

Globalisation of R&D

Concepts of measuring R&D globalisation used in Germany

Christoph Grenzmann^{1,2}

¹ This contribution is based on (Grenzmann, Jakob, Tübke; 2006)

² Christoph Grenzmann, Wissenschaftsstatistik – Stifterverband, Essen

Globalisation of Research and Development

Worldwide economic integration is driving forward a process of globalisation in which distances and national borders are becoming increasingly unimportant. The organisation of research and development (R&D) and innovation is also affected by this process. The increasing trend towards globalisation is also a challenge for statistics. The OECD, as an internationally recognised institution for harmonising the statistical methods of the individual states, has drawn up corresponding standards in the shape of a “Globalisation Handbook” (OECD, 2004). This contribution will consider various approaches towards dealing with a number of questions relating to the globalisation of R&D in public reporting, while having the monitoring system of Germany in the focus of consideration.

It will look, for instance, at the extent to which the “classical” R&D statistics provide possibilities for depicting the globalisation of R&D; against this approach of taking the R&D statistics into consideration with the different branches, size-classes, there is the concept of collecting the balance sheet data of multinational companies and evaluating it on a comparative basis. This concept utilises the public reporting of business enterprises as included in their accounts. So for this approach the well known problems of statistical confidentiality, the R&D deal with, is unknown for a monitoring system based of data which are in public access.

1 R&D Statistics

The R&D input performed in an economy is reported in the research and development statistics based on the gross domestic concept (OECD, 2002). The OECD standards for recording the statistics ensure international and intertemporal comparability. The R&D statistics report about those activities that are either performed domestically or are commissioned from within a country for R&D purposes to “other” R&D institutions. This may constitute either intramural R&D expenditure or extramural R&D expenditure, which stand for R&D orders placed with third parties. Recording of the domestic R&D activities is termed the territorial principle; the R&D statistics report about those R&D activities of the enterprises on the respective national territory. This statistical regulation prevents R&D activities from being doubly recorded in different countries. In simplified terms, it can be said that the sum of the intramural R&D expenditure of various countries mirrors the R&D

expenditure of the group of countries concerned. Even if this means that the R&D statistics are primarily geared to recording the domestic research and development activities, they nevertheless provide some indicators for the global orientation of enterprises.

1.1. Flows of funds in Research and Development

Indications regarding globalisation can be deduced from the R&D statistics in the form of the volume of external orders placed abroad, or in term of the R&D statistics: the amount of extramural R&D expenditure to institution abroad. Despite individual leaps, the volume of extramural R&D expenditure to research institutes outside Germany has shown a clear increase since 1993 (*Tab. 1*).

Table 1:
Extramural R&D expenditure to abroad, R&D funds
from abroad enterprises 1993 – 2003

Year	total R&D- expenditure		R&D- expenditure financed from abroad
	€ m		
	1	2	3
1993	29 159	629	564
1995	29 571	475	628
1997	33 029	853	1 192
1999	39 255	1 132	1 035
2001	43 239	1 215	1 235
2003	46 070	1 886	1 094

Source: Stifterverband Wissenschaftsstatistik

In absolute terms, the volume has tripled within 10 years. Also the share of external expenditure as a percentage of total R&D spending rose from 2.2 % in 1993 to 4.1 % in 2003. This is a clear indication that companies domiciled in Germany are making increasing use of R&D know-how located abroad in order to facilitate innovations.

Viewed from the opposite point of view, R&D funding from abroad, the figure has almost doubled in 10 years. Also as a proportion of total R&D expenditure, the foreign funding has increased slightly. In 1993, 1.9 % of total R&D expenditure was funded from sources abroad, in 2003, the figure stood at 2.4 %. Even if the funds from abroad include grants from the EU, it can nevertheless be stated that, also in these cases, other countries make high use of the know-how of enterprises, located in Germany.

Analysis of the international R&D financial flows on the basis of the R&D statistics show the growing importance of international R&D cooperation. It can also be observed that the utilisation of know-how from abroad was greater than the share of funding from abroad. One exception to this was in the year 2001, when the expenditure and revenues were more or less equal, but also for that year it can be realistically assumed that, taking the grants from abroad into account, the share of R&D financing tied up through orders from abroad was lower than the external R&D expenditure to foreign countries.

