well with the publications output category (“Research Systems”), and inventions, brands and models in particular (“Intellectual Assets”). There is a particularly high deficit, however, with the two groups that measure per-

formance with the conversion of innovation into economic effects (“Employment Impacts” and “Economic Effects”), and with “Human Resources” (in the tertiary education area, among others) and the framework conditions for innovation (“Innovation-friendly Environment”).

The EIS is only one prominent example among many here. If we consider the most important international rankings for innovation performance, competitiveness, etc. over the course of recent years, we can see a generally negative trend (see figure 5). Even if individual rankings, such as the Global Competitiveness Report 2017–2018 of the World Economic Forum or the EIS 2017, now show an upward trend, on the whole the trend is indeed going clearly downward.

These findings are confirmed in the annual Monitoring Report of the Economic Chamber, which summarizes Austria’s performance in

**Figure 4: Austria’s position in partial performance areas of the EIS, 2017**



Source: European Innovation Scoreboard 2017.

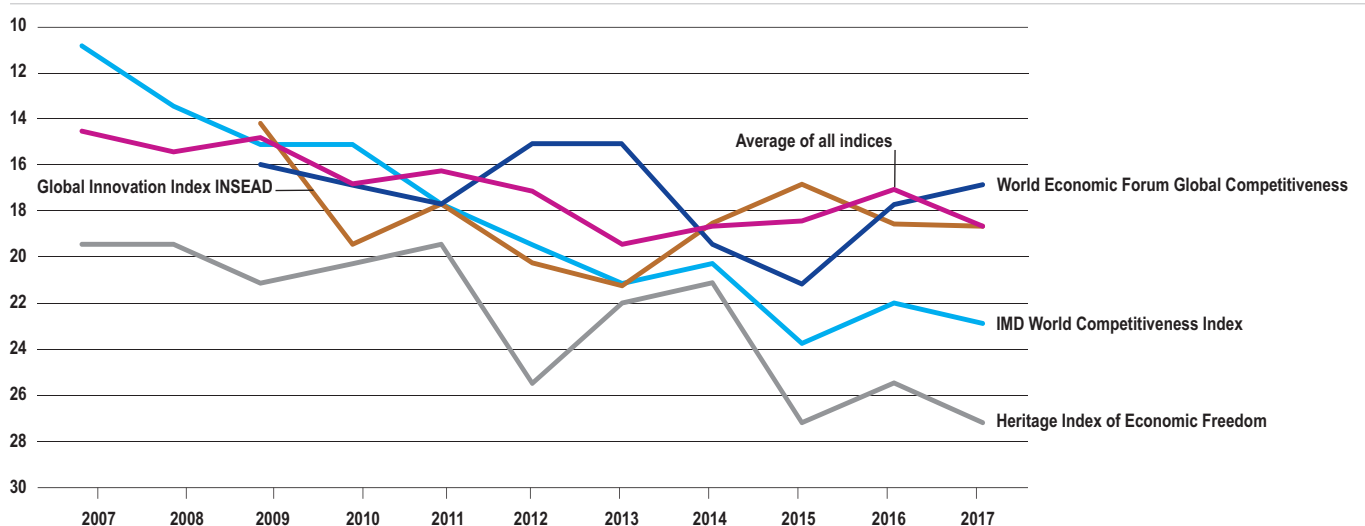
<sup>17</sup> See, inter alia, Austrian Council (2017): Empfehlung für den Weg zur Innovationsspitze. Vienna, p. 4 f.

more than 150 international rankings. Across and beyond all analyses and indicators it shows a clearly negative trend in recent years.<sup>18</sup> Regardless of the respective survey methods and indicators used, on the whole these rankings only show, "... average, for a high-income country

with low rankings and deterioration in many places.<sup>19</sup> The lead places on the other hand are mostly occupied by the innovation leaders, which are also chosen as reference countries for this report.

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**Figure 5: Austria's positioning in selected international rankings**



Source: IMD, World Competitiveness Yearbook 2017; Heritage Foundation, Index of Economic Freedom 2017; INSEAD, Global Innovation Index 2017; WEF, Global Competitiveness Report 2017–2018; own graphic.

### Statistical efficiency analysis: Austria's distance to the frontier in the international comparison

Against this backdrop the Austrian Council commissioned the Austrian Institute of Economic Research (WIFO) to perform a detailed analysis of Austria's innovation efficiency in the international comparison.<sup>20</sup> On the basis of a specific set of indicators, WIFO performed a

statistical efficiency analysis and a "Data Envelopment Analysis (DEA)" for this, which was used to determine Austria's relative efficiency compared with the leading countries. The 22 indicators used for the analysis, which are also specially harmonized with the specifications of

18 Wirtschaftskammer Österreich (2018): Monitoring Report 2018 – Austria in International Rankings. Vienna. The

"Monitoring Report Index" used herein illustrates this declining development, ongoing for some years now. While the Austrian index value in 2005 was still more than 77 percent, today it is only barely 65 percent.

19 Tichy, G. (2017): Mangelnde Effizienz als Erfolgsbremse. In: WIFO-Monatsberichte, 2017, 90(9), pp. 677–699, pp. 690.

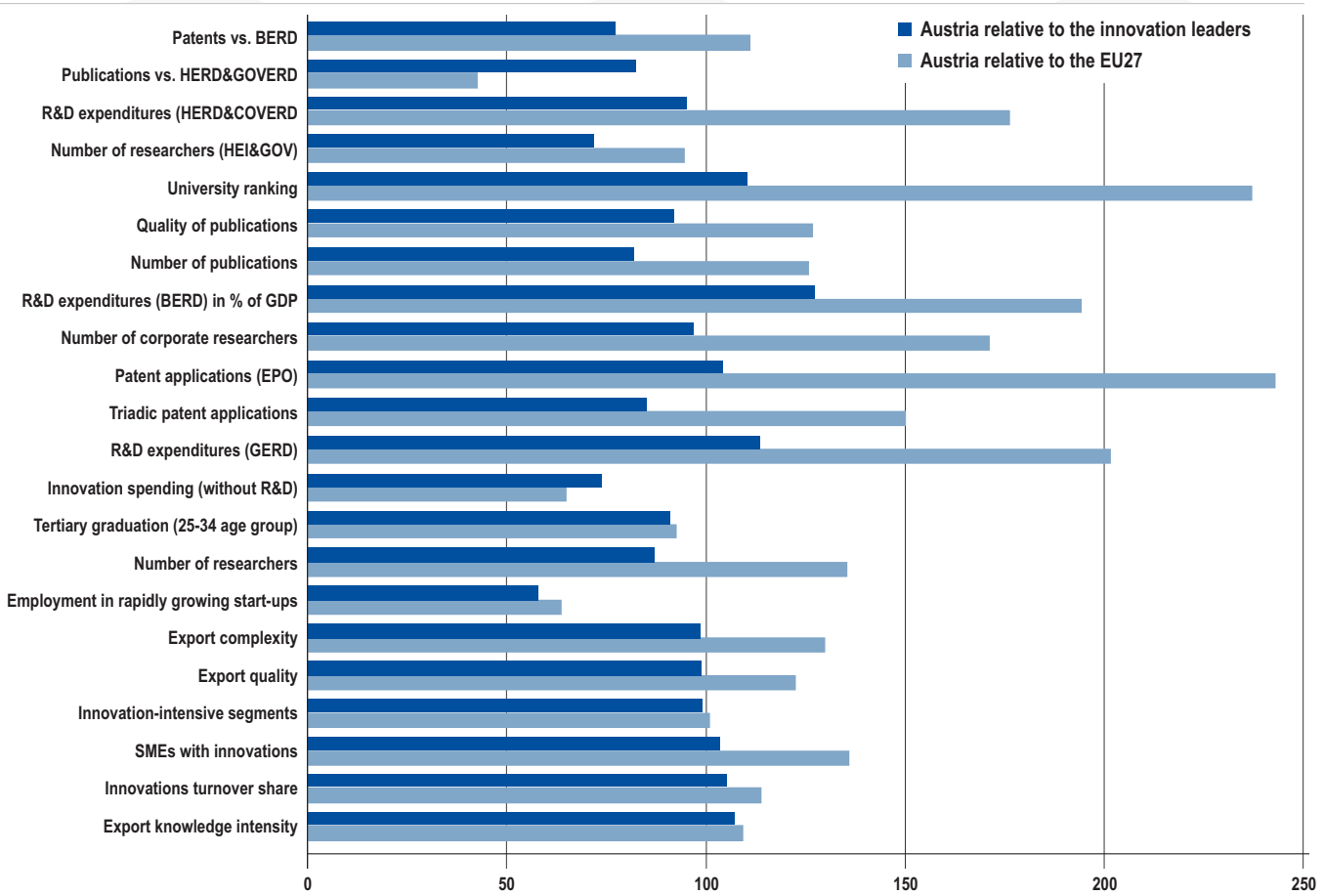
20 Janger, J. / Kügler, A. (2018): Innovationseffizienz, Österreich im internationalen Vergleich. Study commissioned by the Austrian Council. WIFO, Vienna.

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the Austrian RTI system, are provided in Appendix 4. The name, “Data Envelopment Analysis”, comes from the fact that the most efficient units form the “Efficiency Frontier”, which encompasses or envelopes all other units (“Data Enve-

lope”). The efficiency of the remaining units is determined by the distance to this frontier.<sup>21</sup> For the analysis of innovation efficiency, the DEA is applied to Austria’s distance to 1) the *scientific frontier*, 2) the *technological frontier*, and 3) the *innovation frontier* – that is, to the highest

Figure 6: Austria’s position relative to the EU27 and the innovation leaders in input and output indicators



Source: Eurostat, European Innovation Scoreboard, OECD, Patstat, Weltbank, Scimago, CWTS Leiden, WIFO calculations.

The figure shows Austria relative to the innovation leaders and the EU27 in the indicators for the efficiency analysis.

A value below/above 100 means that Austria is below/above the level of the comparison unit.

21 Methodological details can be found in Janger, J. / Kügler, A. (2018): Innovationseffizienz, Österreich im internationalen Vergleich. Study commissioned by the Austrian Council. WIFO, Vienna, pp. 9 ff.

performance level of the leading countries, Germany, Denmark, Finland, the UK, the Netherlands, Sweden and Switzerland. The three areas are defined briefly in the following.<sup>22</sup>

1. The **scientific frontier** refers to the highest distinct capability of countries to contribute to growth in scientific knowledge. It is measured on the quantity and quality of publications relative to the population size.
2. The **technological frontier** refers to the production of technological knowledge and the technical properties of new products or processes. It is measured on the quantity and quality of patents.
3. The **innovation frontier** refers to the ability to transform knowledge and technology into economic successes and is measured on two dimensions: i) structural change, that is, the development of the proportion of the value creation of knowledge-intensive sectors of the overall economic performance, and ii) upgrading, that is, a country's shift on the quality ladder of a sector, or successful penetration into knowledge-intensive areas within a sector.

This performance concept takes Austria's specific economic structure into account by differing between structural change in the direction of knowledge-intensive sectors and upgrading in all sectors. Standardised innovation comparisons, such as the EIS, generally only measure innovation effects on the basis of the structural change component, in which Austria traditionally scores badly. Austria does, however, achieve innovation success in sectors with medium to medium-high knowledge intensity, which are often underestimated.<sup>23</sup>

For every indicator value-scaled (relative to the population, for example), table 1 shows Austria's last available value, the average value of the lead-

ing innovation countries of the EU and the average value of the EU27, followed by the growth for all three units and finally Austria's value relative to the innovation leaders and relative to the EU27. The following applies for the last two values (the two far right columns in the table): Values below 100 mean that Austria is below the level of the comparison unit.

In the scientific frontier area Austria is clearly below the level of the innovation leaders and just below the level of the EU27 with the "number of researchers at universities". With spending it is just below the level of the leading innovation nations and significantly above the level of the EU27. With the outputs the international rankings confirm the familiar situation of a level above the EU average, however below the average of the innovation leaders, with the exception of the university ranking.

In the technological frontier area Austria is significantly above the level of the innovation leaders and even more significantly above the level of the EU27 with corporate spending for R&D. With the number of corporate researchers Austria is just below the level of the innovation leaders, but significantly above the average of the EU27. In terms of technological outputs, Austria is clearly above the EU27 average. With EPO patent applications it is also slightly above the leading innovation nations, but with triadic patents it is below.

In the innovation frontier area all input indicators with the exception of R&D expenditures are below the level of the innovation leaders, and in places also below the level of the EU27. With the output indicators there is a level just above (3 indicators) or below (4 indicators) the innovation leaders, with the exception of employ-

efficiency analysis

22 This concept for impact assessment in the areas of science, technology and innovation is based on Janger, J. / Kügler, A. / Reinstaller, A. / Unterlass, F. (2017): Die „Frontier“ in Wissenschaft, Technologie und Innovation: Messung und Bestimmungsfaktoren. In: WIFO-Monatsberichte 2017, 90(2), pp. 141–151.

23 See Janger, J. / Schubert, T. / Andries, P. / Rammer, C. / Hoskens, M. (2017): The EU 2020 innovation indicator: A step forward in measuring innovation outputs and outcomes? In: Research Policy, 46(1), pp. 30–42.

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ment in rapidly growing companies (“Employment in rapidly growing start-ups” indicator), where Austria shows strong above average values against even the EU27. Otherwise Austria is in places significantly above the EU27 average with all output indicators.

Austria’s performance and efficiency can be illustrated quite well with the two partial R&D productivity indicators, “Publications” and “Patents”. Relative to R&D expenditures we can see a significantly poorer ratio in both areas than with the innovation leaders. This means, per euro invested in R&D, fewer patents and pub-

**Table 1: Austria’s innovation efficiency in the international comparison**

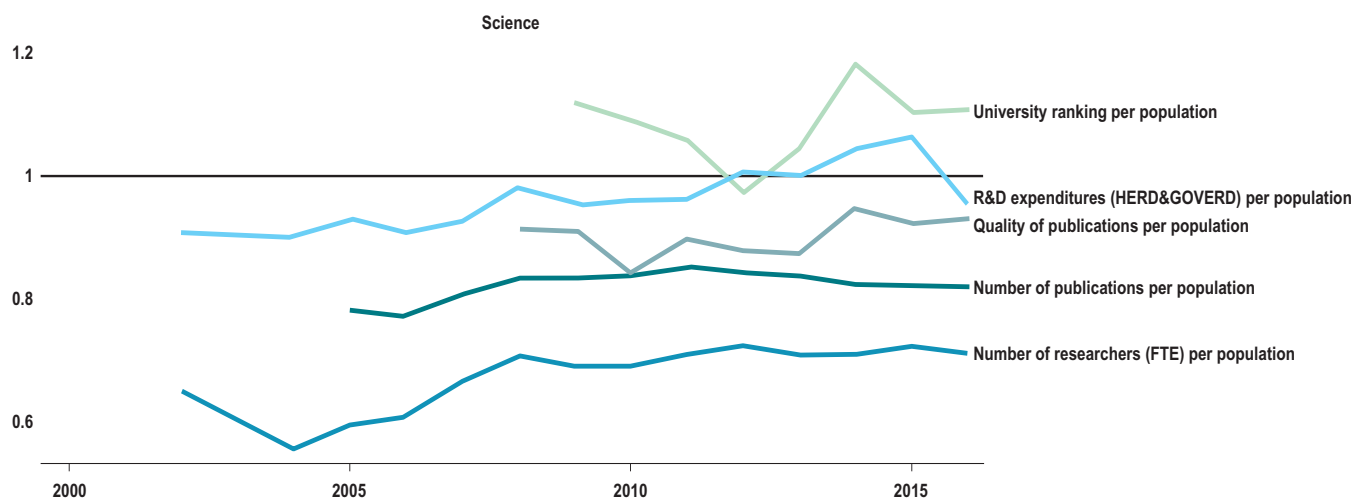
| Area name                  | Indicator  | Austria value | IL average value | EU27 average value | Austrian growth in % p. a. | IL growth in % p. a. | AT IL  | AT EU27 |
|----------------------------|--|---------------|------------------|--------------------|----------------------------|----------------------|--------|---------|
| Science – Input            | Number of researchers (HEI&GOV) per 1,000 inhabitants            | 1.75          | 2.42             | 1.85               | 4.50%                      | 1.40%                | 72.22  | 94.44   |
| Science – Input            | R&D expenditures (HERD&GOVERD) per 1,000 inhabitants             | 0.37          | 0.39             | 0.21               | 4.09%                      | 3.64%                | 95.46  | 176.10  |
| Science – Output           | University ranking per 10 million inhabitants                    | 31.27         | 28.26            | 13.20              | 0.06%                      | -0.42%               | 110.65 | 237.01  |
| Science – Output           | Number of publications per 1,000 inhabitants                     | 2.47          | 3.02             | 1.96               | 3.97%                      | 3.40%                | 81.94  | 126.08  |
| Science – Output           | Quality of publications  | 11.70         | 12.70            | 9.21               | 0.75%                      | 0.63%                | 92.13  | 127.10  |
|                            |  |               |                  |                    | 0.00%                      | 0.00%                |        |         |
| Technology – Input         | R&D expenditures (BERD) in % of GDP                              | 2.18          | 1.71             | 1.12               | 2.86%                      | -0.76%               | 127.36 | 194.31  |
| Technology – Input         | Number of corporate researchers per 1,000 inhabitants            | 3.29          | 3.39             | 1.92               | 3.69%                      | 2.75%                | 96.87  | 171.27  |
| Technology – Output        | Patent applications (EPO) per 1,000 inhabitants                  | 0.19          | 0.18             | 0.08               | 1.85%                      | -1.41%               | 104.51 | 242.99  |
| Technology – Output        | Triadic patent applications per 1,000 inhabitants                | 0.02          | 0.03             | 0.01               | -4.09%                     | -7.20%               | 85.17  | 150.31  |
|                            |  |               |                  |                    | 0.00%                      | 0.00%                |        |         |
| Innovation – Input         | R&D expenditures (GERD) per 1,000 inhabitants                    | 1.31          | 1.15             | 0.65               | 5.55%                      | 3.05%                | 113.84 | 201.65  |
| Innovation – Input         | Innovation spending (without R&D) in % of turnover               | 0.47          | 0.64             | 0.73               | 0.10%                      | 0.35%                | 74.10  | 65.11   |
| Innovation – Input         | Number of researchers per 1,000 inhabitants                      | 5.14          | 5.88             | 3.79               | 3.95%                      | 2.48%                | 87.43  | 135.65  |
| Innovation – Input         | Tertiary graduation (25-34 age group) in % of the age group      | 39.67         | 43.66            | 42.79              | 2.22%                      | 2.41%                | 90.86  | 92.72   |
| Innovation – Output        | SMEs with innovations in % of all SMEs                           | 40.71         | 39.37            | 29.88              | -2.28%                     | 0.60%                | 103.41 | 136.24  |
| Innovation – Output        | Innovation-intensive segments                                    | 0.32          | 0.33             | 0.33               | -0.76%                     | -0.30%               | 99.43  | 98.65   |
| Innovation – Output        | Employment in rapidly growing start-ups in % of total employment | 2.90          | 5.01             | 4.56               | 0.05%                      | -1.97%               | 57.86  | 63.62   |
| Innovation – Output        | Innovations turnover share in % of turnover                      | 11.98         | 11.35            | 10.51              | -1.84%                     | -1.42%               | 105.56 | 113.98  |
| Innovation – Output        | Export quality   | 0.29          | 0.29             | 0.24               | 0.16%                      | -0.75%               | 99.17  | 122.43  |
| Innovation – Output        | Export complexity  | 1.63          | 1.65             | 1.26               | -0.22%                     | -0.91%               | 98.90  | 129.96  |
| Innovation – Output        | Export knowledge intensity in % of total exports                 | 57.79         | 53.90            | 52.90              | 0.40%                      | -0.15%               | 107.21 | 109.23  |
| R&D productivity indicator | Publications vs. HERD&GOVERD                                     | 6.70          | 8.13             | 15.79              | 0.30%                      | 0.19%                | 82.37  | 42.42   |
| R&D productivity indicator | Patents vs. BERD   | 0.18          | 0.23             | 0.16               | -5.88%                     | -4.56%               | 77.53  | 111.36  |

Source: Eurostat, European Innovation Scoreboard, OECD, Patstat, Weltbank, Scimago, CWTS Leiden, WIFO calculations. Values below 100 in the AT IL and AT EU27 columns = Austria’s level below that of the innovation leaders and the EU27. Precise descriptions of the indicators can be found in Janger, J. / Kügler, A. (2018): Innovationseffizienz, Österreich im internationalen Vergleich. Study commissioned by the Austrian Council. WIFO, Vienna.

lications are generated in Austria than in the leading countries. To put it another way, for the generation of publications and patents in Austria, relatively more R&D expenditures is required than is the case with the innovation leaders. Figure 6 illustrates Austria's level in the various indicators relative to the leading innovation countries and relative to the EU27. It emphasizes the generally large distance to the EU average, while Austria is closer to the innovation leaders with regard to most indicators. Austria achieves the highest values compared with the innovation leaders with overall R&D expenditures, the R&D expenditures of companies and the share of medium-high to high technology intensity exports in overall exports ("Knowledge intensity exports" indicator). Austria achieves the lowest values compared with the innovation leaders with "employment in rapidly growing start-ups" in innovation-intensive segments, with the "number of researchers" in universities and in the public sector, as well as with the share of "tertiary graduations" for people aged 25 to 34. Austria achieved higher values with monetary inputs in all three input areas than with human re-

sources ("Number of researchers", "Tertiary level qualified" indicators). This is important for the DEA analysis, because it means high monetary inputs are partially compensated by low HR inputs. Upgrading indicators ("Export complexity", "Export quality", "Sales share with innovations") achieve higher values than the structural change indicators ("Share of innovation-intensive segments", "Employment in rapidly growing start-ups"), with the exception of the export share of high-tech products ("Knowledge intensity exports" indicator). Figures 7–11 show the Austrian value relative to the average of the innovation leaders over the period, summarized according to performance areas. Values below 1 mean an Austrian level below that of the innovation leaders. They illustrate the sharp increase in monetary inputs relative to the leading innovation nations. Such partial indicators cannot, however, replace a holistic efficiency evaluation with a DEA. In the next step the indicators are integrated into a DEA in different compositions to determine the efficiency of the countries in the respective

Figure 7: Austria's position relative to the innovation leaders, 2002 to 2016



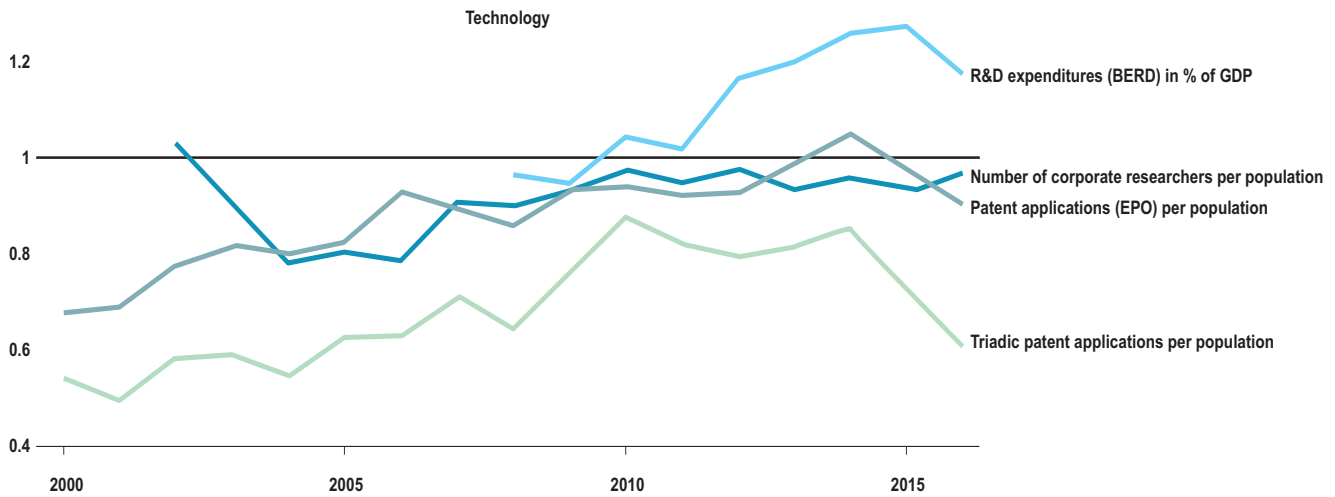
Source: See Appendix 4. Values below 1 mean an Austrian level below that of the innovation leaders.

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performance areas. In contrast to the input indicators, the output indicators are entered into the analysis delayed here, in order to adequately consider the effect of R&D activities that often only begin years later. With a DEA, efficient coun-

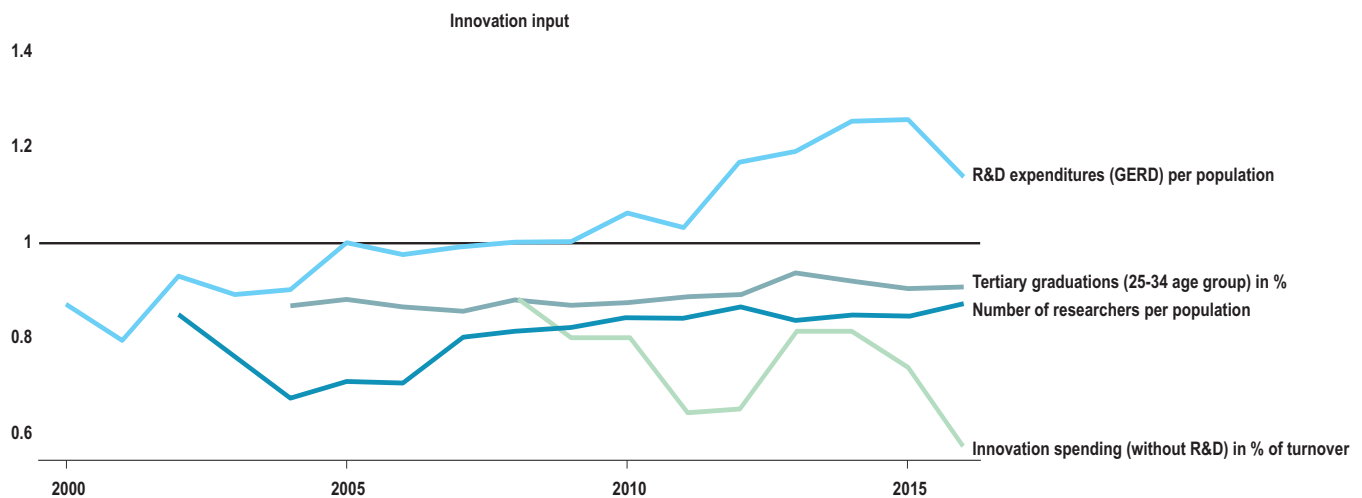
tries have a default efficiency value equal to 1; the values of inefficient countries are greater than 1. As a radial efficiency measure is used, the values above 1 provide information about the percentage that all outputs could be proportionally increased by, without changing the

**Figure 8: Austria's position relative to the innovation leaders, 2000 to 2016**



Source: See Appendix 4. Values below 1 mean an Austrian level below that of the innovation leaders.

**Figure 9: Austria's position relative to the innovation leaders, 2000 to 2016**

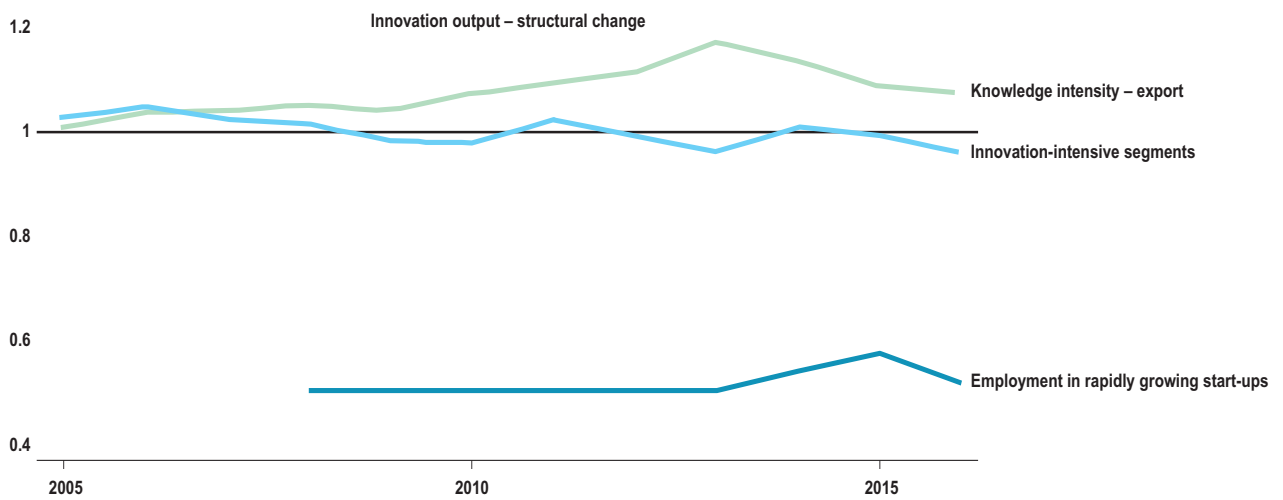


Source: See Appendix 4. Values below 1 mean an Austrian level below that of the innovation leaders.

amount of inputs used at the same time. Table 2 shows that Austria is not among the efficient countries in any area, but nor is it in the bottom third in any area. The value of 1.37 for Austria in the technological frontier area means that Austria could increase its technology out-

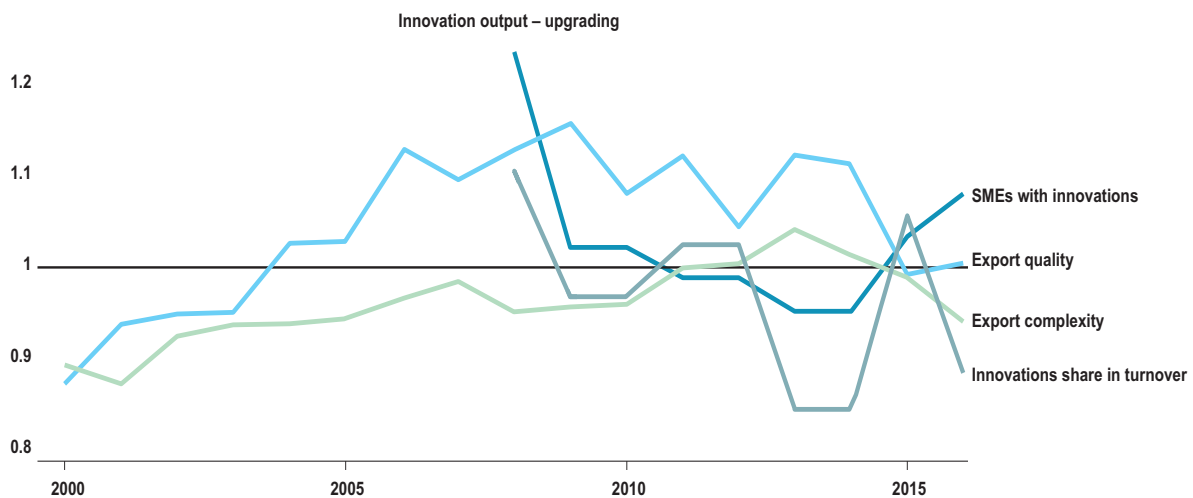
put (quantity and quality of patents) proportionally by 37 percent, if it managed to use its input in a similarly efficient way to that of the countries determined as efficient, which form the basis for calculating the technological frontier.

Figure 10: Austria's position relative to the innovation leaders, 2005 to 2016



Source: See Appendix 4. Values below 1 mean an Austrian level below that of the innovation leaders.

Figure 11: Austria's position relative to the innovation leaders, 2000 to 2016



Source: See Appendix 4. Values below 1 mean an Austrian level below that of the innovation leaders.

