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The Austrian Research and Technology Report for 2002

The "Research and Technology Report for 2002" provides an update on the current technological performance in Austria. The latest R&D data show a rise in spending on research in the 1990s. Nevertheless, structural deficits still prevent the country from reaching a level that would correspond to the economic capacity of Austria.

This article summarises findings of the "Austrian Research and Technology Report for 2002". Its foundations were developed within the scope of the "tip – technology information policy consulting" programme (<http://www.tip.ac.at/>), by Bernhard Dachs, Doris Scharfing (ARC Seibersdorf Research), Helmut Gassler, Wolfgang Polt, Andreas Schibany, Gerhard Streicher (Joanneum Research), Jörg Mahlich (Technopolis Austria), Gernot Hutschenreiter, Norbert Knoll and Hannes Leo (WIFO). • Norbert Knoll is an economist at WIFO. He is grateful to Michael Peneder and Leonhard Jörg for helpful comments. Scientific assistance: Dagmar Guttman and Sonja Patsios • E-mail address: Norbert.Knoll@wifo.ac.at

In industrialised countries, competitiveness is closely linked to their technological performance in developing and utilising innovative products and services. Spending on research and development (R&D) mirrors a large part of the resources a country dedicates to obtaining and securing competitive advantages as an investment into its future. An international comparison will provide a rough guide to the country's positioning, and in the concrete case of Austria shows that this country was starting to catch up in the 1990s.

Technology policies are aimed at expanding research activities and targeted at both the scientific players and the corporate sector. The stock-taking exercise undertaken by the "Research and Technology Report for 2002" makes it abundantly clear that there is an urgent need for action in both fields: on the one hand, the scientific system still suffers from inefficient performance rates in key areas; and on the other, substantial weaknesses are found in the entrepreneurial sector. In both cases, for technology policies to impact on structural change requires a long-term effort, which in turn calls for full-scale anchoring at an institutional level and support by long-term strategies.

Investment into R&D plays a major role in driving technological change and thus impacts on the growth process of an economy in the long term. Accordingly, the level of spending on R&D as a proportion of GDP is given considerable room in any discussion on technology policies. Similarly, attention is also awarded to the structures entrusted with carrying out and financing R&D, in order to gain insights into the functioning and effectivity of a national innovation system.

In Austria, spending on R&D successively grew throughout the 1990s, from 1.39 percent in 1990 to some 1.95 percent of GDP in 2002, according to the latest estimates published by Statistics Austria (Table 1). On an international scale (for which figures are available only until 1999), Austria's spending of 1.86 percent ranks just below the EU average of 1.92 percent, but substantially below the OECD rate of 2.21 percent (Figure 1). Compared with countries of similar economic capacity, such as Ireland, Japan and the Netherlands, Austria's performance is clearly secondary, and the gap is even more noticeable when it comes to the top performers Germany, Finland, France and Sweden.

R&D in Austria and abroad

Table 1: Financing of expenditure on research and experimental development in 1998, broken down by performing/survey sectors and financing sectors

Including overhead and spending on construction in the university sector

	Surveyed units performing R&D	Corporate sector	Financing sectors				Private non-profit sector	Abroad ¹	EU	Total	
			Federal level	State level ²	Public sector Local level ²	Others ³					Total
1,000 €											
<i>Performing/survey sectors</i>											
University sector	1,015	17,643	861,339	17,017	24	82,337	960,717	4,458	9,549	17,353	1,009,721
Universities (excluding university hospitals)	822	13,149	660,811	10,143	–	72,821	743,775	3,972	6,706	16,009	783,611
University hospitals	77	3,772	162,387	6,275	–	6,749	175,411	251	2,098	734	182,266
Art colleges	56	292	8,3	134	–	502	8,950	147	3	20	9,412
Academy of sciences	56	283	29,82	465	24	2,265	32,581	87	743	591	34,284
Technical college research departments	4	148	–	–	–	–	–	–	–	–	148
Public sector ⁴	358 ⁵	6,698	86,46	105,347	3,225	7,050	202,088	4,063	1,946	4,157	218,951
Excluding state hospitals	358	6,698	86,46	30,828	3,225	7,050	127,569	4,063	1,946	4,157	144,432
State hospitals	–	–	–	74,519	–	–	74,519	–	–	–	74,519
Private non-profit sector ⁶	53	3,517	1,4	306	67	432	2,299	2,528	266	1,877	10,486
Business sector	1,317	1,390,574	35,60	19,736	1,757	62,374	119,472	1,152	628,559	20,921	2,160,678
Co-operative sector ⁶	25	27,678	28,11	12,400	848	8,386	49,751	90	102,672	5,008	185,198
Civil engineers	20	739	–	171	64	71	807	19	56	361	1,981
In-house business sector	1,272	1,362,158	6,9	7,166	845	53,917	68,914	1,044	525,831	15,552	1,973,499
Total	2,743 ⁵	1,418,432	984,904	142,406	5,073	152,193	1,284,576	12,200	640,320	44,308	3,399,835

Source: Statistics Austria. Status: April 2002. – ¹ Including international organisations, excluding EU. – ² State level includes Vienna, local level excludes Vienna. – ³ Including moneys from the Forschungsförderungsfonds (Research Promotion Fund) and ITF. – ⁴ Federal institutions (excluding university sector), institutions at state, local and chamber level, R&D facilities operated by the social insurance institutions, publicly controlled private non-profit institutions and R&D facilities run by the Ludwig-Boltzmann-Gesellschaft; including museums and state hospitals. – ⁵ Excluding state hospitals. – ⁶ Private non-profit institutions of a primarily private or private-law, denominational or other non-public status. – ⁶ Including Austrian Research Centers Seibersdorf.

