to improve the teaching. On top of this, investments would be required in buildings and infrastructure. Without doubt the Higher Education Pact 2020 is a step in the right direction. However, in some federal states such as Lower Saxony, Bremen, and Hamburg, cuts are being made to budgets in the higher education sector which are diametrically opposed to these intentions, and which will have negative impact on the technological potential of Germany.

Boom in vocational training in knowledge-intensive segments

In addition to the higher education system, the vocational training system also provides a reservoir of skilled personnel for the employment market. Some 60 percent of all those leaving general secondary school go into vocational training either in a vocational college or in a dual training course involving additional practical training. In 2006 a total of 667 813 trainees obtained a vocational qualification and made themselves available on the labour market, which was about 3 percent more than in the year 2000. Of this total, 480 000 obtained a vocational training qualification in combination with a company apprenticeship. This means at least that the potential of trainees in vocations at the medium qualification level was almost totally fulfilled. However, if the demographic developments are also taken into account then despite the slight increase in 2006 it is not to be expected that the dual system will lead to much above 500 000 young people obtaining qualifications in the foreseeable future.

Looking only at those qualifying in the core vocations or in the knowledge- and technology-intensive sectors, then there has been a clear positive trend. In 2006, 221 000 young people gained vocational qualifications, which is 22 percent higher than in the year 2000. While the overall number obtaining qualifications in the dual system in this period declined, the figure for vocations in knowledge-intensive sectors increased by 18 percent. In addition there were some 80 000 young people with qualifications from full-time vocational colleges (+29 percent) who were also available for these vocations. This favourable development is due not least to the fact that in-firm vocational training is growing in significance in the services sector.

In knowledge-intensive sectors of the economy, 26.5 percent of companies are involved in vocational training, which is slightly above the overall average (24 percent). But in addition the employees in these sectors are also more involved in further training activities. This applies above all for the older personnel. In the sectors of the economy with high knowledge intensity, more than 10 percent of staff took part in continuous learning activities in 2006 – compared with nearly 6 percent in the other sectors. There is a noticeable correlation between the qualification level and the participation in further education. One in eight highly-qualified professionals take part in measures for vocational further training – but for those with lower qualifications it is only one in thirty. In contrast, age and gender do not play a very important role.

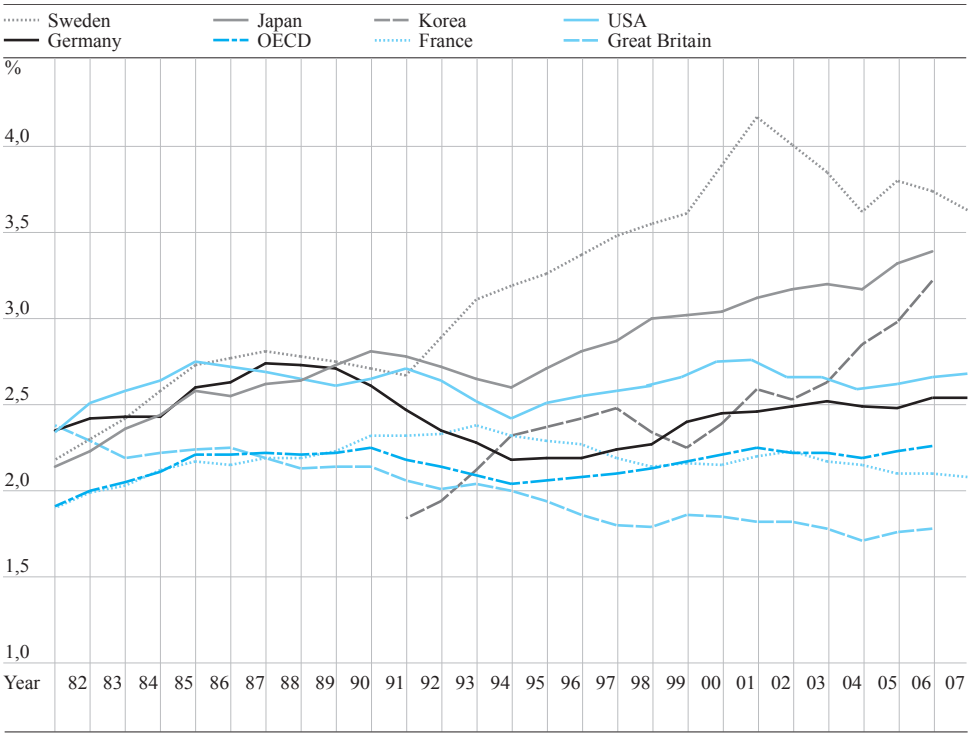
RESEARCH AND DEVELOPMENT[100] C 2

Politicians and the public frequently question how effective investments in research and development actually are – above all when these are financed from taxation. Empirical economic research has meanwhile offered persuasive evidence that R&D-activities not only create direct benefits for private actors in the form of increased productivity, but also bring considerable social returns.[101] Research and development is not the sole cause of economic growth, but in industrialised countries it is one of the most important determinants. Research and development is systematic, creative work to generate new knowledge. The Frascati Manual of the OECD bases statistical comparisons on the financial inputs in the form of expenditure on R&D plant, materials, personnel, and orders, as well as the number of R&D employees (cf. Box 2 in EFI Report 2008). The two parameters provide a basis for the evaluation of the "innovation potential" of an economy or its sectors, because they quantify the materials and resources used for the generation of technological knowledge.

Research and development in stop-and-go

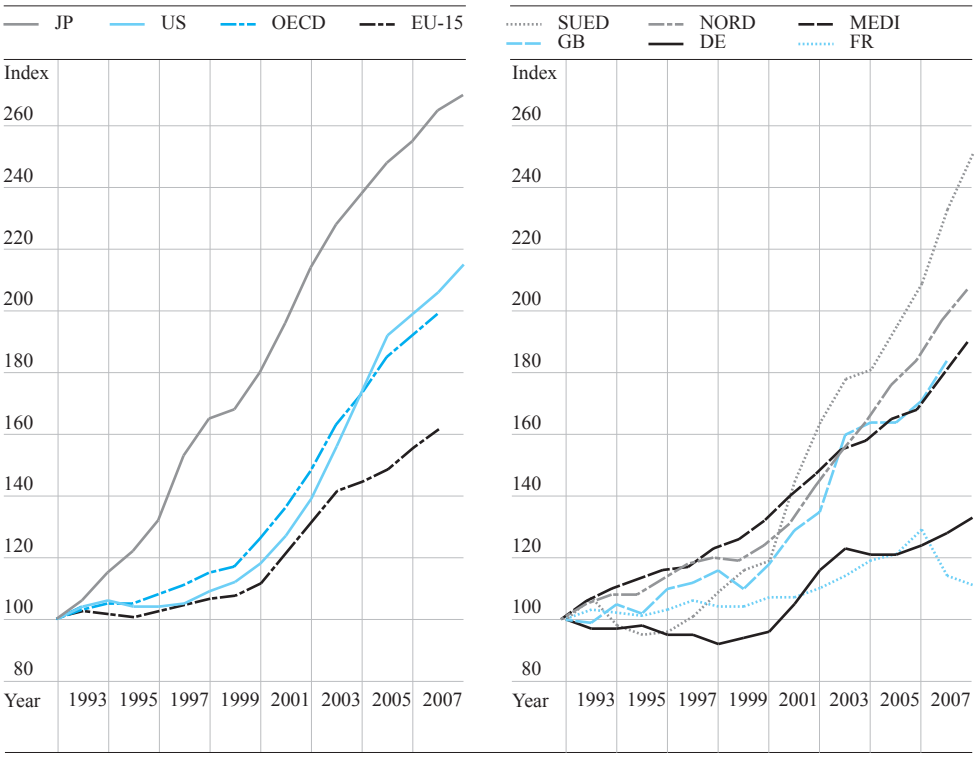
Over the past three decades there has been a clear shift in the worldwide distribution of R&D-capacities. Large economies and whole regions have gone

R&D expenditures as share of gross domestic product for selected OECD-countries FIG 13



Data estimated in part. Germany until 1990: West Germany. R&D-expenditure in Japan slightly overestimated until 1995. Structural breaks in survey methods 1993 and 1995.
Source: OECD, Main Science and Technology Indicators (2008/2). Calculations and estimates of NIW.