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In the scientific frontier area Austria could increase its output (that is, the quantity and quality of scientific publications) with the same inputs by 16 percent; in the innovation frontier area, in terms

of dynamic and export strength of knowledge-intensive activities, by 17 percent. Austria therefore has room to manoeuvre in all areas to achieve more output with the given resources, according to the results of the DEA

Table 2: DEA result – Countries’ ranking according to efficiency in science, technology and innovation

| Science   |           |             | Technology |           |             | Innovation |           |             |
|-----------|-----------|-------------|------------|-----------|-------------|------------|-----------|-------------|
| Country   | Rank      | Value       | Country    | Rank      | Value       | Country    | Rank      | Value       |
| US        | 1         | 0.29        | JP         | 1         | 0.25        | MT         | 1         | 0.42        |
| IE        | 2         | 0.37        | DE         | 2         | 0.47        | CH         | 2         | 0.75        |
| GB        | 3         | 0.61        | CH         | 3         | 0.50        | IE         | 3         | 0.81        |
| CH        | 4         | 0.61        | CY         | 4         | 0.68        | SK         | 4         | 0.82        |
| RO        | 5         | 0.66        | US         | 5         | 0.70        | DE         | 5         | 0.82        |
| EE        | 6         | 0.80        | NL         | 6         | 0.76        | CZ         | 6         | 0.88        |
| SI        | 7         | 0.81        | IT         | 7         | 1.10        | SI         | 7         | 0.88        |
| HR        | 8         | 0.82        | FI         | 8         | 1.15        | JP         | 8         | 0.90        |
| IT        | 9         | 0.95        | SE         | 9         | 1.21        | HU         | 9         | 0.92        |
| DK        | 10        | 1.02        | RO         | 10        | 1.25        | KR         | 10        | 0.97        |
| NL        | 11        | 1.04        | FR         | 11        | 1.29        | CY         | 11        | 0.98        |
| BE        | 12        | 1.10        | DK         | 12        | 1.36        | IT         | 12        | 0.98        |
| SE        | 13        | 1.11        | <b>AT</b>  | <b>13</b> | <b>1.37</b> | FI         | 13        | 1.01        |
| PT        | 14        | 1.12        | LU         | 14        | 1.52        | RO         | 14        | 1.04        |
| ES        | 15        | 1.12        | LT         | 15        | 1.53        | SE         | 15        | 1.11        |
| GR        | 16        | 1.16        | GB         | 16        | 1.59        | EE         | 16        | 1.14        |
| <b>AT</b> | <b>17</b> | <b>1.16</b> | BE         | 17        | 1.67        | LV         | 17        | 1.17        |
| FI        | 18        | 1.21        | IE         | 18        | 2.17        | <b>AT</b>  | <b>18</b> | <b>1.17</b> |
| FR        | 19        | 1.26        | ES         | 19        | 2.19        | FR         | 19        | 1.19        |
| DE        | 20        | 1.29        | KR         | 20        | 2.24        | US         | 20        | 1.22        |
| KR        | 21        | 1.29        | PL         | 21        | 2.36        | GB         | 21        | 1.23        |
| CZ        | 22        | 1.34        | EE         | 22        | 2.43        | BE         | 22        | 1.26        |
| HU        | 23        | 1.38        | BG         | 23        | 2.86        | LT         | 23        | 1.28        |
| PL        | 24        | 1.41        | SI         | 24        | 3.03        | DK         | 24        | 1.31        |
| SK        | 25        | 1.74        | HR         | 25        | 3.13        | HR         | 25        | 1.36        |
| LT        | 26        | 1.74        | SK         | 26        | 4.13        | PL         | 26        | 1.39        |
| JP        | 27        | 1.84        | HU         | 27        | 4.17        | NL         | 27        | 1.44        |
|           |           |             | CZ         | 28        | 4.45        | ES         | 28        | 1.48        |
|           |           |             | PT         | 29        | 4.91        | PT         | 29        | 1.73        |
|           |           |             |            |           |             | BG         | 30        | 2.03        |
|           |           |             |            |           |             | GR         | 31        | 3.09        |

Source: WIFO calculations. Output-oriented DEA with consideration of super-efficiency and declining economies of scale.  
 Interpretation of efficiency values: > 1: inefficient, = 1: efficient, < 1: super-efficient  
 Note: Science + technology = eff1 value; innovation = eff10 value.

that is. The high monetary inputs are, however, partially compensated with low inputs with human resources. Companies in Austria often cite the lack of qualified specialists and researchers as significant innovation or growth impediments.<sup>24</sup>

Table 3 summarises the main results and also names the innovative peers for Austria, the next comparison partners that is. It focuses on the innovatively efficient countries, as these are naturally relevant as such for a comparison with Austria, being efficient, but not innovation leaders. Some Eastern European countries in particular, the Czech Republic, Hungary or Slovakia, for example, achieve high outputs in the innovation area relative to the resources used, but are under no circumstances considered to be among the innovation leaders. These countries are closely involved in international medium-high and high-tech value creation chains, and therefore benefit from high values with the indicators for structural change. However a country such as Italy, which has low R&D expenditures, can also achieve innovation efficiency by upgrading in

more traditional industries.<sup>25</sup> Essentially it must be assumed with innovative countries that public administration and corporate management have competence advantages compared with countries in the catch-up process, which result in a relatively efficient use of resources and higher output levels.

The results clearly show the familiar strengths of the systems of the analysed innovative countries. In the scientific frontier area the USA, the UK and Switzerland are the leading countries, whereby they not only achieve high outputs, but rather also use their inputs relatively efficiently.<sup>26</sup> In the technological frontier and innovation frontier area it is the patent-intensive, strong export countries Japan, Germany and again Switzerland. As expected, Austria is always behind the leading innovation nations with this appraisal, and shows considerable increase potential in places.

Switzerland, Germany and Ireland in science and the Netherlands in technology are also seen as Austria's "DEA peers". This is the name giv-

**Table 3: Summary of the results of the DEA – Austria's position in efficiency ranking and output increase potential in science, technology and innovation**

|   | Science    | Technology | Innovation |
|---|------------|------------|------------|
| <b>Austria's ranking</b>  | 17         | 13         | 18         |
| <b>Output increase potential, without increasing input volume</b> | 16%        | 37%        | 17%        |
| <b>Top 3 efficient countries (only innovative)</b>                | US, UK, CH | JP, DE, CH | CH, DE, JP |
| <b>Austria's peers (innovative)</b>                               | CH, IE     | DE, NL     | CH         |

Source: WIFO Calculations.

24 See Ecker, B. / Fink, N. / Sardadvar, S. / Kaufmann, P. / Sheikh, S. / Wolf, L. / Brandl, B. / Loretz, S. / Sellner, R. (2017): Evaluierung der Forschungsprämie gem. § 108c EStG, Study commissioned by the Austrian Bundesministerium für Finanzen (Austrian Ministry of Finance; BMF). Vienna; Hölzl, W. / Friesenbichler, K. S. / Kügler, A. / Peneder, M. / Reinstaller, A. (2017): Österreich 2025 – Wettbewerbsfähigkeit, Standortfaktoren, Markt- und Produktstrategien österreichischer Unternehmen und die Positionierung in der internationalen Wertschöpfungskette. In: WIFO-Monatsberichte, 90 (3); pp. 219-228.

24 See Janger, J. / Schubert, T. / Andries, P. / Rammer, C. / Hoskens, M. (2017): The EU 2020 innovation indicator: A step forward in measuring innovation outputs and outcomes? In: Research Policy, 46(1), pp. 30–42.

26 For the USA the number of researchers available was not distributed according to sectors. The key with R&D expenditures (share of HERD in GERD) was therefore used as the measure for the distribution of researchers. This result must therefore be considered with caution.

## efficiency analysis

en to those efficient countries that are closest to Austria with their input-output combination, and from which it therefore could learn quite a bit.

The WIFO study has calculated even more additional specifications for innovation and the DEA according to input orientation, which cannot be shown in detail at this point.<sup>27</sup> The overall result of these calculations is, however, consistent with the general findings: Austria is not efficient in any of these specifications. With few exceptions, the efficient countries generally also remain the same, so the DEA can be described as very stable. Austria's potential to increase its output fluctuates in the different specifications for innovation between 5 and 25 percent. Among the innovative countries, Germany and Switzerland are consistently efficient, as are South Korea and Japan, but data availability is restricted here.

Among the catching up countries, the Czech Republic, Hungary and Slovakia are always efficient.

In summary, the DEA also provides plausible results for the estimation of Austrian innovation efficiency compared with the available literature, which also produces a similar picture with different combinations of input and output indicators. To provide an overview of the innovation efficiency (with regard to the effects of the implementation activities of the RTI Strategy as well), in the "Evaluation of Austria's Performance Relative to the Goals and Measures of the RTI Strategy" chapter the performance of the individual elements of the RTI system is analysed on the basis of the indicator sets already used in the reports of previous years. Firstly some approaches to increasing innovation efficiency will be discussed in the following section, and then picked up on in the recommendations.

### Approaches to increasing innovation efficiency

Possible general approaches for measures to increase efficiency are named in the following, and were examined in closer detail. It must first be said here that efforts to increase efficiency must be chosen carefully, as research and innovation at the frontier require freedom for experimenting with new approaches, whose probability of success is highly uncertain. A unilateral focus on efficiency on the basis of easy to measure indicators could even endanger scientific breakthroughs and radical innovations. Risk aversion could possibly lead to the selection of "safe" R&D and innovation projects. Their innovation value can indeed feature high probability, but it will generally be low. Approaches to increasing efficiency, which can increase both ef-

iciency and performance level at the same time, should nevertheless be checked in Austria.

The R&D quota target of 3.76 percent could first be linked with the development of the industrial structure. A quota target without any information on the industrial structure misjudges the marked differences between the industry-specific R&D intensities. An identical R&D quota of 3 percent can be high for a country with an economic structure that specialises in industries with medium technology intensity, but it can be low for a country with a pronounced high technology structure. A reformulation of the target could begin with an R&D quota adjusted to the industrial structure.<sup>28</sup>

A further approach would be to expand input

<sup>27</sup> See the appendix in Janger, J. / Kügler, A. (2018): Innovationseffizienz, Österreich im internationalen Vergleich. Study commissioned by the Austrian Council. WIFO, Vienna.

<sup>28</sup> See, inter alia, Reinstaller, A. / Unterlass, F. (2012): Strukturwandel und Entwicklung der Forschungs- und Entwicklungsintensität im Unternehmenssektor in Österreich im internationalen Vergleich. In: WIFO-Monatsberichte, 85(8), pp. 641–655; and Janger, J. / Kügler, A. (2018): Innovationseffizienz, Österreich im internationalen Vergleich. Study commissioned by the Austrian Council. WIFO, Vienna, pp. 2 ff.

goals with output goals. This is also required to depart from existing tendencies towards input-oriented control and focus more on the efficiency of R&D investments. The effect of innovation efforts should also be considered here.<sup>29</sup> This has already been practised in the RTI Strategy with the goal of joining the leading innovation countries. This aspect must in any case be considered again for the new edition of the RTI Strategy planned by the Federal Government.

In the scientific frontier area, new allocation mechanisms for funding that allow monetary resources to flow into the more innovative or riskier research projects and/or most promising researchers should be checked. The performance agreements in their current form (as the core funding of university research) can indeed be used in many areas, but they have inherent difficulties in overcoming information symmetries between money-givers and money-takers and identifying the most promising researchers and projects, with increased awarding of funds in competition, for example.<sup>30</sup> They are currently only suitable within limits for increased allocation of research funding according to international quality standards. Alternative models, which can be checked, function according to the *ex ante*<sup>31</sup> or *ex post* principle<sup>32</sup>. It is no coincidence that the most efficient countries in the scientific frontier area are often also the most research-oriented, such as Switzerland, for example, with a generously remunerated national fund, the USA also with high *ex ante* funding percentages, and the UK, which practises a combination of *ex ante* and *ex post* funding. The announcement of the Federal Gov-

ernment to fund research, teaching and infrastructure separately now makes it a good time to rethink the mechanisms for research funding.

On the basis of the most recent reform measures, such as the University Act 2018, with a view to efficiency increases, a further development of career and organisational structures could also be revised, which would make Austria's universities and research institutions more attractive for the most promising researchers and would not immediately cost more money. Key points in this respect are tenure track models and early independence in research, as well as flat hierarchies in research groups and institutes.<sup>33</sup> The recently introduced Austrian tenure track model is, however, far from being the standard with new appointments. IST Austria could serve as an example for efficient career and organisational structures, as its structures generally are or must be oriented on international best practice, in order to recruit top scientists.

Further approaches are designed to remove probable cross-funding of teaching through research, while incorporating the principle of uniting research and teaching. This in particular affects study areas where supervision capacities are insufficient for the student numbers. A revision of the expansion of technical college places in suitable subjects (that is, those in which labour market-relevant qualifications are also bestowed on students without intensive research work), could contribute to a more efficient use of funds. Due to their far higher amount of courses, technical colleges are essentially more

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29 For this, see the focus topic in, Austrian Council (2017): Report on Austria's Scientific and Technological Capability 2017. Vienna, pp. 18 ff.

30 See Janger, J. / Kügler, A. / Reinstaller, A. / Unterlass, E. (2017): Österreich 2025 – Die „Frontier“ in Wissenschaft, Technologie, Innovationen und Wirtschaft. Messung und Bestimmungsfaktoren. In: WIFO-Monatsberichte, 90 (2); pp. 141-151.

31 Peer review of research project applications, as practised by the Science Fund (FWF), the Swiss National Fund (SNF), etc.

32 Evaluation of the publication quality by peers, as in England, for example.

33 See, inter alia, Janger, J. / Nowotny, K. (2016): Job choice in academia. In: Res. Policy, 45(8), pp. 1672–1683.



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cost-effective per student than universities, whose research share is significantly higher, which also results in considerably higher costs. In different leading innovation nations the vast majority of students attend a technical college, while in Austria the majority study at a university (for this, see the “Tertiary Education System” section).

In the technological frontier area, companies are essentially in international competition, so there is a natural incentive to use funding goal-oriented. Generally speaking, too little is even invested in R&D here, because positive externalities for economy and society are not (cannot be) considered by the individual company. The know-how that is created by corporate R&D could also be used in other areas thanks to a spillover effect. The public sector funding of corporate R&D is therefore a reaction to market failure, but in Austria it is already high in the international comparison (for this see the “Governance and Financing of the RTI System” section).

New methods could therefore also be developed here, as with the universities and research institutions, to focus the allocation of funds more on the most promising research projects. This is possible ex ante with application reviews with direct funding, with a revision of the funding criteria, for example, or ex post both with direct and indirect funding with evaluations of the effectiveness of the types of funding, which can be used for adjustments (for example, stopping

and/or adjusting funding programs with little effect, or designing new types of funding).<sup>34</sup>

In the innovation frontier area it is about facilitating the conversion of ideas and knowledge into new products and processes. An important route to commercialization, to implementation in value creation, is paved with start-ups and in particular the rapid growth of innovation-intensive start-ups. Austria is held back here with the familiar old problems in the availability of risk capital. The problem’s solution also depends heavily on regulatory reforms, which per se would cost very little money and could therefore make an especially strong contribution to efficiency. The structure of the capital market, especially for smaller companies, also plays a role here (for this see the “Research and Innovation in the Corporate Sector” section).

Risk capital and capital market reforms have an effect on the supply of financing, but not on the demand for it; the potential for promising start-ups also plays a role. Again and again it is stated here that academic spin-offs, for example, emanate from research-intensive universities in particular, so university reforms also provide a double dividend.<sup>35</sup> People with tertiary level qualifications also play an important role for innovation efficiency, because they contribute to removing undesired path dependencies, and therefore promote the diversification of corporate product ranges. This can also contribute to structural change, which, in addition to upgrading, is also an important innovation effect. De-

<sup>34</sup> Performing quantitative ex-post impact evaluations in Austria is difficult because data protection requirements make it hard to combine corporate data from statistical inventories with other data sources. This makes it more difficult if not impossible to use internationally standard econometric methods, which can reliably evaluate the effectiveness of grants by forming control groups and by considering many possible influence factors on the funding effect. Such evidence can also be used for more efficient coordination between direct and indirect funding, as well as to analyse the efficiency of the overall research funding system against the backdrop of sharply increased tax incentives for research funding. See Austrian Council (2017): Recommendation on the way to the forefront of innovation of 30 November 2017; and Falk, M. / Hölzl, W. / Oberhofer, H. (2015): The importance of business-related individual data for empirical economic research and economic policy advice. In: Monographien, 11, pp. 845–857.

<sup>35</sup> See, inter alia, Janger, J. / Firgo, M. / Hofmann, K. / Kügler, A. / Strauss, A. / Streicher, G. / Pechar, H. (2017): Wirtschaftliche und gesellschaftliche Effekte von Universitäten. Vienna.

spite the consideration of the number of graduates of vocational higher level schools, Austria continues to show a deficit with the share of tertiary level qualified workers (for this see the “Tertiary Education System” section).

In addition to the tight funding system, many other economic framework conditions also play a role in the success of innovation efforts. Spending for R&D and innovation only produces a corresponding innovation output (that is, value creation) when factors such as wage costs, broadband infrastructure, labour and product market regulations and the quality and availability of skilled workers enable competitive economic activity and production in Austria. In the current economic boom we can see, for example, that the insufficient availability of skilled workers is a growth impediment for companies. It limits the return on R&D and innovation spending and therefore also the efficiency of Austrian innovation efforts. The potential value creation to be produced by the use of funds for innovation, is consequently limited. Improvements in these framework conditions for innovation can therefore sharply increase Austria’s innovation efficiency.<sup>36</sup>

Finally, with relation to increasing efficiency in the Austrian RTI system, the governance structures must also be addressed, that is the multitude of players in research funding at federal and state level, for example, the variety of programs in direct funding, the distribution of agendas to different departments and the coordi-

ination of the departments with the funding agencies, and finally the federal-state relations (for this see the explanations in the “Governance and Financing of the RTI System” section).

Savings with the relevant players will however scarcely increase efficiency in the named areas, because according to the Court of Auditors, of the approximately 800 full-time equivalents employed here, only 1.5 percent are funded by public sector research funding.<sup>37</sup> All the more important are reforms that optimize the processes for decision-making and coordination, and therefore result in a more efficient use of resources, in effectively coordinated funding programs, for example. Funding decisions require empirical evidence, independent of the governance structure. Improvements in the conditions for impact evaluations are therefore also relevant for increasing the efficiency of RTI governance. The introduction of a research funding database across all government departments is also extremely relevant in this context.<sup>38</sup>

A simple consolidation of funding agencies or of research agendas in one ministry is still no guarantee of efficient coordination, because knowledge sharing between departments can also be limited within institutions, as has been seen in large companies and administrative bodies.<sup>39</sup> Finding consensus on the main bottlenecks that could impede Austria’s scientific and technological performance and its innovation efficiency is

## efficiency analysis

36 See Aiginger, K. / Falk, R. / Reinstaller, A. (2009): Evaluation of Government Funding in RTDI from a Systems Perspective in Austria. Synthesis Report. WIFO – convelop cooperative knowledge design gmbh – Austrian Institute for SME Research – Prognos. Vienna.

37 Rechnungshof (2016): Forschungsfinanzierung in Österreich. Reihe Bund 2016/4.

38 See Austrian Council (2018): Recommendation to set up a nationwide database to illustrate research inputs and outputs of 22 March 2018; and in detail, Rütter Soceco, Senarclens, Leu & Partner and Quantum Analytics (2017): Feasibility study on setting up a nationwide research funding database. Study commissioned by the Austrian Council. Zurich, 11 November 2017.

39 See, inter alia, Tsai, W. (2002): Social structure of “coopetition” within a multiunit organization: Coordination, competition, and intraorganizational knowledge sharing. In: Organization science, 13/2, pp. 179–190.



far more important for successful governance of the RTI system. For this reason the various players in the RTI system must focus on common goals.<sup>40</sup> To achieve these goals, the annual RTI summit of the Federal Government anchored in the government programme should be used to initiate an active and

comprehensive RTI policy reform process to decisively drive forward the implementation of the new RTI Strategy. This must happen at the highest political level, under the supervision of the Federal Chancellery and in cooperation with all ministries responsible for RTI (for this see also the “Governance and Financing of the RTI System” section).<sup>41</sup>



<sup>40</sup> See Austrian Council (2013): Weißbuch zur Steuerung von Forschung, Technologie und Innovation in Österreich. Vienna.  
<sup>41</sup> See Austrian Council (2017): Recommendation on the way to the forefront of innovation of 30 November 2017.



Evaluation of Austria's Performance Relative to the Goals and Measures of the RTI Strategy



**performance  
evaluation**

The science, technology and innovation areas analysed in aggregated form in the previous chapter are handled in a more differentiated way in this chapter. As in previous reports on Austria's scientific and technological performance, a set of indicators oriented on the elements of the RTI Strategy and which enables illustration of a trend development from 2010 to today, which also allows conclusions on the efficiency of the Austrian RTI system and the effects of the implementation activity of the RTI Strategy, was used for this. The important developments in the areas of, "RTI system priority objectives", "Education system (without tertiary area)", "Tertiary education system", "Research at universities and non-university research insti-

tutions", "Research and innovation in the corporate sector", "Governance and financing of the RTI system" are illustrated as an overview in the following.

As already mentioned in the introduction, the group of innovation leaders is composed slightly differently since the European Innovation Scoreboard 2017. The UK recently also joined the existing innovation leaders, Denmark, Germany, Finland, the Netherlands and Sweden. For this report all data points of the UK were therefore also incorporated into the calculation for all indicators since 2010. Compared with previous years this results in some changes in the details. The effects on the overall result can, however, be ignored, which is why they are not expressly stated here.

## Priority objectives

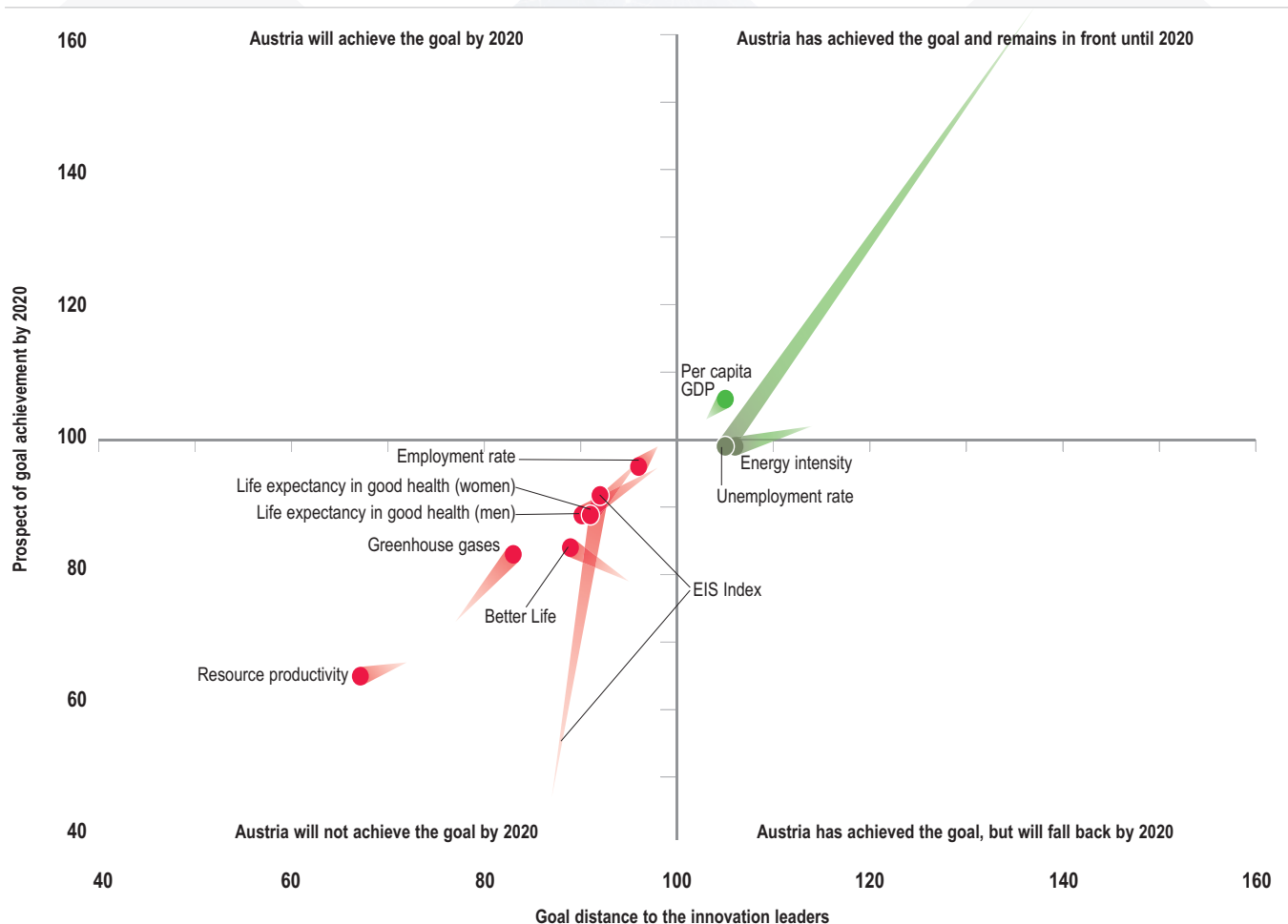
The priority objectives of the RTI Strategy were analysed in detail in the Report on Austria's Scientific and Technological Capability 2017 (especially with regard to the effects of innovation efforts on Austria's economic, social and ecological performance and the efficiency of the Austrian RTI system), which is why they are only

very briefly outlined here. For a more in-depth analysis, please see the appropriate section in the last report.<sup>42</sup>

The priority objectives of the RTI Strategy therefore address areas which generally represent the overriding target of political measures and which are especially im-

performance  
evaluation

**Figure 12: Development of the goal distance and the prospect of goal achievement in the area of priority objectives of the RTI Strategy, 2010 to 2018**



Note: Goal distance = Austria actual value compared to the innovation leaders' actual value (average value most recent available year DE, DK, FI, GB, NL, SE) or to national goal; Prospect of goal achievement = ratio of value projected for Austria in 2020 to the national goal or the value projected for the innovation leaders in 2020.

<sup>42</sup> Austrian Council (2017): Report on Austria's Scientific and Technological Capability 2017. Vienna, pp. 18 ff.



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evaluation**

portant for a country's inhabitants. These in particular include the economic capability, performance in the environment area and in the areas of quality of life, health and life expectancy. Innovation performance is also addressed here on the whole as an RTI Strategy priority goal. Ten indicators are used to evaluate Austrian performance in the area of priority objectives.<sup>43</sup>

Figure 12 provides an overview of the developments in these areas from 2010 to today. The situation has only changed marginally over the comparison period. On the whole the level of the innovation leaders could only be achieved or exceeded with three of the ten indicators: "Per capita GDP", "Energy intensity" and "Unemployment rate". Nothing will change either for the pro capita GDP with the development trend staying as it is until 2020.

Significantly declining trends can, however, be seen in the energy intensity area and with the unemployment rate since 2010 in particular. Both indicators therefore threaten to fall back below the level of the leading countries with the development dynamic remaining as it is until 2020. But the recent strong economy could still have a very positive effect in this respect. In all other areas, however, the development dynamic currently does not appear to be sufficient

to get close to the innovation leaders by 2020. On the contrary, the trend has been predominantly declining since 2010. On the whole, positive trends could only be seen with four indicators – "Per capita GDP", "Quality of life", "Greenhouse gas emissions" and the "EIS index". However, here too the dynamic is still significantly behind that of the innovation leaders. It is therefore welcome news that the Federal Government has set itself the goal of making Austria an innovation leader, to consequently further increase the competitiveness of the domestic economy and to consistently meet social challenges such as climate change and demographic shifts.<sup>44</sup> The intergovernmental agreement therefore addresses the priority objectives of the RTI Strategy directly and on several levels, "to further develop the potential of science, research, technology and innovation in Austria to make our country one of the most innovative in the EU by 2020, and to consequently strengthen the competitiveness of our economy and increase the prosperity of our society (...) and thus to meet the major social and economic challenges of the future"<sup>45</sup>. It remains to be seen if the Federal Government can generate sufficient momentum with the consistent implementation of the measures adopted, to truly achieve these goals.



**RTI Strategy Objectives**  
*See Appendix 7 on page 108*

<sup>43</sup> When interpreting the results it should be noted that Austria's performance in the area of priority objectives is not only influenced by RTI activities, but rather by the result of many other factors as well. These include, for example, specific regulations with environment and health, which have a direct influence on the performance of the corresponding areas, or the general economic development, which also has an effect on the quality of life.

<sup>44</sup> Bundesregierung (2017): Zusammen. Für unser Österreich. Regierungsprogramm 2017–2022. Vienna, pp. 4 ff., pp. 68 ff. and pp. 75 ff.

<sup>45</sup> The Federal Government's RTI Strategy: The Path to Becoming an Innovation Leader. Vienna 2011, p. 9.

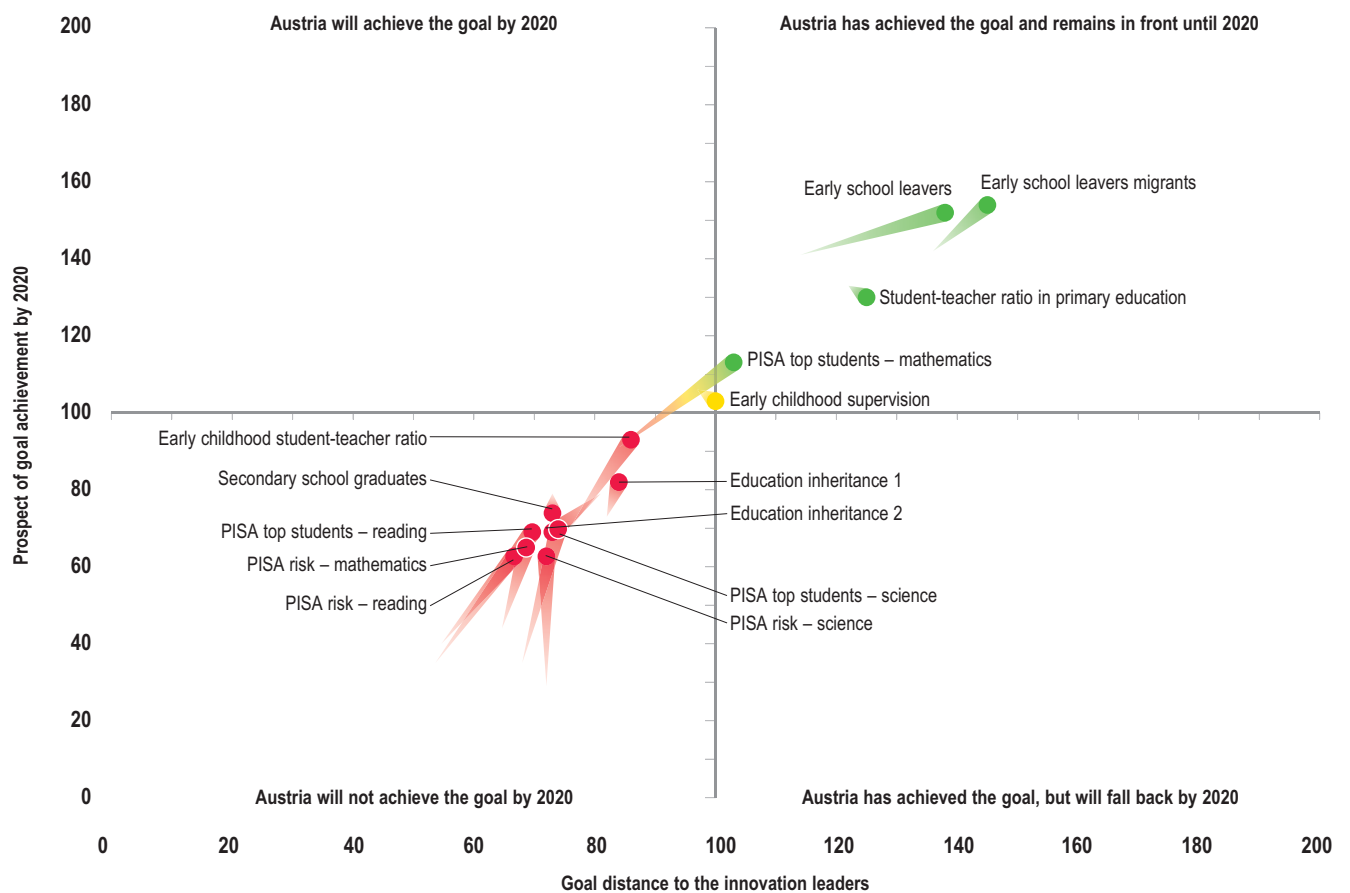
## Education System – without tertiary education

The primary and secondary education system as the basis and starting point of the research and innovation system of a country has been characterised by an insufficient dynamic for some years now. The 14 indicators in total<sup>46</sup> show only minor changes in relation to the group of in-

novation leaders for the comparison period 2010 to 2018. As in previous years, only three indicators, “Early school leavers”, “Early school leavers migrants” and “Student-teacher ratio in primary education”, are clearly in the target area, how-

performance  
evaluation

**Figure 13: Development of the goal distance and the prospect of goal achievement in the education system (without tertiary area), 2010 to 2018**



Sources: See Appendix 1, WIFO presentation. Raw data, see Appendix 2. Explanation, see Appendix 3.