Throughout the 1990s, Austria was intent on catching up with international figures. Since the early 1990s its spending on R&D grew at a much more dynamic rate than the OECD average (an annual average of 4.70 percent for Austria compared to 2.78 percent for the OECD), and rose at more than double the rate of the EU average (+1.62 percent). With this, Austria outdistanced Italy, Canada and Australia, all of which had spent more on R&E in 1990.

Funding for R&D in Austria derives chiefly from the corporate sector (some € 1.4 billion), closely followed by the public sector (almost € 1,3 billion; Table 2). Compared to the international situation, funding contributed by the corporate sector shows two special characteristics:

- At 20 percent, Austria records the highest funding from foreign sources among the highly developed OECD countries. Most of the money for R&D activities comes from companies domiciled abroad (e.g., the parent companies of local businesses); only a relatively small part is derived from international research programmes such as the EU Framework Programmes.
- Generally, companies' contributions to R&D financing in Austria are about 10 percentage points below that of countries comparable in terms of level and dynamism, such as Denmark and the Netherlands (Figure 2). A relatively low share borne by domestic companies is supplemented by an above-average contribution by foreign companies, so that the shortage of research funds from local companies can be, at least partly, compensated. This situation may also be used as an indication that Austria has been able to position itself as an attractive location for corporate research.

Seen in international terms, by spending 1.86 percent of its GDP on R&D in 1999, Austria positioned itself just below the EU average of 1.92 percent.

Table 2: Global estimate for 2002 – gross domestic spending on R&D

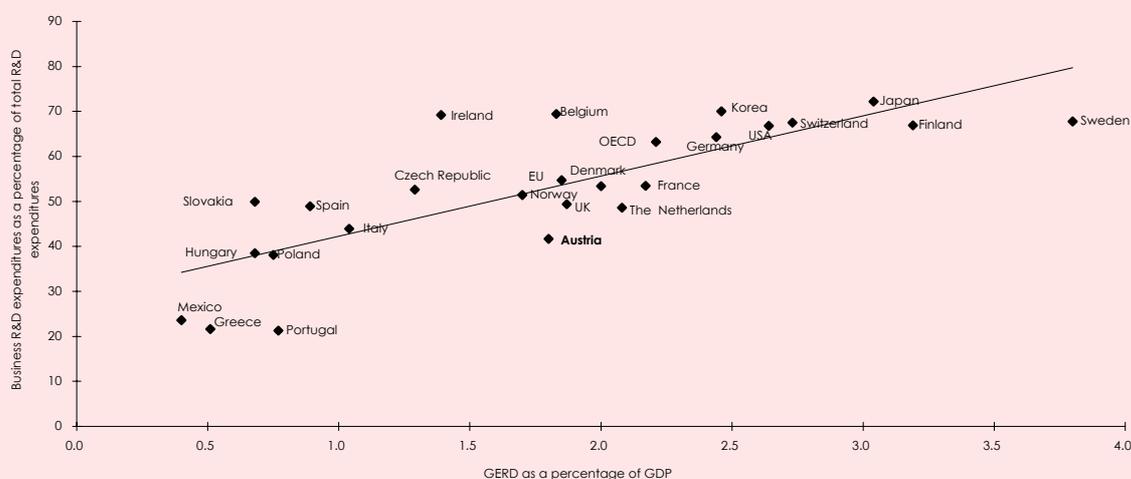
Funding of research and experimental development activities performed in Austria in 1981-2002

	Funding sectors						Nominal GDP ¹	
	Federal level ²	State level ³	Corporate level ⁴	Abroad ⁵	Others ⁶	Total	Billion €	Billion ATS
	Gross domestic spending on R&D in percent of GDP							
1981	0.46	0.06	0.57	0.03	0.02	1.13	79.62	1,095.6
1985	0.51	0.07	0.61	0.03	0.01	1.24	100.77	1,386.6
1989	0.50	0.07	0.72	0.04	0.02	1.35	123.48	1,699.1
1990	0.52	0.08	0.72	0.04	0.02	1.39	133.60	1,838.4
1991	0.58	0.09	0.74	0.04	0.02	1.47	143.23	1,970.9
1992	0.59	0.09	0.72	0.04	0.02	1.45	151.83	2,089.2
1993	0.61	0.08	0.72	0.04	0.02	1.47	156.94	2,159.5
1994	0.65	0.10	0.71	0.06	0.02	1.54	165.41	2,276.1
1995	0.63	0.09	0.72	0.11	0.02	1.57	172.29	2,370.7
1996	0.60	0.09	0.72	0.19	0.02	1.62	178.05	2,450.0
1997	0.59	0.09	0.74	0.26	0.03	1.71	182.49	2,511.1
1998	0.58	0.07	0.75	0.36	0.03	1.79	189.94	2,613.6
1999	0.61	0.10	0.75	0.37	0.03	1.86	196.66	2,706.1
2000	0.60	0.12	0.75	0.36	0.03	1.86	204.84	2,818.7
2001	0.64	0.12	0.75	0.36	0.03	1.91	210.70	2,899.3
2002	0.68	0.12	0.76	0.36	0.03	1.95	215.74	2,968.7