1.2. R&D Breakdown by Country of Enterprise Ownership

R&D flows of funds from home to other countries and from other countries to home provide indications regarding the cross-border utilisation of know-how through the placing of R&D orders. However, it leaves open the question of the extent to which multinational companies favour or avoid Germany in their global R&D allocation. In order to also find an answer to this question, it is necessary to determine to what extent R&D enterprises located in Germany are the subsidiaries of foreign multinational groups and are therefore – presumably – dependent within their own R&D organisations on directions given by their foreign group parent. The same question also applies to German groups of companies: To what extent do their subsidiaries abroad conduct R&D?

In the first case, the question is examined as to what extent foreign-owned companies perform R&D in Germany, and in the second case, to what extent German groups of companies perform R&D at their group-owned subsidiaries abroad (Belitz 2006 and Belitz, Edler, Grenzmann 2006).

First, the role of Germany as an R&D location for foreign multinationals will be considered. The development in R&D expenditure, broken down by domestic and foreign owners, between 1993 and 2003 indicates (*Tab. 2*) that a significant shift has taken place in R&D expenditure conducted in Germany towards foreign enterprises. If, for reasons of simplicity, it is assumed that the R&D spending of enterprises with an unclarified ownership position is distributed in the same way as for those where the ownership position is clear, it can be seen that the share of R&D arranged from abroad initially amounted to around 16 %, while by 2003 it had risen to approx. 27 %; this is again a clear indication for the growing internationalisation of R&D in the business enterprise sector.

Table 2:
Intramural R&D expenditure of enterprises in Germany 1993 – 2003

Year	Intramural R&D-expenditure								
	grand total	country of owner identified ^{*)}						country of owner not identified	
		total			thereof				
				Germany		abroad			
	€ m		%	€ m	%	€ m	%	€ m	%
1	2	3	4	5	6	7	8	9	
1993	25 643	21 871	85,3	18 400	84,1	3 471	15,9	3 773	14,7
1995	26 564	21 682	81,6	18 200	83,9	3 482	16,1	4 883	18,4
1997	28 651	24 360	85,0	20 177	82,8	4 183	17,2	4 291	15,0
1999	33 330	28 934	86,8	23 773	82,2	5 161	17,8	4 396	13,2
2001	35 969	32 346	89,9	24 333	75,2	8 013	24,8	3 623	10,1
2003	37 743	35 800	94,9	26 227	73,3	9 573	26,7	1 942	5,1

*) ultimate beneficial owner

Source: Stifterverband Wissenschaftsstatistik

Figures may not sum due to roundings

Compared to other OECD-members the R&D globalisation in term of domestic R&D performed in foreign controlled enterprise is still “moderate”. For the manufacturing industries in Ireland more than 75 % are foreign – controlled, in the US roughly 18% (OECD, 2005)

It is mostly European countries and North America (NAFTA) performing R&D in Germany (Tab. 3).

Table 3:
R&D data 1995 – 2003 in enterprises in Germany by country of owner ¹⁾

Year	grand total	country of owner ¹⁾ identified						country of owner not identified
		total	Germany	abroad	thereof			
					NAFTA	EUROPE	JAPAN SO-ASIEN	
1	2	3	4	5	6	7	8	
Total R&D expenditure (€ m)								
1995	29 571	24 542	20 442	4 100	2 215 ²⁾	1 828	57 ³⁾	5 030
1997	33 030	26 636	21 786	4 850	2 220 ²⁾	2 496	134 ³⁾	6 394
1999	39 255	34 602	28 327	6 275	3 005	3 174	96	4 653
2001	43 239	39 252	28 833	10 419	4 465	5 882	72	3 987
2003	46 070	43 961	32 292	11 669	4 484	6 877	198	2 110
Intramural R&D expenditure (€ m)								
1995	26 564	21 681	18 199	3 482	1 776 ²⁾	1 663	43 ³⁾	4 883
1997	28 650	24 360	20 177	4 183	1 851 ²⁾	2 226	106 ³⁾	4 290
1999	33 333	28 937	23 774	5 163	2 296	2 787	80	4 396
2001	35 969	32 344	24 331	8 013	3 236	4 719	58	3 623
2003	37 743	35 800	26 227	9 573	3 563	5 744	167	1 942