Note: Goal distance = Austria actual value compared to the innovation leaders' actual value (average value most recent available year DE, DK, FI, GB, NL, SE);

Prospect of goal achievement = ratio of value projected for Austria in 2020 to the national goal or the value projected for the innovation leaders in 2020.

<sup>46</sup> The “Skill Mismatch” indicator was not determined in 2018.

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ever the “PISA top students group – mathematics” indicator also managed to join this group. There were indeed positive developments (with the exception of the “Secondary school graduates” indicator) with all other attributes, however, the development dynamic is too weak to really be able to keep up here with the leading innovation nations.

A familiar overall picture therefore emerges (see figure 13): The weaknesses of the Austrian education system with the risk groups surveyed with the PISA tests are in the reading, mathematics and science areas, as well as in the system-inherent problem of education inheritance<sup>47</sup>.

The reclassification of<sup>48</sup> the Hauptschulen (HS – secondary schools) as Neue Mittelschulen (NMS – new secondary schools), introduced in 2008 and nationwide since 2015, has not had the desired effect either of dismantling existing education barriers by creating more equal opportunity and thus also increasing the respective educational returns – on the contrary. Although there are significant differences with regard to the acceptance of NMS in the comparison of urban and rural regions, there are also “major discrepancies (...) with regard to the amount of admissions to higher education and the level of the requirements necessary for this”<sup>49</sup>, on the whole it can nevertheless be said that, “a corol-

lary effect of the selective absorption of high-performance students by the AHS lower cycle (and) by schools with special focus points and private schools is the formation of ‘Restschule/Restklassen’ or ‘schools/classes for leftovers’, the teaching of which is a considerable challenge for the teaching staff”<sup>50</sup>.

In the NMS evaluation report presented in 2015 the authors also clearly stated: “The expectation that the introduction of NMS would result in more students and their parents deferring an early schooling decision between AHS and HS with a decision for an NMS, in order to be able to later make a sounder career decision, will not be met. With regard to equal opportunity in schooling decisions it is also clear that students with the same performance have considerably fewer opportunities after graduating from an NMS or HS of going on to higher education than graduates of the AHS (grammar school) lower grade have. The slight trend towards higher transfer rates to AHS for NMS graduates marginally reduces the inequality of opportunities, but in comparison with AHS there are still drastic side effects to the choice of school. A significant contribution to the reduction in inequality by the NMS is therefore not a given here, after the important career decisions have already been made with entrance to an NMS (...)”<sup>51</sup>

To date education policy consensus has not been

## RTI Strategy Objectives

See Appendix on page 108

<sup>47</sup> These findings apply for the entire education system and are based on the corresponding indicators of the OECD (see Appendix 1). An exception, which is of course not a significant effect on the overall performance, are the vocational higher level schools (BHS), with which a correlation between the education level of the parents and the children cannot be established. See Austrian Council (2016): Report on Austria’s Scientific and Technological Capability 2016. Vienna, p. 16 f. See also: Lassnigg, L. / Laimer, A. (2013): Berufsbildung in Österreich. Hintergrundbericht zum Nationalen Bildungsbericht 2012. Projektbericht des IHS, Wien, pp. 39–44.

<sup>48</sup> The NMS was originally conceived as a model project for the organisational and pedagogical further development of secondary level I in the form of school trials. Only with its nationwide introduction in 2012 as “mainstream school” did it become a new school form, which then replaced all secondary schools by 2015.

<sup>49</sup> Eder, F. et al. (2015): Evaluation der Neuen Mittelschule (NMS). Befunde aus den Anfangskohorten. Salzburg and Linz 2015, p. 3. “For pupils with average performance potential in rural areas it is more difficult to achieve qualifications comparable to those of their peers in urban schools.”

<sup>50</sup> Eder et al. (2015), p. 3.

<sup>51</sup> Eder et al. (2015), p. 3.

established in Austria on the question of a comprehensive school for 10 to 14-year-olds, a discussion incidentally, which was already had in the First Republic (1918-1938), and which goes back to education policy attitudes during the Habsburg Monarchy.<sup>52</sup> Specific measures to counter early education selection and therefore “education inheritance” are still not available, which is why the Austrian education system cannot leverage and promote all the available talents and skills of its students either. It is feared that the current government plans<sup>53</sup> will not bring the required improvements here either, because the challenges brought by increased migration and the higher numbers of students whose native language is not German, will be answered with concepts that exacerbate rather than improve the situation. This once again produces the requirement for a comprehensive and in-depth structural reform of the Austrian education system, the number one priority of which is to tackle education inheritance.

The study authors of the NMS evaluation also refer to the substantial use of resources, especially in the form of nationwide team teaching, which however, (to date) has not delivered the anticipated improvements in the area of professional performance and interdisciplinary competencies. They therefore ask that, “the resources be put into curriculum-compatible activities

that support learning (...)” and discourage “a lump sum awarding of resources with a scattergun approach”<sup>54</sup>.

This requirement for revising and focusing on the use of resources for the needs of students incidentally also applies to the entire education system, because input is indeed not efficient in relation to output.

In 2014, for example, education spending per student in Austria was USD 13,507. It was therefore far above the OECD average of USD 10,759. The same also applied for the respective individual areas: In 2014 the annual spending per student for all services ran to USD 11,154 in the primary area (OECD average: USD 8,733), USD 15,106 in secondary area I (OECD average: USD 10,235) and USD 15,079 in secondary area II (OECD average: USD 10,182). In the area of early childhood education and care, with USD 9,525 per year, Austria also spent somewhat more than the average of the OECD countries with USD 8,858. This significantly higher financing (according to the OECD in its report<sup>55</sup>) is driven by teachers’ salaries, which are above the OECD average, combined with lower pupil-teacher ratios. In Austria’s secondary area there are only approximately nine pupils per teacher, which is the lowest pupil-teacher ratio in all OECD countries (OECD average: 13 pupils per teacher).

performance  
evaluation

52 As the basis for educational policy reforms within the context of the “Politische Schulverfassung” of 1805, historian Brigitte Mazohl consequently already established the presence of a “political will to codify social differences via education: rudimentary knowledge for the lower farming social strata, requirements-oriented training for the urban middle classes (and) educated elite knowledge exclusively for the small stratum of secondary school and university graduates, who were beneficial for state and society as lawyers, doctors, theologians and high school teachers”.

Mazohl, B. (2016): Vom Tod Karls VI. bis zum Wiener Kongress (1740–1815). In: Winkelbauer, T. (ed.): Geschichte Österreichs. Reclam Verlag, Stuttgart, pp. 290–358, here in particular p. 333.

53 For this, see „Bewährtes differenziertes Schulsystem erhalten und ausbauen“ (“Maintain and expand proven differentiated school system”), in: Bundesregierung (2017): Zusammen. Für unser Österreich. Regierungsprogramm 2017–2022. Vienna, p. 60.

54 Eder, F. et al. (2015): Evaluation der Neuen Mittelschule (NMS). Befunde aus den Anfangskohorten. Salzburg und Linz 2015, p. 25.

55 OECD (2017): Education at a Glance 2017: OECD Indicators. OECD Publishing, Paris, pp. 168 ff. Online source: <http://dx.doi.org/10.1787/eag-2017-en>. For this and the following, see in particular: OECD (2017): “Austria” (Country Note), in: Education at a Glance 2017: OECD Indicators. OECD Publishing, Paris. Online source: <http://dx.doi.org/10.1787/eag-2017-39-en>



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At the same time however, Austria's education spending measured on economic efficiency was below the OECD average: In 2014 in this country, 4.9 percent of GDP, for example, was used for education institutions in the primary to tertiary area, compared with 5.2 percent in the OECD average. The share of the public sector education spending of the overall public sector spending in Austria was 9.3 percent, and therefore also below the OECD average with 11.3 percent. And the share of early childhood education of GDP in Austria with 0.6 percent was also clearly lower than the OECD

average of 0.8 percent, although an early investment in education and development for children in particular delivers high returns, as it forms an essential basis for future learning in life.<sup>56</sup>

Finally the positive effects of measures such as the Autonomy Package 2017, which gives students the opportunity to adjust their offering to specific target groups and local conditions, the introduction of the "Training Guarantee" and the "Training Obligation" as well as the binding introduction of the "Pre-scientific Work" (AHS) and "Thesis" (BHS) to awaken and intensify interest in science and research, should also be acknowledged at this point.

### **Recommendations of the Austrian Council for Achieving the Goals of the RTI Strategy in the education system – Excluding Tertiary Education**

The Austrian Council welcomes the current commitment included in the government programme to quality primary school teaching, but in this context also recommends a significant increase in the number of multi-lingual teachers. Instead of a scattergun approach, the Austrian Council recommends better financial and human resources (keyword: support staff) for those schools that are confronted with special challenges, especially with regard to the socio-economic structure of their students (the aptly named "hotspot schools").

To tackle early social selection in the education system, in addition to the continuous expansion of day care, the Austrian Council in particular recommends the expansion of all-day schools with "verschränkter Unterricht" (interwoven activities) and effective measures to end early separation. At the same time specific support measures must be introduced to raise the overall performance level. The Austrian Council also suggests a comprehensive international comparison of corresponding models and options for this.

<sup>56</sup> OECD (2017): Education at a Glance 2017: OECD Indicators. OECD Publishing, Paris, pp. 180 ff. and: OECD (2017): "Austria" (Country Note), in: Education at a Glance 2017: OECD Indicators. OECD Publishing, Paris. Online source: <http://dx.doi.org/10.1787/eag-2017-39-en>

## Tertiary Education System

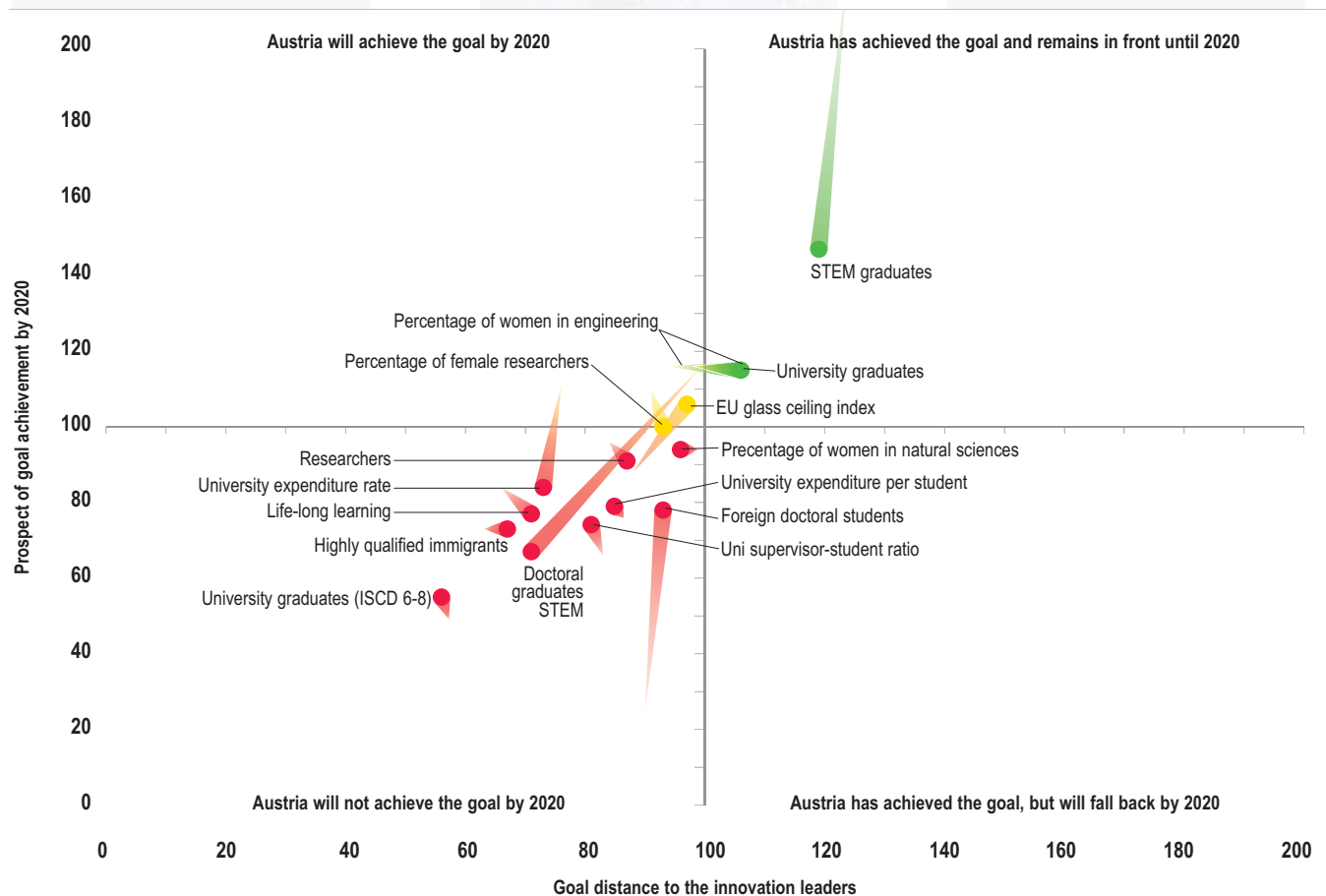
The 12 indicators for the tertiary education area show only very few changes over the 2010 to 2018 comparison period relative to the group of innovation leaders. In total only three indicators, “STEM graduates”, “Share of women in engineering” and “University graduates (all)”, are in the target area. Its above average good status compared with the leading innovation nations has been maintained continuously since 2010. On the whole, however, the reality is a below av-

erage performance in relation to the leading countries, which is due to numerous inefficiencies in the tertiary education system.

A target of 2 percent of GDP was set with the RTI Strategy for the university spending quota. This value for Austria is currently at 1.46 percent for the “tight” tertiary university area, that is, without the vocational higher level schools. In terms of GDP, Finland (1.93 percent), Denmark

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**Figure 14: Development of the goal distance and the prospect of goal achievement in the tertiary education system, 2010 to 2018**



Sources: See Appendix 1, WIFO presentation. Raw data, see Appendix 2. Explanation, see Appendix 3.

Note: Goal distance = Austria actual value compared to the innovation leaders' actual value (average value most recent available year DE, DK, FI, GB, NL, SE);

Prospect of goal achievement = ratio of value projected for Austria in 2020 to the national goal or the value projected for the innovation leaders in 2020.



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(1.88 percent) and Sweden (1.76 percent) invest the most financial resources in the tertiary sector. Coupled with a high number of students in Austria, not surprisingly this quota results in a below average value for the “University expenditure per student” indicator. This is certainly a key point for increasing efficiency in the university area, because both should be achieved – a higher student quota (Austria is behind Finland, Denmark, the Netherlands and Sweden here), and an improvement in study conditions –, and a significant increase in the university spending quota is then urgently required. The minimum target here is 2 percent of GDP, which also requires an increase in the private sector funding share.

The increase in the budget for universities for the performance agreement period 2019–2021 was a first measure in this respect, but it is not sufficient. The targeted university quota of 2 percent of GDP cannot be achieved with the budgetary increases included in the Federal Government’s estimated budget presented on 21 March 2018 either, because it says the university budget will grow by only 2.5 percent by 2022. This means the university quota in the coming years will even fall, as nominal GDP grows faster. Under the current framework conditions, approximately EUR 2 billion are required to achieve the university quota in the strict sense by 2020.

With the amendment of the University Act to introduce capacity-oriented study place funding anchored in the government programme, a further step has been taken towards increasing the efficiency of the university system. The extension of the existing regulations for the minimum number of study places to three further study fields and studies, as well as the possibil-

ity of introducing admission procedures for particularly high in demand bachelor and diploma programmes<sup>57</sup> for improved controlling of university access, is also a step in the right direction.<sup>58</sup> Further measures are, however, also required to further develop the university area specifically and society-oriented.

The imbalance connected with student access to universities and technical colleges is a serious efficiency barrier for the Austrian university system. The share of students at public universities in Austria is approximately 78 percent. Federal spending per student here is about twice as high as in the technical college sector, whose share of the overall number of students is approximately 14 percent.<sup>59</sup> A look at the innovation leaders shows that considerably more students are trained at technical colleges in those countries. The share of students at technical colleges in the Netherlands is 60 percent, in Finland it is 50 percent and in Switzerland and Germany it is at least 30 percent.<sup>60</sup>

Another closely connected factor in this respect, which has a big influence on the efficiency of Austrian universities, is the insufficient and in comparison to the leading countries stagnating supervision ratio. The supervision ratios at universities in particular have not been continuously improved, which is reflected in the insufficient development of the corresponding indicator. The lack to date of a capacity-oriented study place and study access management system and study place funding that hasn’t been implemented for years meant a substantial improvement was not possible, despite academic staff being beefed up. This is confirmed by a survey of the capacities at the universities as part of the all-Austrian university development plan.<sup>61</sup>

57 See Austrian University Act §71d (admission to a university for particularly high in demand bachelor and diploma programmes).

58 See Austrian University Act §71b (law, foreign languages and educational sciences).

59 The rest are distributed across teacher training colleges and private universities.

60 See Austrian Council (2017): Recommendation for the further development of the technical colleges sector in the Austrian education and science system of 30 May 2017.

61 See the all-Austrian university development plan 2019–2024; Appendix, fig. 1: Over and under-capacities of the universities, study year 2015/2016.

The situation is, as it was, still precarious in most study subjects. Its effects include longer study periods on average, and higher drop-out numbers. The situation is also exacerbated in places by a high number of students in work.<sup>62</sup> While the indicator for the “Graduate quota ISCED 6–8” (for bachelors, masters and PhDs) does not provide a direct reference to the capacities, in system terms it remains unchanged for Austria, and significantly below the level of the innovation leaders.<sup>63</sup>

The burdening of the universities with the relatively high number of students and the comparably low financial and human resources is immense and results in considerable efficiency losses. The attractiveness of the universities certainly also suffers from this. An indication of this could also be the “Doctorate holders STEM” indicator, which has fallen markedly compared with the group of innovation leaders. The declining trend is also due to increasing graduate numbers in the comparison countries and a stagnating number of doctorate holders of just over 2,200 people across Austria. The doctoral programmes evaluated as very good (the FWF doctoral programmes and the IST-Austria PhD programme, for example), should therefore be expanded.

Graduating from a doctoral programme in Austria also appears to have limited appeal for doctoral students from non-EU countries. With a share of approximately 10 percent, Austria is therefore clearly behind Sweden, the Netherlands

and the UK, and about equal with Germany, Finland and Denmark.

It must therefore be positively stressed that, in addition to the recently adopted “Universitätsfinanzierung NEU” (NEW university funding) and further measures for a capacity-oriented access control management system, measures to improve study conditions at universities and technical colleges, which the Austrian Council believes are extremely suitable, are also anchored in the government programme 2017–2022.<sup>64</sup> The increase in the number of career positions and the development of the university sector in line with social requirements announced once again (keyword: expansion of the technical college sector) must also be seen as important steps in the right direction in this respect. However, the funds planned for in the budget are not sufficient to finance the required growth path, which allows for an expansion of more than 1,200 study places each year.

The development of gender mainstreaming in Austria will be observed for this report using the “Share of female researchers”, “Share of women in science”, “Share of women in engineering” and “Glass ceiling index” indicators. Three of these indicators are highly likely to have reached the goal by 2020. To draw closer to the average level of the innovation leaders, efforts must nevertheless be intensified in the area of women’s issues and equality policy. An invitation to do so is provided in the “Gender in Focus” study by

62 According to the Student Social Survey in the 2015 summer semester 61 percent of the students were continuously or occasionally in work. Of these 18 percent had a full-time position. For 75 percent of students a job is necessary to cover their living expenses. The quota of study grant recipients is 19.9 percent. Only 7.4 percent here receive a maintenance grant of an average EUR 678 per month. 12.3 percent receive a conventional study grant of EUR 307. The share of students that receive a conventional study grant is continuously falling here: from 18 percent in the 2009 summer semester to 12 percent in the 2015 summer semester. This can be attributed to the fact that the limits of study funding were not increased since 2008. For this, see the “Studierenden-Sozialerhebung” (Student Social Survey) 2015: Report: Materialien zur sozialen Lage der Studierenden 2016, chapter 10, “Erwerbstätigkeit”, pp. 60 ff.; chapter 14 “Beihilfen”, pp. 71 ff.

63 With just under 24 percent of the relevant age group the quota in Austria is clearly behind the leading countries, whose share (with the exception of Germany with similar education and training structures) is over 40 percent. Austria’s position is negatively influenced here by the structural differences in the comparison countries – delimitation of the higher education sector from the secondary education sector.

64 Bundesregierung (2017): Zusammen. Für unser Österreich. Regierungsprogramm 2017–2022. Vienna, pp. 69 ff.

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the University of Vienna, which rather impressively shows the divergent course of career and salary developments for women and men. Balanced gender relations can be found with assistants, pre-docs and lecturers. Over-represented are women in the senior lecturers group and student employees group. Female quotas of

less than 30 percent can be found with professors and lecturers.<sup>65</sup>

This data clearly shows how fair competition between women and men in science is still not a given, even now in the 21st century. Not the academic qualification, but rather far more a socio-political and social debate, must effectuate an improvement in this current situation.

### Recommendations of the Austrian Council for Achieving the Goals of the RTI Strategy in the Tertiary Education System

The Austrian Council welcomes the commitment in the government programme 2017–2022 to improve study conditions and the budgetary increase specified in the estimated budget for the performance agreement period 2019 to 2021, with which an important step for the implementation of the planned capacity-oriented study place management at the universities was taken. However the Austrian Council urgently recommends the path taken continue to be followed consistently. At the same time, study funding adjusted with the 2017 amendment should also be continuously evaluated and indexed, to guarantee equal opportunity and increase social permeability. The number of those receiving study grants must be significantly increased for this, which would require an increase in the funding rates and limits of study funding.<sup>66</sup> The increases anchored in the estimated budget in this respect are very welcome. However the Austrian Council recommends a revision of the effects of these increases, and a guarantee of the actual increase in the number of recipients.

The Austrian Council also recommends the university spending quota be increased by 2020 to 2 percent of GDP, to guarantee the financing of the required reforms planned by the Federal Government, in particular however the improvement in the supervision ratios at the universities and the massive increase in the number of academic career positions.<sup>67</sup>

The Austrian Council believes it is also necessary to push through measures for the structural further development of the Austrian university area. To this end the tasks and functions of universities and technical colleges must be strategically coordinated with one another more intensively than before. In this respect the Austrian Council supports the Federal Government's goal of driving forward the social requirements-oriented expansion of the technical college sector, and recommends an annual five percent increase in the number of TC study places for this. The goal should be to increase their share by 2040 to approximately 40 percent.<sup>68</sup>

<sup>65</sup> Gender in Focus – Women and Men at the University of Vienna. Gender Equality and Diversity Unit. University of Vienna (2015).

<sup>66</sup> See Austrian Council (2017): Recommendation on the way to the forefront of innovation of 30 November 2017.

<sup>67</sup> The Austrian Council's recommendation on funding research and development in Austria of 30 May 2016; the Austrian Council's recommendation on funding for education, research and innovation in Austria of 5 September 2016; the Austrian Council's recommendation on budgetary priority setting in Austria of 19 December 2016.

<sup>68</sup> See Austrian Council (2017): Recommendation for the further development of the technical colleges sector in the Austrian education and science system of 30 May 2017.

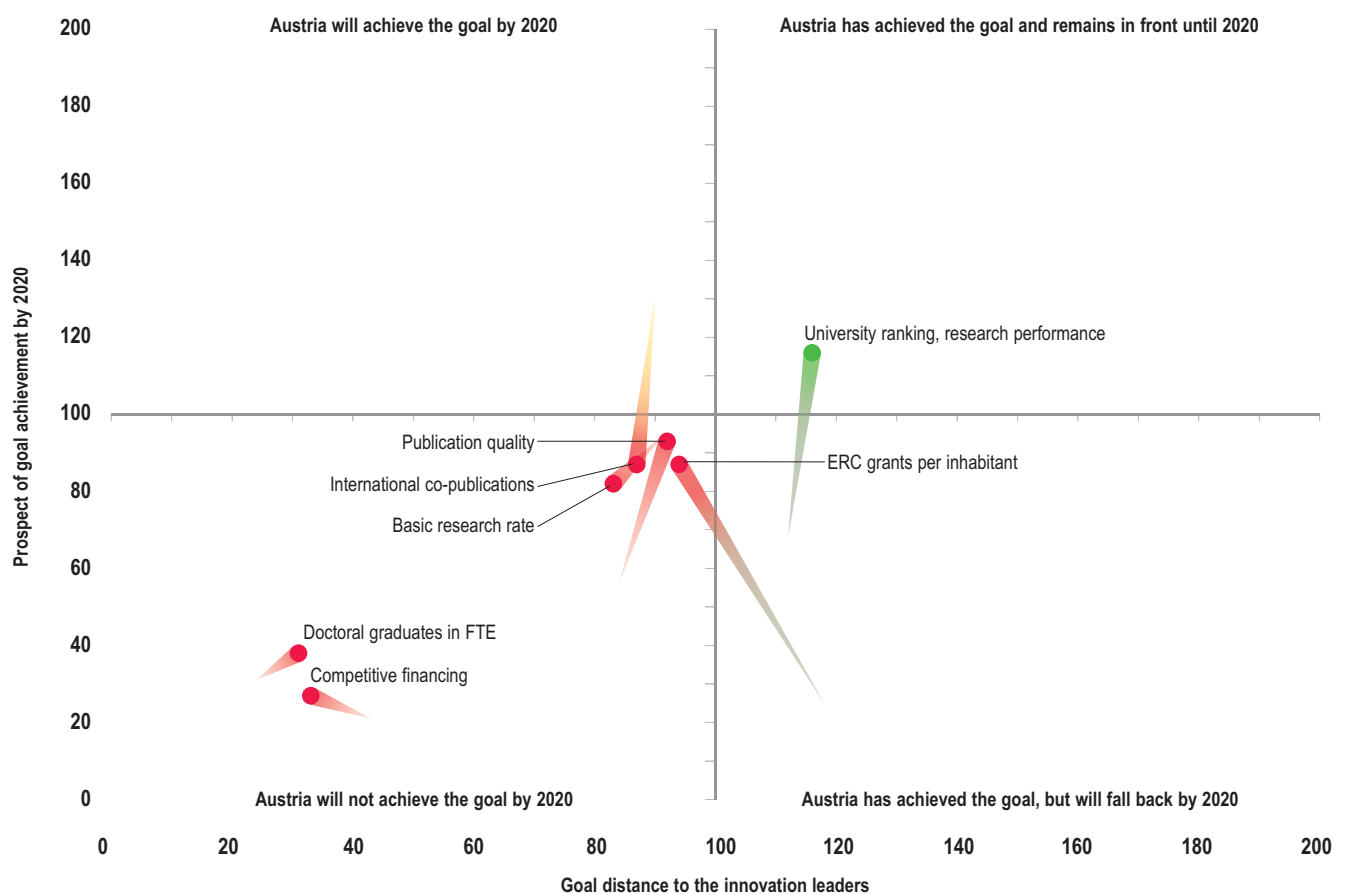
## Research at Universities and Non-University Research Institutions

Figure 15 shows an already familiar scenario: The “Research at universities and non-university research institutions” area effectively remains practically unchanged since 2010. Only one of the total of seven indicators, “University ranking/research performance”, is firmly in the target area or significantly above the average level of the leading innovation nations. This positive performance is contrasted for years now without change by lagging trends behind the level of the innovation leaders in key areas, such as the fi-

nancing of basic research or publication activity. Evidently the performance of the “ERC grants per inhabitants” indicator, key for measuring top quality international scientific research, has declined sharply since 2010, which is largely due to the significantly increased dynamic of the innovation leaders, Denmark, Finland and the Netherlands in particular.

The bibliometric data for the “Publication quality” and “International co-publications” indica-

**Figure 15: Development of the goal distance and the prospect of goal achievement in the area of research at universities and non-university research institutions, 2010 to 2018**



Sources: See Appendix 1, WIFO presentation. Raw data, see Appendix 2. Explanation, see Appendix 3.

Note: Goal distance = Austria actual value compared to the innovation leaders' actual value (average value most recent available year DE, DK, FI, GB, NL, SE);

Prospect of goal achievement = ratio of value projected for Austria in 2020 to the national goal or the value projected for the innovation leaders in 2020.

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tors is actually close to the average of the innovation leaders and therefore close to the goals of the RTI Strategy for 2020. However a declining and insufficient dynamic has for several years indicated an urgent need for action here. As the results of the statistical efficiency analysis (see “Analysis of the Efficiency of the Austrian RTI System” chapter) show, in this respect there is considerable efficiency increase potential, as the leading countries generate their scientific output considerably more efficiently.

There is an additional efficiency barrier in the area of basic research funding, because despite one of the highest R&D quotas worldwide, there is a lack of funds awarded in competition in Austria for this important pillar of the innovation chain. Austria has indeed joined the group of scientific leading countries in the international comparison with the basic research quota, however as the group developed significantly more dynamically in the comparison period, Austria falls back in relative terms. Switzerland and South Korea in particular are some distance ahead of Austria. The target value for basic research is 0.94 percent of GDP. The Aus-

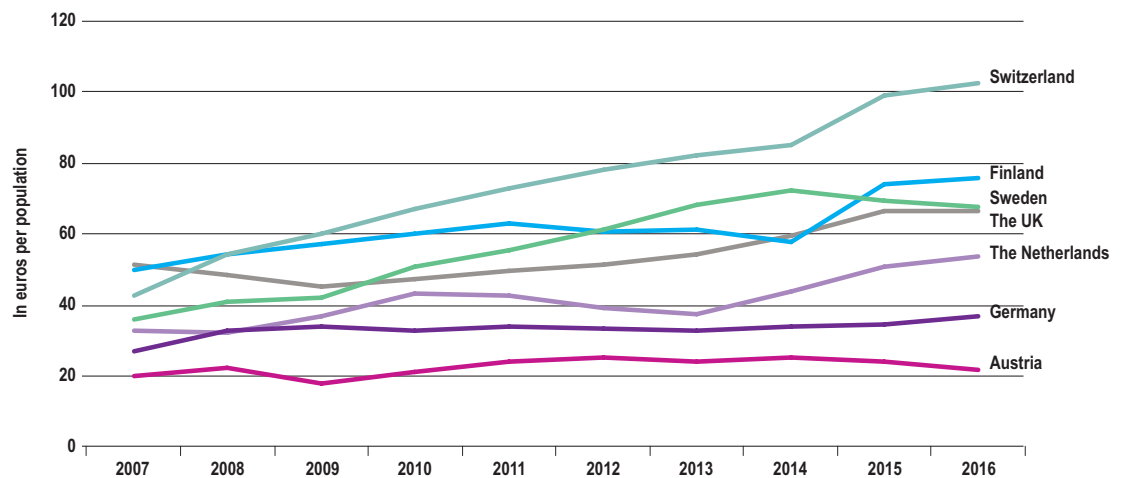
trian basic research quota is currently just half that – with a declining trend.