¹ 1981 to 2000: Statistics Austria. 2001, 2002: WIFO estimate (April 2002). – ² 1981, 1985, 1989, 1993, 1998: survey results (federal level includes moneys from the two research promotion funds, from 1989 also those from the ITF). 1990 to 1992, 1994 to 1997, 1999 to 2002: Enclosure T/Part b ("Research" item of the federal budget); in 1990 addition of special programme to promote R&D projects focussed on international trade (ATS 50.0 billion). 1999 and 2000: including reserves remaining from the technology billions assigned in 1997 and 1998 which were used for research in 1999 and 2000. 2001, 2002: The budget item 1/5182 12 of the "research" budget provided for € 508.7 million (ATS 7 billion) for the R&D strategy for 2001. According to information available so far, some € 130.2 million (ATS 1,791 billion) of this sum were spent in 2001. For 2002, it is assumed that some € 218 million (ATS 3.0 billion) will have been spent, and the remaining funds (€ 160 million or ATS 2.2 billion) are designed to be spent on R&D in 2003. The estimate made by Statistics Austria for R&D spending thus includes only those moneys which were spent in 2001 or proposed to be spent in 2002, thus deviating from Enclosure T/Part b. – ³ 1981, 1985, 1989, 1993, 1998: Survey findings, including Statistics Austria estimate of spending on R&D by the state hospitals: € 27.3 million (ATS 375.9 million in 1981; € 37.1 million (ATS 510.9 million) in 1985; € 46.3 million (ATS 637.7 million) in 1989; € 65.6 million (ATS 903.1 million) in 1993; € 74.5 million (ATS 1,025.4 million) in 1998. – ⁴ Business-financed (including Anniversary Fund of the Austrian National Bank). 1981, 1985, 1989, 1993, 1998: survey results. 1990 to 1992, 1994 to 1997, 1999 to 2002: estimate by Statistics Austria based on findings of the R&D survey made by the Austrian Economic Chamber (1989, 1991, 1993) and Statistics Austria (1989, 1993, 1998 – results of the R&D survey made by Statistics Austria in the corporate sector). – ⁵ 1981, 1985, 1989, 1993, 1998: summary findings, 1990 to 1992, 1994 to 1997, 1999 to 2002: estimate by Statistics Austria with due consideration of the results of the R&D survey of 1998 by Statistics Austria. 1995 to 2000 includes returns from the 4th EU Framework Programme for research, technological development and demonstration and, from 1999 to 2002 including returns from the 5th EU Framework Programme for research, technological development and demonstration (status: April 2002). – ⁶ Financed by local governments (excluding Vienna), chambers, social insurance institutions and other public funding sources (1989 to 1998 including projects financed by ASFINAG, and 1993 to 2000 including projects financed by BIG outside the national budget for the university sector) and financed by the private non-profit sector. 1981, 1985, 1989, 1993, 1998: survey findings. 1990 to 1992, 1994 to 1997, 1999 to 2002: estimate by Statistics Austria.

Figure 1: GERD as a percentage of GDP and financing contributed by the business sector as a percentage of total R&D expenditures

1999



Source: OECD (2001A), Switzerland (1996), Ireland, Greece, Czech Republic (1997), The Netherlands (1998). – GERD . . . gross domestic expenditure on R&D.