State research and development budgets in selected regions of the world FIG 14



Index: 1991 = 100. Semi-log scale. Data estimated in part.
NORD: SE, FI, NO, DK, IE, IS. SUED: IT, PT, ES, GR. MEDI: BE, NL, AT, CH.
Source: OECD, Main Science and Technology Indicators (2008/2). Calculations and estimates of NIW.

through a range of changes one way and then the other – depending on the prevailing conditions. In addition, the overall progress of research and development has become less constant, including in Germany. After a sharp rise in the share of R&D-expenditure in the German gross domestic product in the 1980s, there was a considerable decline in the 1990s. Other countries, in particular Japan and the USA, showed similar trends, although the variations were not as extreme. In the second half of the 1990s, the USA further expanded R&D-expenditure, in contrast to Germany. Between 1994 and 2000, 52 percent of additional R&D-capacities created in the western industrialised countries were established in the USA.

In the large western industrialised nations, R&D-expenditure is generally pro-cyclical. If growth stagnates, R&D-expenditure mostly stays at the same level. A number of smaller economies, in contrast, continually increased their R&D-efforts in real terms throughout the 1990s: this includes countries such as Sweden, Finland, and Ireland, but also Korea. Above all, the economic structural change to the advantage of cutting-edge technology sectors has boosted the R&D intensity and overlayered short-term reactions to the economic fluctuations.

In the late 1990s, business and government in Germany had halted the decline in R&D-expenditure and switched back to expansion. In a global comparison, this took place with a delay of three years. Today, Germany is one of the countries in which research and development is carried out both on a broad industrial base and also with above-average intensity. The USA, Japan and, with reservations, France and Korea can also be classed in this category. In contrast, smaller economies such as Sweden, Finland, and Switzerland tend to concentrate their R&D-capacities: research and development is carried out in a few sectors with above-average intensity, but the process is not as broadly based as in Germany.

Over the past decade, the dynamic of the R&D capacities of Germany has lagged considerably behind the average of the western industrialised countries, which is largely characterised by the development in the USA. Among the OECD countries, however, the Nordic countries have been most dynamic, even if they have had to reduce the growth of their R&D capacity again somewhat since the year 2000.

Germany's R&D-intensity remains slightly above the OECD-average

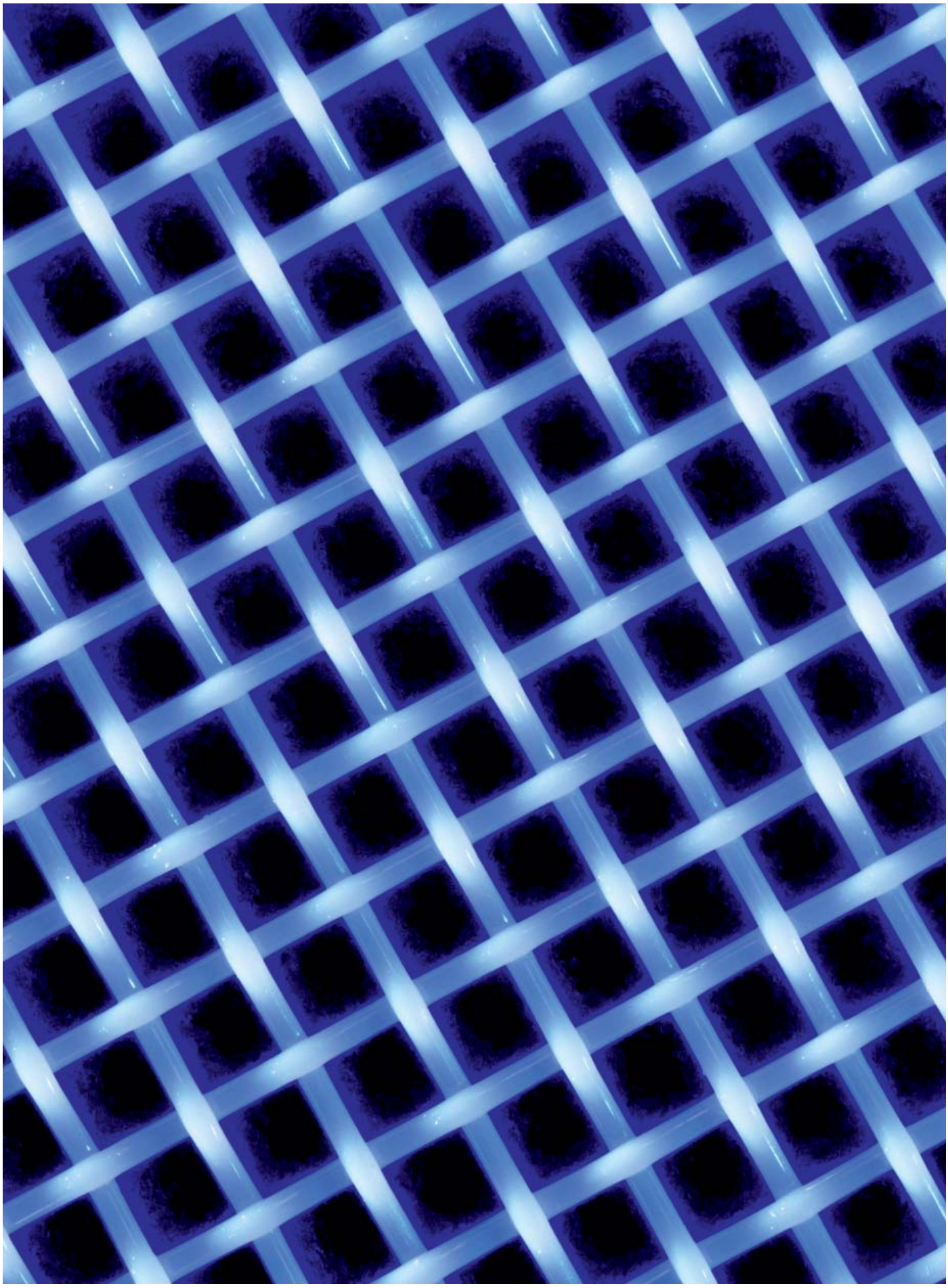
Currently (figures for 2006), Sweden is top in a worldwide comparison of national R&D-intensities with 3.7 percent, followed by Finland (3.5 percent), Japan (3.4 percent), Korea (3.2 percent), Switzerland (2004: 2.9 percent) and the USA (2.7 percent). Austria is next with 2.6 percent (2007: 2.7 percent) in front of Germany and Denmark (2.5 percent). Bringing up the rear of the countries shown in Fig. 13 is Italy. In Germany the R&D-intensity has also remained constant overall in 2007.