There has also been a particular catch-up requirement for some time now compared with the leading countries with regard to financing the resources awarded in competition for basic research. Compared with the innovation leaders, and also other research-oriented countries, Austria continues to fall back with 22 euros per inhabitant. Essentially this changes nothing either with the planned budgetary increase for the FWF Science Fund by EUR 110 million for 2018 to 2021, as it is far from sufficient to achieve the level of the comparison countries. This development is extremely alarming, bringing rather poor conditions for the Austria science and research location with it. Funds awarded in competition result in higher research quality, so they could sharply increase efficiency in basic research.

The values for Finland, the UK, the Netherlands and Sweden are about three times as high. Switzerland surpasses Austria in competitive funding of basic research with a continuous, almost five-fold increase in funds over recent years. With more than EUR 100 it is therefore the undisputed leader at the head of the international comparison. On average the innovation

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Figure 16: Development of competitive financing of basic research in euros per inhabitant, 2007 to 2016



Sources: see Appendix 1.

leaders spend approximately EUR 67. Figure 16 also shows how the leading countries continuously increase their corresponding funding, while in Austria there is even a slight downward trend.

The insufficient competitive funding of basic research, coupled with an excessively hesitant reform of the universities in the observation period and an insufficient increase in the number of career positions, certainly does not contribute to bringing talent to Austria or keeping excellent researchers at its universities. This is also confirmed by the result of the efficiency analysis (see “Analysis of the Efficiency of the Austrian RTI System” chapter) and by the “Doctoral candidates with employment contracts” indicator, which is significantly below the level of the leading countries. It remains to be seen if the expansion of structured doctoral programmes with

the EUR 30 million provided as part of the Higher Education Area Structural Funding from 2017 will be sufficient to improve the situation. Further measures for this are certainly required.

It is therefore welcome news that the measures repeatedly called for by the Austrian Council have now also become a political concern: An increase in funding awarded in competition for basic research as part of an excellence initiative is announced in the 2017–2022 government programme. It aims to specifically support outstanding young scientists and to significantly increase the level of funding awarded in competition to universities and non-university research institutions. Both can make an important contribution to improving Austria’s performance with regard to the results of the efficiency analysis.

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### **Recommendations of the Austrian Council for achieving the goals of the RTI Strategy in the area of research at universities and non-university research institutions**

The continuing deficit in competitive funding of basic research compared with the innovation leaders is considerable and acts as an impediment to the performance and international appeal of scientific research in Austria. In order to broaden the spearhead of superb research in Austria and to improve the framework conditions of Austria as a science location, in addition to the increase in the budget for universities for the performance agreement period 2019–2021, the Austrian Council again recommends consistently increasing competitively awarded resources for funding basic research to the level of the leading countries.<sup>69</sup>

To achieve this the Austrian Council recommends developing an excellence initiative, embedded in

Austria’s science and research landscape, which is equipped with considerably more resources, to thus on one hand create more attractive research conditions for domestic and international top executives, and on the other hand to meet the requirements for successful participation in top quality international research.<sup>70</sup>

As an accompanying measure for the implementation of the excellence initiative, the Austrian Council also recommends a strategic expansion of modern research infrastructures with long-term planning horizon. This will require the promotion of research infrastructures across institutions and the bundling of federal and state resources via “Matching funds for research infrastructures”.

<sup>69</sup> See, inter alia, Austrian Council (2017): Recommendation on the way to the forefront of innovation of 30 November 2017; idem (2017): Report on Austria’s Scientific and Technological Capability 2017. Vienna, p. 49 f.

<sup>70</sup> Austrian Council (2018): Recommendation for an excellence programme to promote science as key for more cooperation and competition in basic and top-quality research of 22 March 2018.

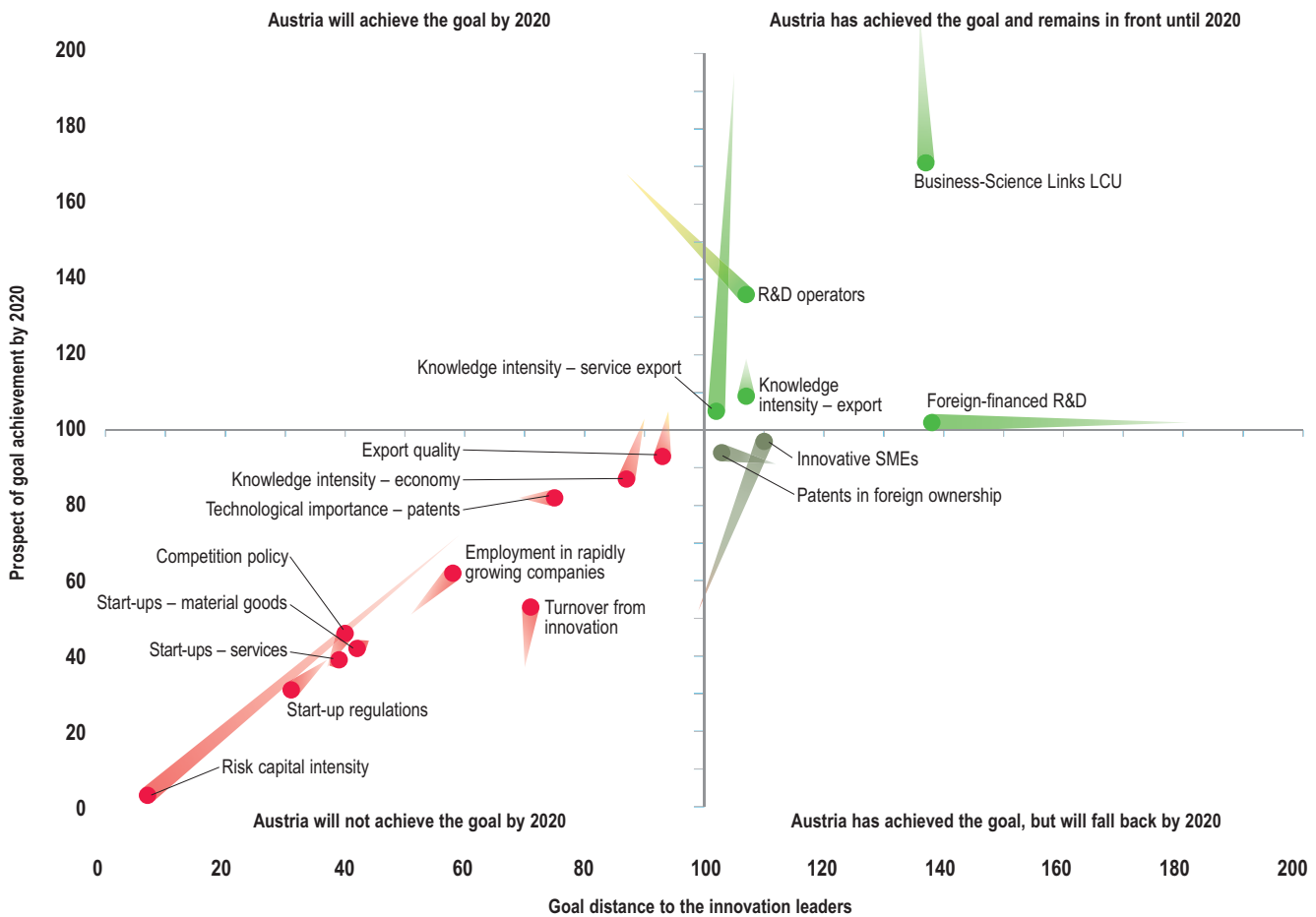
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### Research and Innovation in the Corporate Sector

A look at figure 17 reveals how there is still considerable potential to increase efficiency over the years in the corporate sector as well. Seven indicators are indeed currently above the level of the leading countries. The majority of the indicators continue, however, to be still behind the innovation leaders, and some with clearly neg-

ative trends in places. Taken together this presents a problematic performance barrier for innovation activities, especially in the area of start-up activities, because despite the increased importance of start-ups in political awareness, the start-up dynamic in Austria is still behind the targets of the RTI Strategy. The core reasons for this in par-

**Figure 17: Development of the goal distance and the prospect of goal achievement in the area of research and innovation in the corporate sector, 2010 to 2018**



Sources: See Appendix 1, WIFO presentation. Raw data, see Appendix 2. Explanation, see Appendix 3.

Note: Goal distance = Austria actual value compared to the innovation leaders' actual value (average value most recent available year DE, DK, FI, GB, NL, SE); Prospect of goal achievement = ratio of value projected for Austria in 2020 to the national goal or the value projected for the innovation leaders in 2020.

ticular include the insufficient availability of private financing forms, such as venture capital or crowdfunding, and the adverse bureaucratic, regulatory and taxation framework conditions that entrepreneurs have to deal with in Austria. Costs and the time taken to set up a limited liability company (GmbH), as well as its legal structure, must in particular be emphasized here. Ultimately the start-up regulations in Austria create detrimental framework conditions for start-ups, which is also reflected in Austria's below average score in the efficiency analysis (for this see "Analysis of the Efficiency of the Austrian RTI System" chapter).

This is also confirmed by a current analysis of the framework conditions for innovative start-ups in Austria commissioned by the Austrian Council.<sup>71</sup> On the basis of the information and estimates collected here, it becomes clear that the start-up process in Austria (especially in the international comparison) is characterised by high bureaucracy and significant time and financial strains for Start-Up Founders. The biggest hurdles in the start-up process here are the (as a rule) legally mandatory presence of a notary as a formal requirement, the process for entry in the commercial register, and in general the inflexibility of the limited company (GmbH) legal form.

In this respect the Austrian Council welcomes the de-bureaucratisation regulations brought forward in the current government programme, such as removal of the obligation to publish in the official gazette section of the *Wiener Zeitung* and publication requirements for businesspeople in the Edicts Archive of the Ministry of Justice. These are a first step, but they must go further, as already stated above.

In addition to the start-up regulations, the main weak point here is the availability of private ven-

ture capital, and risk capital in particular. The trend is still declining here, and a change by 2020 cannot be expected under the current conditions (see figure 17). Despite the specific measures of the public sector, the *Start-Up Fund* transacted by awfs, the *Business Angel Fund* and the *Venture Capital Initiative*, for example, to counter the supply problem, Austria's position in the international comparison has not improved, but rather has even deteriorated. This is also confirmed by the results of the GEM 2016 Austria Report. The experts surveyed believe when it comes to the financial environment for start-ups, Austria is at the bottom end of the field of the European comparison countries.<sup>72</sup> As already stated several times, there is a particular deficiency in internationally competitive framework conditions, which would be a requirement to enable institutional investors in Austria to invest in this area.<sup>73</sup> There is scarcely any progress to speak of here. There are still no plans for a private equity legal framework. Added to this is the fact that the Austrian funding system for innovative start-ups in the international comparison may be very comprehensive, but it is characterised by a high level of complexity and lack of transparency (for this see also the "Governance and Financing of the RTI System" chapter). The observable political practice of launching small, subcritical funded programmes for reasons of public perception of the costs of established, well-functioning mechanisms is problematic here. A streamlining and a re-structuring would be urgently required here to make access to the system easier for potential Start-Up Founders.

The Austrian Council believes the further formulation of the innovation and funding concept with the establishment of regulatory "sandbox-

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71 Ruhland, S. / Kaufman, J. (2017): Analyse der Rahmenbedingungen, Hemmnisse und Hindernisse für innovative Unternehmensgründungen in Österreich. Study commissioned by the Austrian Council.

72 Global Entrepreneurship Monitor 2016. Report on the entrepreneurship situation in Austria.

73 Jud, T. (2013): Functional model and framework condition of risk capital financing. In: WIFO-Monatsberichte 2013, 86(8), pp. 663-672.



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es” for innovative companies announced in the government programme, the specific funding of business model innovations and the funding of test environments and test labs are also positive steps. With regard to the confirmed expansion of the GIN programme, however, it should only go ahead after the evaluation of success to date has been presented.

This is, however, not only about the increase in start-up numbers anchored in the RTI Strategy, but rather also and especially about their development over the course of time, if we want to benefit from the economic effects associated with them (employment, economic dynamic, competitive head start). The first years of a start-up in particular see especially high risk and a high number of company closures. According to the Austrian credit protection association (KSV), founded in 1870, more than one third of new start-ups do not survive the first three years. It also believes the reasons for failure are mostly a lack of business expertise and insufficient planning.<sup>74</sup> There would therefore be no point in increasing the number of start-ups while they still have no access to upscaling (demonstrator development, prototypes, etc.) and markets. It is also true in most cases that the networking of small companies with big ones is very effective. But please note, it is in the nature of start-ups that many also “fail”. The essential message here should therefore not be to “try to reduce failures”, but rather to promote the growth of promising ventures.

Provision of secure, primarily private follow-up financing is also required in this respect. Location Austria’s low level of activity means, however, there is a lack of private venture capital in the country.<sup>75</sup> The body politic is urgently re-

quired to create more attractive framework conditions here, both to bring investors to Austria, and to mobilise potential private Austrian investors, such as appropriate legislative and taxation framework conditions for private equity – with an improvement in the quality of the Austrian capital market and assessment stipulations of pension and insurance funds, for example.<sup>76</sup> In this respect the Austrian Council welcomes the current initiative in the new Federal Government’s programme to promote alternative financing methods with the expansion of funds-of-funds models and easier tax processing of private investments in higher risk projects.

The start-up numbers in the services area and jobs in rapidly growing companies do indeed show slightly positive trends, but it would be wrong to expect target attainment by 2020. Start-up activities in the material goods area on the other hand are declining, as is the economy’s knowledge intensity. Technologically important patents have developed slightly positively in their dynamics, however are still behind the innovation leaders. With patents in foreign ownership, Austria is currently still ahead of the innovation leaders, but with trends staying as they are it will be surpassed by 2020. The same applies for innovative SMEs, which, however, show a positive development trend. The Austrian medium sector is increasingly more innovative and therefore significantly contributes to increasing the national innovation performance due to the small-scale structure of the Austrian economy. This is also reflected in the increasingly positive development trend of sales generated with innovation. The previous “lighthouse” in the corporate area (the cooperation between science and leading companies) is still well ahead of the innovation leaders’ average, but has lost positive dynamic.

<sup>74</sup> DiePresse.com on 12 August 2010. Jungunternehmer: Ein Drittel scheitert in ersten 3 Jahren.

<sup>75</sup> Der Standard on 18 May 2016. Start-ups: Noch immer wenig privates Risikokapital in Österreich.

<sup>76</sup> See, inter alia, Peneder, M. (2013): From the “dry valleys” of venture and growth funding. In: WIFO-Monatsberichte, 86 (8); pp. 637-648.

## Recommendations of the Austrian Council for achieving the goals of the RTI Strategy in the area of research and innovation in the corporate sector

The Austrian Council recommends the funding package for start-ups be better coordinated and access for entrepreneurs be made easier. Just a few programmes of critical financial spending should be offered. The adjustment of existing measures should take priority here over the creation of new programmes. More intensive communication and publication work are also required here, as is increased coordination between the funding offer service and the advisory service.<sup>77</sup>

The Austrian Council recommends setting up a central and highly visible contact point for innovative entrepreneurs for each region (with the appropriate adjustment of the existing AplusB centres or adjustment of the services of the Economic Chamber's start-up service) and that the bureaucratic and regulatory framework conditions for funding start-ups must also be continuously improved. In a first step, the (as a rule) legally mandatory presence of a notary as a formal requirement should therefore be done away with, the inspection obligation of the register court should be limited and a liberalisation of the share classes with limited companies should be introduced.

The Austrian Council supports measures to further reduce debt relief after insolvency and liq-

uidation times for honest entrepreneurs, so that failed start-ups get a second chance quicker than they used to.<sup>78</sup> For this reason, the current move towards the amendment on personal bankruptcy in the Federal Government's Work Programme is also very welcome.

The Austrian Council recommends a tax relief and support with social security funds in wage moderation. It therefore welcomes the incidental wage costs promotion recently rolled out by aws. This is however conceived as promotion and restricted to three years. To also ensure structural effects, this measure should be arranged as a permanent aid in the form of a basic waiver and a reduction in incidental wage costs in the first years.<sup>79</sup>

In addition to funding by banks, the Austrian Council also recommends developing funding options for innovative entrepreneurs and SMEs. A suitable framework is required to increase equity capital intensity from the private side, such as appropriate legislative and taxation framework conditions for private equity, an improvement in the quality of the Austrian capital market and assessment stipulations of pension and insurance funds, for example.

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77 See Austrian Council (2016): Report on Austria's Scientific and Technological Capability 2016. Vienna, pp. 32 ff.

78 See European Commission (2014): Trade and Industry, SBA data sheet 2014, AUSTRIA.

79 Austrian Council (2018): Recommendation for the improvement of the framework conditions for starting innovative companies in Austria of 22 March 2018.

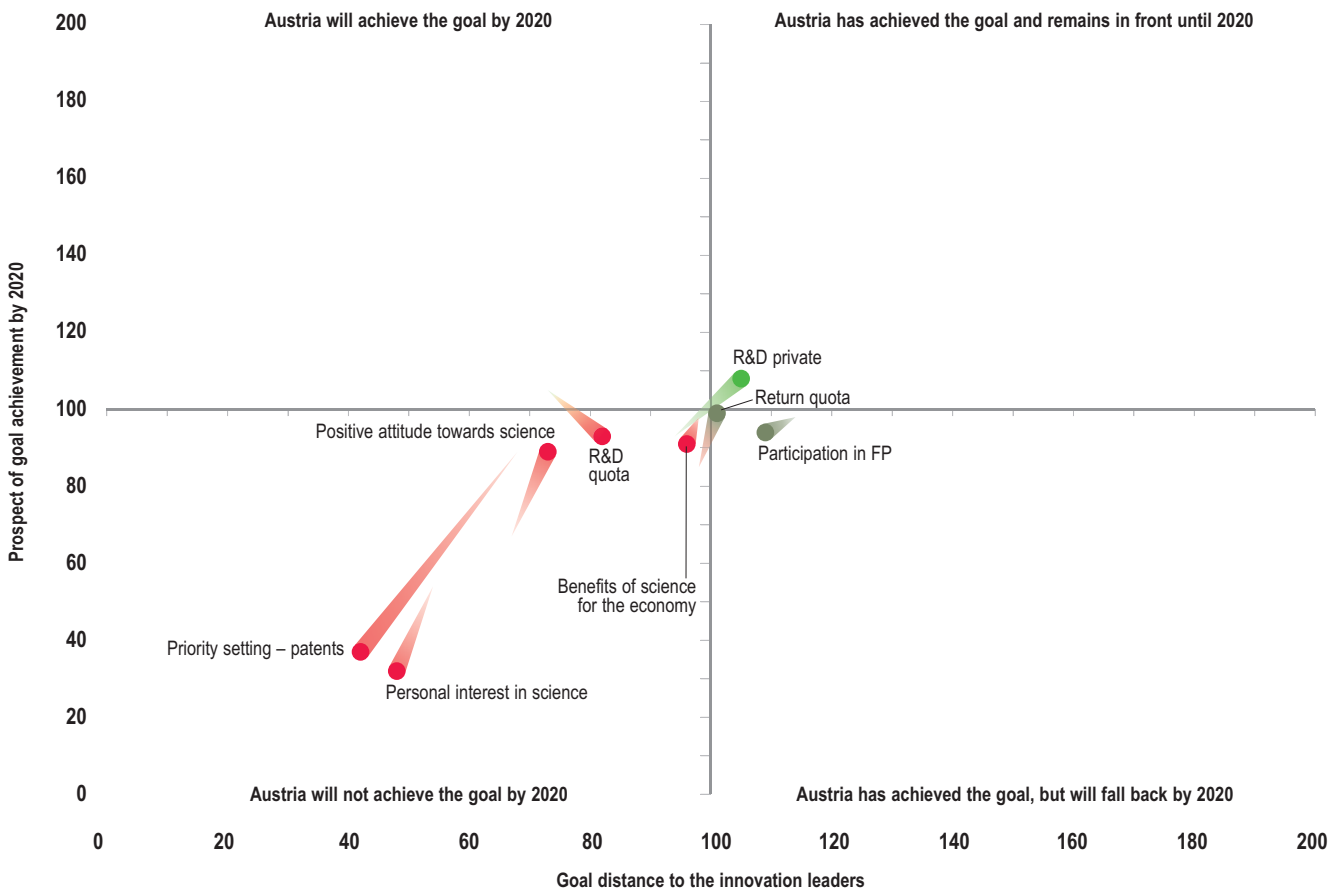
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### Governance and Financing of the RTI System

Figure 18 shows how Austria's performance in the area of governance and financing of the RTI system is clearly behind the level of the innovation leaders. Clearly it has not been possible to substantially change the situation over the comparison period and increase Austria's performance. It is therefore welcome news that a number of the objectives and measures of the government pro-

gramme directly address this subject area, and the Austrian Council believes they will improve the efficiency of the Austrian RTI system and innovation performance. This is urgently required because the level of most of the indicators is below that of the leading countries. Austria's EU Council Presidency coming up in the second half of 2018 will bring with it important pointers for the future cornerstones of

**Figure 18: Goal distance and prospect of goal achievement in the area of governance and financing of the RTI system, 2010 to 2018**



Sources: See Appendix 1, WIFO presentation. Raw data, see Appendix 2. Explanation, see Appendix 3.

Note: Goal distance = Austria actual value compared to the innovation leaders' actual value (average value most recent available year DE, DK, FI, GB, NL, SE); Prospect of goal achievement = ratio of value projected for Austria in 2020 to the national goal or the value projected for the innovation leaders in 2020.

the European Research Area. The domestic research community sees itself faced with higher competition from Southern and Eastern Europe in the competitive contest for European funding. The return quotas that recently rose sharply could therefore fall in coming years, which would be explained by the increased competitiveness of these countries. It is therefore all the more important to maintain and expand the established structures for supporting and advising researchers. References and scientific capital must be built up to be able to participate as project partners at European level. The national funding mechanisms for domestic institutions are therefore essential and must be coordinated in this direction with regard to future EU projects. The redesign of the RTI Strategy anchored in the government programme must satisfy these requirements and create the appropriate strategic basis with high planning security with regard to framework conditions, objective and financing.

In this respect the Austrian Council expressly welcomes the Federal Government's plans to update the RTI Strategy.<sup>80</sup> The first important steps for this have been introduced with the continuous analysis process of Austrian innovation performance by the OECD and the planned publication of the OECD Review of Innovation Policy for the end of 2018. As part of the strategy development, the Austrian Council believes special attention should be paid to the

continued increase in innovation efficiency. The planned set-up of an annual Federal Government RTI summit, repeatedly recommended by the Austrian Council, is also welcomed.<sup>81</sup> The topics of research, technology and innovation will consequently be awarded more political focus than was previously the case. It can also be used to initiate an active and comprehensive RTI policy reform process and strategically drive forward the implementation of the new RTI Strategy under the direction of the Federal Chancellery and in cooperation with all ministries responsible for RTI.<sup>82</sup>

The Austrian Council has referred various times to the high complexity and in places excessive diversification of the research funding system.<sup>83</sup>

The Court of Auditors has also drawn attention several times to the problem, most recently, for example, with regard to the fragmentation of the Federal Government's research programme.<sup>84</sup>

The domestic performance in terms of an input-output consideration exhibits very clear weaknesses compared with other countries: In addition to tendencies to over-regulate, these in particular include fragmentations, unclear responsibilities and a complex, non-harmonised body of rules for individual mechanisms. This problem is addressed in the government programme and, among other things, the unbundling of the interfaces between ministries and agencies is topicalised, which is considered an important

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RTI Strategy Objectives  
See Appendix on page 110

80 Bundesregierung (2017): Zusammen. Für unser Österreich. Regierungsprogramm 2017–2022. Vienna, p. 76 f.

81 See, inter alia, Austrian Council (2013): Weißbuch zur Steuerung von Forschung, Technologie und Innovation in Österreich. Vienna, pp. 22; idem (2015): Report on Austria's Scientific and Technological Capability 2015. Vienna, pp. 69 f.; idem (2017): Recommendation on the way to the forefront of innovation of 30 November 2017.

82 See Austrian Council (2017): Recommendation on the way to the forefront of innovation of 30 November 2017.

83 See Austrian Council (2013): Weißbuch zur Steuerung von Forschung, Technologie und Innovation in Österreich. Vienna, pp. 11 ff.; idem (2015): Report on Austria's Scientific and Technological Capability 2015. Vienna, pp. 60 ff.; idem (2017): Recommendation on the way to the forefront of innovation of 30 November 2017.

84 Rechnungshof (2018): Development of selected federal research programmes. Reihe Bund 2018/12; idem (2016): Forschungsfinanzierung in Österreich. Reihe Bund 2016/4.



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step towards increasing the efficiency of the funding system with the further measures implemented by the Austrian Council.<sup>85</sup>

Researchers believe, however, that both improved transparency of the offers and a significant revision of the multitude of funding criteria, guidelines and accounting criteria are required. A considerable amount of the work in projects is dedicated solely to excessive verification management. The level of complexity for documentation is high, and with the use of various funding mechanisms it is not only extremely work-intensive, but rather also requires special solutions, as conflicting criteria are demanded in places. Making research funding more attractive and improving the ratio of input to output therefore then require a holistic consideration of the current status, or in any case a radical revision of the regulations on all levels, especially the many, mostly piecemeal regional funding mechanisms as well. In addition to simplification and work reduction, the emerging legal certainty could also reduce the frequency of errors and increase the input-output ratio.

In another context this could also contribute to overcoming the efficiency barriers of the RTI system, as the general public's attitude to science and research also makes its contribution to increasing the significance of the policy area and therefore pushing through the required setting of political and budgetary priorities. The sometimes worrying developments in the international political arena with regard to the importance of science and evidence-based knowledge acquisition should illustrate the relevance of science and research's dialogue with the general public even more than it has in the past. The three relevant indicators ("Personal interest in science", "Positive attitude towards science" and "Benefits of science for the economy") in figure

18 reflect the continuing low personal interest in science, and the assessment of the benefit of knowledge acquisition requires massive efforts by Austria in this area. Research funding mostly only includes dissemination in the faculty and only marginally considers the discourse with the general public. A change in evaluation criteria for researchers could have greater bearing on this aspect and, for example, have an influence during the course of a doctorate and habilitation. An incentive system on compensation via ECTS would entail low costs and could contribute, for example, to increasing awareness of the importance of science, research, technology and innovation, as well as intellectual property and knowledge acquisition among large swathes of the population.

The funding of research, technology and innovation is an important cornerstone in achieving the objectives of the RTI Strategy. As figure 18 shows, sufficient dynamic is not identified with the key indicator for financing, the R&D quota, to achieve the national goal of a 3.76 percent R&D quota by 2020, even if the quota in the international comparison is already above average high and the dynamic has improved with the "R&D private" indicator compared with previous years. This observation is confirmed by recent study results, which outline the required path to achieving the research quota goal.<sup>86</sup> An increase in R&D expenditures from EUR 11.3 billion by 38.5 percent to EUR 15.7 billion by 2020 would be required to achieve the targeted 3.76 percent, assuming a starting value of 3.06 percent (postulated at the time the study is published). With a steady closing of the gap to the public sector target share of one third (36.6 percent to be precise), the public sector financing of the spending would have to increase from EUR 4.1 billion by 26.1 percent to EUR 5.2 billion; private from EUR 7.2 billion by 45.7 percent to EUR 10.5 billion (see figure 19).

<sup>85</sup> Bundesregierung (2017): Zusammen. Für unser Österreich. Regierungsprogramm 2017–2022. Vienna, pp. 77 ff.

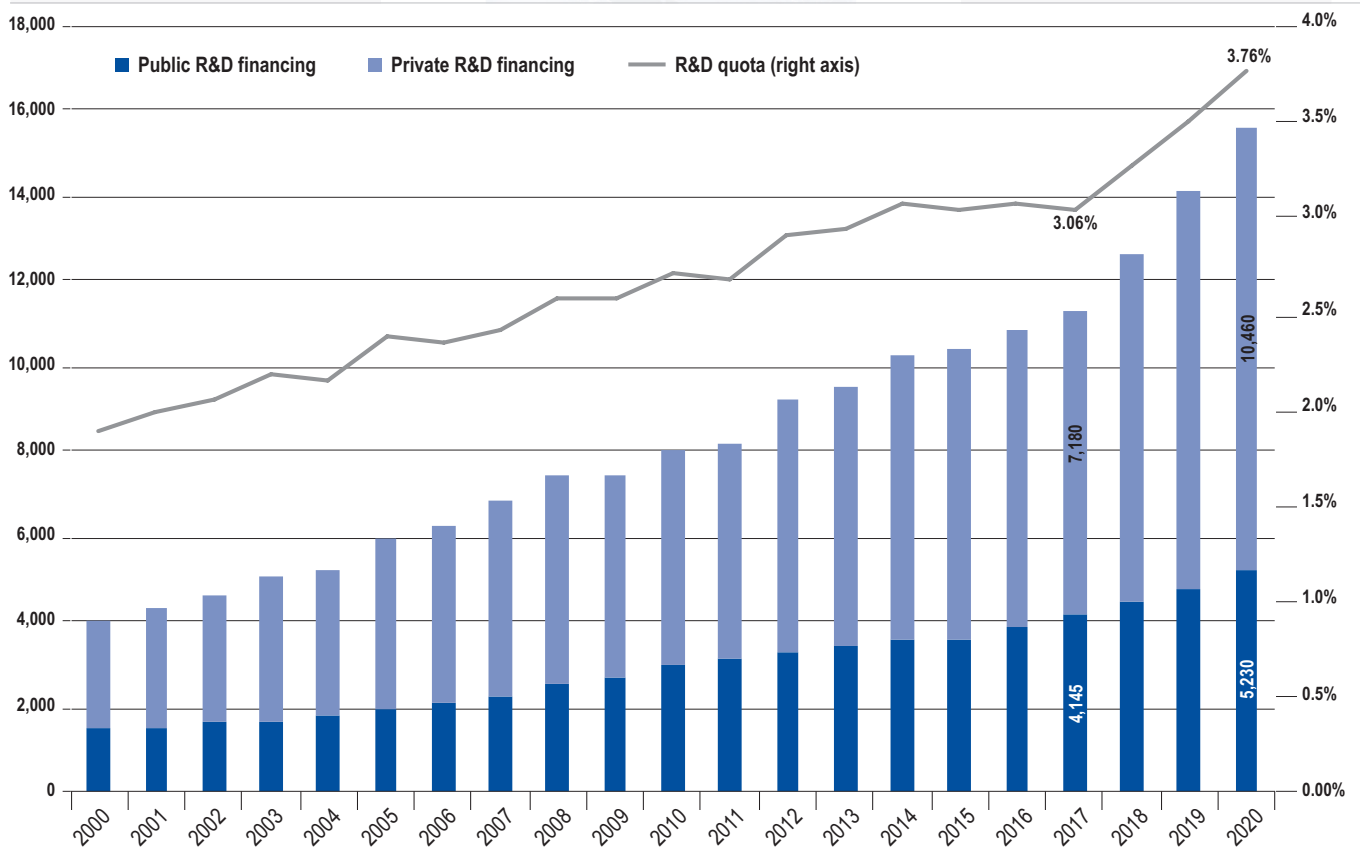
<sup>86</sup> Strauss, A. / Janger, J. (2018): Forschungsquotenziele 2020. Study commissioned by the Austrian Council. Vienna, WIFO.

The figures of the estimated budget of 21 March 2018 imply that the increase rates of the public sector share (assuming all other factors remain the same) are not sufficient to achieve the goal of a research quota of 3.76 percent. The funding gap will not get smaller either, which is why it is unlikely that Austria can achieve the quota it has set itself in the RTI area.