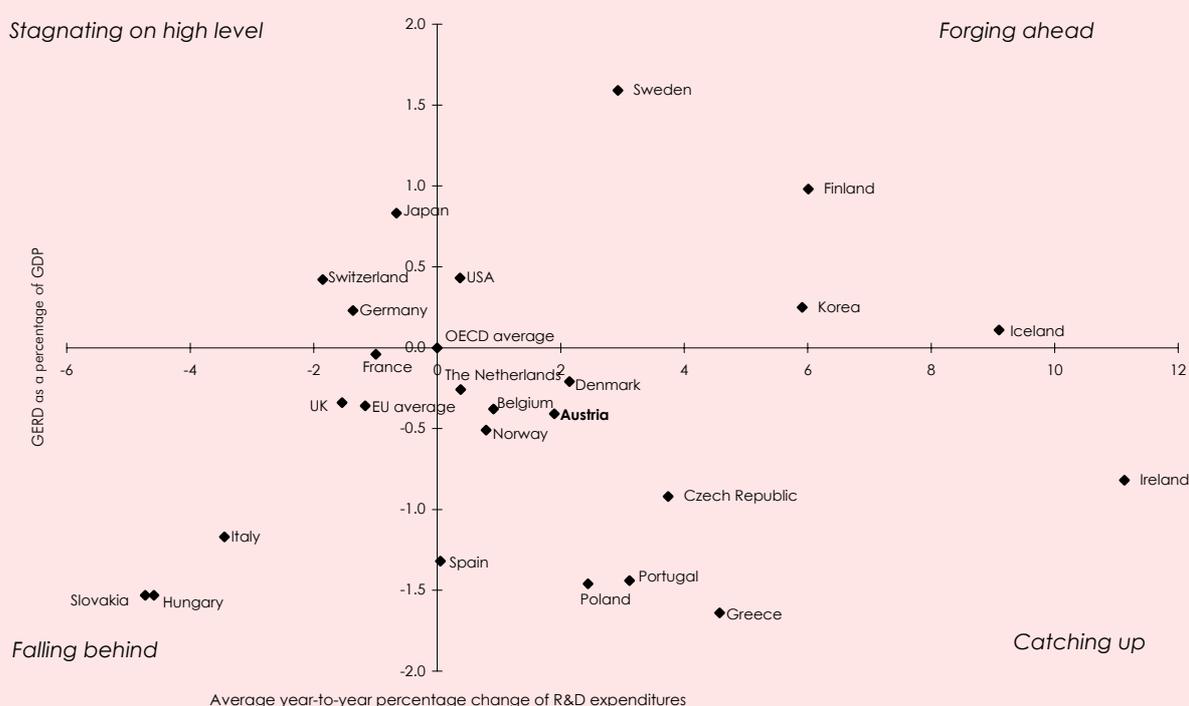
Within the OECD, spending on R&D in the 1990s was not uniform, as can be deduced from expenditures and their average annual rates of change (Figure 2). We find four groups: In Germany, Japan and Switzerland, spending stagnated at a high level; Finland, Sweden and the USA further improved their already substantial edge. A declining trend accelerated in European OECD countries, such as the UK, Italy and the EU in general. Austria, like Belgium, Denmark and Ireland, is among a group of countries that have managed in the last decade to catch up from a low level.

Generally speaking, the dynamism of expenditure on research is closely linked to the structure of the sectors that contribute funds. In countries where the corporate sector plays a key role in funding R&D, total spending on R&D tended to grow at a greater rate in the 1990s¹. This applies in particular when comparing the USA and the EU. In Austria, the corporate sector contributes a relatively low share of the funding, so that its growth rate for R&D spending is expected to continue to lag behind.

Austria, like Belgium, Denmark and Ireland, is among a group of countries that have managed in the last decade to catch up from a low level.

Figure 2: Level and dynamism of R&D expenditures

Deviation from OECD average in percent



Source: OECD (2001A), R&D expenditures 1999; Switzerland 1996, Ireland, Greece, Czech Republic 1997, the Netherlands 1998; rates of change in 1991-1999; Ireland, Greece, Czech Republic 1991-1997, Portugal 1992-1999, Belgium 1993-1997, Spain, Germany 1992-1999, the Netherlands 1991-1998, Japan 1996-1999, Switzerland 1992-1996, Hungary 1994-1999, Slovakia 1994-1999.

In Austria more than in other countries, research activities are concentrated in the publicly financed university sector: With € 1 billion available at the latest count, universities carry out some 30 percent of overall research in Austria – a share that is higher by 10 percentage points than the EU average. At the same time, the scope of research performed by the state itself is much lower than the corresponding EU figure. This applies in spite of the proviso to be made that institutions of extra-university co-operative research² – such as the Austrian Research Centres – are organised as corporations and thus allocated to the corporate sector in line with international standards.

¹ The proportion contributed by companies to financing R&D rose most substantially in Denmark, Finland, Ireland, Sweden and the US (OECD, 2002, p. 101).

² Extra-university co-operative research makes up some 5 percent of total domestic research.

Overall, the relatively low share contributed by companies to financing and carrying out research in Austria stands out as a major structural weakness of the Austrian innovation system, in spite of the fact that associated foreign companies add substantially to financing from abroad. This is particularly true considering that, in other countries, companies supplied a disproportionately large share of the growth of research activities in the 1990s. Any efforts by economic policy to boost spending on research to 2.5 percent of GDP must therefore start out from the current financing structure and change it by stimulating corporate research, a need that is even more urgent in view of present and future measures to consolidate the public households.

The relatively low contribution made by companies to financing and carrying out research is a major structural weakness of the Austrian innovation system.

A key component of any national innovation system is its scientific system. The contributions made by scientific research institutions to their country's innovative capacity generally are difficult to quantify, but point in two directions:

- On the one hand, science is a driving factor of basic research, by carrying out experimental and theoretical scientific work aimed primarily at tapping new knowledge and explaining known phenomena, but not at discovering specific applications. Spending on basic research reflects a large part of the resources available in a scientific system, and the results of such research are typically measured by the number and quality of scientific publications.
- On the other hand, the scientific system contributes substantially to the grooming of highly specialised human resources within a community. In this, learning processes from carrying out research (and in particular basic research) and the offer of specific training provided by the tertiary education system play a role.