In the OECD area, the overall expenditure on research and development is about 825 billion dollars (2006) which corresponds to 2.3 percent of the domestic product of the member countries. Whereas Germany was in first place in the 1980s, and was still in the leading group in the early 1990s (fourth in 1991), by 2006 it was only at the front of the chasing pack among the OECD-countries. In a European context, however, the situation is still comparatively positive, because the EU-15 member states as a whole put up only 1.9 percent of their domestic product for research and development (EU-27: nearly 1.8 percent). In 2007 there was a slight improvement. The European Union has not shown progress in recent years despite intensively pursuing the three percent target for 2010 and it is still clearly behind the USA and Japan.

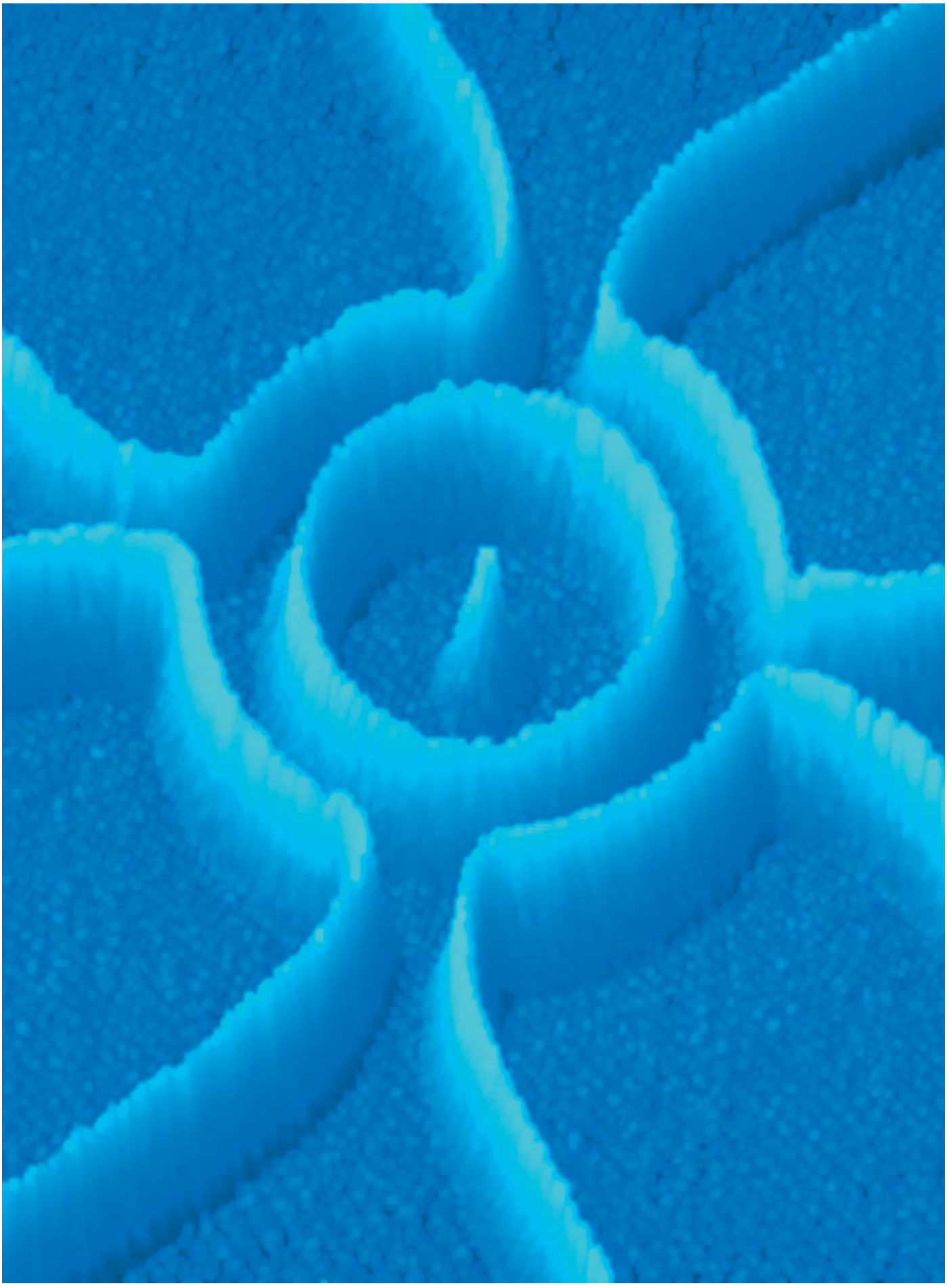
The growth of real R&D-expenditure in the OECD countries has just about halved since the year 2000, from 5 percent p.a. in the upswing phase for R&D between 1994 and 2000 to 2.7 percent between 2000 and 2006. The decline in R&D growth rates has been sharpest in the North European countries (from 7.4 to 3.4 percent) and the USA (from 6.1 to 1.6. percent). In Germany, France, and Great Britain the R&D growth rates between 2003 and 2006 were lower than in the USA (Tab. 03).

State R&D financing in Germany at an historical low?

With the increased innovation competition, the focus has again been on state research activities and state aid for research and development in business companies. Even if entrepreneurial R&D-activities dominate



Polyester silk fibres
© Pasieka / SPL / Agentur Focus



Quantum ring

Change of real R&D expenditures according to regions and sectors 1994–2006 TAB 03

	OECD	US	JP	EU-15	DE	GB	FR	NORTH	SOUTH	MID
Business sector										
1994 – 2000	5.9	7.4	3.8	4.3	4.9	1.9	1.6	8.9	4.0	5,0
2000 – 2003	0.8	−1.9	4.2	1.6	0.9	0.5	1.7	2.9	3.9	1,8
2003 – 2006	4.5	4.0	5.4	2.7	1.9	1.6	1.3	3.2	6.5	4,3
1994 – 2006	*4.2*	*4.2*	*4.3*	*3.2*	*3.2*	*1.5*	*1.5*	*5.9*	*4.6*	*4,0*
Public sector										
1994 – 2000	3.3	2.8	4.0	2.3	2.0	1.6	1.1	4.4	4.2	1.4
2000 – 2003	4.0	7.1	−2.6	2.7	1.9	2.3	1.5	4.3	4.7	2.4
2003 – 2006	1.9	1.1	1.3	2.6	1.7	4.6	0.6	4.1	3.6	1.9
1994 – 2006	*3.1*	*3.4*	*1.6*	*2.5*	*1.9*	*2.5*	*1.1*	*4.3*	*4.2*	*1.8*
Total										
1994 – 2000	5.0	6.1	3.9	3.6	4.0	1.8	1.4	7.4	4,1	3,7
2000 – 2003	1.8	0.5	2.3	2.0	1.2	1.1	1.6	3.3	4,3	2,0
2003 – 2006	3.7	3.1	44	2.6	1.8	2.7	1.1	3.5	5,0	3,5
1994 – 2006	*3.9*	*3.9*	*3.6*	*2.9*	*2.8*	*1.9*	*1.4*	*5.4*	*4,4*	*3,2*

In percent. Public sector: universities and R&D institutions. Data in part estimated.
NORTH: SE, FI, NO, DK, IE, IS. SOUTH: IT, PT, ES, GR, MID: BE, NL, AT, CH
Source: OECD, Main Science and Technology Indicators (2008/2). Calculations and estimates of NIW.

in many industrialised countries, public R&D expenditure is important for innovation in the economy in general.