1) ultimate beneficial owner

Source: Stifterverband Wissenschaftsstatistik

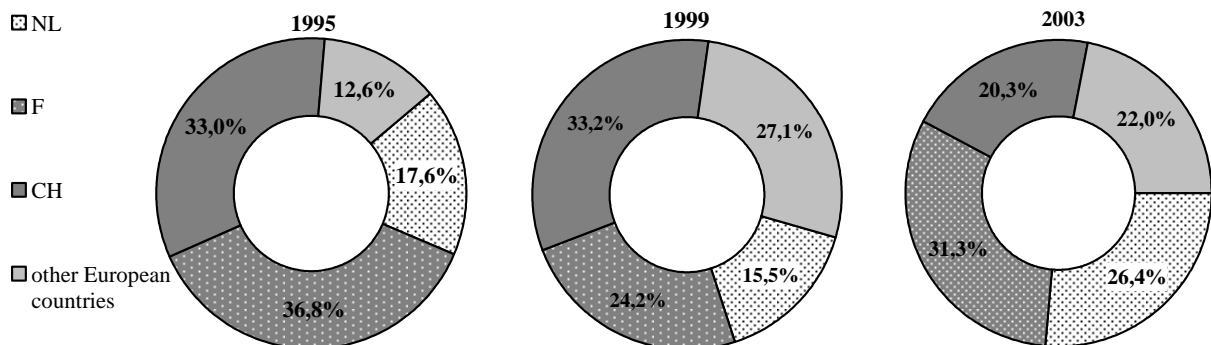
2) USA

3) Japan, South-eastern Asia and Canada

Figures may not sum due to roundings

In 2003, around 60 % of the internal R&D conducted in Germany by foreign companies was accounted for by European countries and about 40 % by North American companies (1993: Europe: 54 %; USA = 45 %). Within Europe, three of Germany's neighbour countries stand out in particular: the Netherlands, France and Switzerland. In 2003, these three countries accounted for 78 % of the European R&D engagement. Between these three countries, a continuous shift has taken place towards the EU members France and the Netherlands. (Fig.1)

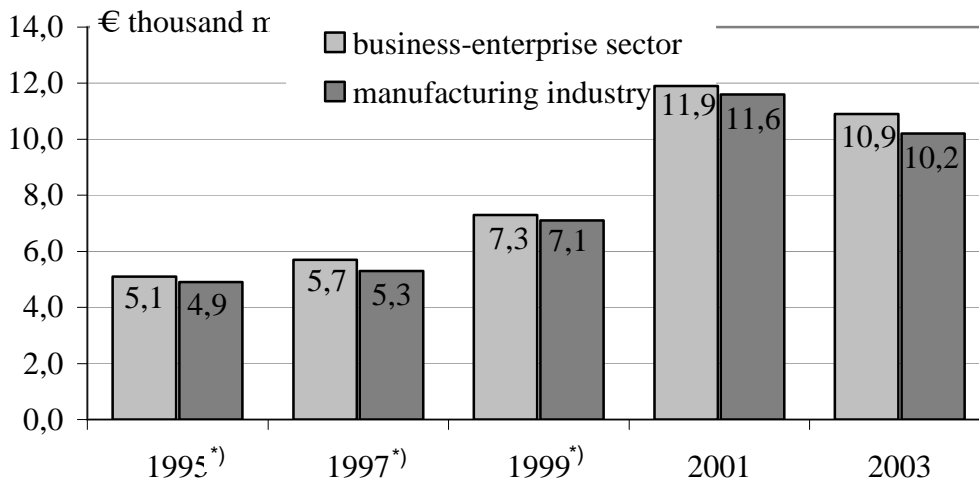
Figure 1: Intramural R&D expenditure of enterprises in Germany 1995 – 2003 with headquarters in Europe (outside Germany)



Source: Stifterverband Wissenschaftsstatistik

On the other side, the question poses itself as to what volume of R&D is conducted by German groups of companies in other countries. This reveals that in 2003, groups with their headquarters in Germany had R&D worth € 11 thousand m done abroad. This is a clear increase compared to 1999, but a fall as against 2001. According to this, the German multinationals have slightly reduced their foreign R&D engagement (*Fig. 2 / Tab. 4*).