Basic research is typically performed by scientific research institutions, and direct exploitation of the knowledge generated from such basic research is limited to a few science-driven sectors, such as the pharmaceutical industry. Nevertheless, indirectly and in the long term, basic research still feeds technological change in many areas of the economy, e.g., by developing scientific methods and tools, improving human resources available for top research, and fostering an exchange of knowledge in international networks. Any country will thus ignore basic research at its peril.

No clear trend can be discovered across countries for the 1990s with regard to the extent of basic research. Even though basic research is chiefly in the hands of the public sector and although research activities of the corporate sector showed a greater dynamism during the decade, the share of overall R&D spending taken up by basic research is not necessarily declining³. Taking the OECD average, it actually grew from 19.4 percent in the early 1980s to 21.2 percent by the end of the 1990s. Austria followed the general trend: spending on basic research rose from 17.1 percent at the start of the 1980s to 22 percent in the late 1990s.

Basic research in Austria is characterised by the dominant role played by the universities, as well as the emerging activities of the corporate sector. Already back in the 1980s, universities undertook some 70 percent of Austria's basic research, a figure well over the OECD average which further rose to 77 percent in the 1990s. Nevertheless, compared to other EU countries, the corporate sector contributes substantially to financing and carrying out basic research (Figure 3), although it must again be considered that the co-operative research institutions are allocated to the corporate sector in Austria.

The performance and efficiency of a scientific system are frequently measured by bibliometrical methods. Countrywise comparisons use, i.a., the number of publications in scientific journals and the number of citations in scientific articles (impact factor)⁴. When taking the per-capita number of scientific publications as a measure,

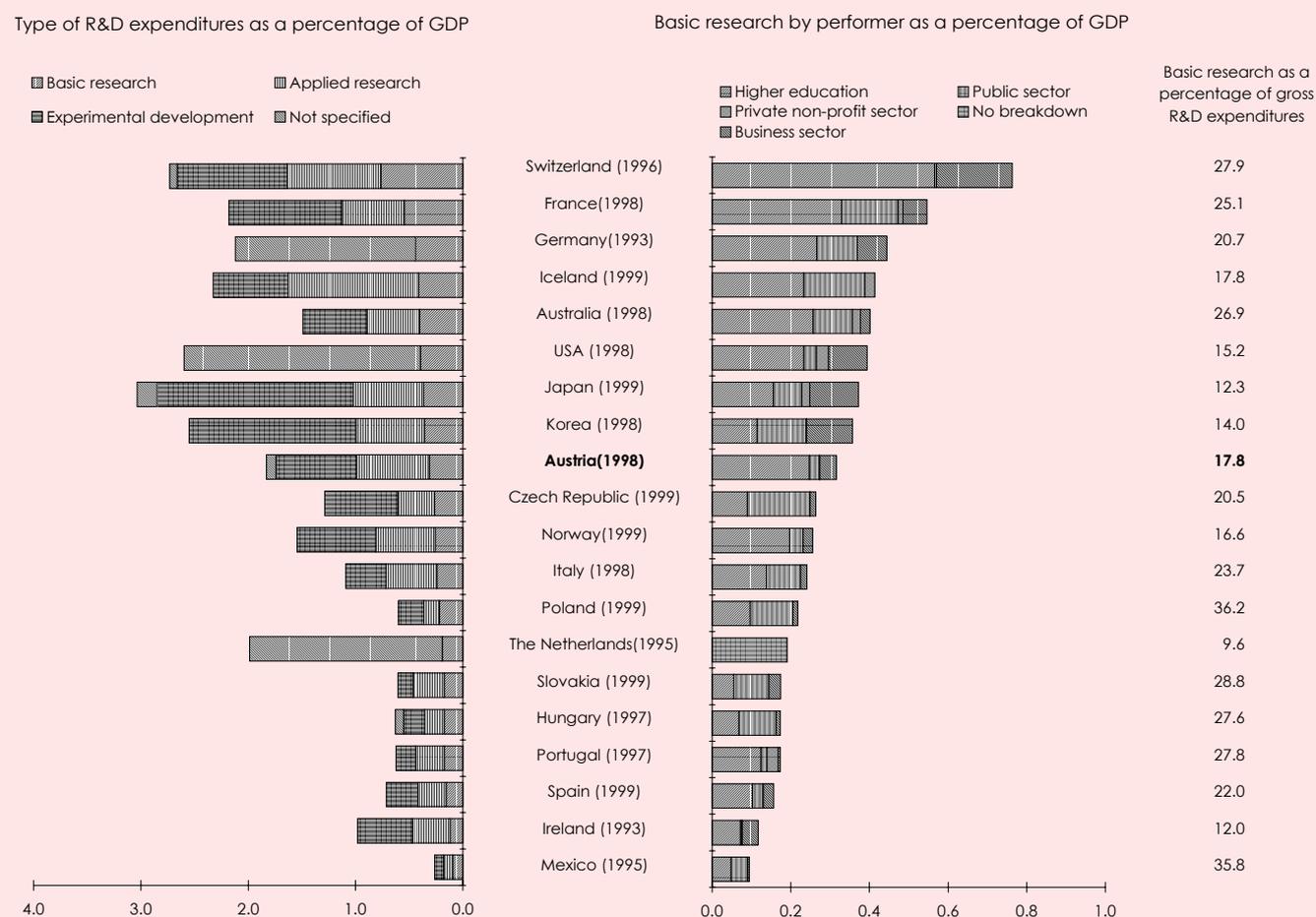
³ There is no uniform growth pattern in the share contributed by the corporate sector to financing and carrying out basic research: "While basic research expenditures have increased in many countries as a percentage of GDP, data on business performance of R&D show that the share of business R&D allocated to basic research fell in the USA and Japan between 1991 and 1998 while increasing modestly in France, Germany, Italy and UK" (OECD, 2002, p. 113).