Above all in the 1980s and 1990s there was a steady decline in state funding for research and development. On average, the state contributions of the OECD-countries in the year 2000 were well below 30 percent, compared with about 45 percent in 1980. Currently about a third of R&D costs are met by national governments, including in Germany and in the USA. In contrast, the state share of R&D-financing in emerging markets is frequently 50 percent and more. This process can currently be observed in some countries in Asia and eastern Europe. Relative to the domestic product, the state contributions to R&D-financing in the OECD have sunk since 1985 from 0.91 through 0.83 (1990) to 0.62 percent (2000), and in Germany from 0.98 to 0.77 percent. The new decade brought a rise in the OECD to 0.67 percent (by 2003), fed above all by the R&D involvement of the USA. In contrast, in Germany the level in 2005 was 0.7 percent, the lowest since 1981.

Following the general trend, state R&D involvement also initially declined in the EU member states. The declared goal was a state funding contribution of 1 percent of GDP, but in 2006 the EU-15 were far away from this with only 0.63 percent. Since then, the EU member states have reacted, and the R&D budget provisions no longer match the picture of (absolute or relative) declining state R&D commitments. Increases in R&D aid for companies or expanding the R&D-capacity at universities and research institutions are indications of the increased government involvement in the R&D sector. The OECD countries report a (nominal) rise in R&D-expenditure of more than 7 percent per annum between 1998 and 2006.

Marked increase in state R&D budgets

In Germany, after a virtual standstill in the 1990s, the state R&D budget was increased by about 1 percent point annually beginning in 1998. From 2006 to 2007 there was even an expansion by 4.5 percent. However, considerably more importance was attached to research and development by countries such as the USA, Korea, Great Britain or Canada, where the R&D budgets were increased much more. Germany concentrated its state R&D-expenditure to a much greater extent on civilian sectors than most of the

TAB 04 **Types of R&D activities in selected OECD countries**

	Land/Region	Basic research	Applied research	Experimental development
Total	OECD-19	18.2	23.6	57.0
Universities and research institutions	OECD-19	74.8	21.7	3.5
Scientific institutions	OECD-19	28.4	34.7	36.3
Business	OECD-19	5.3	21.2	73.5
Business	OECD-23	5.2	25.0	69.8
	Germany	4.5	51.8	43.8
	USA	4.2	18.7	77.1
	Japan	6.0	19.3	74.5
	Great Britain	14.1	25.5	60.3
	France	5.0	41.2	53.7
	Italy	4.6	50.9	44.5

2004 or current year. Percentages, slight inexplicable differences.
Source: OECD, Basic R&D Statistics. Calculations by NIW.

other countries. But even so the slight increase in state R&D expenditure in Germany was not sufficient for it to maintain its position even there.

The intensity with which industrial research and development was supported by the state varies considerably between countries, and the typical national characteristics often have historical roots. The state funded share of the R&D-expenditure in Italy, France and the USA is about 10 percent, which has a clear quantitative effect. In Great Britain the level was similarly high for a long time. Germany had a level of 6 percent in 2004 according to statistics,[102] and according to BMBF figures only 4.5 percent since 2005 (down from about 10 percent in the mid-1990s and 18 percent in the early 1980s). The OECD-mean since 2002 has been 7 percent, at times even slightly higher. This shows that state support for industrial research in Germany is weak.

The Federal Government has recently reacted by adopting political measures, for example the Excellence Competition for universities and the High-Tech Strategy. Because the relevant statistics are not yet available, it is not yet possible to say whether it has been possible to emerge from the trough described above.

Public research institutions as important business cooperation partners

The growing importance currently attached to state R&D institutions is not to be regarded as temporary and compensatory. This is also because business companies are now less likely to be adopting medium-term R&D strategies, and are reacting increasingly to short-term market prospects. In order to prevent their own technological possibilities from becoming too restricted, the companies buy in additional knowledge from research institutions or they cooperate with business partners in Germany or elsewhere.[103] Open Innovation is becoming increasingly common.

Research-intensive universities and faculties are often integrated in innovation networks, and they have become more attractive as cooperation partners, in particular for small and medium-sized enterprises. The universities and research institutions, in turn, can acquire external funding for personnel and equipment through such cooperation projects, which benefits the quantity and quality of their research and teaching. At the same time, the practical relevance of research findings can be tried and tested. The focus of state-financed research and development in Germany is on applied research, which has a positive effect on the cooperation between university and business. More than half the funding flows into this area, while only

Proportion of research and development funded by business in public institutions in OECD-countries TAB 05

	Universities	Scientific institutions	Total	Business R&D-funds for science/research (percent of internal R&D-expenditures)
Germany	14.2[1]	10.5	12.5[1]	5.4[1]
Great Britain	4.8	9.0	5.9	3.5
France	1.7[2]	8.1[2]	4.7[2]	2.6[2]
Italy	1.2	4.1	23[2]	2.2[2]
Netherlands	6.8	16.1[3]	10.0	7.4
Sweden	5.1[2]	5.1	4.4	1.5
Finland	6.6	12.7	8.6	3.4
Switzerland	8.7	no figures	no figures	no figures
USA	5.4[2]	2.6[2, 3]	4.7[2, 3]	1.6[2, 3]
Canada	8.4[2]	2.8[2]	7.3[2]	5.9[2]
Japan	2.9	0.7	2.0	0.6
Korea	13.7	4.5	8.8	2.4
EU-15 total	*6.7[1]*	*8.3[1]*	*7.2[1, 2]*	*4.0[1, 2]*
OECD total	*6.2[1]*	*3.7[1]*	*5.2[1, 2]*	*2.2[1, 2]*

Data 2006. In percent. Netherlands, EU-15 and OECD: 2003 not 2006, Sweden: 2005 not 2006, Switzerland: 2004 not 2006.
1 Estimates. 2 Provisional. 3 Including private non-profit organisations.
Source: OECD, Main Science and Technology Indicators (2008/2). Collation, calculations and estimates by NIW.

4.5 percent goes into basic research. 43.8 percent flows to experimental development (Tab. 04).