Figure 2:
R&D expenditure of German multinationals ¹⁾ in affiliates abroad 1995 – 2003



1) Enterprise groups with headquarter in Germany

*) Because of modification in method of the survey only restricted comparability to 2001 and 2003

Source: Stifterverband Wissenschaftsstatistik

Table 4:
R&D expenditure of German multinationals ¹⁾ in affiliates abroad 1995 – 2003

Year	R&D-expenditure abroad	
	business-enterprise sector	manufacturing industry
	€ thousand m	
1995	5,1	4,9
1997	5,7	5,3
1999	7,3	7,1
2001	11,9	11,6
2003	10,9	10,2

1) Enterprise groups with headquarter in Germany

*) Because of modification in method of the survey only restricted comparability to 2001 and 2003

Quelle Stifterverband Wissenschaftsstatistik

In the recent past, it has been primarily the multinationals in the automobile and chemical industries that have undertaken R&D abroad. The chemical industry is also conspicuous by the very high level of its R&D abroad. In this sector, the multinationals with headquarters in Germany undertake 42 % of their R&D expenditure in other countries. In the electrical industry (production of office machines, IT hardware, accounting & computing machines etc.), the figure is around 37 %, and in the automobile industry approx. 21.5 %. (Tab. 5)

Table 5:
R&D expenditure of German multinationals ¹⁾ 2003 according to R&D in Germany and abroad

Industrial classification	R&D-expenditure					total R&D-expenditure of all enterprises in Germany € m	
	worldwide	thereof					
		R&D abroad		R&D in Germany			
	€ m		%	€ m			%
1	2	3	4	5	6		
D Manufacturing industry	34 145	10 248	30,0	23 944	70,1	42 273	
among them							
DG Chemicals	8 011	3 291	41,1	4 720	58,9	8 044	
DJ Basic metals and metal products	102	14	13,7	88	86,3	885	
DK Machinery and equipment	1 918	622	32,4	1 309	68,3	4 021	
DL Electrical industry; precision and optical instruments	6 833	2 506	36,7	4 357	63,8	8 476	
DM Motor vehicles, other transportation equipment	16 935	3 634	21,5	13 305	78,6	18 976	
Others	2 139	658	30,7	1 494	69,8	3 797	
TOTAL	36 284	10 906	30,1	25 438	70,1	46 070	

1) ultimate beneficial owner; headquarters in Germany
Figures may not sum due to roundings

Source: Stifterverband Wissenschaftsstatistik

Altogether, the R&D statistics show that the R&D activities of multinationals with headquarters in Germany performed in affiliates abroad is matched by an approximately equally high level of R&D performance by foreign R&D companies in Germany. The occasionally expressed fear of a decreasing relevance of industrial R&D activities and its migration to other countries is not backed by the R&D statistics (Rose, 2006). The R&D statistics do not reflect a “one-way-exodus” of German industrial Research to other countries.

2. The EU Scoreboard Method

Another approach towards understanding R&D globalisation is adopted by the “EU Scoreboard”, which is based on data taken from the business reports of companies, and hence from publicly accessible sources (European Commission, 2005). Company business reports, in particular, show that, from the viewpoint of the R&D actors in industry, national borders are becoming less and less important as globalisation progresses. In their annual reports, multinational groups usually state the R&D expenditure for their R&D activities in all parts of the company throughout the world. From the point of view of the enterprise, therefore, the country in which R&D is carried out is not a consideration of primary importance and depends on the overall R&D concept of the group.

The EU Scoreboard analyses the R&D expenditure published by business enterprises in their annual reports. Company reports are produced in accordance with individual company policy and the requirements of accounting regulations. Evaluation of the annual reports of multinationals therefore reflects both the overall R&D concept of the group as well as legal accounting standards. The focus of the EU Scoreboard approach is therefore not on the R&D performed in a country or an economy – as is the case with R&D statistics based on the OECD standards – but the R&D activities of the individual groups of companies, which basically are the multinational enterprises

The EU Scoreboard covers the R&D activities of 1,400 business enterprises: the 700 biggest R&D investors which have their registered office within the EU, and the 700 biggest R&D investors which have their registered office outside of the EU. This is part of a further-reaching EU project to record industrial R&D expenditure and its changes. The goal is to acquire broader understanding for the development of company-financed R&D investment the R&D performance and the factors that influence it.

The R&D data were taken from the published consolidated accounts of multinational enterprises encompassing the results of both the parent company and also its subsidiaries. Subsidiaries are therefore not included separately as an individual entity in the Scoreboard if their R&D expenditure is already included in the consolidated accounts of the group to which they belong. The annual financial statements have been independently audited and cover the worldwide corporate activities of the group concerned.