⁴ The impact factor indicates the proportion of publications of a given country being cited in terms of the world average.

The scientific system

Austria positioned itself in the European middle in the second half of the 1990s, but noticeably behind the leaders Switzerland, Sweden, Denmark, Finland and the Netherlands.

Figure 3: Breakdown of R&D expenditures by type of research activity and share of basic research by sector of performance



Source: OECD (2001A).

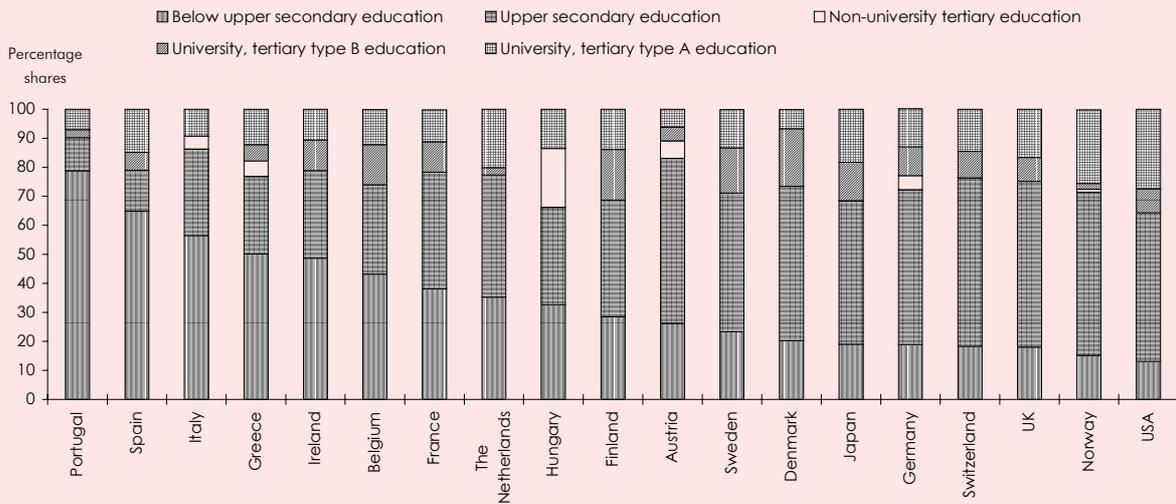
When comparing scientific and technological disciplines we find some serious differences: thus Austrian scientists working in immunology and clinical medicine have gathered an above-average share of global publications in their fields, whereas Austrian agricultural scientists have substantially fewer publications to their name. Citation data are extremely high for scientists publishing in physics, mathematics and pharmacology. Similarly above-average rates are achieved by those working in the material sciences, mechanical engineering, computer sciences and molecular biology. Their peers in the geosciences, sociology and space sciences, on the other hand, register a particularly low impact.

The capacity and performance of the scientific system also impacts on the quality and availability of highly specialised human resources. International comparisons of the qualification level of populations confirm Austria's traditional strength in the middle segment, i.e., a high rate of graduations from secondary level II courses, whereas the country is at the lower end of the scale with regard to tertiary education (Figure 4).

In the second half of the 1990s, Austria positioned itself in the European middle, but noticeably behind the leaders Switzerland, Sweden, Denmark, Finland and the Netherlands, when taking the per-capita number of scientific publications as a measure.

Figure 4: Educational attainment of the population, 1999

Distribution of the population aged 25 to 64, by highest level of education attained



Source: OECD (2001B).

Figure 5: Education levels compared with R&D expenditures and research output

1998



Source: OECD (2001B).

Consequently, Austria is in at the top, together with Denmark, Germany and Sweden, when it comes to its share of graduations from medium-level schools, but moves to the lower end of the scale when measured by the number of graduations

from tertiary education, only just before Italy and Portugal. A comparison based on age cohorts provides conclusions on the change of educational levels across longer periods of time. In contrast to countries such as France, Ireland and Spain where the number of tertiary graduates is catching up rapidly, their number is stagnating at a low level in Austria. Similarly, indicators such as the proportion of scientific staff among the labour pool and the rate of researchers among labour in general confirm the extraordinarily low positioning of Austria compared to international figures (Knoll, 2001, *European Commission*, 2001).