Trend for less state funding in private research and development …

The worldwide increase in state R&D-expenditure this century is only in part attributable to the fact that the state has provided businesses with more R&D support. It is mainly related to the increase in the R&D capacities in universities and research institutions. In Germany, the proportion of the overall government R&D budget flowing to business has sunk from 32 percent (1982) to between 10 and 11 percent (2006).[104]

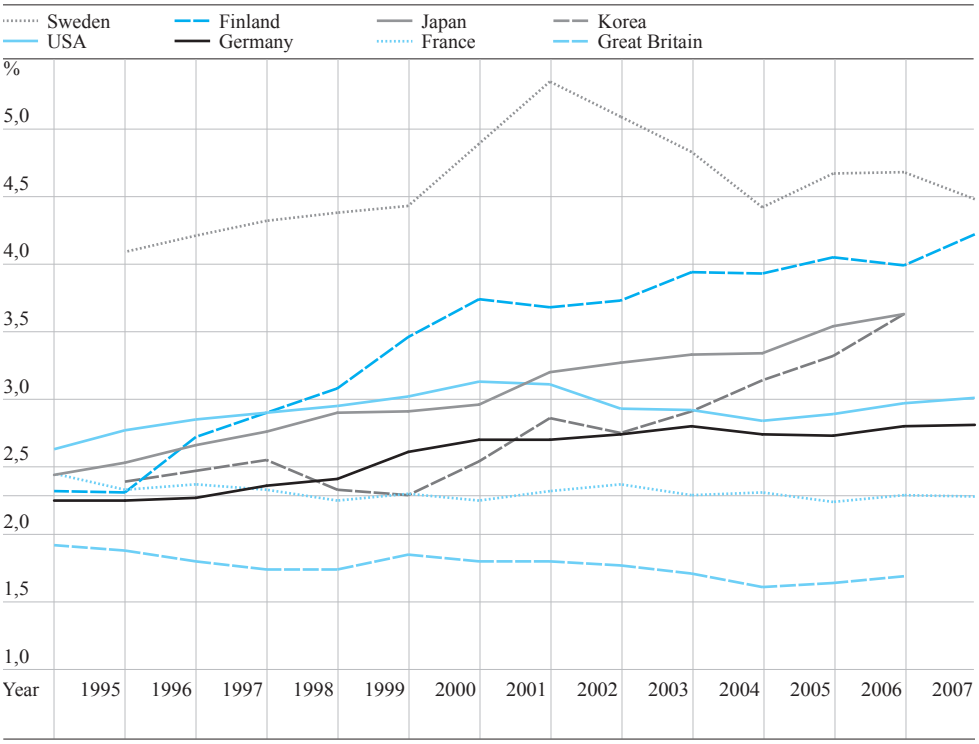
Viewing the long-term development since the early 1990s, R&D expenditure in the public sector in Germany has risen in real terms (28 percent bis 2007), but much more weakly than in the Nordic countries (95 percent), Southern Europe (75 percent), Great Britain (51 percent bis 2006), and USA (56 percent) as well as in comparison with Japan (35 percent bis 2006). It took until 2005 for public R&D-capacities in Germany to exceed the volumes of 2002 again. In general, most countries in the first half of the new decade again showed a slightly increased state share in the R&D expenditure.

Nearly 45 percent of the (weak) real growth in capacity for carrying out research and development in the OECD countries is in the public sector, and 55 percent is in the business sector. From a German perspective, businesses had lost significant shares in research and development expenditure in the first half of the 1990s, but then bounced back, so that its share of R&D capacities is now 70 percent, slightly above the OECD-average (69 percent).

… but increasing private share in financing public research and development

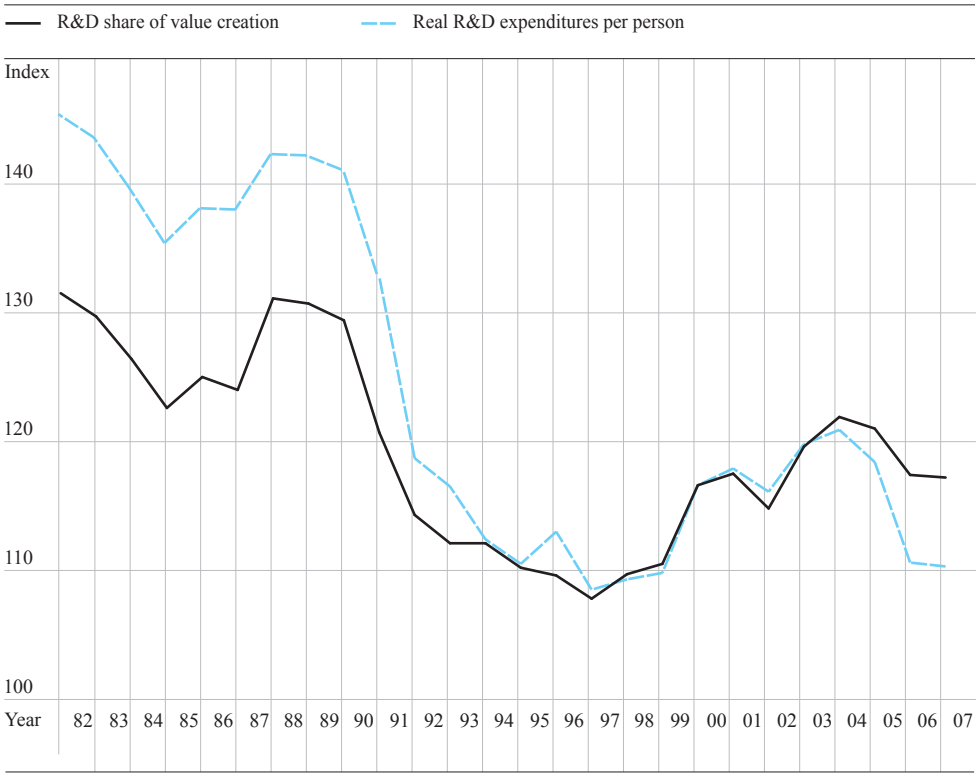
When research and development are carried out in the public sector this does not mean that it is funded in full by the government. On average in the OECD (2006), business companies finance 6.2 percent of university research and 3.7 percent of research and development in non-university R&D institutions. Germany is one of the front-runners concerning the business share in financing research and development in public institutions. 14.2 percent of university research and 10.5 percent of the research in non-university institutions is provided by the business sector. R&D-cooperation relationships between business and science are also particularly close in the Netherlands, in Korea, and in Finland – mostly due to the intensive

FIG 15 **R&D intensity of the business sector in selected OECD countries***



Data estimates in part.
* Gross domestic expenditure on R&D as percentage of the gross value creation.
Source: OECD, Main Science and Technology Indicators (2008/2). WSV. Calculations and estimates by NIW.

FIG 16 **R&D-intensity of the German economy 1981 to 2006 in comparison to OECD**



Index: OECD = 100. Until 1990 West Germany.
Source: OECD, Main Science and Technology Indicators (2008/2). Calculations by NIW.

orientation of non-university science institutions to the needs of businesses.

In Germany, the business funding contribution for public R&D projects, compared with in-house activities, has increased to more than 3.5 percent, against the trend. After a revision of the statistics for 2005, the last available year, a figure of 5.4 percent is obtained. It seems that the science system has become more relevant for German businesses.

More research and development activity in the business sector since 2003

Businesses OECD-wide spent 570 billion dollars on research and development in 2006, which is 2.4 percent of gross value-creation in the company sector. The R&D intensity of business in Sweden is 4.7 percent (2007: 4.5 percent) which is almost twice the OECD average; Finland follows with 4.0 percent (2007: 4.2 percent), and then Japan and Korea (both 3.6 percent) and Switzerland (3.1 percent in 2004). Business R&D intensity is also above average in the USA (3.0 percent), Denmark (2.9 percent), Germany (2.8 percent), Austria (2.6 percent, 2007: 2.7 percent) and Iceland (2.5 percent). Germany's business sector is therefore not in a bad position in comparison with the other western industrialised countries regarding research and development, but it has lost ground. At the start of the 1980s the companies in Germany had an R&D-share of 2.4 percent of the value created in the business sector, placing it second behind the USA (2.5 percent), but in 2006 it was only in eighth place.