An enterprise is attributed to the country where it has its officially registered headquarters. Thus, EADS is attributed to the Netherlands. On the other hand DaimlerChrysler is classified to Germany, though an atypical high proportion of R&D is evidently performed in the US. In this sense, the Scoreboard and the R&D statistics have the same definition of the “nationality”

of the Multi National Enterprise, both reflect to the headquarters. The difference is basically the classification of the R&D activities to the countries is different.

R&D investments are defined as expenditure within the meaning of the International Accounting Standards, e.g. IAS 38. Research and development is defined as in the OECD standards for R&D statistics (OECD, 2002).

Classification by business sectors or branch is based on the London FTSE³ system; therefore there may be a slight divergence to the R&D statistics, which classifies the enterprise by the NACE-classification. The method used for collecting data for the Scoreboard by accessing only to public available information means that only those companies are included, that disclose their R&D expenditure in their audited consolidated accounts.

The 2005 EU Scoreboard only encompasses business enterprises that invested more than € 4.1 million in case of an EU enterprises or for non-EU-enterprises € 32.7 million in R&D in 2004 and documented this in their annual reports. Altogether, in the financial year 2004, the 1,400 enterprises included in the Scoreboard invested € 315 thousand m in R&D, corresponding to just over half of all private R&D investment worldwide. The R&D investment of German companies in the Scoreboard amounted to € 37.9 thousand m.

One of the most important results of the most recent study is that the trend towards falling R&D expenditure compared to the previous year was reversed. In the case of the enterprises with headquarters in the EU, it was even possible to observe slight growth in R&D investment (0.7 %). This also applied to the German multinationals. The multinationals in the Scoreboard with their registered office outside of the EU, however, increased their R&D investment much more strongly (6.9 %), making the gap between them and the EU companies still greater. Current surveys and forecasts confirm the reverse in trend for 2005 observed in the Scoreboard for 2004. The Scoreboard also shows that in the various sectors, R&D intensity (R&D expenditure measured as a share of turnover) of EU enterprises is similar to that of non-EU-enterprises. However, compared to the non-EU-enterprises, there are relatively fewer EU enterprises in sectors with a high level of R&D intensity. EU enterprises are more likely to operate in sectors with medium R&D intensity. Because of the mix of sectors, the R&D intensity of all 700 EU enterprises in the Scoreboard is only 2.9 %, i.e. significantly less than the figure of 4.2 % for the 700 non-EU-enterprises.

It can also be found that enterprises from Germany, France and the UK account for more than two-thirds of the R&D investment and the total sales of the Scoreboard enterprises (*Tab. 6*).

Table 6: Proportions of R&D and sales in total by EU Member States and number of companies, in 2004

EU Member State	Proportion of R&D in total (%)	Proportion of sales in total	Number of companies in <i>Scoreboard</i> 2005
Germany	37,03	29,31	135
France	18,94	21,04	81
UK	16,72	24,87	211
<i>Subtotal D+FR+UK</i>	<i>72,69</i>	<i>75,22</i>	<i>427</i>
Netherlands	7	3,69	33
Sweden	5,97	3,98	60
Finland	4,75	3,33	43
Italy	4,3	5,82	25
Denmark	1,77	1,3	31
Belgium	1,42	1,44	26
Spain	0,93	2,57	13
Austria	0,37	0,97	21
Luxemburg	0,35	0,97	4
Ireland	0,28	0,22	7
Hungary	0,06	0,03	2
Slovenia	0,04	0,04	2
Greece	0,03	0,03	2
Poland	0,02	0,13	2
Czech Republic	0,01	0,09	1
Portugal	0,01	0,17	1
Total EU	100	100	700