Austria boosted its educational spending from 5.10 percent of GDP in 1990 to 6.36 percent in 1998, an indicator which raised it above the OECD average. This above-average rise throughout the 1990s has so far not shown any visible effect in terms of an improvement in higher qualifications. In the OECD, on average more than a quarter of overall education spending is dedicated to institutions of the tertiary sectors. The lead is taken by the USA which invests more than 2.30 percent of its GDP in the tertiary sector. With 1.46 percent, Austria is at the same level as Denmark and Norway, whereas Finland and Sweden are in the undisputed lead position in Europe with 1.67 percent of their GDP. Yet in spite of its relatively high investment in tertiary education in terms of its GDP, Austria (as mentioned above) continues to have a low number of graduates from tertiary education among its population. Similarly, when measuring the number of publications by university members against R&D spending in this sector, we find a low efficiency rate of the domestic scientific system compared to international levels (Figure 5).

In terms of its share of medium qualifications, Austria ranks among the top countries in Europe, jointly with Denmark, Germany and Sweden; whereas in terms of its share of tertiary qualifications, it is at the lower end of the scale, placed only just before Italy and Portugal.

In connection with the structure of expenditures for research, it has already been mentioned that the corporate sector contributes little momentum to an expansion of overall research. Considering that the research intensity differs considerably between sectors, an important factor here is the sectoral structure of an economy. Seen from a European point of view, the Austrian economy includes a disproportionately high share of labour-intensive industries which are faced by a low share of high-tech industries. Austria specialises in products of medium-tech level (such as mechanical and vehicle engineering), whereas high-tech sectors are largely underrepresented (*BMBWK – BMVIT*, 2001).

Terms created in recent years, such as "technology gap" or "structure/performance paradox" (*Hutschenreiter – Peneder*, 1997, *Peneder*, 2001), point at this structural weakness suffered by the Austrian economy, which is visible both in production and in its international trade. A comparison of patenting indicators at European level confirms the finding that the corporate sector in Austria suffers from a weakness of technological capacity:

- The Current Impact Index, a measure of the frequency of citations of patents in other patents, is particularly low in Austria. Austrian patents thus have little technological relevance for other users. This points at both excessive specialisation and low technological level.
- Austrian patent specifications make excessive reference to one or two year old patents. In this, only Denmark and Portugal do worse than Austria. This is a sign of Austrian patent holders tending to specialise in rather traditional sectors where technological change progresses at a slower pace.
- Scientific publications are rarely quoted in Austrian patent specifications. This points at a rather loose connection between the scientific system and the corporate sector, and it may be another sign of specialisation in sectors which receive little momentum from current scientific research.
- The structural portfolio of Austrian patent holders in terms of technology sectors shows that they are highly specialised in traditional fields (such as textiles, synthetics, metals, timber, paper), lag slightly behind in fields such as biotechnology, vehicle engineering, machines and tools, are catching up in chemistry and office machinery, and are below-average in information and communication

Technological capability of the corporate sector

technologies (such as computers, semi-conductors, electronics and medical technology).

An analysis of patent data similarly indicates how the industrial structure impacts on research activities on the part of business. The Austrian data deviate from the European average primarily in the lower share of patents contributed by the chemical industry, motor vehicle construction, as well as electricity distribution and control equipment producers. Equally underrepresented are aviation and space engineering, whereas the primary industry, such as production and processing of metals, timber, paper and cardboard, supplies an above-average number of patents. Generally speaking, the economic structure therefore precludes patent activities in the research-intensive high-tech and technology-supported sectors, whereas sectors which tend to be labour- and capital-intensive offer structural advantages. By themselves, these structural differences do not translate into an advantage or disadvantage from an economic policy point of view; competitive advantages may, after all, be derived from successful specialisation in niches, endowment with useful resources or other location factors. However, empirical studies (e.g., *Peneder, 2002*) point at a link between structural advantages and growth: the greater the weight of technology-intensive sectors, the more favourable will be the growth prospects.

From a research and technology policy perspective, such structural disadvantages are certainly of a serious nature and contribute to explaining why Austria lags behind in its expenditure on R&D. In OECD countries, R&D spending concentrates almost exclusively (almost 90 percent) on high- to medium-tech sectors (*OECD, 2001A*). In Austria, too, more than 80 percent of corporate R&D activities are carried out by these sectors.

Seen against this background, we find a close link between research and technology policy on the one hand and more general economic policy issues, such as structural change and founder dynamism, on the other. It requires considerable resources in order to catch up and close a historical technology gap: in Germany, to give but one example, it took generous and extensive programmes for the country to become a preferred location for biotechnology in Europe. Even though Austria is highly competitive in terms of its scientific base and is widely used as a research location by international pharmaceutical corporations, the country is still faced with obstacles in following the example of Germany and boosting the founder rate.

Some well-known findings on the weaknesses and performance of the Austrian innovation system⁵ are confirmed by the stock-taking exercise included in the "Research and Technology Report for 2002". Spending on research is still characterised by a comparatively low share of funds contributed by the corporate sector and a relatively high share of expenditures at university level. Nevertheless, spending on research has steadily risen over the past years (due to bundled measures of the public sector), and now corresponds approximately to the EU average rate.