After a weak phase at the start of the new millennium, business R&D activity has increased again since about 2003 in the OECD countries. Until 2006 the annual average growth rate was 4.5 percent, driven above all by Japan and Korea, but also by Southern Europe; the USA and Central Europe were at 4 percent, Northern Europe above 3 percent, and Germany below 2 percent. The EU-15 achieved an annual value of 2.7 percent. In particular China made considerable progress with R&D activity in the business sector. In the past decade, companies in in China have increased their R&D expenditure by more than a factor of ten, primarily in the R&D-intensive industry. China has also become one the largest recipients worldwide of of foreign direct investments in the R&D-segment.

Since 1994, German companies have expanded their R&D-capacity at just about the average rate for the EU. They are ahead of the company sectors of France and Great Britain, but have lost the dynamic lead of the past in a European comparison. This is because practically all small European economies have been making efforts to come as close as possible to the European Commission's R&D-target of 3 percent in 2010.

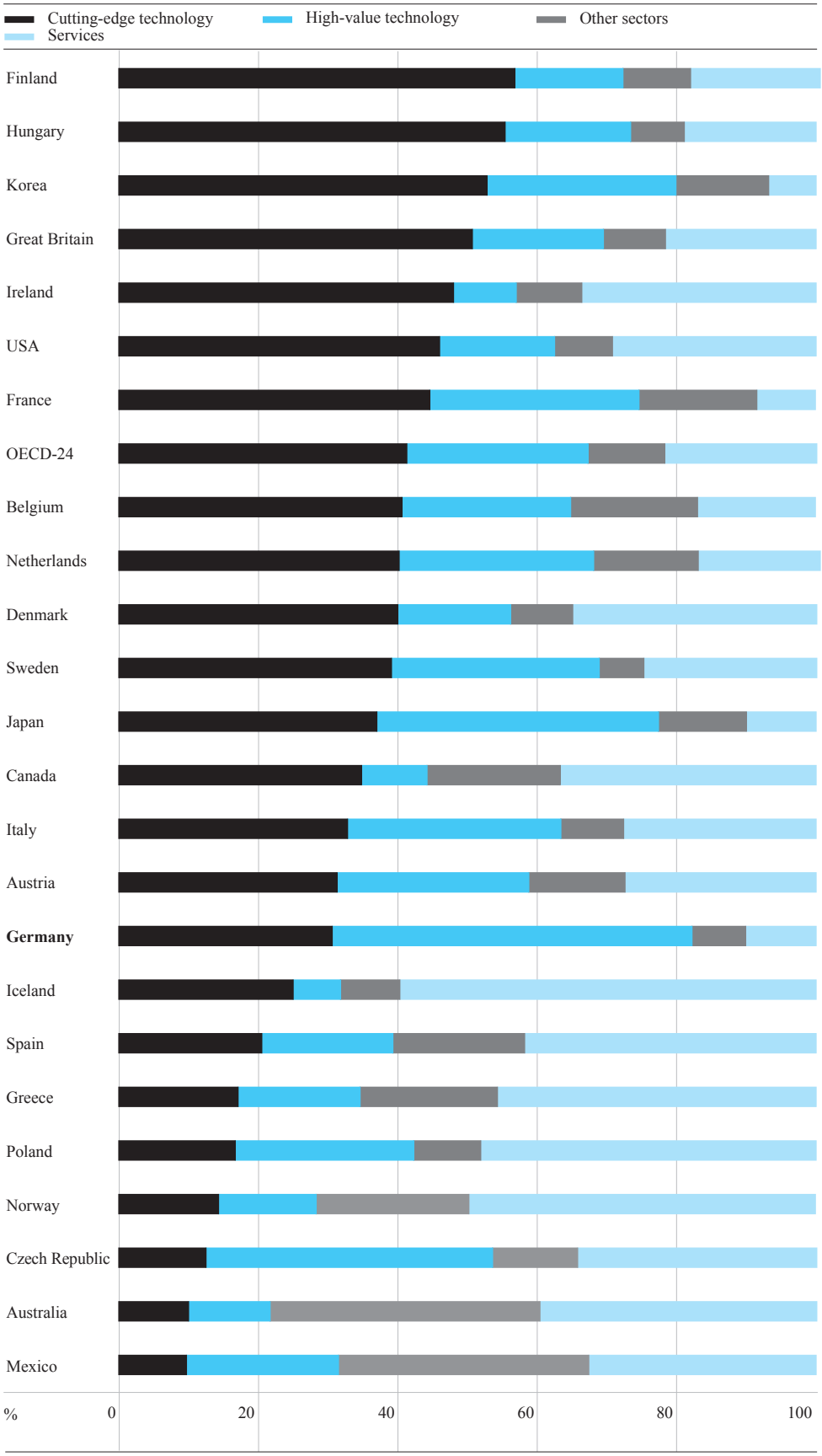
However, the EU as a whole is a long way away from its target. With a 1.9 percent share of value-creation in the company sector, research and development has not grown in importance since 2000, for all the declarations. No ground has been lost to the USA, but the R&D position has clearly worsened in comparison with Japan and the other Asian countries.

Below average increase in R&D activity of German businesses

German businesses produce with a higher R&D intensity than the average in an OECD comparison, but the lead over other countries is melting away. The R&D-activities of companies are being adapted in the new decade to the progress of the economy in general and the revenues anticipated from the individual R&D-projects. Research and development activity has almost lost an independent dynamic and its own long-term perspective. In 2007, German companies invested 54.2 billion euros, which was 4.2 percent more than in the previous year. Over recent years the companies in Germany always invested a little more in research and development than initially planned, which is a sign of trust in a good economic development and an expression of a positive attitude to R&D and an appreciation of it. The tendency towards increased R&D – particularly in large companies in cutting-edge technology sectors – is probably related to a growing medium-term strategic orientation of industrial research. Nevertheless, the increase in R&D expenditure in the recent past has always lagged behind the revenue development.