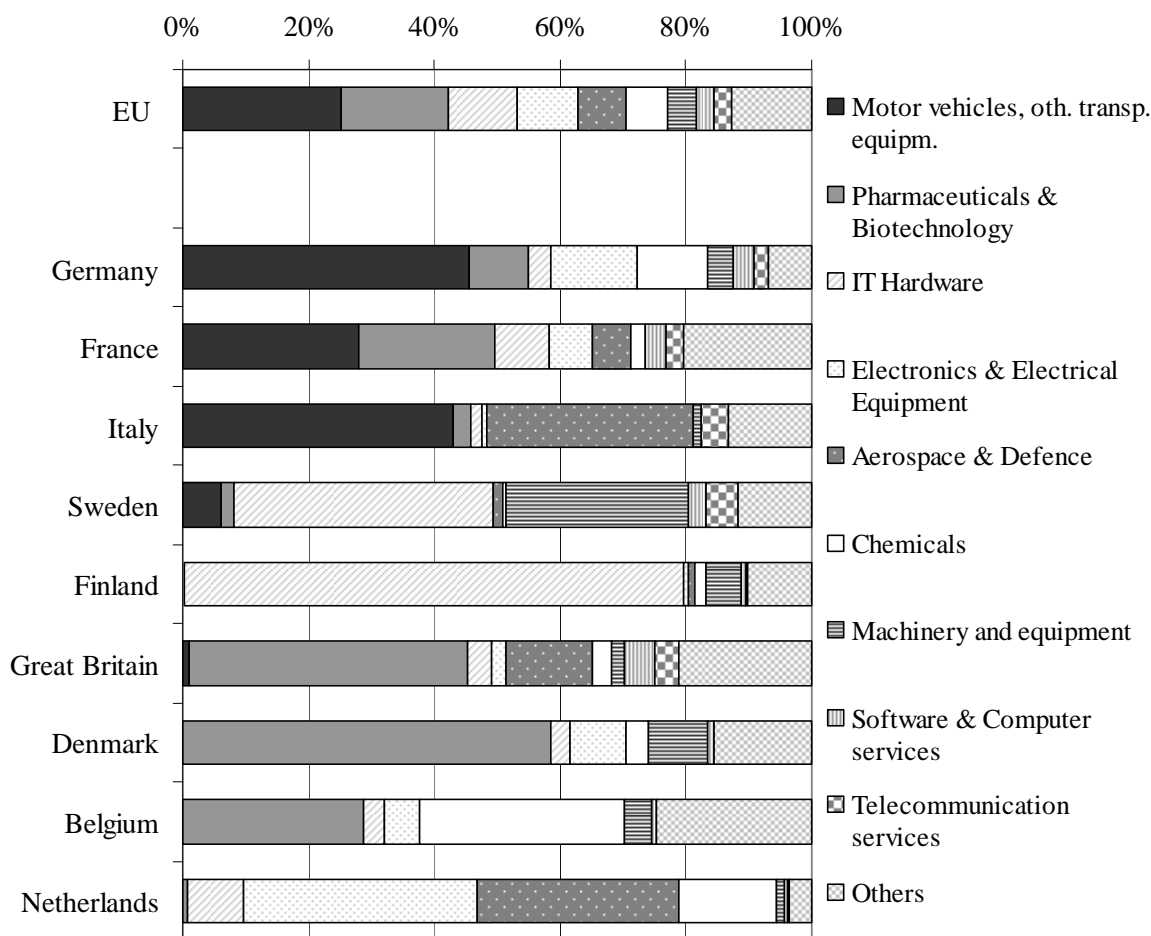
Source: compiled from EU Scoreboard 2005.

Compared to the enterprises from the UK, the enterprises from France and Germany have a higher share of the total R&D investment of the 200 biggest R&D investors in the Scoreboard. Companies from the UK, on the other hand, occur particularly frequently in the group of enterprises below “Scoreboard ranking position” 200.

A particularly important aspect for assessing the sectoral focuses of the enterprises in the individual countries can be found in *Fig. 3*. The overview reveals a clear specialisation of the German enterprises in the automobile and parts sector, followed by electronics and electrical equipment and the chemicals industry. These sectors of medium R&D intensity tend to be dominated by large companies.

³ FTSE = Financial Times Stock Exchange Index

Figure 3: The proportion (%) of total investment of the EU Scoreboard companies accounted for by major sector groups, by country of registration, in 2004