The size of the “gap” to the target value is also interesting. It is currently at 0.36 percentage points (2014: 0.05; 2015: 0.14, 2016: 0.24) or EUR 1,316 million (2014: EUR 171 million; 2015: EUR 461 million; 2016: EUR 851 mil-

lion) and 7.1 percent of the estimated global spending and has increased further due to the nominally sharply increasing GDP in particular. In optimistic and pessimistic scenarios with current trends continuing as they are, WIFO calculates the probable size of the R&D quota in 2020 (while including the usual confidence intervals and uncertainty factors): In the optimistic variant the R&D quota in 2020 achieves a value of 3.29 percent, 0.47 percentage points below the target value, but higher, for example, than in Germany or Denmark at the mo-

**Figure 19: Financing path to achievement of the R&D quota target of 3.76 percent in 2020, in EUR millions**



Source: WIFO research rate targets 2020. The calculation is based on an R&D quota of 3.06 percent in 2017 assumed at the time of publication. According to Statistik Austria's global estimate of 19 April 2018 the quota was actually at 3.16 percent.



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ment; in the pessimistic scenario the value is 2.98 percent, whereby it would fall back below the starting level.

Regardless of the actual development of the quota, the new RTI Strategy should allow for a reformulation of the quota target, which is oriented on the Austrian industrial structure.<sup>87</sup> Some thought might even be given to completely replacing input goals with output goals, to counter the existing trends towards input-oriented control and to focus even more on the effectiveness and efficiency of R&D investments.

With regard to the innovation efficiency priority issue, once again reference must be made at this point to the fact that, in addition to the complexity and lack of transparency in research funding with the resulting friction losses, for years now divergent development trends with regard to the public and private financing shares on one hand, and the funding of basic research and applied research on the other hand, both result in imbalances in the distribution of funds. These must also be identified as significant efficiency barriers for the RTI system.

Firstly there is an imbalance with the pro rata distribution of R&D expenditures. The shares in overall spending for R&D of EUR 12.3 billion for 2018 forecast by Statistik Austria have indeed, as intended by the RTI Strategy, developed in the right direction, however the goal of a ratio of 30 percent public to 70 percent private funding was not achieved. According to the 2018 global estimate, the public share in R&D expenditures is 34.6 percent, so the private share, that is the corporate sector including shares from abroad, contributes 65.4 percent. The national goal of the RTI Strategy has therefore not been

achieved. Although the private funding share in Austria is slightly above the average level of the innovation leaders, most of the leading comparison countries actually have a funding structure of close to 30 to 70.<sup>88</sup>

At the same time business spending in Austria for R&D is financed more by the public sector than in the leading innovation nations. The state-financed share of the funding of corporate research in 2015 (last available year with comparison figures) in Austria was 0.27 percent of GDP and therefore approximately 0.1 percentage points of GDP higher than the average of 21 EU countries.<sup>89</sup> Compared with this the corresponding shares with the innovation leaders – Switzerland (0.03), the Netherlands (0.17), Denmark (0.13), Germany (0.07), Finland (0.07), the UK (0.23) and Sweden (0.13) – are all significantly lower, and this still before the increase in the research premium from 10 to 12 percent in 2016.<sup>90</sup>

On the other hand the growth in basic research in Austria was lower than the growth in public sector funding for corporate research and the growth in public sector financing of R&D at universities and non-university research institutions was lower than the growth of public sector financing of corporate R&D. Furthermore, with public sector R&D expenditures there is also an imbalance between core funding and funding awarded in competition, which should be corrected in the interests of increased competitiveness.

Ultimately an imbalance in the budgetary priority setting at federal level can be seen on the whole, because only 13.4 percent of direct federal funds go into the RTI area, compared with 26 percent for agriculture and forestry or 22 percent

87 The R&D quota target could be defined, for example, with an R&D quota adjusted to the industrial structure, or an adjusted quota could specify bands for the unadjusted R&D quota.

88 For this, see Statistik Austria (2018): Research and experimental development in the international comparison, SB 8.1, p. 22.

89 See <http://www.oecd.org/sti/rd-tax-stats.htm>

90 Data source: OECD Main Science and Technology Indicators. The figures refer to the last available year. For this, see also Deutsches Institut für Wirtschaftsforschung Berlin (2016): Funding of private research and development in OECD countries: always more, but always less efficient. DIW weekly report no. 8/2016, p. 149–157.

for social security.<sup>91</sup> A revision of the appropriate use of funding in the RTI system and elsewhere will therefore be unavoidable to produce an appropriate forward-looking approach for public sector funds.

Due to the restrictive data situation in Austria, however, an analysis of the overall efficiency of the funding system is currently only possible within limits. However, meaningful information about the mechanisms of action of the devices used and their interactions, and especially of those between the sharply increased research premium and direct funding, would be required to increase funding efficiency. This also requires an adjustment of the Federal Statistics Law, to enable scientific access to corporate microdata while still respecting all data protection requirements according to the international example. Without the relevant basics it will not be possible to revamp and make the system for public sector research funding more efficient in terms of the required future orientation of state spending.

It is therefore welcome news that the government programme will afford a prominent posi-

tion to the area of financing RTI activities. With the implementation of the Research Financing Act already anchored in the RTI Strategy, an agreement on research and development will be adopted, which ensures long-term RTI financing and guarantees more planning security.<sup>92</sup> In addition to a reduction in bureaucratic hurdles, this will therefore also entail a continuous annual increase in federal research spending, to actually achieve the Government's targeted research quota of 3.76 percent. This announcement is a true innovation in the Austrian RTI policy and is expressly welcomed by the Austrian Council, because it for the first time guarantees long-term planning security. However, as Austria's R&D quota is already above average, structure reforms that enable a more efficient and more effective use of resources must be linked with this increase. The Austrian Council therefore also welcomes the fact that the government programme intends to give preference to awarding the additional public funding in competition, where systemically possible.

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### **Recommendations of the Austrian Council for achieving the goals of the RTI Strategy in the areas of governance and financing**

The Austrian Council recommends affording greater attention to an increase in the efficiency of research funding in the future than was previously the case. This will require the consistent removal of obvious efficiency barriers, such as overlapping multiple structures, over-regulation, fragmentations, unclear responsibilities and a complex, non-harmonised body of rules for individual mechanisms. Necessary reforms should be worked out with the inclusion of relevant stakeholders, such as research institutions, industry and essential users, and should target the simplification of funding structures and

processes, and above all guarantee legal certainty. The holistic consideration in the interests of multi-level control will raise the potential of all mechanisms and ensure a more efficient interaction of EU level, national programmes and regional funding. A further concentration of research-specific spending on fewer organisational units is also required, as is a reduction in the number of funding programmes. The practice of updating once established mechanisms without limit should be consistently scrutinised, and financially ineffective programmes should be bundled. A further reduction in the number of fund-

91 For this see Parliamentary Budget Office (2017): Funding Report 2015. Vienna, p. 13.

92 Bundesregierung (2017): Zusammen. Für unser Österreich. Regierungsprogramm 2017–2022. Vienna, p. 77.



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ing agencies should be reflected at state level in particular, but at federal level as well.<sup>93</sup>

The Austrian Council recommends pushing through suitable initiatives that contribute to increasing the importance of science and research among the general public. An incentive system should also be designed, which rewards the participation of scientists in the dialogue with society and in public discussions within the scope of their scientific careers.

The Austrian Council welcomes the research funding act anchored in the government programme, with which the medium to long-term stability of RTI funding in Austria will be secured. In this context it also recommends a revision of the appropriate use of funding in the Austrian RTI system. Due to the low output efficiency compared with the innovation leaders (with given above-average inputs), the Austrian Council recommends this ratio be examined in even more detail, especially with regard to how Austria can improve in innovation efficiency

terms (for this see the “Approaches to increasing innovation efficiency” chapter). For this purpose the Austrian Council once again recommends an improvement in the access to and scientific use of federal statistics data.<sup>94</sup>

To increase innovation efficiency, the Austrian Council also recommends a concentration of public resources and mechanisms to increase the incentive effect on private R&D expenditures, whereby the ratio of the public to private funding share could develop from 34.6 to 65.4 percent at the moment further towards 30 to 70 percent. The ratio between awarded in competition and core financed public funds should also be shifted in favour of the awarded in competition share.

As only 13.4 percent of all direct federal funding in Austria flows into R&D, the Austrian Council also recommends a revision of the budgetary priority setting. The goal must be to make state spending significantly more future-oriented. Special focus should also be afforded here to the competitive awarding of funds, especially for basic research.

<sup>93</sup> See, inter alia, Austrian Council (2017): Recommendation on the way to the forefront of innovation of 30 November 2017.

<sup>94</sup> Austrian Council (2017): Recommendation on the way to the forefront of innovation of 30 November 2017.



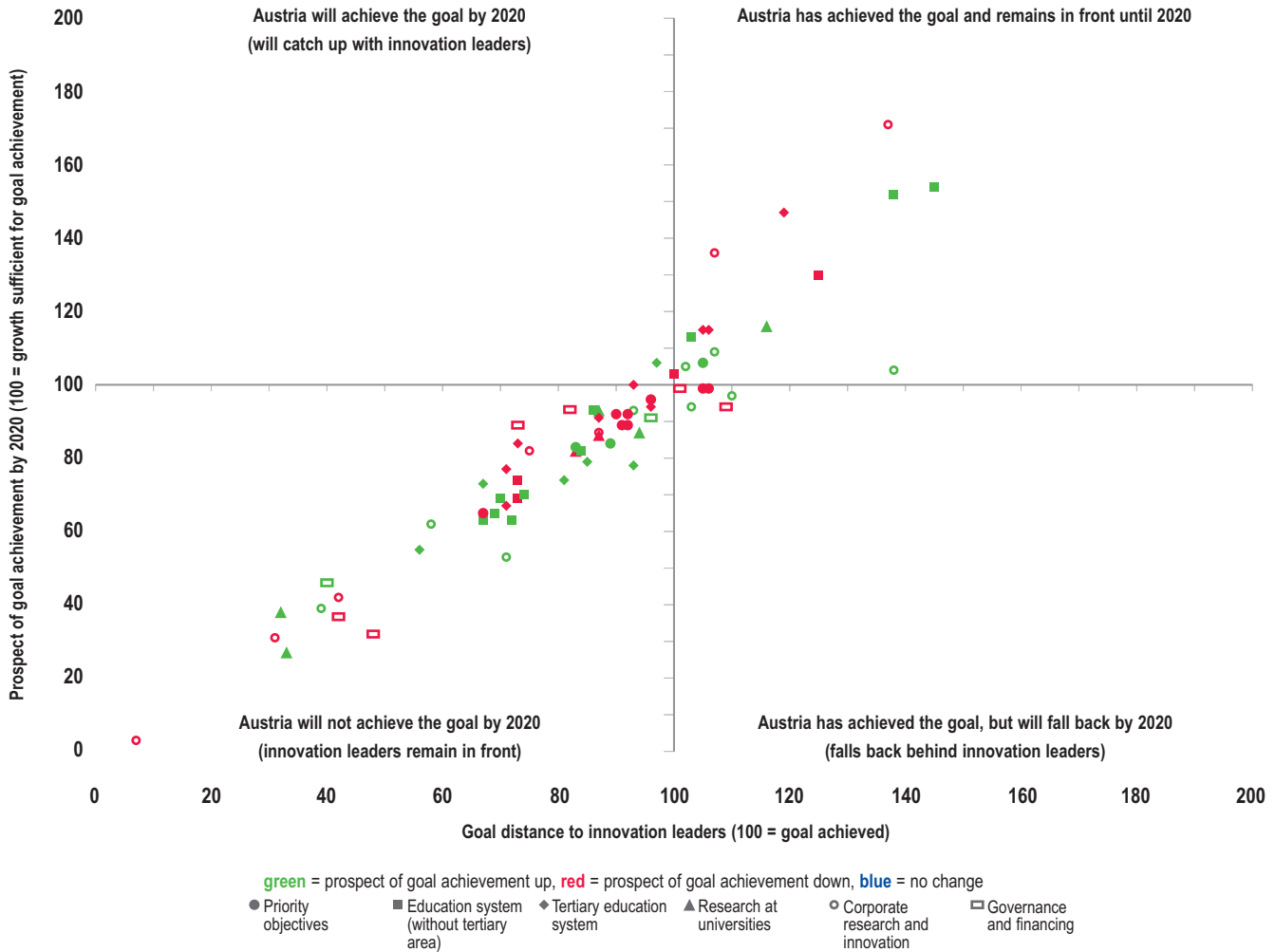
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## Key Results

The analysis of the input-output ratio performed for this report, whose results were presented in the “Analysis of the Efficiency of the Austrian RTI System” chapter, clearly shows that Austria is not

among the efficient countries in any area of the RTI system. Although it is not in the bottom third in any area either, Austria’s innovation efficiency is nonetheless significantly below the average level of the innovation leaders. The re-

**Figure 20: Overview of Austria’s performance in all areas of the RTI Strategy in relation to the innovation leaders**



Sources: See Appendix 1, WIFO presentation. Raw data, see Appendix 2. Explanation, see Appendix 3.

Note: Goal distance = Austria actual value compared to the innovation leaders’ actual value (average value most recent available year DE, DK, FI, GB, NL, SE); Prospect of goal achievement = ratio of value projected for Austria in 2020 to the national goal or the value projected for the innovation leaders in 2020.

sults show Austria's familiar strengths and weaknesses and those of the comparison countries in detail.

In the science area the USA, the UK and Switzerland are the leading countries, whereby they not only achieve high outputs, but rather also use their inputs relatively efficiently for this. Austria ranks only 17th with this appraisal. In the areas of technology and innovation it is the patent-intensive, strong exporting countries, Japan, Germany and again Switzerland, which take the top places among the leading innovation nations with regard to an efficient conversion of input to output. In the technology area Austria is ranked 13; in the innovation area 18. There is therefore considerable potential in all three areas to increase the efficiency of the Austrian RTI system.

Austria's potential to accelerate its outputs in this respect is between 16 and 37 percent. If it did manage to use its input with similar efficiency to that of the countries identified as efficient, Austria could increase its output in the science area with the same input by 16 percent. In the technology area, Austria's potential to increase its output is even 37 percent, and in the innovation area it is 17 percent. Austria therefore has room for manoeuvre in all areas, to achieve more output with the given resources. Among the innovation-strong countries, Germany and Switzerland are constantly efficient. South Korea and Japan also rank right at the top; however, data availability is limited with these countries. Among the catching up countries the Czech Republic, Hungary and Slovakia are continuously efficient. The analysis also shows that, in very general terms Switzerland and Germany in particular, as well as Ireland in science and the Netherlands in the technology area, can be considered reference countries for Austria. These are the efficient countries that Austria is closest to with regard to its input-output combination, and whose RTI systems are easiest to compare with Austria's, which makes them realistic benchmarks.

The areas of science, technology and innovation examined in aggregated form with the efficiency analysis were also discussed in differen-

tiated form in the Austrian Council's previous reports. A set of indicators oriented on the elements of the RTI Strategy and which enables illustration of a trend development from 2010 to today, which also allows conclusions on the effects of the implementation activity of the RTI Strategy, was used for this. The detailed results of this indicator-supported analysis are addressed in the "Evaluation of Austria's Performance Relative to the Goals and Measures of the RTI Strategy" chapter.

Figure 20 provides a summarised overview of this analysis and the performance of the Austrian RTI system in relation to the leading innovation nations. It maps all 74 indicators for the objectives of the RTI Strategy in the comparison with the average level of the innovation leaders. The figure illustrates the areas in which the goals of the RTI Strategy have already been achieved and Austria's performance and development dynamic is better than that of the innovation leaders – all indicators in the right top quadrant – and in which it is behind the leading nations, and with development trends remaining as they are, has no realistic chance of achieving the level of the leading nations by 2020 (all indicators in the left bottom quadrant).

The figure also shows that the greater part of the indicators is in the left bottom quadrant. This overall situation has not changed much since 2010. This means that Austria's catch-up dynamic is insufficient on the whole to achieve the goals of the RTI Strategy and the level of the innovation leaders. Those areas that will not achieve their objectives by 2020 as they currently stand, predominantly affect the problem areas of the Austrian RTI system already addressed several times by the Austrian Council, in the education system, at the universities, with innovative start-ups and in research funding.

The overview in table 4 illustrates the insufficient level of goal achievement with regard to the objective of the RTI Strategy. On the whole, positive trends can only be seen in about half of the target areas, that is, only 49 percent of the indicators show an improvement in the goal

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distance and prospect of goal achievement. Across and beyond all areas the average goal distance (86) from the innovation leaders (=100) has remained almost unchanged compared to 2010 below the dynamic required to achieve the goal. It is therefore quite clear that the development process of all indicators is currently insufficient, and with Austrian innovation performance, on the whole there are still catch-up requirements if the goals of the RTI Strategy are to be achieved by 2020. Compared with the base year 2010 the overall findings have deteriorated on the whole. For all 74 indicators for measuring the goal achievement of the RTI Strategy, taken together the prospect of goal achievement has not changed, and the average goal distance has grown slightly by one percent. Comparable positive develop-

ments can only be seen for two areas of the RTI Strategy: the education system (without tertiary area) and basic research. In these two areas goal distance and prospect of goal achievement have improved since 2010 with close to two thirds of the indicators. In the corporate research area there were positive changes with approximately half the indicators; in the other areas only less than 40 percent of the indicators improved. On the other hand the level of 60 percent of the indicators has fallen since 2010 in the areas of priority objectives and tertiary education. The area of “Research at universities and non-university research institutions” currently scores the worst. Goal distance (77) to the leading nations continues here at the highest and the prospect of goal achievement (76) at the lowest.<sup>95</sup> This situation could however improve significantly in the future. With an unchanged trend

**Table 4: Overview of the average goal distances and prospects of goal achievement and changes in comparison with 2010**

|                          | Number of objectives | Average GD | Average PGA | Goal achievement 2017: percentage of indicators | Goal achievement 2020: percentage of indicators | Indicators risen in % | Indicators fallen in % | Average GD change in percentage points | Average PGA change in percentage points |
|--------------------------|----------------------|------------|-------------|---|---|-----------------------|------------------------|--|---|
| <b>Total</b>             | <b>74</b>            | <b>86</b>  | <b>86</b>   | <b>31%</b>                                      | <b>28%</b>                                      | <b>49%</b>            | <b>46%</b>             | <b>-1</b>                              | <b>0</b>                                |
| Priority objectives      | 10                   | 93         | 90          | 30%   | 20%   | 40%                   | 60%                    | -6                                     | -2                                      |
| Education                | 15                   | 91         | 93          | 33%   | 33%   | 67%                   | 27%                    | 7                                      | 14                                      |
| Tertiary education       | 15                   | 87         | 9           | 13%   | 27%   | 40%                   | 60%                    | 1                                      | -5                                      |
| Basic research           | 7                    | 77         | 76          | 43%   | 43%   | 71%                   | 29%                    | -4                                     | 15                                      |
| Corporate innovations    | 19                   | 89         | 89          | 42%   | 21%   | 47%                   | 53%                    | -4                                     | -3                                      |
| Governance and financing | 8                    | 82         | 80          | 13%   | 13%   | 25%                   | 38%                    | -1                                     | -16                                     |

Sources: See Appendix 1, raw data see Appendix 2.

Note: Innovation leaders (IL) average = 100. Goal distance (GD) average: Where is Austria currently relative to the ILs?

Average prospect of goal achievement (PGA): Where will Austria probably be in 2020 relative to the ILs, on the basis of development in the past?

Goal achievement 2016: What proportion of the goals have currently been achieved? Goal achievement 2020: What proportion of the goals will probably be achieved in 2020?

<sup>95</sup> See Appendix 3 for an explanation of these values.

in 2020, approximately half of the objectives in this chapter of the RTI Strategy will be achieved. Measured on the percentage of indicators that will have achieved the goal by 2020, the “Research at universities and non-university research institutions” area ranks ahead of all other areas. From this perspective the areas of “Governance and financing” with 13 percent and “Priority objectives” with just about 10 percent are at the bottom end of the scale. In contrast to this, measured on the level of goal achievement, the areas of “Priority objectives”, “Education system” and “Research and innovation in the corporate Sector” currently have the best performance. The development dynamic and therefore the outlook until 2020 will, however, not match the current performance, as from today’s point of view it will not be possible in any of the three areas to achieve the average

level of the innovation leaders and the objectives of the RTI Strategy, let alone surpass them.

On the whole, while considering the prospect of goal achievement, a mere 27 percent of all objectives of the RTI Strategy will be achieved by 2020. There is currently not one single area of the RTI Strategy in which both the goal distance and the prospect of goal achievement are above the average level of the innovation leaders. With this insufficient development dynamic, from today’s point of view it can therefore not be assumed that the goals of the RTI Strategy can be achieved by 2020. This is due in good measure to the significant efficiency and performance barriers of the Austrian RTI system, summarised once again as an overview in the following.

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### Significant efficiency barriers

The problem areas of the Austrian RTI system identified with the analysis supported with indicators are also some of the key areas under construction that stand in the way of increasing the efficiency of the Austria science and innovation location. The Austrian Council has repeatedly described these in its previous reports on Austria’s scientific and technological capability. They are in the education area, in the education sector, especially the universities, and basic research, in the area of research funding and in the area of start-up activities. Structural reforms to increase efficiency are urgently required

in all these areas. The Austrian Council has already referred several times to the existing needs for reform.<sup>96</sup>

Added to this, however, an accentuated reallocation of resources is also required, as the universities are under-funded in comparison with those of the leading countries. The funding of basic research, at least that awarded in competition, has stagnated for years at a low level compared to the innovation leaders, and for start-up activities, from an international point of view, there is still too little funding available across the board. In addition to structural re-

<sup>96</sup> See Austrian Council (2017): Recommendation for policy prioritisation for the tertiary education sector, especially the universities of 14 September 2017; idem (2015): Report on Austria’s Scientific and Technological Capability 2015. Vienna, pp. 29 ff.; idem (2015): Recommendation for governance and management structures at the universities of 3 March 2015; idem (2014): Recommendation on the amendment to the Alternative Investment Fund Manager Act (AIFMG) of 6 March 2014; idem (2013): Weißbuch zur Steuerung von Forschung, Technologie und Innovation in Österreich. Vienna, idem (2012): Recommendation to optimize RTI-related start-ups of 19 November 2012; idem (2011): Recommendation on the efficient implementation of research results in innovations of 24 November 2011; idem (2011): Recommendation to create suitable framework conditions for private equity of 24 November 2011; idem (2011): Recommendation on the introduction of a participation amount of 24 November 2011.



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forms, an optimisation of the distribution of the funding in the RTI system is therefore also urgently required to remove the efficiency barriers.

In the **education area** the problem of education inheritance, high social selectivity and the insufficient expansion of all-day education in particular are serious efficiency barriers.

Evidently it has not been possible to exploit the existing potential of all students to the same degree. The Austrian education system therefore continues to produce graduates whose performance tends to be attributed more to their family background than to their personal performance capabilities. At the same time, despite high financial inputs compared with the leading innovation nations, significantly poorer performances are yielded. On the whole this contributes to the input-output ratio in the education system having significant improvement potential, which could be exploited with structural reforms.

In the **universities and basic research** area, in addition to the insufficient funding situation relative to the leading countries, problems in the area of governance at the universities and uncontrolled student flows in particular present an obstacle to increased performance. The imbalance connected with student access to universities and technical colleges in particular is a serious efficiency barrier, because while with the innovation leaders significantly more students are trained at technical colleges than at universities, in Austria approximately two thirds of students attend a public university. This is also to the detriment of the supervision ratios in many fields of study, which consequently are not competitive compared with international top universities. Added to this the below average financing situation in the area of funding awarded in competition for basic research, particularly compared with the leading countries, is a clear efficiency barrier for science in Austria.

In the area of **innovative start-ups**, in addition to the familiar and serious problems of the Austrian capital market, which result in insuffi-

cient availability of private financing through risk capital or crowdfunding, the adverse bureaucratic, regulatory and taxation framework conditions can also be identified as key barriers. Costs and the time it takes to set up a limited liability company and its legal structure are in particular addressed with the framework conditions. Despite some improvements in recent years, the start-up regulations in Austria effectively continue to create detrimental framework conditions for start-ups and the growth of young companies.

An extremely complex system of how federal government funding flows from the ministries via the agencies down to the individual research institutes has established itself in the area of **research funding**. It exhibits signs of over-regulation, fragmentation, unclear responsibilities and a complicated, non-harmonised set of rules for individual mechanisms, which together generate high friction losses and obstruct an efficient distribution of resources for research funding. However, due to the restrictive data situation in Austria, there is a lack of information on how the efficiency of the entire research funding system and in particular also the interaction between the mechanisms of sharply increased tax incentives for research funding and direct research funding can be improved. The emerging imbalance with the availability of direct and indirect research funding and the excessive range of funding, especially in the area of the pro rata very high funding of individual projects, in particular require revision.

A further efficiency barrier can be observed in the context of the **R&D financing** area. Austria is indeed very well positioned in this respect with the highest research quotas worldwide. There are, however, evident imbalances in the distribution of funds, which must be corrected in the interests of increased efficiency in the entire RTI system. The private sector share of all R&D funding, despite a notable closing of the gap compared with the leading countries, therefore continues to be below the level intended by the RTI Strategy, which requires continuous compensation by the public sector. With public sector R&D funds on the other hand,

especially with those for universities and basic research, an increasing imbalance between core funding and funds awarded in competition is evident, and should be revised in the interests of closing the gap with the leading innovation nations. And ultimately a serious imbalance

with regard to direct federal funds in Austria is also apparent, with only just over 13 percent flowing into the RTI area. This is definitely not in the interests of the frequently requested future orientation of government spending.

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## Conclusion and Recommendations

The cited efficiency barriers stand in the way of a further increase in the capability of the Austrian RTI system. Its performance in the international comparison is actually quite good, as Austria's efforts to join the leading innovation nations and consequently ensure prosperity, quality of life and environmental protection have certainly triggered a positive dynamic in some areas. It is, however, clear from today's point of view that Austria, despite above average R&D investment and the objective of the RTI Strategy, will not join the group of innovation leaders by 2020. This is primarily due to the outlined efficiency barriers and imbalances in the distribution of funds.

With an R&D quota of 3.19 percent estimated by Statistik Austria, in 2018 Austria will invest an above average high amount in the international comparison in its RTI system. At the same time, however, this only generates comparably moderate output. These findings apply to all areas of the RTI system. It has clearly not been possible to convert the above average R&D expenditures into performance that is appropriate for Austria's advanced science and innovation level. At best we could say that, despite Austria's high input, performance in the areas of education, science, research, technology and innovation is stagnating compared with the leading countries in Europe. If we compare the high (especially financial) input with the output or outcome generated from it, it becomes evident that the Austrian RTI system suffers from partially avoidable inefficiencies compared with the leading countries.

The order of the day is therefore to remove efficiency barriers, and the available funds must be used more efficiently and effectively than befo-

re, to generate increased top performances. How this could work is demonstrated by the leading innovation nations, especially Switzerland and Germany, from whom Austria could learn quite a bit when it comes to innovation efficiency. In addition to structural reforms, a more efficient and more effective distribution of funds will also be required to correct the evident imbalances in research funding. An adjustment of the ratio of the public to private funding share towards a share of 30 to 70, as is the case with the innovation leaders, must also be targeted. A number of the measures included in the government programme can contribute to an improvement in the input-output ratio. It remains to be seen, however, if and with what intensity the Federal Government will also actually implement these measures. It also remains to be seen what significance the new RTI Strategy planned by the Federal Government will afford the increase in efficiency of the Austrian RTI system and the boosting of the effectiveness of science and research funding.

Funding cuts with outputs remaining the same would in any case be a problematic approach to increasing efficiency for two reasons: Firstly cuts send negative location signals, and secondly Austria continues to have catch-up requirements with its outputs compared with the leading innovation countries, with, for example, scientific publications, patents and knowledge-intensive start-ups. Austria has, according to the results of the analyses for this report, rather high potential to increase its efficiency in all areas of the RTI system examined and, similar to the leading countries, to increase its outputs with given inputs. Austria usually ranks in the midfield of the comparison countries, so efficiency is the-

## summary

refore not very low. However the Austrian Council believes this is not sufficient for a country that operates close to the scientific, technological and innovation frontier.

The new Federal Government will have to concentrate more than its predecessor on increasing the efficiency of the Austrian RTI system and on boosting the effectiveness of the funding of science and research. Otherwise the obvious efficiency barriers threaten to continue impeding the country's success, whereby Austria also runs the risk of stagnating in the upper midfield in the future, or even falling further back.

The Austrian Council therefore recommends setting a political priority on the further development of the Austrian RTI system to join the leading innovation nations in line with its potential. In addition to working out a new RTI Strategy, the familiar areas under construction that stand in the way of increased innovation efficiency must also be addressed as priorities. The most relevant aspects for this will be highlighted in the following recommendations for what the Austrian Council believes are the key areas of "Education system", "Universities and basic research", "Innovative start-ups", "Research funding and R&D financing".

### **The Austrian Council's recommendations for increasing the efficiency of the education system and the RTI system**

The recommendations that the Austrian Council believes are the most important to increase the efficiency of the education system and the RTI system are summarized in the following. For details and more specific measure proposals please see the recommendations in the respective chapters of the report, the underlying individual recommendations and the comprehensive "Recommendation on the way to the forefront of innovation"<sup>97</sup>.

#### **Education System**

To increase the efficiency of the education system, the Austrian Council recommends the problem of education inheritance and (across the board) excessive social selectivity be prioritised. In this respect the Austrian Council once again recommends a commitment to comprehensive schools for 10 to 14-year-olds and the expansion of all-day schools. Specific measures must be defined here to further raise the achieved performance level across the board. In this context the Austrian Council welcomes the commitment included in the government programme to quality primary school teaching, but also recommends a significant increase in the number of qualified

teachers, and multi-lingual teachers in particular. Instead of a scattergun approach, the Austrian Council recommends better financial and human resources (keyword: support staff) for those schools that are confronted with special challenges, especially with regard to the socio-economic structure of their students (so-called "hotspot schools").

#### **Universities and basic research**

To increase the efficiency of the university area, the Austrian Council recommends the swift and consistent implementation of the measures anchored in the government programme for the structural further development of the higher education area and to improve the governance structures of the universities, the study conditions and the control of student flows. In addition to the structural reforms planned by the government, it also recommends an increase in the university expenditure rate to two percent of GDP, to be able to finance the required upgrades. This also requires an increase in the private sector financing share. To remove one of the major efficiency barriers of the RTI system, the Austrian Council urgently recommends the con-

<sup>97</sup> Austrian Council (2017): Recommendation on the way to the forefront of innovation of 30 November 2017.

tinued increase in the funds awarded in competition for funding basic research to the level of the leading countries.

### **Innovative start-ups**

To increase innovation efficiency, the Austrian Council recommends the administrative and financial hurdles for start-ups be specifically removed. To do this, first of all the adverse bureaucratic, regulatory and taxation framework conditions must be improved, in particular to reduce expenses, costs and set-up time for innovative start-ups. The familiar problem of insufficient availability of private financing with risk capital or crowdfunding must also be addressed. In addition to funding by banks, the Austrian Council recommends developing funding options for innovative entrepreneurs and SMEs. A suitable framework is required to increase equity capital intensity from the private side, such as appropriate legislative and taxation framework conditions for private equity, an improvement in the quality of the Austrian capital market and assessment stipulations of pension and insurance funds, for example.

### **R&D financing and research funding**

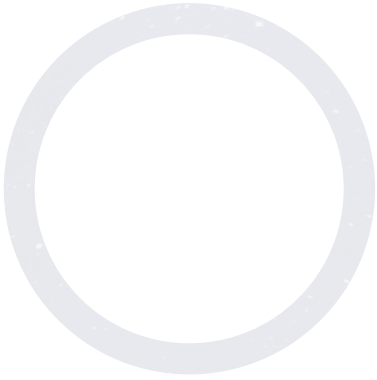
With respect to the coming funding period of the EU, and wherever else applicable, the Austrian Council recommends the domestic research funding offers be adjusted so that on one hand a complementary offer for the European framework programmes is made, and on the other hand the funding logic is also harmonised and simplified. The Austrian Council generally recommends that excessive administration and piecemeal and unclear funding offers be avoided in

research funding. An increase in the efficiency of research funding should be afforded greater attention in the future than it has been to date. Existing structures must be critically scrutinised here and incentive effects must be increased with specific funding.