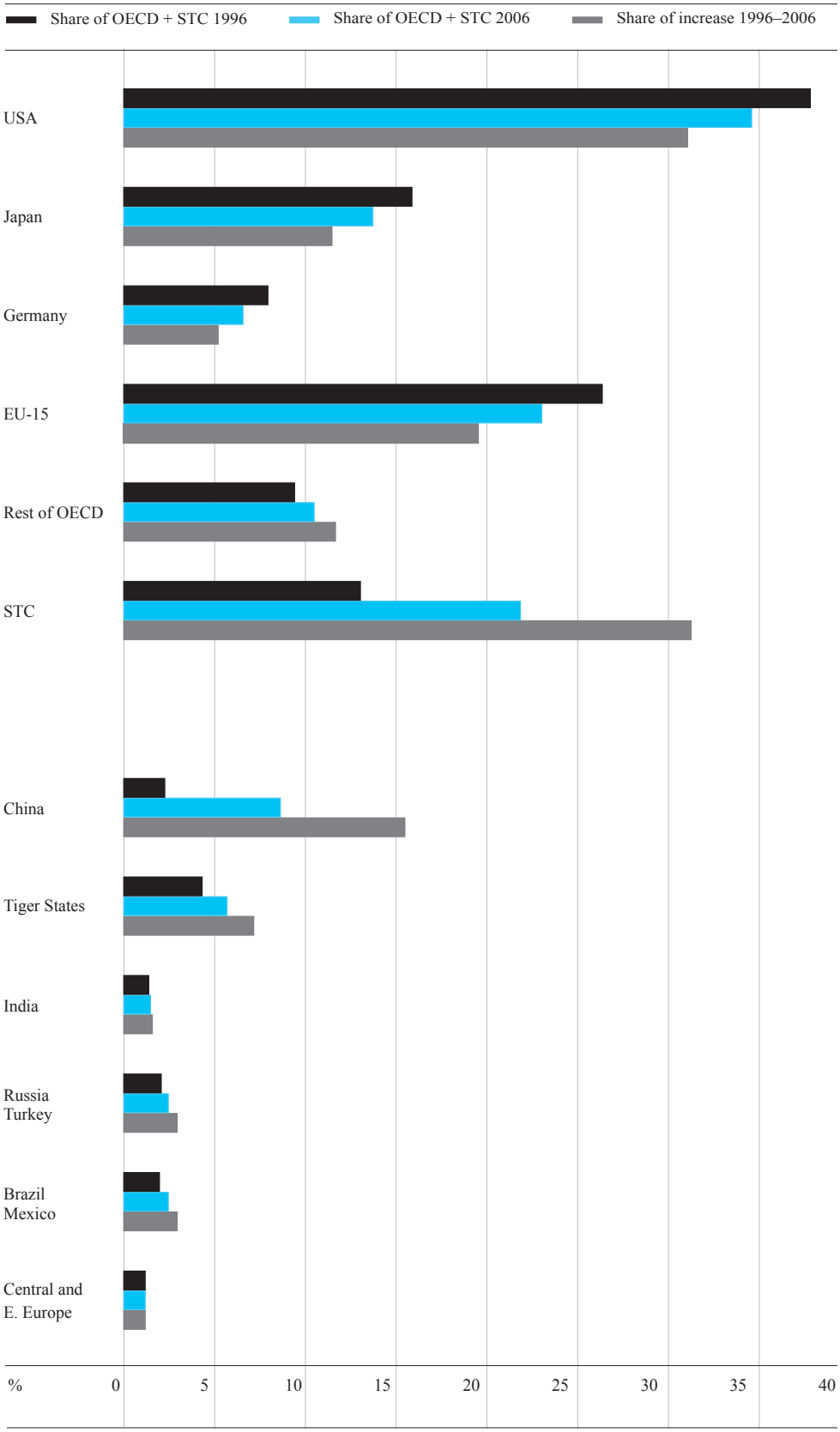
German companies can no longer keep up with the international dynamic. Leaving aside the USA, the position of German economy has worsened in comparison with most world regions since 2000. Since 2004 the R&D-capacities in the business sectors of OECD countries have expanded on average by 5.8 percent,

FIG 17 **International comparison of R&D-expenditures in various sectors in 2005**



Source: OECD, ANBERD Database. STI-Database. Calculations and estimates by NIW.

Proportion of GDP expenditure on R&D (GERD) in an international comparison FIG 18



India: 2005 instead of 2006. Rest of OECD: OECD without US, JP, DE, KR, TR, PL, HU, CZ, SK, MX.
Selected Threshold Countries (STC): All emerging economies. Tiger States: KR, TW, SG.
Central and Eastern Europe: PL, HU, CZ, SK, SI, EE, LV, LT, BG, RO.
Source: OECD, MSTI (2008/2), Eurostat, MOST India (2006), MCT do Brasil (2008). Calculations by NIW.

but the German business sector is a long way from this, at 2.9 percent. Correspondingly, the importance of its research and development in the global economy has also declined significantly, from 12 percent at the start of the 1980s to about 7 percent in 2005.

Automotive sector most important for research and development in Germany

In the OECD countries, 76 percent of all internal R&D expenditures is in the manufacturing sector, more than 67 percent in the R&D-intensive manufacturing sector alone (2005). Nearly 22 percent is in the services sector. Other sectors, including non-R&D-intensive manufacturing, energy supplies and water management, construction, and agriculture, account for 2 percent of R&D-expenditure. Germany differs considerably from the average structure. R&D-intensive manufacturing, at 82 percent, has the highest proportion of R&D-expenditure among the countries included, while the services sector only had a very low share of 10 percent, similar to Korea, Japan, and France, where this sector accounts for some 8 to 10 percent of R&D-expenditure. In Germany the focus for decades has been on the high-value technology sector, which accounts in total for nearly 52 percent of R&D-expenditure. No other OECD countries have such a large proportion in this sector (mean: 26 percent).

In this sector group it is above all automotive construction, and also mechanical engineering and the chemical industry which represent Germany's outstanding strength. In contrast, the electronics-related sector (IT, electronics/media technology, IC) and the services sector (including company and data services) are relatively weak, not only in an international comparison, but also in most cases since the mid-1990s. R&D capacity growth in the German car industry has been very high: more than half the growth in R&D-capacity in Germany since 1995 has been in the automotive sector, and this development has even increased since 2005. 22 percent of the R&D-capacity of the automotive industry in the entire OECD are based in Germany.

Thus the “German innovation system” is increasingly dependent on this industrial sector. It is solely due to the automotive industry that the R&D-intensity in the German economy is above average. In all other sectors of the economy, research and development have lagged behind between 1995 and 2005. Previous strong points of Germany, for example have weakened in the pharmaceutical industry and in telecommunications. This specialisation pattern is found throughout the German innovation system and is not only apparent for R&D, but also in the economic structure and in foreign trade or patents.