What is more, Austria's more frequent participation in international research programmes (such as the EU Framework Programmes) reflects its progress in becoming involved in international co-operative research ventures. According to preliminary data on the current 5th Framework Programme (1998-2002), Austrian project partners are showing a greater presence and financial returns generally develop satisfactorily⁶. As of late March 2002, Austrian partners participated in 1,086 projects (some 11 percent of all projects subsidised in the EU); the success rate of Austrian applicants (i.e., the ratio of submitted to approved projects) was more or less in line with the EU average. This makes for a clear improvement over the previous Framework Programme which ran until 1997: in this 4th Framework Programme, Austria's annual share of subsidies ranged from 1.5 to 1.7 percent; for the 5th Programme, its share has visibly increased to some 2.6 percent. The returns from subsidies made up just about 60 percent of Austria's contribution to the 4th Programme, whereas the cover

An analysis of patent indicators confirms the impact of a given industrial structure on its R&D: the weak technological performance of the Austrian corporate sector thus has its roots in the relatively low-tech approach of production.

Technological capacity and innovation policy

⁵ Specifically *BMBWK – BMVIT (2001)* and *Knoll et al. (1999)*.

⁶ *Topolnik et al. (2001)*.

ratio for its successor has risen to 99 percent, i.e., a balance has almost been achieved between contributions and returns⁷.

In order to achieve further improvements, it is crucial to use nationally available tools of technology policy efficiently. In recent years, the range of such tools – such as narrowly focussed subsidy programmes and competence centres – was expanded in order to target specific problems (co-operation and knowledge transfer between science and industry, achieving critical momentum in research fields, etc.).

In view of persistent structural deficits and considering that a substantial increase in the expenditure on research was already envisaged in 1999, it will be necessary for the federal government once again to amplify innovation and technology policies. Even though considerable progress was made in some aspects such as tax breaks for R&D⁸, also compared to what is offered in other countries, such efforts do not yet suffice to secure and strengthen Austria as a preferred location for research.

Austria's involvement in international co-operative research ventures is progressing: the country's participation in European Framework Programmes is almost balanced financially (contributions versus returns).

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⁷ Topolnik et al. (2001) and Schibany et al. (2001).

⁸ For detailed studies on tax breaks for R&D see Hutschenreiter – Aiginger (2001) and Hutschenreiter (2002). Compared to international figures, tax exemptions for R&D have reached a scope in Austria which almost equals direct technology subsidies.

The Austrian Research and Technology Report for 2002 – Summary

Expenditure on R&D encompasses much of those resources which are used more or less like an investment into the future and spent with a view to obtaining and securing competitive advantages. During the 1990s, Austria made a serious effort to catch up: From 1.39 percent of GDP in 1990, spending on research successively grew to 1.95 percent in 2002, which has brought Austria to a medium level within Europe; but there is still a wide gap to leading countries such as Finland or Sweden.

Disadvantages for Austria stem from the comparatively low participation of domestic companies in the financing and carrying-out of research activities. During the 1990s, countries such as Denmark, Finland, Ireland, Sweden and the USA stood out for their substantial widening of the share of company-financed R&D. Furthermore, these countries showed a particularly high growth rate in their overall R&D expenditure.

Considering that industry sectors differ considerably in their expenditure for R&D, the sectoral structure of the Austrian economy constitutes a barrier against accelerating the catching-up process. The domestic economy not only includes a high share of labour-intensive sectors, but also specialises to a large degree in products of medium-tech level, such as mechanical and vehicle engineering. High-tech sectors, on the other hand, are mostly underrepresented. An analysis of patent data shows similar structural weaknesses of the Austrian economy; these are also indicated by data on production and international trade: salient features are an excessive specialisation in low-tech sectors (e.g., those in which technological change progresses at a slower rate and those which get little impetus from current scientific research).

Science contributes to the technological performance of an economy by carrying out basic research (experimental and theoretical scientific work aimed primarily at achieving new knowledge and explaining known phenomena, but not at discovering applications) on the one hand and by developing highly specialised human resources on the other.

When using selected indicators of the scientific publication rate, Austria is found to be positioned in the European middle, but noticeably behind the leaders Switzerland, Sweden, Denmark, Finland and the Netherlands. Domestic scientists achieve their greatest response rates when working in physics, mathematics and pharmacology. Rates are still above average for those working in the material sciences, mechanical engineering, computer sciences and molecular biology.

As a result, Austrian science still connects to international developments in many scientific disciplines. The situation, however, differs when it comes to higher education. International comparisons of qualification levels confirm Austria's traditional strength in the medium segment, i.e., a high rate of graduations from secondary level II courses, where Austria is in the top group together with Denmark, Germany and Sweden. When it comes to tertiary education levels, on the other hand, Austria is at the lower end of the scale, together with Italy and Portugal. And contrary to countries such as France, Ireland and Spain which have over the past two decades put considerable efforts into catching up with regard to tertiary graduation levels, Austria is stagnating at a low level.