The Austrian Council welcomes the research funding act anchored in the government programme, which will secure the medium to long-term stability of RTI funding in Austria. In this context the Austrian Council recommends a revision of the appropriate use of funding in the Austrian RTI system, to correct existing imbalances in funding distribution. In the universities and basic research area, the ratio between core financed and public sector funds awarded in competition must in particular shift in favour of the competitive share. To increase innovation efficiency, the Austrian Council also recommends concentrating public sector funding and mechanisms on increasing the private sector financing share of corporate research spending, which is still too low compared with the leading countries. Better data access could enable meaningful analyses on the effect of the overall system and on the interaction of sharply increased tax-based and direct funding in particular.

As only 13.4 percent of all direct federal funding in Austria flows into R&D, the Austrian Council also recommends a revision of the budgetary prioritisation in the international comparison as well. The goal should be to make state spending significantly more future-oriented. Special focus should also be afforded here to the competitive awarding of funds, especially for basic research.

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## Background

The Austrian Council's Global Innovation Monitor supplements the preceding analysis by comparing selected countries (China, Israel, Canada, Switzerland, South Korea, the USA) with Austria on the basis of the indicators used in this report from the areas of education, university research, corporate research, economy, society and environment. This comparison of innovation performance in the global context will illuminate the capability of the Austrian RTI system in the light of global trends and relevant developments with the global innovation leaders.

The comparison countries for the Global Innovation Monitor were chosen for a number of reasons: Firstly, they were defined as the target countries for Priorities 1 and 2 in the recommendations of the working group 7a to the RTI Task Force.<sup>98</sup> Secondly, the selected countries are – with the exception of China – deemed to be global innovation leaders that can serve as benchmarks due to their successful performance. China was included in the list because it has faster growth rates for spending on research, publications, patents etc. than any other country. Thirdly, members of the Austrian Council who took part in official visits to these countries were given deeper insights into the RTI systems there.

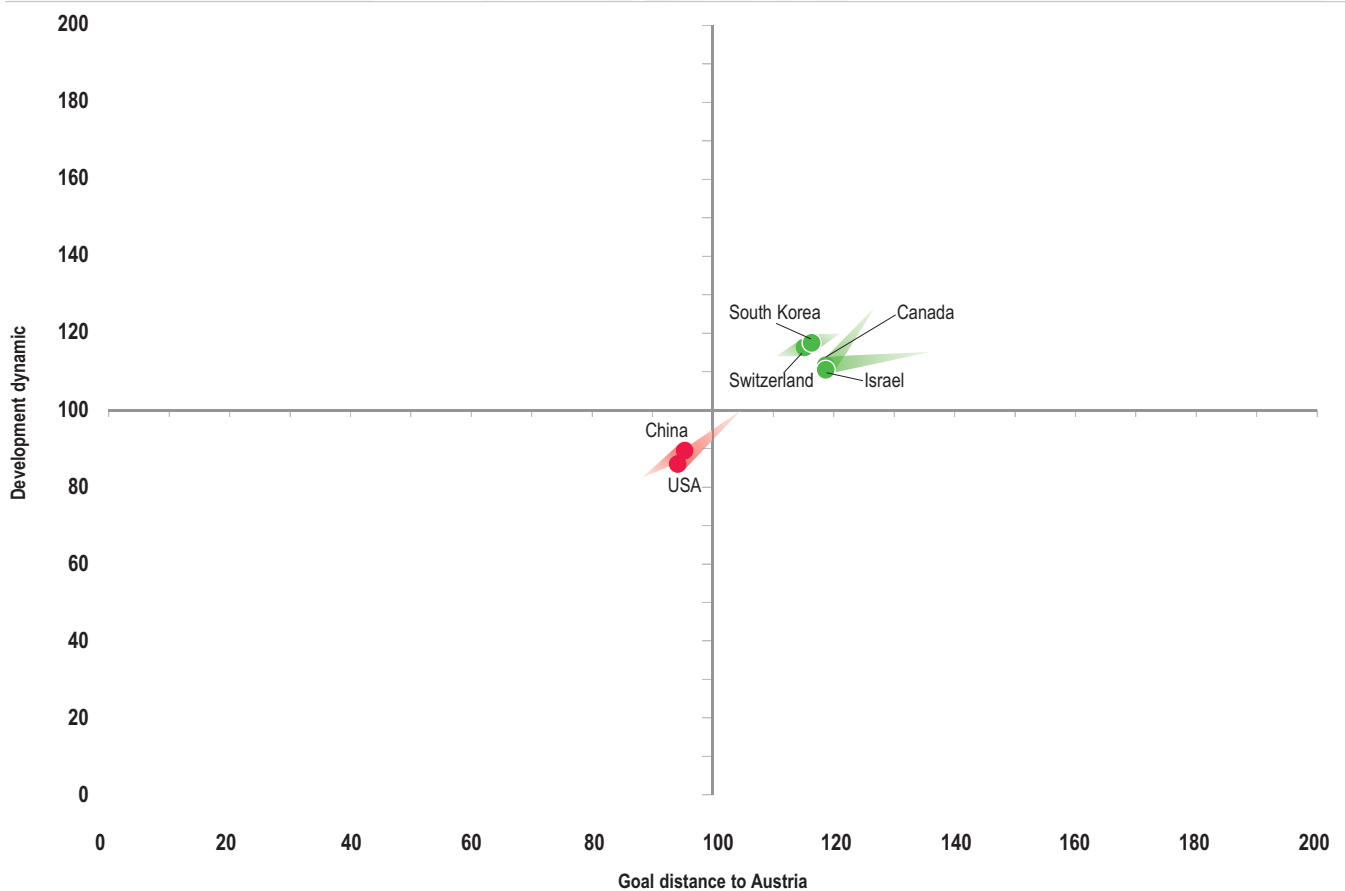
<sup>98</sup> Beyond Europe: Austria's internationalization in research, technology and innovation beyond Europe. Recommendations of Work Group 7a to the Federal Government's Task Force (July 2013), p. 7.

## Education

The assessment of the education system presents the results of the PISA studies in aggregated form as output component and the spending in the tertiary education sector for students as input component. If we compare the current analyses, Austria's education performance is ahead of that of China and Canada, more or less on a par with the USA, but clearly behind that of the Israel, South Korea and Switzerland (see figure 21). With regard to the performance of education

systems, Switzerland, South Korea and Israel are still more or less ahead of Austria with regard to both goal distance and development dynamic. Compared with the USA, Austria is more or less the same, even though the USA has lost dynamic, which indicates a longer term fall behind Austria's position. China is significantly behind and with the trend remaining as is has no realistic chance of catching up on Austria by 2020.

Figure 21: Education in the international comparison



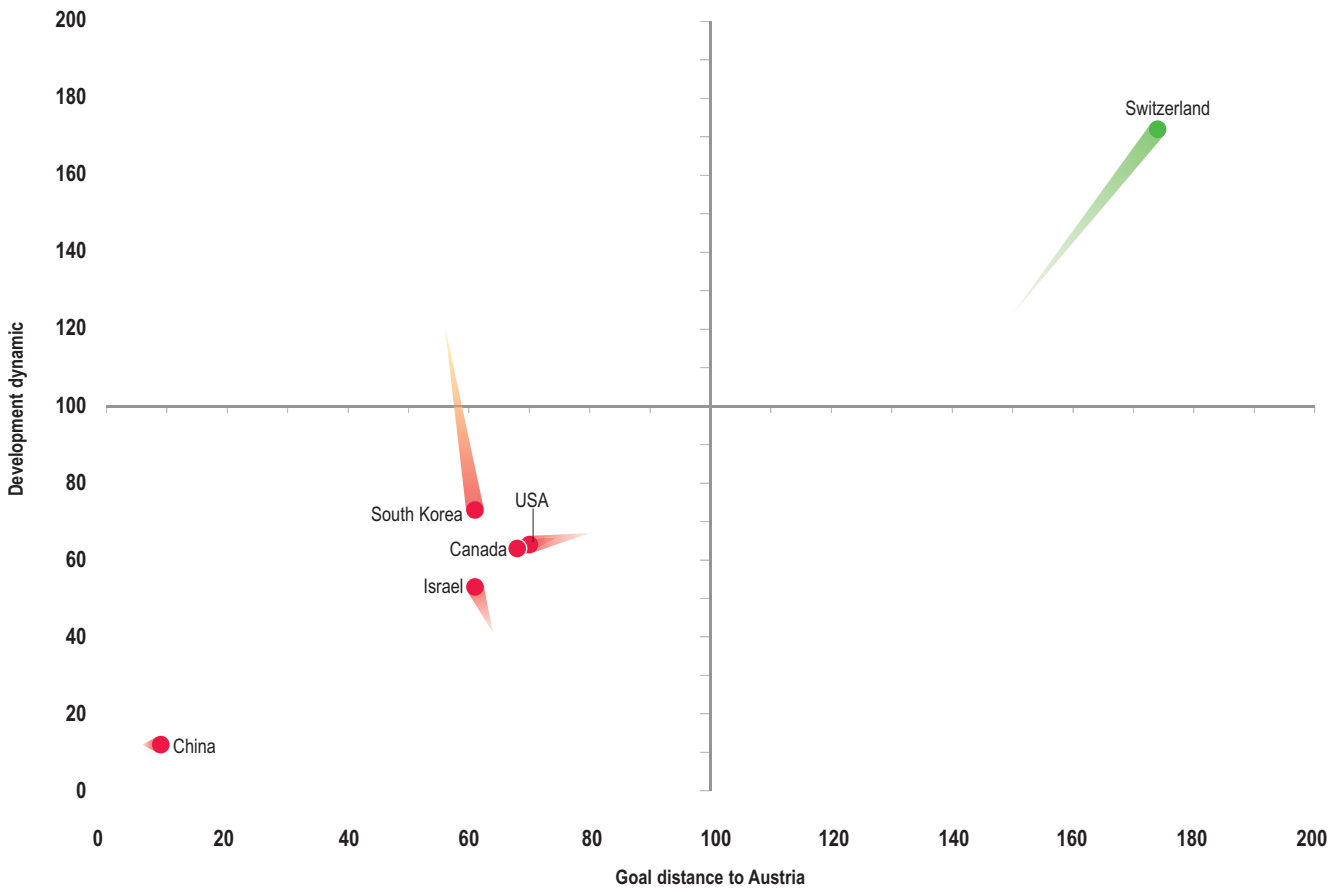
Source: See indicators list Appendix 4, WIFO presentation; Methodology and Notes for Interpreting the Figures and Indicators, see Appendix 5.

### University Research

The trend in the area of university research appears to be somewhat better than that in the education area. On the basis of the aggregated individual indicators of “University ranking”, “Expenditure for basic research” and “Expenditure for tertiary education, research and development in relation to the general public”, Austria is far behind Switzerland, but clearly ahead of China, Canada, South Korea, Israel and the USA (see figure 22).

Switzerland is the top research nation in the most diverse international rankings. This will hardly change if the development trend does not change. Austria will therefore not even come close to catching up on Switzerland by 2020. The prospect of China catching up on Austria’s current dynamic is extremely low. But Israel, Canada, South Korea and the USA will not achieve Austria’s level by 2020 either with the trend remaining as it is.

Figure 22: University research in international comparison



Source: See indicators list Appendix 4, WIFO presentation; Methodology and Notes for Interpreting the Figures and Indicators, see Appendix 5.

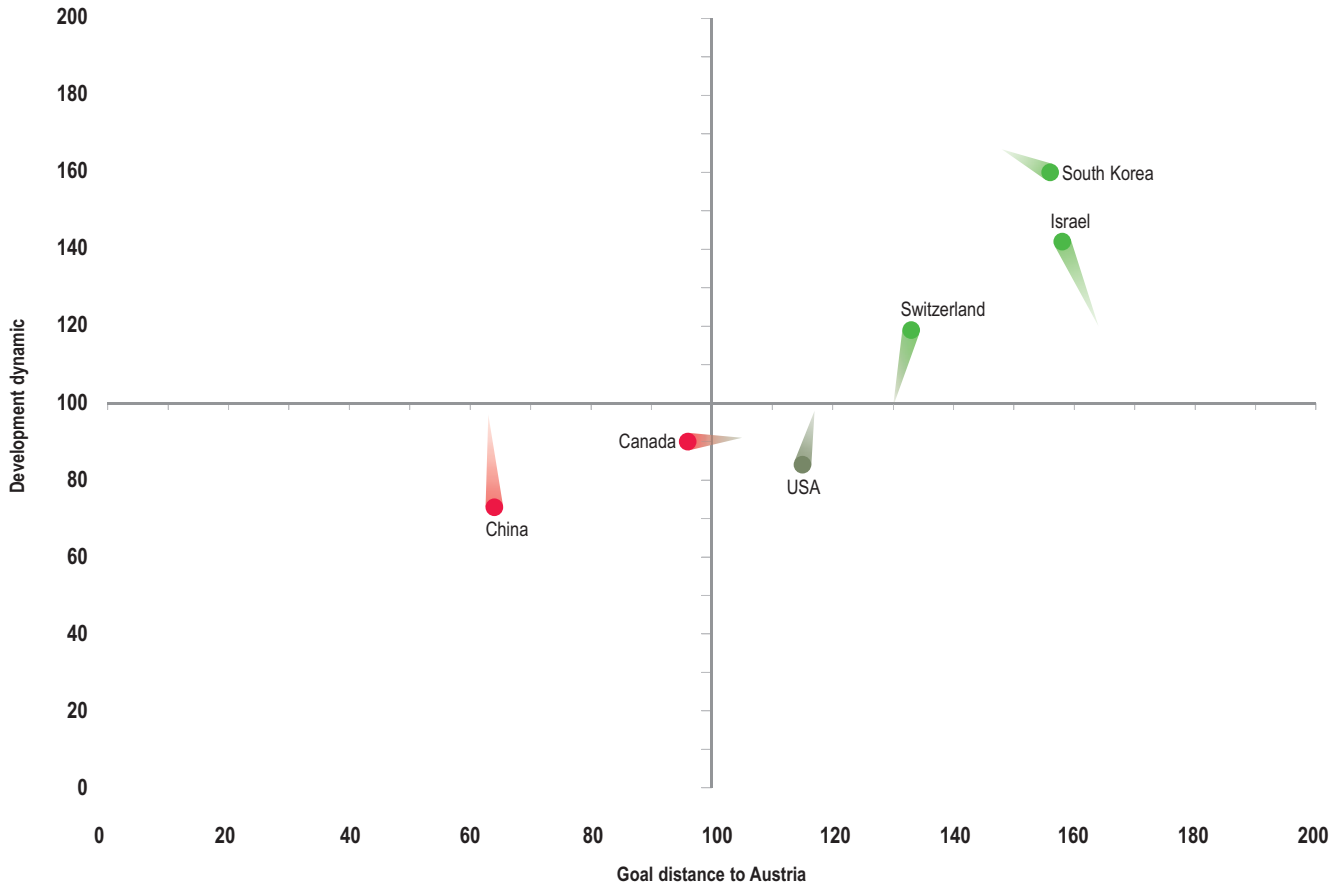
### Corporate Research

Figure 23 shows a catch-up requirement for Austria with regard to performance in the indicators for corporate research and innovation, which have been summarised for this illustration. Apart from China and Switzerland, all selected countries are ahead of Austria, and three of these – Ca-

nada, South Korea and Israel – will further increase their lead on Austria on the basis of their dynamic development. With the trend remaining constant in the area of corporate research, Austria could, however, close the gap on the USA.



Figure 23: Corporate research in the international comparison



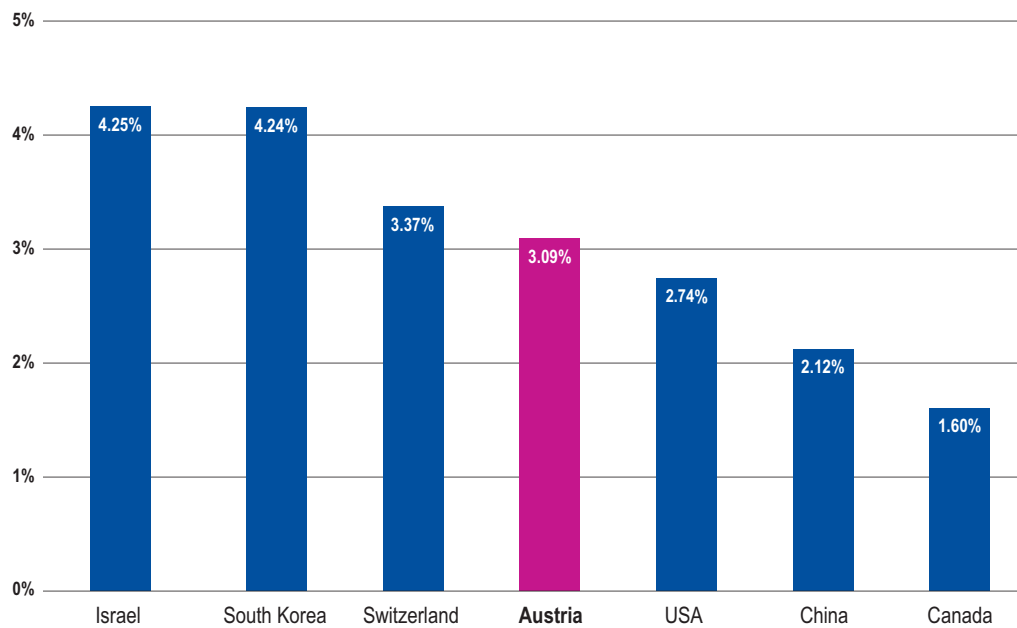
Source: See indicators list Appendix 4, WIFO presentation; Methodology and Notes for Interpreting the Figures and Indicators, see Appendix 5.

### R&D Financing

Figure 24 shows a comparison of the R&D quotas of the countries chosen for the Global Innovation Monitor according to OECD data (“Main science” and “Technology” indicators, last available year). There are hardly any changes compared with previous years. Israel and South Korea continue to have the by far highest research rates; Switzerland and the USA are

more or less on a par with Austria. Measured on the overall volume, with approx. USD 412 billion, China is already ranked number 2 behind the USA (USD 464 billion). In the comparison for this, with R&D expenditures of approx. USD 11.6 billion (at purchase power parity), in 2016 Austria ranked among the TOP 20 in the global list of countries. In per capita terms it even ranks at number 5.

Figure 24: R&D quotas (in % of GDP) selected countries, last available year



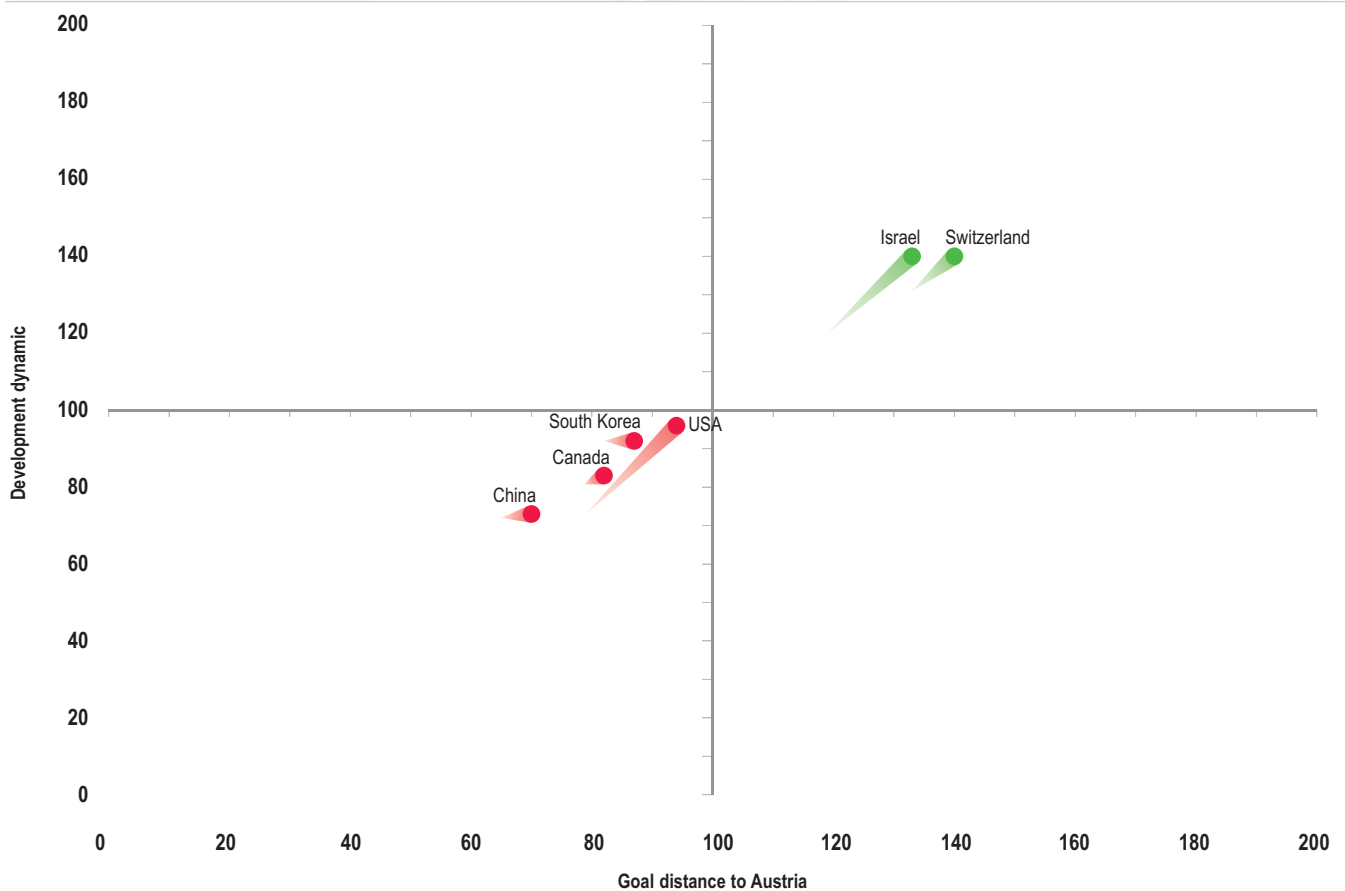
Source: OECD MSTI (2017). OECD data deviates from national data due to the time delay.

## Economy, Society and Environment

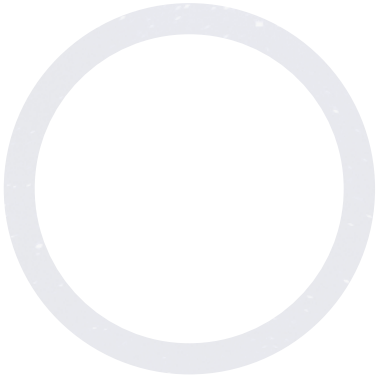
Figure 25 shows that Austria is positioned relatively well with regard to the economic, social and environment-relevant KPIs in relation to the countries considered here. Only Switzerland and Israel score better than Austria with these indicators at the moment, whereby Israel in particular improved sharply against Austria compared to last year's report. With regard

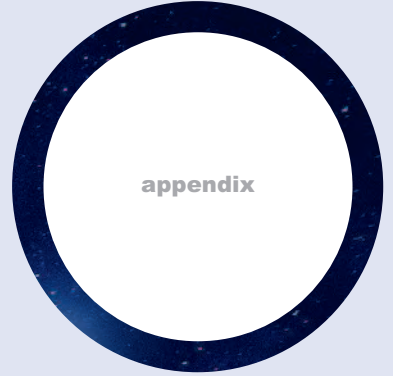
to the above average development dynamic, Israel and Switzerland are also in an area that allows us to conclude that nothing will change with this positioning by 2020. The performance of China, Canada, South Korea and the USA is insufficient to be able to overtake Austria by 2020.

Figure 25: Economy, society and environment in the international comparison



Source: See indicators list Appendix 4, WIFO presentation; Methodology and Notes for Interpreting the Figures and Indicators, see Appendix 5.





## Appendix 1: Indicator Set

appendix

| Strategic Objectives   | Indicator to track target achievement  | Abbreviation      | Numerator  |
|--|--|-------------------|--|
| <b>Priority Objectives</b>   |  |                   |  |
| Vision: In 2020 Austria is an Innovation Leader.<br>Objective: We want to further develop the potentials of science, research, technology and innovation in Austria to make our country one of the most innovative in the EU ... | EIS Innovation Index (Summary Innovation Indicator)  | EIS Index         | Innovation index value (normalized 0–1)                        |
| ... and thus strengthen the competitiveness of our economy and increase the wealth of our society ...  | GDP per capita at purchasing power standards (PPS)   | GDP/per capita    | Gross domestic product (GDP) at purchasing power standards     |
|  | Employment-to-population ratio   | Employment rate   | Employed (20-64 years)   |
|  | Unemployment rate  | Unemployment rate | Unemployed (15-74 years)                                       |
| ... and overcome the big social and economic challenges of the future.   | OECD Better Life Index   | Better Life       | Better Life Index- value (0–10)                                |
|  | Healthy life years: Number of years a person of a certain age can expect to live without illness/disability. | HLY (F)           | Years without chronic illness/ activity limitation             |
|  |  | HLY (M)           |  |
|  | Reduction of greenhouse gas emissions in %   | Greenhouse gases  | Emissions of greenhouse gases, base year 1990 Index (1990=100) |
|  | Efficiency increase: energy intensity  | Energy intensity  | Gross Domestic Energy Consumption (kg. oil equivalents)        |
| Efficiency increase: productivity of resources   | Resource productivity  | GDP               |  |

| Denominator                          | Brief Explanation of Indicator   | Source  | Calculation information   | ID No. |
|--------------------------------------|--|---|---------------------------|--------|
| n. a.                                | The EIS Innovation Index is supposed to make the innovation performance of the EU member states comparable. It is made up of 25 unweighted single indicators covering several innovation areas (such as human resources, research spendings, patents and structural change).   | EIS European Innovation Scoreboard            |                           | 1      |
| Total population                     | Gross Domestic Product (GDP) per capita is a measure of a country's total economic output. It is defined as the value of all newly-created goods and services, minus the value of all goods and services consumed as inputs. The underlying figures are expressed in PPS, a common currency, which balances price level differences between countries and allows significant GDP volume comparisons. | Eurostat                                      |                           | 2      |
| Working-age population (20-64 years) | The employment rate complements GDP per capita as a measurement of a country's economic development. The working population comprises people who during the reference week worked in gainful employment for at least one hour or who did not work, but had a work place and were only temporarily absent.  | Eurostat                                      |                           | 3      |
| Persons in Employment (15-74 years)  | The unemployment rate complements GDP per capita as a measure of a country's economic development. The unemployment rate is the number of people unemployed as a percentage of the labour force. The labour force is the total number of people employed plus unemployed. The figure is seasonally adjusted.   | Eurostat                                      | Inverted                  | 4      |
| n. a.                                | The indicator measures wealth and quality of life across a wide range of factors. It covers several areas but as income, education and health overlap with other areas these are not included. The remaining areas are work-life balance, integration in social networks, participation in social/political events, personal security, environmental quality, housing and life satisfaction.         | OECD Better Life Index                        |                           | 5      |
| Life expectancy                      | This indicator reflects the challenges of ageing populations. The number of healthy life years an individual will enjoy can be influenced by medical and technological progress and by social innovations such as new preventative healthcare models at the workplace.   | Eurostat                                      |                           | 6      |
|                                      |  |   |                           | 7      |
| n. a.                                | This indicator is one of Austria's Europe-2020 goals and reflects the fact that climate change can only be efficiently stemmed by a reduction in absolute terms of greenhouse gases. The target aims for a reduction and not an increase.  | Eurostat; Austrian Federal Environment Agency | Inverted; national target | 8      |
| GDP (in 1,000 €)                     | This indicator shows the development of energy efficiency; i.e. energy consumption required for Austria's annual economic output.  | Eurostat; Statistik Austria                   | Inverted                  | 9      |
| Domestic material consumption (kg)   | This indicator measures the total amount of physical resources directly used in Austria's annual economic output.  | Eurostat; Statistik Austria                   |                           | 10     |

| Objective target of the strategy  | Indicator to track target achievement  | Abbreviation                               | Numerator  |
|---|--|--|--|
| <b>Educational System – Pre-Primary and Primary Education</b>   |  |  |  |
| The educational system as a whole needs to be optimised, starting with the early childhood phase. Vision 2020: age-based, early childhood educational support has been established. | Participation in early childhood education   | Early childhood care                       | Children (4–primary level) in institutional childcare facilities   |
|   | Ratio of students to teaching staff  | Student-teacher ratio early childhood      | Number of children (3 years and older) in institutional childcare facilities   |
|   | Ratio of students to teaching staff in primary education   | Student-teacher ratio in primary education | Number of students in primary education  |
| <b>Educational System – Secondary Education</b>   |  |  |  |
| The proportion of early school leavers should be reduced to 9.5% by 2020.   | Percentage of early school leavers   | Early school leavers                       | People aged 18-24 with lower secondary educational attainment or less  |
| The proportion of pupils graduating with a secondary school-leaving certificate within an age cohort should be increased to 55% by 2020   | Percentage of secondary school graduates   | Secondary school graduates                 | Passed final school leaving examination  |
| The number of students with a first language other than German, who complete the upper secondary level should increase from 40% at present to 60%. Better integration of immigrants | Number of students with a first language other than German who have completed the second level of secondary school | Early school leavers immigrants            | Number of students with a first language other than German who have completed the upper secondary level of education (AHS, BHS, 3-year technical school, apprenticeship) |
| The reforms aim at mitigating social selectivity.   | Influence of socio-economic background on reading competence   | Inheritance of education 1                 | Influence of PISA Index for the socio-economic background on reading competence (increase in socio-economic gradient)  |

|  | Denominator   | Brief explanation of indicator  | Source                      | Calculation information | ID No. |
|--|---|---|-----------------------------|-------------------------|--------|
|  | Population 4–5 for Austria, for other countries depending on the age at which children start school (4–6) | The percentage of the population between the age of 4 and the age at which children start school who are participating in early childhood education. This indicator is used to measure progress toward the primary goal set out in the Strategy “General and Vocational Education” of increasing the proportion of children (between the age of 4 and the age at which compulsory primary education starts) who participate in preschool education to at least 95% by 2020.   | Eurostat                    | National target         | 11     |
|  | Number of qualified teachers without teaching assistants  | The ratio of students to teaching staff compares the number of students (full-time equivalent) to the number of teachers (full-time equivalent and not teaching assistants) at a given level of education and in similar types of institutions.   | OECD, Education at a glance | Inverted                | 12     |
|  | Number of teachers (full time-equivalents) at primary level   | The ratio of students to teaching staff compares the number of students (full-time equivalent) to the number of teachers (full-time equivalent) at a given level of education and in similar types of institutions.   | Eurostat                    | Inverted                | 13     |
|  | Total population between 18-24  | This is a core target within the framework of the Europe 2020 strategy. “Early leavers from education and training” are people aged 18 to 24, who fulfill the following conditions: the highest level of education or training attained is ISCED 0,1,2 or 3c short – i.e. lower secondary level – respondents should not have received any education or training in the four weeks preceding the survey.  | Eurostat                    | Inverted                | 14     |
|  | Age cohort 18-19 years  | Final examination rate: students who passed final school-leaving examinations (without second or subsequent qualifications), as measured by the arithmetic mean of the population aged 18 to 19.  | Statistik Austria           | National target         | 15     |
|  | Age cohort 18-19 years with a first language other than German  | The indicator shows the share of students with a first language other than German, who have attained upper secondary educational attainment level (final school leaving examination, apprenticeship, intermediate technical schools).   | Statistik Austria           | National target         | 16     |
|  | n. a.   | The average difference in students' reading attainment which indicates a one unit increase in the PISA index of economic, social and cultural status is defined as an increase in the socio-economic gradient. The wider the average attainment gap, the greater the impact of students' socio-economic background on their reading skills. The socio-economic background is measured by the PISA-index of economic, social and cultural status and is based on information provided by the students on their parents' education level and occupational status and household possessions, such as a writing desk for studying and the number of books. Statistical fluctuations are taken into consideration in the assessment. | OECD PISA                   | Inverted                | 17     |