More countries are entering into the international innovation competition

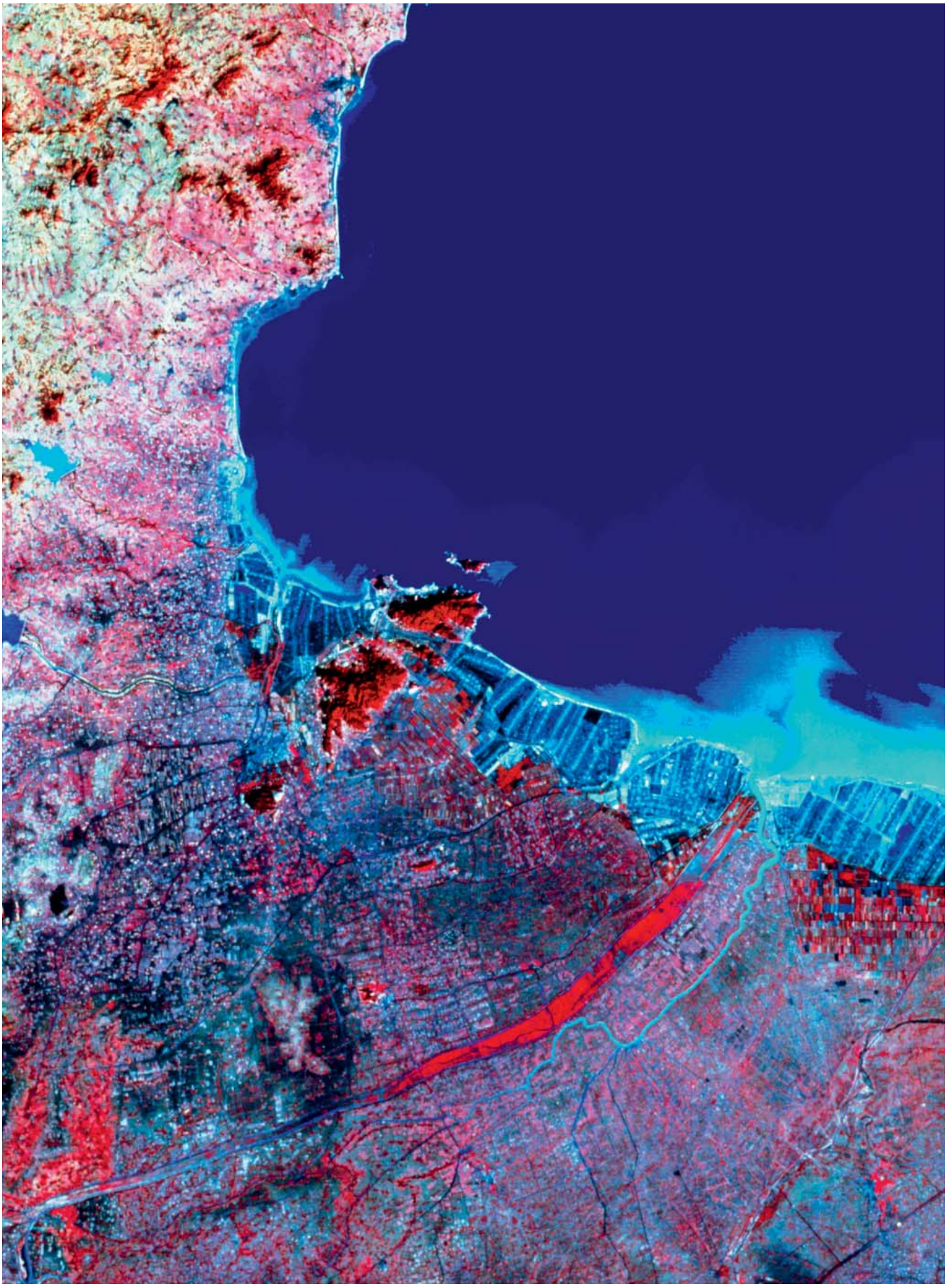
In addition to the western industrialised countries, other countries also have to be included in the R&D analysis and compared with Germany. This is the case in particular for Korea, Taiwan, and Singapore, the larger central and eastern European emerging markets, as well as the five young EU member states. China and India must also be included.[105]

With the development of a knowledge economy in these countries, the international innovation race has considerably more participants on the starting blocks. The emerging markets in 2006 were spending more than one fifth (22 percent) of gross domestic expenditure for research and development of the OECD countries and emerging markets combined. Since the mid-1990s the R&D-growth centres have been shifting increasingly into the Asian area, above all to the Asian emerging markets. China, India and the Tiger States have doubled their share from 8 percent to 16 percent between 1996 and 2006. Nearly one third of additional R&D-expenditure by OECD countries and emerging markets together is spent by the latter, of which half is by China alone. They have increased their share of worldwide R&D-resources from 13 percent (1996) to 22 percent (2006). For company expenditure the increase was even greater (from 11 percent to 20.5 percent).

China continues its rapid expansion

Quantitatively, China is on a particularly rapid R&D course of expansion. R&D expenditure since the mid-1990s has increased more than seven-fold to 87 billion dollars and in only a short period it has moved ahead of Germany (67 billion dollar) into third place among the R&D-rich countries (USA 349 billion dollar, Japan 139 billion dollar). Korea lies in sixth place in absolute terms between France and Great Britain, Russia, Brazil and Taiwan follow Canada in places

Europe by night



Satellite view of Linhong Kao bay, China
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9 to 11; and India and Turkey are also still under the Top 20.

The OECD countries can no longer keep up with the (nominal) R&D-growth rates of the emerging markets. At 13 percent, the average annual growth of the emerging markets between 1996 and 2006 is more than double that in the OECD (6 percent). China has set the pace for R&D expansion since 1996 with 22 percent per annum, followed by the Baltic States with 14 to 18 percent. Singapore, Turkey, Hungary, Mexico and Taiwan also have R&D growth rates of above 10 percent.

As explained, a central indicator for assessing the technological potential of an economy is the intensity with which it conducts research and development: the R&D-expenditure relative to the gross domestic product (GDP). This established measure has to be used with more care in the case of dynamic emerging markets than with established countries, because the quotient is the result of a future-oriented factor (R&D) related to a current variable (GDP). Between 1991 and 2006 there have been some drastic changes to the situations of the countries considered here. Currently, the EU-15 average for R&D intensity (1.9 percent) forms a demarcation line between the research-intensive manufacturing economies and the emerging markets. The European and Latin American emerging markets are on average below 1 percent. Only the Asian emerging markets have been able to catch up from an initial R&D-intensity of below 1 percent (1996) to nearly 1.5 percent in 2006.

This is attributable in particular to the Tiger States but also to the performance of China. Measured in terms of EU or OECD averages, Singapore and Taiwan caught up some time ago; Korea has become an OECD member.

Korea, with an R&D intensity of 3.22 percent of gross domestic expenditure on research and development relative to GDP is ahead of the USA. Only Japan, Sweden, Finland and Israel have a higher R&D intensity. Taiwan follows close behind the USA with an R&D intensity of 2.58 percent, and is ahead of Germany (2.54 percent) and Singapore (2.31 percent) – all above the average for the OECD countries (2.26 percent).

C 3 INNOVATION ACTIVITIES OF GERMAN BUSINESSES

Innovation activities of companies are aimed at achieving at least a temporary competitive advantage over competitors. In the case of a product innovation, a new or improved good is launched with properties which differ markedly from goods already on the market.[106] The introduction of a new or improved production method is a process innovation. The following results, in which the innovation behaviour of industry and services are described, are based on the annual innovation survey of the *Zentrum für Europäische Wirtschaftsforschung (ZEW)*, the Mannheim Innovation Panel.[107]

Lower proportion of companies with product innovations

In 2007, the innovator rate in the German economy could not be increased, despite a favourable general economic situation. The proportion of companies which had introduced at least one new product or a new process within a three-year period remained constant in the R&D intensive manufacturing sector at 75 percent. In the rest of the manufacturing sector the innovator rate fell slightly to 49 percent. Only the knowledge-intensive services managed an increase in the proportion of companies with product or process innovations in 2007, to 54 percent.

The innovation activities of the company in the survey shifted somewhat in 2007 in the direction of process innovation. In the R&D intensive manufacturing sector there was a fall in the proportion of companies launching new products, from 69 to 66 percent. The proportion of companies using new or improved processes to manufacture their products remained constant at 45 percent. In the rest of the manufacturing sector the proportion of companies with product innovations fell from 39 to 37 percent. The proportion of process innovators also sank slightly to 31 percent. The proportion of product innovators in the knowledge-intensive services remained at 40 percent, the proportion with process innovations increased here slightly to 34 percent. The Expert Commission had already expressed concern in EFI Report 2008 about the long term decline in the innovator rate. This trend could not be reversed in 2007.