appendix

| Objective target of the strategy   | Indicator to track target achievement  | Abbreviation                     | Numerator   |
|--|--|----------------------------------|---|
| <b>Education System – Secondary Level</b>  |  |                                  |   |
|  |  | Inheritance of education 2       | Influence of the PISA Index for the Socio-Economic Background on Reading Skills (strength of correlation–share of the declared variance)  |
| The reforms aim at continuously increasing quality in education (secondary level). | Share of students with poor performance in basic skills (literacy, numeracy, science)<br>Target: 15% at most | PISA risk students – reading     | Students who at best achieve competence level 1 of the relevant PISA scale  |
|  |  | PISA risk students – mathematics |   |
|  |  | PISA risk students – science     |   |
|  | Share of students who reach at least competence level 5 (in literacy, numeracy, science)                     | PISA top students – reading      | Students who reach the competence level 5 or higher   |
|  |  | PISA top students – mathematics  |   |
|  |  | PISA top students – science      |   |
| Optimum qualification for economic activity (...)                                  | Share of graduates in employment aged 20 to 34)  | Skill Mismatch                   | Individuals between the ages of 20 and 34 who are in employment and who graduated from an educational programme of at least secondary level II and who left the general education and vocational education system no more than three years before the reference year. |

|                           | Denominator  | Brief explanation of indicator   | Source    | Calculation information   | ID No. |
|---------------------------|--|--|-----------|---|--------|
|                           | n. a.  | The strength of the relationship between reading performance and socio-economic background is measured by the percentage of the variance of students' performances, which can be explained by the differences in students' socio-economic background. The higher the share of the declared variance, the greater the influence of the socio-economic background. | OECD PISA | Inverted  | 18     |
|                           | Total number of students participating in OECD PISA  | This indicator provides information about the number of students as a percentage of the total population who on the basis of their test results at best attain proficiency level 1 on the relevant PISA scale. It can be assumed that low proficiency levels in these three basic skills results in significant disadvantages in personal and social life.       | OECD PISA | Inverted; national target   | 19     |
| Inverted; national target |  |  |           | 20  |        |
| Inverted; national target |  |  |           | 21  |        |
|                           | Total number of students participating in OECD PISA  | This indicator shows the distribution of school performance upwards, i.e. the share of students with very good results.  | OECD PISA |   | 22     |
|                           |  |  |           | 23  |        |
|                           |  |  |           | 24  |        |
|                           | All individuals between the ages of 20 and 34 who graduated from an educational programme of at least secondary level II and who left the general education and vocational education system no more than three years before the reference year | This indicator attempts to reflect the mismatch between training/education and the demands of the job market. It is an official target of the European Education and Training Strategy.  | Eurostat  | National target; as no time series is available, the prospect of goal achievement was calculated with the goal distance | 25     |

| Objective target of the strategy  | Indicator to track target achievement  | Abbreviation                                | Numerator   |
|---|--|---|---|
| <b>Educational System – Tertiary Education</b>  |  |   |   |
| 38% of 30 to 34-year-olds have a university degree in 2020  | Share of 30 to 34-year-old university graduates in the 30 to 34-year age cohort. | University Graduates                        | Number of 30 to 34-year-olds with a graduation in the tertiary sector (ISCED 5-8) |
|   |  | University Graduates (ISCED 6–8)            | Number of 30 to 34-year-olds with a graduation in the tertiary sector (ISCED 6-8) |
| The conditions of study at universities should be fundamentally improved, which will require establishing new financing models for higher education.  | Student-to-Staff ratio   | Staff-Student ratio university              | Number of student   |
| Vision: universities, universities of applied sciences and non-university research institutions work within excellent framework conditions and are sufficiently financed to optimally perform their tasks in research and teaching. | Percentage of GDP spent on higher education                                      | Percentage of GDP spent on higher education | Expenditure for the whole tertiary sector   |
|   | University expenditure per student   | University expenditure per student          | Expenditure for the whole tertiary sector   |
| This is to guarantee universities, research institutions and companies a sufficient supply of highly-qualified researchers.   | Number of researchers per 1,000 employees  | Researchers                                 | Researchers according to OECD Frascati definition                                 |
|   | Doctors in STEM subjects per 1,000 of the population                             | Doctors in STEM subjects                    | Doctors in STEM subjects  |
|   | STEM graduates per 1,000 of the population                                       | STEM graduates                              | Graduates STEM fields   |
| The reforms are aimed at balancing the gender imbalances in research.   | Women researchers as a percentage of total researchers                           | Percentage of female researchers            | Number of female researchers (OECD Frascati definition)                           |
|   | Percentage of women in Science, Technology, Engineering and Mathematics (STEM)   | Share of women in science                   | Number of female graduates in science   |
|   |  | Share of women in engineering               | Number of female graduates in engineering   |
| Glass Ceiling Index (percentage of female professors relative to the percentage of female scientific and artistic staff)  | Glass Ceiling Index EU   | Percentage of female professors             |   |

|  | Denominator   | Brief explanation of indicator  | Source                                  | Calculation information | ID No. |
|--|---|---|---|-------------------------|--------|
|  | 30 to 34-year-olds                                      | This is an Austrian Europe 2020 core indicator and reflects successful participation in tertiary education. With the adjustment in the ISCED classification, the two last age groups of BHS are now included in the tertiary sector (ISCED 5, formerly ISCED 4a).   | Eurostat, Statistik Austria Mikrozensus | National target         | 26     |
|  |   | This indicator uses a closer definition for university graduates, essentially from bachelor level (ISCED 6, formerly ISCED 5).  |   |                         | 27     |
|  | Academic staff at universities                          | The indicator shows the staff-to-student ratio at universities. It is calculated, wherever possible, on the basis of full-time equivalents.   | OECD, Education at a Glance             | Inverted                | 28     |
|  | GDP   | Share of expenditure on tertiary education as a percentage of GDP as a measure for funding in an international comparison. The Federal Government has set a goal of 2% in the Government programme.   | OECD, Education at a Glance             | National target         | 29     |
|  | Number of students (ISCED 2011 6-8)                     | The indicator university expenditure per student complements the GDP rate by considering different dimensions of the tertiary sector in different countries. A tertiary sector with a 50 % graduation rate will ceteris paribus require considerably more funds than a sector with a 25% graduation rate. | OECD, Education at a Glance             |                         | 30     |
|  | Total employment  | The indicator shows the number of researchers relative to total employment, i.e. the researcher-intensity in employment.  | OECD MSTI                               |                         | 31     |
|  | 25 to 34-year-olds/1,000                                | Tertiary degrees ISCED 6 in the sciences and technological disciplines per 1,000 of the population aged 25 to 34  | Eurostat                                |                         | 32     |
|  | Age cohort of 20 to 29 year-olds/1,000                  | Tertiary education in science and technology subjects (ISCED 5–8) per 1,000 people aged 20 to 29.   | Eurostat                                |                         | 33     |
|  | Number of female researchers (OECD Frascati definition) | This indicator measures the number of women as a percentage of research staff   | OECD MSTI                               |                         | 34     |
|  | STEM graduates science in total                         | This indicator measures the percentage of women in STEM graduates (ISCED 6-8), who are frequently involved in technological innovation processes.   | Eurostat                                |                         | 35     |
|  | STEM graduates engineering in total                     | This indicator measures the percentage of women in STEM graduates (ISCED 6-8), who are frequently involved in technological innovation processes.   | Eurostat                                |                         | 36     |
|  | Percentage of women among scientific staff              | The indicator shows how likely it is that a woman makes the leap from scientific staff to a top position at university.   | European Commission                     | Inverted                | 37     |

| Objective target of the strategy  | Indicator to track target achievement                                      | Abbreviation                                      | Numerator   |
|---|--|---|---|
| <b>Education System – Further Education/Skill Structure Migration</b>   |  |   |   |
| Vision: The immigration of highly-skilled people will be encouraged and utilised.   | Highly-qualified immigrants as a percentage of the foreign-born population | Highly-qualified immigrants                       | Foreign-born, highly-qualified workers residing in Austria  |
|   | Foreign doctoral students  | Foreign doctoral students                         | Number of doctoral students from abroad   |
| To do this, the entire education system must be optimised – to models of lifelong learning.   | Participation in lifelong learning   | Lifelong-learning                                 | Participants in measures for further education aged 25 to 64  |
| <b>Research at Universities and Non-University Research Institutions – Basic Research and Universities</b>  |  |   |   |
| Increase investments in basic research by 2020 to the level of leading research nations.  | Basic research expenditure as a percentage of GDP                          | Basic research expenditure as a percentage of GDP | Expenditure on basic research as defined by the OECD Frascati Manual  |
| Strengthening of basic research through further structural reforms of the university system. Vision: Austria is a top location for research, technology and innovation, which offers optimum working conditions and career opportunities for excellent scientists. Excellent research is a matter of course in Austria. | Publication quality  | Publication quality                               | Number of publications among the 10% most cited publications worldwide  |
|   | International co-publications  | International co-publications                     | Number of scientific publications with at least one foreign co-author   |
|   | ERC Grants per inhabitants in million                                      | ERC Grants per inhabitants                        | ERC Grants (Starting, Advanced and Consolidator Grants)   |
|   | Positioning of Austrian universities in international research rankings.   | University ranking research performance           | Number of Austrian universities in broad ranking groups (1-500) of international comparisons of research performance, weighted by ranking groups and relative to the population (currently only Leiden Ranking) |

|  | Denominator                                 | Brief explanation of indicator   | Source  | Calculation information | ID No. |
|--|---|--|---|-------------------------|--------|
|  | All foreign-born people residing in Austria | The indicator reflects the qualification structure of immigration. It comprises foreign-born people with residence permit and at least three-month duration of stay. A university degree is the qualification criterion.   | OECD  |                         | 38     |
|  | All doctoral students                       | Share of foreign doctoral students in all doctoral students  | Eurostat WIFO calculations (analogous to EIS, European Innovation Scoreboard) |                         | 39     |
|  | Total population 25 to 64                   | Participation in lifelong learning is an official target of the ET 2020 Strategy (general and vocational learning)   | Eurostat  |                         | 40     |
|  | GDP   | The Innovation Leaders are not used for comparative purposes, as only Denmark collects data on basic research. In this case, the reference countries are the five OECD countries with the highest level of basic research expenditure as a percentage of GDP for which data is available (most recent available year: 2010: Switzerland, South Korea, Denmark, France, USA)  | OECD MSTI   |                         | 41     |
|  | Total number of scientific publications     | The indicator is a measure for the quality of scientific publications, i.e. the quality of research.   | EIS European Innovation Scoreboard  |                         | 42     |
|  | Total population                            | International scientific co-publications can be interpreted as an indication of the quality of scientific research, since international co-operation normally increases scientific productivity.   | EIS European Innovation Scoreboard  |                         | 43     |
|  | Total population in million                 | The indicator reflects the success in obtaining ERC funds, which are awarded only for international top research following a strict evaluation process. The indicator is calculated on the basis of the data published annually by the ERC.  | ERC or OECD MSTI  |                         | 44     |
|  | n. a.                                       | The indicator shows how Austrian universities position themselves in terms of international research performance. It shows the number of Austrian universities in broad ranking groups (1-50, 51-100, 101-200, 201-300) in international university comparisons (currently only Leiden Ranking) relative to the size of the country (number of universities per 10 million inhabitants); the number of universities is weighted with the ranking groups (the better the ranking group, the higher the weighting). This indicator also shows whether a country has only a single leading institution or a broader range. Calculated on the basis of a new methodology, in 2015 the data from the University of Leiden resulted in a significant change over 2014. | Leiden Ranking  |                         | 45     |

| Objective target of the strategy  | Indicator to track target achievement                                  | Abbreviation                       | Numerator  |
|---|--|------------------------------------|--|
| <b>Research at Universities and Non-University Research Institutions – Basic Research and Universities</b>  |  |                                    |  |
| Reform university funding (more competitive and project-related, incl. cost coverage). The funding of university research through competitive external funding from the FWF needs to be reinforced. | Budget of funds for funding basic research per inhabitant              | Competitive funding                | Budget for funds to support basic research per academic researcher   |
| Vision: attractive scientific careers based on international models are a common standard at Austrian universities.   | Percentage of doctoral students employed at university (uni:data)      | Employed doctoral candidates       | Doctoral students with an employment contract at university  |
| <b>Research and Innovation in the Corporate Sector – Innovation and Business Research</b>   |  |                                    |  |
| Enhance domestic value creation by encouraging research intensive industries and knowledge intensive services.  | Share of knowledge-intensive sectors in employment                     | Knowledge-intensity economy        | Employment in knowledge-intensive sectors (sectors in which more than 33 % of the employed labour force have completed tertiary education) |
|   | Share of medium level and advanced technology products in total export | Knowledge-intensity exports        | Export of medium level and advanced technology products  |
|   | Innovation-intensive sectors as a share of total services exports      | Knowledge-intensity service export | Export innovation-intensive service sectors  |
| The structure of the manufacturing and service sectors has to be improved by increasing the innovation and knowledge-intensity of firms.  | R&D quota in the corporate sector, adjusted by industry structure      | R&D intensity business             | Corporate-sector R&D expenditures, adjusted by the industry-specific R&D intensities   |
|   | Export quality in technology-orientated industries                     | Export quality                     | Exports of technology-orientated industries of material goods in the highest and middle price segment                                      |

|  | Denominator   | Brief explanation of indicator   | Source  | Calculation information  | ID No. |
|--|---|--|---|--------------------------|--------|
|  | Total population  | Funds for funding basic research generally award their resources in competition and project-related. The budget per inhabitant is therefore an indicator for the structure of university funding.  | OECD MSTI, FWF  |                          | 46     |
|  | Number of doctoral students   | An employment contract while studying for a doctorate is standard international practice to ensure the attractiveness of careers in science. Doctoral programmes in science can last 3 to 6 years; during this period students who have not enrolled in a doctoral programme are already working. Without employment, careers in science are therefore hardly an attractive option compared with a career in industry.               | Uni:Data  | National target was used | 47     |
|  | Total employment  | The indicator shows the weight of employment in sectors, which employ many university graduates in an international comparison and are thus regarded as particularly knowledge-intensive.  | Eurostat WIFO calculations (analogous to EIS, European Innovation Scoreboard)           |                          | 48     |
|  | Total value of all exports  | The indicator measures the contribution of medium and high technology products to the trade balance and can thus also be seen as a measure of the knowledge intensity of the export structure.   | Comtrade, Eurostat WIFO calculations (analogous to EIS, European Innovation Scoreboard) |                          | 49     |
|  | Total exports of services without tourism                           | The indicator shows the export weight of service sectors with high innovation intensity and can thus also be seen as a measure of the knowledge intensity of the export structure. Due to the specific characteristics of Austria (Alps, cultural cities) tourism accounts for a far higher share of services exports in an international comparison. Thus this sector is not taken into consideration.                              | EBOP, WIFO calculations   |                          | 50     |
|  | Value creation in the corporate sector                              | The R&D intensity can be interpreted as a measure of knowledge intensity. However, the average R&D intensities vary greatly depending on the sector and an adjustment of the industry structure is necessary in order to make an internationally comparable statement on the R&D intensity of the corporate sector. Adjustments in the economic classification (NACE 1.1 to NACE 2) resulted in extensive changes in 2015 over 2014. | EBOP, WIFO calculations   |                          | 51     |
|  | Total export of technology-orientated industries for material goods | Export quality can be interpreted as a measure to improve the product structure.   | Eurostat, WIFO calculations   |                          | 52     |

| Objective target of the strategy  | Indicator to track target achievement   | Abbreviation                          | Numerator   |
|---|---|---------------------------------------|---|
| <b>Objectives “Leverage knowledge, add value” – innovation and corporate research</b>   |   |                                       |   |
| The number of firms that systematically conduct research and development should be increased between 2010 and 2013 by a total of 10% from 2,700 and by a total of 25% by 2020.                | Increase in the number of companies conducting systematic research and development                          | R&D Performers                        | Number of companies in Austria conducting systematic research and development   |
| Mobilise SMEs in research and innovation performance  | Share of innovative SMEs  | Innovative SMEs                       | SMEs with product or process innovation   |
| Further increase Austria’s attractiveness as a location for research and technology intensive firms.  | Foreign-funded R&D  | Foreign-funded R&D                    | R&D funding from abroad   |
|   | Share of foreign owners (applicants) of EPO patents with the participation of inventors residing in Austria | Foreign-owned patents                 | Number of patents with purely foreign applicants and at least one domestic inventor                                       |
| Sustainable increase in the level of innovation in companies by increasing the share of innovations, which are new to the market  | Share of innovations, which are new to the market as measured by the revenue they generate                  | Innovation revenue                    | Revenue produced by innovations, which are new to the market  |
| <b>Research and Innovation in the Corporate Sector – Cooperation between Science and Business</b>   |   |                                       |   |
| We want to increase the co-operation intensity of Austrian firms and strengthen strategically-orientated collaboration between science and business (focus on excellence and sustainability). | Share of companies with innovation co-operation with universities/research institutions                     | Business-Science Links LCU            | Companies with innovation co-operation with universities/research institutions  |
| Reduce barriers to, and companies’ (SMEs) fears about, co-operation with science/research   | Share of SMEs with innovation co-operation with universities/research institutions                          | Business-ScienceLinks SMEs            | SMEs with innovation co-operation universities/research institutions  |
| More firms should expand their technology leadership and attain top positions in innovation   | PCT applications relative to GDP  | Technological significance of patents | Number of patents applications filed under the PCT, at international phase, designating the European Patent Office (EPO). |

|  | Denominator  | Brief explanation of indicator  | Source                                    | Calculation information | ID No. |
|--|--|---|---|-------------------------|--------|
|  | n. a.  | Survey units engaged in R&D, by performance sector (co-operative research and in-house research subsumed)   | Statistik Austria                         | National target         | 53     |
|  | Total number of SMEs   | The indicator describes the share of SMEs with innovation activity, i.e. a measure of innovation breadth.   | Eurostat, CIS (analogous to EIS)          |                         | 54     |
|  | Gross domestic expenditure on R&D  | A disproportionately large share of research spending in Austria is financed from abroad. While this is an indication of Austria's quality as a location for research, it also increases the fragility of research activity in Austria. Thus, there is no need for continued growth in the share of foreign funding, at the same, however, a dramatic fall is also undesirable. | OECD MSTI                                 |                         | 55     |
|  | Number of all patents with the participation of at least one domestic inventor | This indicator shows the control of foreign entities over inventions made by inventors living in Austria. Consequently it demonstrates the share of patents with at least one domestic inventor and where all applicants live abroad as a percentage of total patents owned by national inventors.  | PATSTAT (autumn 2016)<br>WIFO calculation |                         | 56     |
|  | Companies' revenues  | The indicator reflects the economic significance of innovations, which are not only new to the company, but also new to the market and are therefore particularly innovative. It is thus an impact indicator for innovation   | Eurostat                                  |                         | 57     |
|  | Total population of companies  | This indicator reflects the intensity of co-operation between companies and science and research  | Eurostat                                  |                         | 58     |
|  | Total population of SMEs   | This indicator reflects the co-operation intensity of SMEs with science and research  | Eurostat                                  |                         | 59     |
|  | GDP at PPS   | The number of patent applications can be understood as an indicator of the number of innovations  | Eurostat, PATSTAT, WIFO calculations      |                         | 60     |

| Objective target of the strategy  | Indicator to track target achievement   | Abbreviation                            | Numerator   |
|---|---|---|---|
| <b>Research and Innovation in the Corporate Sector – Start-Ups and Venture Capital Financing</b>  |   |   |   |
| Substantially increase the intensity of private equity and venture capital in the formation of technology-based, innovative firms.  | Venture capital intensity (market statistics)   | Venture capital intensity               | Venture capital invested in Austria (also through foreign funds)                                |
| Number of knowledge- and research-intensive new start-ups should climb annually by an average of 3% until 2020.   | Average annual growth in the number of knowledge and research-intensive start-ups.                      | Start-ups material goods                | Number of knowledge and research-intensive business start-up (material goods)                   |
|   |   | Start-ups services                      | Number of knowledge and research-intensive start-ups (services)                                 |
| Starting a business should be made much easier and relieved of cost burdens.  | Ranking with respect to start-up regulations in doing business  | Start-up regulation                     | Ranking with respect to start-up regulations in doing business                                  |
|   | Employment in rapidly growing companies   | Employment in rapidly growing companies | Employment in rapidly growing companies in knowledge-intensive sectors                          |
| <b>Research and Innovation in the Corporate Sector – Innovation and Competition</b>   |   |   |   |
| Stimulate innovation via an active competition policy. To do this, institutions that monitor competition should be strengthened.  | OECD indicator Competition policy   | Competition policy                      | OECD indicator Competition policy   |
| <b>Political Governance of the RTI System – Setting Priorities</b>  |   |   |   |
| Strengthen Austria's competitiveness in a wide range of cross-cutting fields in science and technology by focusing activities on units of internationally competitive size. To do this, fields in which domestic science and business are strong should be taken into account. Special attention must be paid to the competences and potentials of Austrian firms that can help implement research results for overcoming the Grand Challenges. | PCT patent applications in fields of technology that are particularly important for societal challenges | Priority: Patents                       | PCT patent applications in selected technological fields (climate change mitigation and health) |

|  | Denominator  | Brief explanation of indicator   | Source                               | Calculation information                           | ID No. |
|--|--|--|--------------------------------------|---|--------|
|  | GDP  | This indicator measures venture capital intensity on the basis of the total sums invested in Austria, also by foreign funds (market statistics).   | AVCO, EVCA                           |   | 61     |
|  | n. a.  | This indicator measures start-up activity in knowledge and research-intensive sectors of the material goods industry.  | Statistik Austria                    | National target                                   | 62     |
|  | n. a.  | This indicator measures start-up activity in knowledge and research-intensive industries within the service sector.  | Statistik Austria                    | National target                                   | 63     |
|  | n. a.  | The indicator compares the regulatory framework for founding an LLC (GmbH) in the different countries based on the following four criteria: number of necessary administrative steps, time, costs (% GDP per capita) and minimum capital (% GDP per capita). | World Bank                           | Inverted  | 64     |
|  | Employment in rapidly growing companies in the total economy | The indicator shows the dynamic of rapidly growing companies in knowledge-intensive sectors. It is not known, however, if the companies in question actually achieve their growth on the basis of innovation activities.                                     | EIS – European Innovation Scoreboard |   | 65     |
|  | n. a.  | The indicator classifies a number of rules governing competition in terms of their propensity to facilitate competition.   | OECD                                 | Inverted, normalised; break in time series (2013) | 66     |
|  | GDP in PPS   | This indicator measures inventive activity in fields of technology that make an important contribution to overcoming two societal challenges (climate change and the ageing population, and health).   | EIS European Innovation Scoreboard   |   | 67     |

| Objective target of the strategy   | Indicator to track target achievement   | Abbreviation                         | Numerator   |
|--|---|--------------------------------------|---|
| <b>Political Governance of the RTI System – Funding System and International Positioning</b>   |   |                                      |   |
| Increased Austrian participation in European funding programmes, for example in the Research Framework Programmes or the European Structural Funds.  | Returns ratio   | Returns ratio                        | Austria's share in funding in the 7th framework programme/ Horizon 2020 (core framework programme)        |
|  | "Utilised capacity" (participation in Framework Programme based on researchers per country) | Participation in Framework Programme | Austrian participations as a share of total participations (EU 27) in the respective Framework Programme. |
| <b>Political Governance of the RTI System – To Society Research and Society</b>  |   |                                      |   |
| A culture of appreciation for research, technology, and innovation, and an understanding of how this field makes an essential contribution to increasing the quality of life and societal prosperity   | Attitude towards science (personal interest, economic benefits)                             | Personal interest in science         | Share of people with a high to medium appreciation of science in different areas                          |
|  |   | Economic benefits of science         |   |
|  |   | Positive attitude toward science     |   |
| <b>Objectives "Offer incentives, open up options" – research financing</b>   |   |                                      |   |
| Increase research intensity by one percentage point, from 2.76% today to 3.76% in 2020.  | R&D intensity   | R&D intensity                        | Gross domestic expenditure on research and development  |
| Of this investment amount, at least 66%, but 70% if possible, should come from the private-sector. To this end, firms should be stimulated on a broad front (including an improved regulatory situation and sufficient incentive structures) to perform more research and innovation. The number of firms conducting research and development should be increased. | Share of research funding provided by the private-sector                                    | Private-sector R&D                   | R&D financing from non-governmental sources   |

|  | Denominator   | Brief explanation of indicator  | Source                       | Calculation information | ID No. |
|--|---|---|------------------------------|-------------------------|--------|
|  | Austria's contribution to the EU budget.                  | The indicator shows Austria's success at obtaining EU funding relative to its total EU budget contribution, i.e. whether Austria obtains an above or below-average return in research. An above-average return indicates that Austria receives a high proportion of European grants.                | PROVISO and EU-PM (FFG)      |                         | 68     |
|  | Researchers/country as a share of total researchers EU 27 | This indicator shows whether a country's involvement in the FP is above or below its theoretically available capacity (potential). The indicator is calculated over the period of the relevant Framework Programme as of the census date).  | PROVISO and EU-PM (FFG)      |                         | 69     |
|  | All respondents   | This indicator shows the public perception of science. The questions in the Special Eurobarometer were divided into two groups. One set of questions addressed the personal benefits of, or interest in, science and technology, the other, the benefits of science and technology for the economy. | Eurobarometer                |                         | 70     |
|  |   |   |                              |                         | 71     |
|  |   |   |                              |                         | 72     |
|  | GDP   | R&D Intensity: Gross domestic expenditure as a percentage of GDP  | OECD MSTI, Statistik Austria | National target         | 73     |
|  | Total expenditure on R&D                                  | The share of private-sector research funding is the share of total R&D spend that is financed by business enterprises.  | OECD MSTI, Statistik Austria | National target         | 74     |

## Appendix 2: Indicators' Raw Data

| Indicator                                   | Current value |             | Unit   | Goal distance | Growth |             | Productive growth | Prospect of goal achievement | Available time series | ID |
|---|---------------|-------------|--|---------------|--------|-------------|-------------------|------------------------------|-----------------------|----|
|   | AT            | Inno. Lead. |  |               | AT     | Inno. Lead. |                   |                              |                       |    |
| EIS Index                                   | 121.47        | 131.58      | But relative to EU (= 100)                                   | 92            | 0.45   | 0.48        | 2.51              | 92                           | 2009–2016             | 1  |
| Per capita GDP)                             | 126.00        | 119.50      | Volume index of real per capita spending in PPS (EU 28 =100) | 105           | -0.20  | -0.29       | -1.60             | 106                          | 2000–2016             | 2  |
| Employment rate                             | 74.80         | 77.57       | In %   | 96            | 0.29   | 0.31        | 1.23              | 96                           | 2000–2016             | 3  |
| Unemployment rate                           | 5.50          | 5.94        | In %   | 108           | 2.04   | -0.12       | 2.71              | 102                          | 2000–2017             | 4  |
| Better Life                                 | 6.79          | 7.59        | Index 0-10   | 89            | -3.07  | -0.94       | 2.87              | 84                           | 2013–2017             | 5  |
| Life expectancy in good health (F)          | 69.40         | 75.08       | In %   | 92            | -0.52  | 0.05        | 1.78              | 89                           | 2004–2015             | 6  |
| Life expectancy in good health (M)          | 73.50         | 80.73       | In %   | 91            | -0.34  | 0.12        | 2.11              | 89                           | 2004–2015             | 7  |
| Greenhouse gases                            | 101.63        | 84.00       | In %   | 83            | -0.10  | -1.51       | -3.74             | 83                           | 2000–2015             | 8  |
| Energy intensity                            | 4.48          | 4.73        | Gross Domestic Consumption in terajoule/GDP                  | 106           | -0.44  | -1.87       | -0.66             | 99                           | 2000–2015             | 9  |
| Resource productivity                       | 1.67          | 2.50        | GDP/material consumption in kg                               | 67            | 1.28   | 1.74        | 12.95             | 65                           | 2000–2016             | 10 |
| Early childhood care                        | 95.00         | 95.00       | In %   | 100           | 0.73   | 0.81        | 0.00              | 103                          | 2000–2016             | 11 |
| Teacher-child ratio early childhood         | 13.50         | 11.67       | Number (children/supervisor)                                 | 86            | -2.29  | -1.50       | -3.75             | 93                           | 2002–2015             | 12 |
| Student-teacher ratio in primary education) | 11.80         | 14.78       | Number (children/teachers)                                   | 125           | -1.36  | -0.57       | 3.97              | 130                          | 2001–2015             | 13 |
| Early school leavers                        | 6.90          | 9.50        | In %   | 138           | -2.41  | -2.16       | 8.32              | 152                          | 2000–2016             | 14 |
| Secondary school graduates                  | 39.90         | .           | In %   | 73            | 0.56   | .           | 8.35              | 74                           | 2000–2016             | 15 |
| Early school leavers – Migrants             | 87.03         | .           | In %   | 145           | 1.45   | .           | -8.88             | 154                          | 2011–2016             | 16 |
| Education inheritance 1                     | 45.10         | 37.87       | Increase of socio-economic gradients                         | 84            | 0.12   | -0.55       | -3.74             | 82                           | 2000–2015             | 17 |
| Education inheritance 2                     | 14.57         | 10.66       | Percentage of declared variance                              | 73            | -0.88  | -2.09       | -8.03             | 69                           | 2000–2015             | 18 |
| PISA Risk – Reading                         | 22.54         | 15.00       | In %   | 67            | 1.04   | 0.92        | -7.82             | 63                           | 2000–2015             | 19 |
| PISA Risk – Mathematics                     | 21.75         | 15.00       | In %   | 69            | 1.24   | 1.56        | -7.16             | 65                           | 2003–2015             | 20 |
| PISA Risk – Science                         | 20.83         | 15.00       | In %   | 72            | 2.73   | 3.21        | -6.35             | 63                           | 2006–2015             | 21 |
| PISA Risk – Reading                         | 7.24          | 10.31       | In %   | 70            | -0.20  | -0.07       | 7.35              | 69                           | 2000–2015             | 22 |
| PISA Risk – Mathematics                     | 12.46         | 12.14       | In %   | 103           | -1.13  | -3.00       | -3.52             | 113                          | 2003–2015             | 23 |
| PISA Risk – Science                         | 7.72          | 10.40       | In %   | 74            | -2.80  | -1.43       | 4.32              | 70                           | 2006–2015             | 24 |
| Skill Mismatch                              | na            | na          | na   | n. a.         | n. a.  | n. a.       | n. a.             | n. a.                        | n. a.                 | 25 |
| University graduates                        | 40.10         | 38.00       | In %   | 106           | 2.07   | 2.44        | -1.34             | 115                          | 2004–2016             | 26 |
| University graduates (ISCED 6-8)            | 23.55         | 41.97       | In %   | 56            | 1.00   | 1.47        | 17.23             | 55                           | 2004–2016             | 27 |
| Supervisor-student ratio (university)       | 16.48         | 13.34       | Number (students/supervisor)                                 | 81            | 1.86   | -0.28       | -4.20             | 74                           | 2002–2015             | 28 |
| University expenditure rate                 | 1.46          | 2.00        | In %   | 73            | 2.40   | 1.60        | 5.44              | 84                           | 2000–2014             | 29 |
| University expenditure rate per student     | 17,060.91     | 20,154.25   | In USD   | 85            | 3.29   | 4.24        | 7.37              | 79                           | 2000–2014             | 30 |
| Researchers                                 | 10.36         | 11.87       | In %   | 87            | 3.52   | 2.37        | 5.91              | 91                           | 2002–2016             | 31 |
| Doctoral graduates STEM                     | 0.90          | 1.27        | In %   | 71            | 2.74   | 4.03        | 11.31             | 67                           | 2000–2015             | 32 |
| STEM graduates                              | 22.10         | 18.62       | In %   | 119           | 7.76   | 3.22        | -0.22             | 147                          | 2000–2015             | 33 |
| Share of female researchers                 | 29.49         | 31.74       | In %   | 93            | 2.76   | 1.32        | 2.73              | 100                          | 2002–2015             | 34 |
| Share of women in natural sciences          | 48.43         | 50.57       | In %   | 96            | -0.46  | -0.01       | 0.84              | 94                           | 2005–2015             | 35 |
| Share of women in engineering               | 26.71         | 25.15       | In %   | 106           | 1.86   | 0.24        | -0.96             | 115                          | 2005–2015             | 36 |
| EU Glass Ceiling Index                      | 1.76          | 1.71        | Index (measured ratio value)                                 | 97            | -3.34  | -2.38       | -2.59             | 106                          | 2004–2013             | 37 |

| Indicator                                     | Current value |             | Unit                                      | Goal distance | Growth |             | Productive growth | Prospect of goal achievement | Available time series | ID |
|---|---------------|-------------|---|---------------|--------|-------------|-------------------|------------------------------|-----------------------|----|
|   | AT            | Inno. Lead. |   |               | AT     | Inno. Lead. |                   |                              |                       |    |
| Highly-qualified Immigrants                   | 19.22         | 28.61       | In %                                      | 67            | 2.58   | 1.14        | 7.20              | 73                           | 2000–2013             | 38 |
| Foreign doctoral students                     | 27.00         | 29.03       | In %                                      | 93            | 0.56   | 3.80        | 5.76              | 78                           | 2008–2015             | 39 |
| Lifelong learning                             | 14.90         | 20.90       | In %                                      | 71            | 3.72   | 1.50        | 10.67             | 77                           | 2000–2016             | 40 |
| Basic research quota                          | 0.54          | 0.64        | In %                                      | 83            | 3.11   | 2.64        | 7.29              | 82                           | 2002–2015             | 41 |
| Publication quality                           | 11.70         | 12.70       | Top publications in % of all publications | 92            | 0.75   | 0.63        | 2.31              | 93                           | 2008–2015             | 42 |
| International co-publications                 | 1,335.89      | 1,540.35    | Number per million inhabitants            | 87            | 7.82   | 7.57        | 11.78             | 87                           | 2009–2016             | 43 |
| ERC grants per inhabitant                     | 2.97          | 3.15        | Number (grants/inhabitants)               | 94            | 8.51   | 10.46       | 12.36             | 87                           | 2009–2016             | 44 |
| University ranking research performance       | 31.27         | 26.98       | Number per ranking group/population       | 116           | 0.06   | -0.68       | -2.87             | 116                          | 2009–2015             | 45 |
| Competitive financing                         | 22.02         | 67.14       | In EUR/population                         | 33            | 1.15   | 5.72        | 40.58             | 27                           | 2007–2016             | 46 |
| Doctoral candidates with employment contracts | 31.19         | 0.00        | In %                                      | 31            | 5.09   | 0.00        | 33.81             | 38                           | 2010–2016             | 47 |
| Knowledge intensity business                  | 14.60         | 16.77       | In %                                      | 87            | 0.62   | 0.63        | 4.21              | 87                           | 2008–2016             | 48 |
| Knowledge intensity exports                   | 57.79         | 53.90       | In %                                      | 107           | 0.40   | -0.15       | -1.83             | 109                          | 2005–2016             | 49 |
| Knowledge intensity exports service industry  | 76.48         | 74.99       | In %                                      | 102           | 0.65   | -0.09       | -0.57             | 105                          | 2010–2016             | 50 |
| R&D intensity of the economy                  | 0.96          | 0.28        | In percentage points                      | 339           | 12.50  | 3.42        | 5.77              | 136                          | 2005–2015             | 51 |
| Export quality                                | 78.61         | 84.55       | In %                                      | 93            | -0.30  | -0.30       | 1.54              | 93                           | 2010–2016             | 52 |
| R&D performers                                | 3,611.00      | 0.00        | Number                                    | 107           | 4.89   | 0.00        | -1.34             | 136                          | 2002–2015             | 53 |
| Innovative SMEs                               | 40.71         | 36.90       | In %                                      | 110           | -2.00  | -0.41       | -1.56             | 97                           | 2006–2014             | 54 |
| Foreign-funded R&D                            | 16.55         | 11.97       | In %                                      | 138           | -1.21  | 4.31        | -1.69             | 102                          | 2000–2015             | 55 |
| Foreign-owned patents                         | 24.59         | 23.80       | In %                                      | 103           | -0.84  | 0.87        | 0.17              | 94                           | 2000–2014             | 56 |
| Innovation revenue                            | 8.40          | 11.88       | In %                                      | 71            | 1.90   | 1.28        | 13.32             | 53                           | 2004–2014             | 57 |
| Business-Science Links LCU                    | 56.80         | 41.60       | In %                                      | 137           | 4.62   | 0.84        | -4.34             | 171                          | 2004–2014             | 58 |
| Business-Science Links SMEs                   | 29.90         | 20.92       | In %                                      | 143           | 8.03   | 2.06        | -4.11             | 204                          | 2004–2014             | 59 |
| Patents' technological significance           | 4.95          | 6.59        | Number of applications/GDP                | 75            | -0.22  | -1.90       | 3.83              | 82                           | 2008–2015             | 60 |
| Risk capital intensity                        | 0.03          | 0.40        | In % of GDP                               | 7             | -23.41 | -7.07       | 78.41             | 3                            | 2007–2016             | 61 |
| Start-ups material goods                      | -8.43         | .           | In %                                      | 42            | -4.39  | .           | 18.69             | 42                           | 2010–2015             | 62 |
| Start-ups service industry                    | -5.64         | .           | In %                                      | 39            | -4.18  | .           | 20.42             | 39                           | 2010–2015             | 63 |
| Start-up regulation                           | 118.00        | 36.67       | Ranking                                   | 31            | 4.33   | 1.90        | -29.60            | 31                           | 2006–2017             | 64 |
| Employment in rapidly growing companies       | 2.90          | 5.01        | In %                                      | 58            | 0.05   | -1.97       | 9.94              | 62                           | 2008–2015             | 65 |
| Competition policy                            | 0.35          | 0.14        | Compound indicator index value            | 40            | -10.00 | -11.07      | -19.43            | 46                           | 2003–2013             | 66 |
| Priority setting – patents                    | 0.63          | 1.50        | Applications/GDP                          | 42            | 1.58   | 2.94        | 17.17             | 37                           | 2000–2013             | 67 |
| Returns ratio                                 | 127.82        | 125.99      | Index value                               | 101           | 0.36   | -0.45       | 0.56              | 99                           | 2012–2016             | 68 |
| Participation in FP                           | 124.69        | 114.39      | Index value                               | 109           | -1.23  | 1.07        | 0.21              | 94                           | 2012–2016             | 69 |
| Personal interest in science                  | 9.20          | 18.98       | In %                                      | 48            | -24.06 | -21.11      | -10.63            | 32                           | 2010–2013             | 70 |
| Benefits of science for the economy           | 63.63         | 66.47       | In %                                      | 96            | -2.16  | -1.45       | -0.76             | 91                           | 2010–2013             | 71 |
| Positive attitude towards science             | 44.52         | 61.14       | In %                                      | 73            | 2.37   | -0.48       | 4.13              | 89                           | 2010–2013             | 72 |
| R&D quota                                     | 3.09          | 3.76        | In %                                      | 82            | 3.13   | 0.24        | 5.05              | 93                           | 2000–2016             | 73 |
| Private sector R&D                            | 69.32         | 66.00       | In %                                      | 105           | 0.70   | 0.00        | -1.22             | 108                          | 2000–2016             | 74 |

Goal Distance = actual value AT/actual value Innovation Leaders or actual value AT/target AT

Prospect of Goal Achievement = Value projected for Austria in 2020 relative to the national goal or the value projected for the Innovation Leaders in 2020

### Appendix 3: Methodology and Notes for Interpreting Graphics and Indicators

All indicators used in this Report were proposed by the WIFO, subjected in the cooperation with WG 8 (RTI rankings) of the RTI Task Force to a wideranging discussion with experts and coordinated with the ministries responsible for implementing the RTI Strategy. They are based on explicit objectives of the RTI Strategy of the Austrian Federal Government and on internationally used classifications of the OECD, Eurostat, etc. and corresponding databases. These are accessible to the public and are regularly surveyed nationally and internationally.

For this report the indicators are illustrated in the corresponding figures according to their distance to the goal (**goal distance**) and their prospect of **goal achievement**. The **goal distance** on the horizontal axis illustrates the current Austrian value. It shows the ratio and the distance of the last available Austrian value to the national set goal according to the RTI Strategy and the Education and Training 2020 Strategy.<sup>96</sup> If there is no national goal, the goal of the last available average value of the current five innovation leaders, Denmark, Germany, Finland, the Netherlands and Sweden (“innovation leaders actual value”) is used.<sup>97</sup> This is because Austria’s move into the innovation leaders is a priority goal of the RTI Strategy.

All indicators must be interpreted in the same direction, i.e. values above 100 signal goal achievement, values below 100 a corresponding distance to the goal. The standardisation of the values is achieved as follows: The Austrian value is divided by the respective target value and multiplied

by 100. If performance improvements are accompanied by a decline in the indicator values, such as with the unemployment rate, for example, the values would be inverted (i.e. target value in the numerator, Austrian value in the denominator), in order to retain the interpretation of “greater equal to 100 = goal achievement”. Corresponding indicators are identified in the indicators list under “Calculation Information”. Values above 200 are limited in the graphics to 200. The goal distance says something about the level difference to the goal – about Austria’s current performance, but not about the changes or dynamic required for goal achievement. An indicator that is currently just below goal could therefore worsen again due to a negative dynamic. To put it another way, the exclusive comparison of the goal distances does not allow any conclusions on the probability of goal achievement.

For this reason the prospect of **goal achievement** on the vertical axis was selected as the second dimension of the indicators-based illustration. It shows whether or not the past growth of the indicator is sufficient for goal achievement. It is the ratio of the projected value for Austria in 2020 to the target value for 2020 – based on the average annual growth rate of the respective data series in the past (for this, see also the values in Appendix 2). As a target value for the growth calculation, if there is no national goal, the projected value for 2020 will be used, and not the actual value of the innovation leaders. This in turn is determined on the basis of the average growth rates of the comparison countries in the past.<sup>98</sup>

99 For the education system, at the suggestion of the Federal Ministry of Education, Arts and Culture at the time, target values of the European Education and Training 2020 Strategy, which is independent of the RTI Strategy, were used for some indicators.

100 The term “innovation leader” refers to those EU countries in the top group in the annual European Innovation Scoreboard (EIS) of the European Commission.

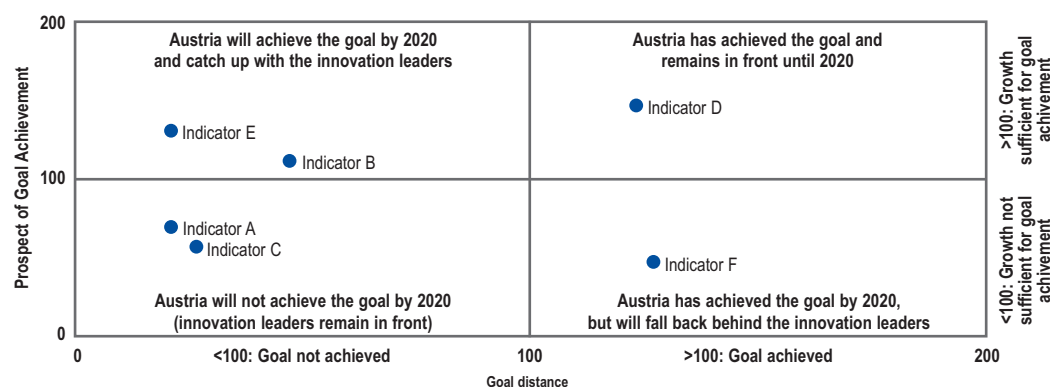
101 The argument for this is that it is unlikely that the innovation leaders will remain at their current level. Austria’s placing in the European Innovation Scoreboard is therefore always made increasingly more relative to the placing of the other countries, i.e. it always considers the growth of all countries. A setting of the target value on the actual value of the innovation leaders would result in prospects of goal achievement that are too optimistic, whereby the priority setting of the measures could be distorted.

A prospect of goal achievement above 100 means that the growth in the past had been above the growth required for goal achievement. The prospect for goal achievement in 2020 should be correspondingly high. If the value is under 100, the past dynamic gives cause to fear the goal will be missed. Values above 200 on the other hand are limited to 200.

On the whole it must be emphasised that these calculations are based on the average growth rates of the past. They therefore do not represent any

prognoses based on assumptions, but rather illustrate the development under the proviso that everything continues as it was before. The results will change with the growth course of coming years and are integrated into the regular updating of the graphics. Like all calculations they must be interpreted with due caution, but they do however produce a general view of the dynamic in the individual objectives, from which priority areas of action can be concluded.

Figure 26: Sample graphic for explaining the interpretation of the indicators



Sources: See Appendix 1. Note: Goal Distance = Austria's actual value relative to the national target or the innovation leaders' actual value (value for the most recent available year for DE, DK, FI, GB, NL, SE); Prospect of Goal Achievement = Value projected for Austria in 2020 relative to the target value. Values over 200 limited to 200. Raw data, see Appendix 2.

The combination of goal distance and prospect of goal achievement produces a graphic illustration of four areas with varying implication (see figure 26).

If an indicator is in one of the two areas on the left side, this means that Austria has not yet achieved the corresponding goal. For indicators in the bottom left area this will very probably also stay as it is until 2020 due to the weak growth without additional measures or measure intensification. Measures that are suitable to increase the indicator values in this area should therefore be handled as special priority. In the top left area a further continuous development could result as before in achieving the goal by 2020, as the Aus-

trian development dynamic is greater than that of the comparison countries. That is, in these areas no further measures would be required, always assuming a continuously constant development.<sup>99</sup> Indicators in the two right quadrants show that the corresponding goals have already been achieved. In all likelihood the right top area will also remain as it is due to the high growth of the specific indicator, provided the growth of the innovation leaders remains within the expected scope. In the right bottom area Austria's growth is insufficient to maintain its edge ahead of the innovation leaders in the longterm. The development should be observed very closely here to also counteract in good time where required.

102 Trend changes are however recorded rather quickly due to the annual updating of the indicator sets.

## Appendix 4: Overview of Indicators Used In The Efficiency Analysis

| Area name                  | Long description  |
|----------------------------|---|
| Science – Input            | Researchers in PTE in the university sector and public sector, per 1,000 inhabitants                            |
| Science – Input            | R&D expenditures in the public sector and universities, in USD and purchasing power parities                    |
| Science – Output           | Aggregation of the Leiden university ranking, relative to population  |
| Science – Output           | Number of certifiable publications, per 1,000 inhabitants   |
| Science – Output           | Number of publications among the most cited, 10% worldwide  |
| Technology – Input         | R&D expenditures in the corporate sector, in USD and purchasing power parities, in % of GDP                     |
| Technology – Input         | Researchers in FTE in the corporate sector, per 1,000 inhabitants   |
| Technology – Output        | Patent applications at the EPO according to inventor's place of residence, per 1,000 inhabitants                |
| Technology – Output        | Patent applications at the EPO, JPO and USPTO according to inventor's place of residence, per 1,000 inhabitants |
| Innovation – Input         | R&D expenditures in all sectors, in USD and purchasing power parities   |
| Innovation – Input         | Innovation spending in % of turnover, without R&D expenditures  |
| Innovation – Input         | Researchers in FTE in all sectors, per 1,000 inhabitants  |
| Innovation – Input         | Share of 25 to 34 year-old university graduates, in % of the 25-34 age group of the population                  |
| Innovation – Output        | Share of innovative SMEs in the SME population in the CIS   |
| Innovation – Output        | Share of innovation-intensive sectors in value creation, in %   |
| Innovation – Output        | Employment in rapidly growing companies in innovation-intensive sectors   |
| Innovation – Output        | Share of innovations in turnover  |
| Innovation – Output        | Share of exports in high price segment in all exports   |
| Innovation – Output        | Complexity score of exported products   |
| Innovation – Output        | Share of exports with medium-high to high technology intensity in overall exports                               |
| R&D productivity indicator | Number of publications relative to R&D expenditures in the university sector and public sector                  |
| R&D productivity indicator | Number of patent applications (EPO) relative to R&D expenditures in the corporate sector                        |

| Short description                              | Period    | Countries sample   | Source  |
|--|-----------|--|---|
| Number of researchers (HEI&GOV) per population | 2002–2015 | EU28, CH, JP, KR, US   | OECD, Eurostat, WIFO calculations   |
| R&D expenditures (HERD&GOVERD) per population  | 2002–2016 | EU28, CH, JP, KR, US   | OECD, Eurostat, WIFO calculations   |
| University ranking per population              | 2009–2015 | AT, BE, CH, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IT, JP, KR, LT, NL, PL, PT, RO, SE, SI, SK, US | CWTS Leiden   |
| Number of publications per population          | 2005–2016 | EU28, CH, JP, KR, US   | Scimago, World Bank, WIFO calculations  |
| Quality of publications                        | 2008–2015 | EU28, CH, JP, KR, US   | European Innovation Scoreboard  |
| R&D expenditures (BERD) in % of GDP            | 2008–2015 | EU28, CH, JP, KR, US   | OECD, Eurostat, WIFO calculations   |
| Number of corporate researchers per population | 2002–2016 | EU28, CH, JP, KR, US   | OECD, Eurostat, WIFO calculations   |
| Patent applications (EPO) per population       | 2000–2014 | EU28, CH, JP, KR, US   | PATSTAT, autumn 2017, World Bank, WIFO calculations                           |
| Triadic patent applications per population     | 2000–2014 | EU27 (without GR), CH, JP, KR, US  | PATSTAT, autumn 2017, World Bank, WIFO calculations                           |
| R&D expenditures (GERD) per population         | 2000–2016 | EU28, CH, JP, KR, US   | OECD, Eurostat, WIFO calculations   |
| Innovation spending (without R&D)              | 2008–2015 | EU28, CH   | European Innovation Scoreboard  |
| Number of researchers per population           | 2002–2016 | EU28, CH, JP, KR, US   | OECD, Eurostat, WIFO calculations   |
| Tertiary graduation (25-34 year-olds)          | 2004–2016 | EU28, CH, JP, KR, US   | OECD  |
| SMEs with innovations                          | 2008–2015 | EU28, CH, JP, KR, US   | European Innovation Scoreboard  |
| Innovation-intensive segments                  | 2005–2015 | EU28, CH, KR, US   | OECD, Eurostat, WIFO calculations   |
| Employment in rapidly growing start-ups        | 2008–2015 | EU27 (ohne GR), CH   | European Innovation Scoreboard  |
| Innovations turnover share                     | 2008–2015 | EU28, CH   | European Innovation Scoreboard  |
| Export quality                                 | 2000–2015 | EU27 (without LU), CH, JP, KR, US  | BACI, WIFO calculations   |
| Export complexity                              | 2000–2015 | EU27 (without LU), CH, JP, KR, US  | BACI, WIFO calculations   |
| Export knowledge intensity                     | 2005–2016 | EU28, CH, JP, KR, US   | Comtrade, WIFO calculations (similar to EIS – European Innovation Scoreboard) |
| Publications vs. HERD&GOVERD                   | 2005–2016 | EU28, CH, JP, KR, US   | Scimago, OECD, Eurostat, WIFO calculations                                    |
| Patents vs. BERD                               | 2002–2014 | EU28, CH, JP, KR, US   | PATSTAT, autumn 2017, OECD, WIFO calculations                                 |

## Appendix 5: Indicators for the Global Innovation Monitor

appendix

|                                  | Indicator name   | Available time series |
|----------------------------------|--|-----------------------|
|                                  |  | Austria               |
| Economy, society and environment | Per capita GDP for purchasing power standards (PPS)              | 2000–2016             |
|                                  | Employment rate  | 2000–2016             |
|                                  | Unemployment rate  | 2000–2016             |
|                                  | Life expectancy at birth   | 2000–2015             |
|                                  | Efficiency increase: resources productivity                      | 2000–2015             |
|                                  | Efficiency increase: energy intensity                            | 2000–2016             |
| Education                        | Early childhood supervision ratio                                | 2002–2015             |
|                                  | University spending per student                                  | 2000–2014             |
|                                  | PISA average points number, reading                              | 2000–2015             |
|                                  | PISA average points number, mathematics                          | 2003–2015             |
|                                  | PISA average points number, science                              | 2006–2015             |
|                                  | PISA education inheritance                                       | 2000–2015             |
|                                  | University graduates (25-34 age group)                           | 2000–2015             |
|                                  | STEM graduates   | 2000–2015             |
|                                  | STEM graduates – women   | 2000–2015             |
| University research              | University ranking, research performance                         | 2009–2015             |
|                                  | University spending for R&D / population                         | 2002–2016             |
|                                  | Basic research quota   | 2002–2015             |
| Corporate research               | R&D quota  | 2000–2016             |
|                                  | Private research financing share (financed by industry & abroad) | 2000–2016             |
|                                  | Number of researchers per 1,000 employees                        | 2002–2016             |
|                                  | Patent applications acc. to PCT relative to GDP                  | 2000–2014             |
|                                  | Start-up regulations   | 2006–2016             |

| Available time series |           |           |             |           |           |             |                                       |
|-----------------------|-----------|-----------|-------------|-----------|-----------|-------------|---------------------------------------|
|                       | China     | Israel    | South Korea | Canada    | USA       | Switzerland | Source                                |
|                       | 2000–2014 | 2000–2016 | 2000–2016   | 2000–2016 | 2000–2016 | 2000–2016   | OECD                                  |
|                       | 2000–2016 | 2000–2016 | 2000–2016   | 2000–2016 | 2000–2016 | 2005–2016   | OECD, World Bank (data for China)     |
|                       | 2000–2016 | 2000–2016 | 2000–2016   | 2000–2016 | 2000–2016 | 2000–2016   | OECD, World Bank (data for China)     |
|                       | 2000–2015 | 2000–2015 | 2000–2015   | 2000–2012 | 2000–2015 | 2000–2015   | OECD                                  |
|                       | 2000–2015 | 2000–2015 | 2000–2015   | 2000–2015 | 2000–2015 | 2000–2015   | IEA, Energy Balances, 2015 ed.        |
|                       | 2000–2014 | 2000–2016 | 2000–2016   | 2000–2016 | 2000–2016 | 2000–2016   | IEA, Energy Balances, 2015 ed.        |
|                       | 2002–2015 | 2004–2011 | 2002–2015   |           | 2002–2015 | 2004–2013   | OECD Education at a Glance            |
|                       |           | 2000–2014 | 2000–2014   | 2007–2014 | 2000–2010 | 2000–2014   | OECD Education at a Glance            |
|                       | 2000–2015 | 2000–2015 | 2000–2015   | 2000–2015 | 2000–2015 | 2000–2015   | OECD PISA                             |
|                       | 2003–2015 | 2006–2015 | 2003–2015   | 2003–2015 | 2003–2015 | 2003–2015   | OECD PISA                             |
|                       | 2006–2015 | 2006–2015 | 2006–2015   | 2006–2015 | 2006–2015 | 2006–2015   | OECD PISA                             |
|                       | 2000–2015 | 2006–2015 | 2000–2015   | 2000–2015 | 2000–2015 | 2000–2015   | OECD PISA                             |
|                       | 2010–2015 | 2003–2015 | 2000–2015   | 2000–2015 | 2000–2015 | 2000–2015   | OECD Education at a Glance            |
|                       | 2003–2005 |           | 2000–2013   |           | 2000–2013 | 2000–2015   | UNESCO                                |
|                       | 2003–2005 |           | 2000–2013   |           | 2000–2013 | 2000–2015   | UNESCO                                |
|                       | 2009–2015 | 2009–2015 | 2009–2015   | 2009–2015 | 2009–2015 | 2009–2015   | CWTS Leiden Ranking, WIFO calculation |
|                       | 2000–2016 | 2000–2016 | 2000–2016   | 2000–2016 | 2000–2016 | 2000–2014   | OECD MSTI, World Bank                 |
|                       | 2000–2015 | 2000–2015 | 2000–2015   |           | 2000–2015 | 2000–2015   | OECD MSTI                             |
|                       | 2000–2016 | 2000–2016 | 2000–2016   | 2000–2016 | 2000–2016 | 2000–2014   | OECD MSTI                             |
|                       | 2000–2016 | 2000–2014 | 2000–2016   | 2000–2016 | 2000–2016 | 2000–2014   | OECD MSTI, WIFO calculation           |
|                       | 2000–2016 |           | 2000–2016   | 2000–2013 | 2000–2014 | 2000–2014   | OECD MSTI                             |
|                       | 2000–2014 | 2000–2014 | 2000–2014   | 2000–2014 | 2000–2014 | 2000–2014   | OECD                                  |
|                       | 2006–2016 | 2006–2016 | 2006–2016   | 2006–2016 | 2006–2016 | 2006–2016   | World Bank                            |

## appendix

### Appendix 6: Methodology and Notes for Interpreting the Figures and Indicators from the Global Innovation Monitor

The graphics of the Global Innovation Monitor provide an overview of the development trends of the selected countries with regard to their performance in the areas of education, university research, business research, economy, society and environment. Austria (AT) represents the reference point here. Austria's goal distance (x-axis) and the

development dynamic (y-axis) are calculated standardised for Austria (=100). Those countries that are currently rated better than Austria appear axis right of 100 in this illustration. With a y-axis value >100 the countries shown have a higher development dynamic than Austria; by doing so, they either reduce their gap to Austria or cannot be caught up with.

### Appendix 7: RTI Strategy Objectives

#### RTI Strategy Objectives – Priority objectives and Effects of the RTI Strategy

- To advance to the group of leading innovation nations in the EU by 2020
- To boost the Austrian economy's competitiveness
- To increase social prosperity
- To meet the major social and economic challenges of the future

#### RTI Strategy Objectives – Education System (without Tertiary Area)

- We want to promote the talents of people at all levels of education, awaken their passion for research and enable them to achieve the best-possible qualifications for economic activity and scientific research. Universities, research institutes and businesses will therefore be guaranteed a sufficient offering of highly qualified researchers.
- The education system must also be optimized in its entirety, beginning in the early childhood phase through to models for lifelong learning.
- The reforms focus here on the mitigation of social selectivity, improved permeability between educational programmes and paths, continuous quality improvements in the class (...), as well as improved integration of immigrants (...).
- The rate of early school leavers will be reduced by 2020 to 9.5 percent.
- The secondary school graduates quota will be raised to 55 percent of one age group by 2020.
- The percentage of students with a first language that is not German, who complete secondary school, will increase from 40 percent at the moment to 60 percent

#### RTI Strategy Objectives – Tertiary Education System

- Study conditions at universities will improve significantly, whereby new financing models for university teaching will also be established.
- The reforms focus on (...) a continuous quality improvement in university teaching and improved integration of immigrants (...).
- The percentage of 30 to 34 year-olds that have completed university studies or have a similar qualification will be increased to 38 percent by 2020.

### RTI Strategy Objectives – Research at Universities and Non-University Research Institutes

- We want to increase investments in basic research by 2020 to the level of the leading research nations.
- We want to boost basic research with further structural reforms in the university system.
- The university financing model will also be reformed. Research financing will be more competitive and project-based.
- University research financing must be boosted via third-party resources of the Austrian Science Fund (FWF) acquired competitively and organized with appropriate cost coverage.
- The universities' profiling will be supported by setting up excellence clusters.
- The orientation of teaching and research topics at universities and the cooperation with non-university research institutes will be better coordinated as part of an overall strategy.
- Development of clearer role models in line with defined performance goals for the various institutions in the non-university research sector.
- The internal structures of the research institutes will be boosted by reforms and adjusted to new requirements.
- The overall structure of the non-university research sector will be optimized for better coordination.
- We want to expand the research infrastructures in Austria as the basis for excellent research and for Austrian research's international positioning in a coordinated fashion.
- The profiling of universities and non-university research institutes as the carriers of the research infrastructures will guarantee optimum coverage of strengths and synergy effects in usage.

### RTI Strategy Objectives – Research and Innovation in the Corporate Sector

- We want to increase domestic value creation by pushing forward research-intensive industry and knowledge-intensive services and implementing more demand-side mechanisms in procurement, regulation or standardisation to stimulate innovations.
- The product and services structure must be improved by increasing knowledge and innovation intensity in business.
- The number of companies active in systematic research and development will be increased from the estimated level of about 2,700 between 2010 and 2013 by about 10 percent in total and by 2020 by about 25 percent in total.
- The internationally successful leading Austrian companies will be strengthened in their leading role for the innovation system and SMEs will become more active in increasing their research and innovation performance.
- The attractiveness of location Austria as the base for research and technology-intensive companies must be improved further.
- The innovation level in companies must be sustainably raised by increasing the number of radical innovations that are new for the market.
- We want to increase the cooperation intensity of Austrian companies and strengthen the strategically oriented cooperation between science and industry – with special focus on excellence and sustainability.
- This must include the removal of barriers and start-up fears, especially for SMEs, for collaborations with science and research, and easier access for innovative businesses to external resources.
- More companies should therefore expand their technological leadership and target top innovation positions.
- We want to significantly increase equity and venture capital intensity at start-ups of technology-based and innovative companies.
- The number of knowledge and research-intensive start-ups will be increased by an average of three percent a year by 2020.
- We want to significantly increase the equity and venture capital intensity in setting up technology-based and innovative companies.
- The number of knowledge and research-intensive start-ups will be increased by an average of three percent a year by 2020.

### RTI Strategy Objectives – Governance and Financing of the RTI System

- We want to clearly coordinate the competencies of the responsible ministries with one another. Efficient coordination mechanisms among the responsible departments will be set up for this.
- The allocation of assignments among departments and funding agencies will be optimized with increased operational independence for agencies with a parallel increase in strategic control by the departments.
- Duplicate assignment allocation must also be prevented at funding agency level.
- System effectiveness and system intelligence must be increased with higher goal and output control.
- We want to boost Austria's competitiveness in generic cross-disciplinary areas in science and technology by focusing on activities in internationally competitive movers and shakers. We would refer here to the key strengths of domestic science and industry. The competencies and potential of Austrian companies that can contribute to overcoming the "grand challenges" in the implementation of research results must in particular be considered here.
- Priorities must be set in research and technology development based on systematic selection and decision processes. Sufficient justification of state prioritisation must be ensured here to prevent market and system failure.
- A new priority definition for specific challenges will result here in a more concentrated coordination of the activities in a system-wide deployment of all relevant departments within the scope of the Research, Technology and Innovation Task Force.
- System-wide priorities to address major social challenges of the future (the "grand challenges") must in particular be established.
- Priorities must be defined on the basis of preliminary analyses, should have a time-limited effect and be subject to parallel reviews.
- We want to develop a coordinated foreign science and research policy by bundling existing measures to support internationalization. The appropriate institutional structures will also be set up for this.
- Austria will position itself optimally in the "European Knowledge Area" with active participation in the formulation of an all-European research, technology and innovation policy.
- Stronger Austrian participation in European funding programs will also be targeted, such as the research support programs or the European structural funds, for example, with the goal of a continuously increasing return quota.
- Selective global cooperation will also be set up and expanded with innovation frontrunners such as the USA, selected Asian countries and the competitive BRIC countries.
- The cooperation with countries in Central, Eastern and South-East Europe will also be further intensified.
- We want to establish a policy approach in the funding system that will deploy the most efficient bundle of measures in a coordinated fashion in the respective context.
- Direct research funding will be further developed here oriented on the use of an adequate range of mechanisms.
- The legal bases for research funding will be standardized.
- The principle of allocation through competition will be enhanced.
- We want to promote a culture of appreciation of research, technology and innovation and the understanding that these make a considerable contribution to increasing quality of life and social prosperity.
- A stable and infrastructural environment for diverse forms of the dialogue on science and society will also be established here in the interests of a "scientific citizenship".
- Responsibility and integrity in science matters must also be boosted with institutionalised processes.
- We want to increase the funding quota by 2020 by one percentage point from the current 2.76 to 3.76 percent of GDP.
- At least 66 percent, but if possible 70 percent must be contributed here with investments from the private sector.

- Businesses will be stimulated here on a broad front with improved support conditions and adequate incentive structures to invest more in research and innovation. The number of companies active in research and development will be increased.

- Public sector resources will be allocated on the basis of increased output and impact orientation of the innovation system.

- The players in the innovation system must be guaranteed the greatest possible planning security.

**appendix**

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