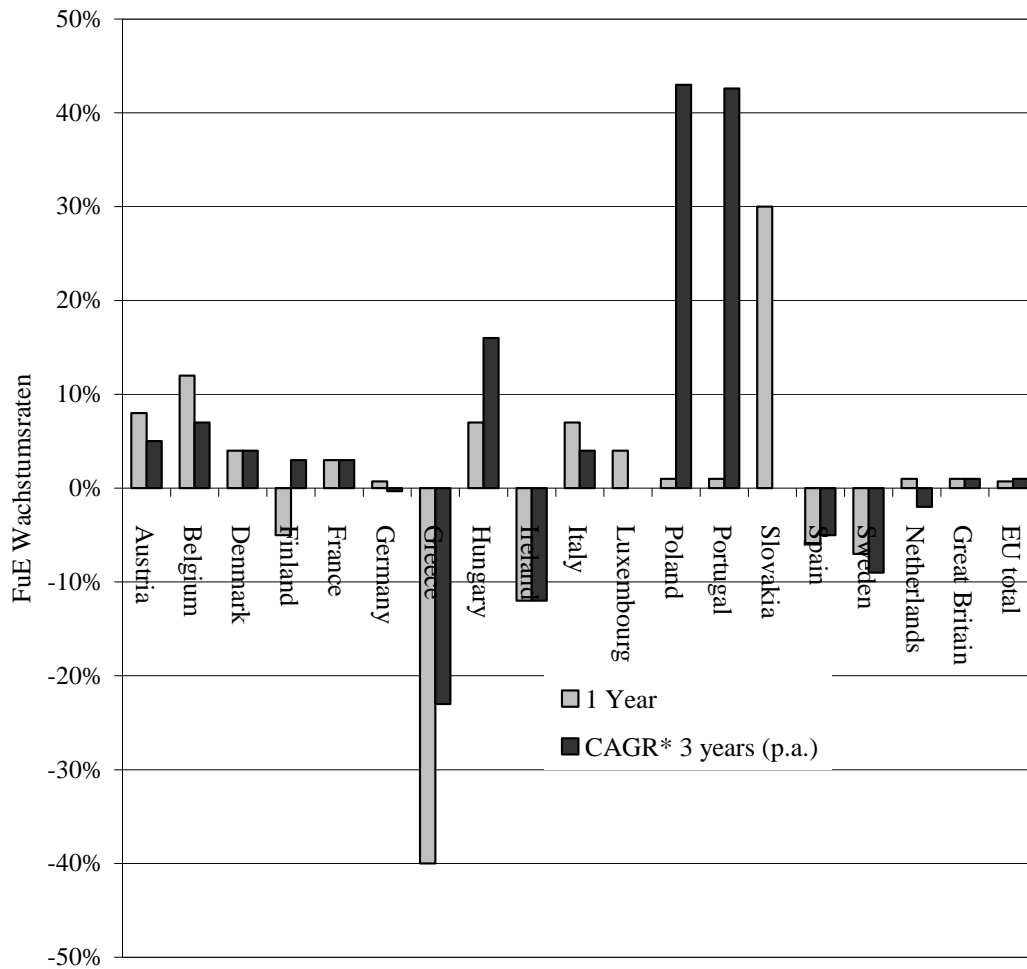


Source: Compiled from EU Scoreboard 2005.

As the bigger economies generally have a large number of enterprises in the Scoreboard, the sectoral distribution in those countries does indeed represent genuine specialisation, while in the smaller economies it is mostly due to the presence of a few large firms in a sector (examples of this are Finland and Sweden). One fact that stands out for the UK enterprises is that the biggest share of R&D investments in the Scoreboard is in the pharmaceuticals and biotechnology sectors. Besides a few large companies, there are especially many medium-sized or even small enterprises (biotechnology start-ups) in this sector in the UK in the Scoreboard.

Analysis for the last four years shows, however, that altogether, the R&D share of German enterprises in the Scoreboard has been stagnant, whereas that of enterprises from other countries has either risen (e.g. France or Italy) or fallen (e.g. the Netherlands or Sweden). As Fig. 4 indicates, the fluctuations in the R&D investments of the Scoreboard enterprises in other countries were in some cases very great.

Figure 4: R&D growth rate in different countries



* annual average rate of change
 Source: compiled from EU Scoreboard 2005.

It should be remembered that in the case of some smaller economies, the number of enterprises in the Scoreboard is very small and the fluctuations therefore relate to a relatively small total R&D investment volume.

Tab. 7 shows the growth rates of the German enterprises in the Scoreboard for a number of individual sectors, which are regarded as most important. The table shows, that for this branches the three-years-average growth rate of the enterprises with headquarters in Germany tends to be the growth rates of the EU-enterprises and those groups with its headquarters outside Europe. This can be observed even for “automobiles & part” and “chemicals”, two brunches where Germany has a seat in the first row. These data do not necessarily reflect the R&D located in Germany, because the Scoreboard reports about the global R&D activity of the enterprise-group, but is shows a certain hesitation of the enterprises to enlarge their global R&D engagement.

Table 7: R&D growth rate of German enterprises for selected industrial sectors

Industrial classification	R&D-investments of German enterprises ¹ (2004, in Mio €)	R&D-growth-rate ² per Sector			
		German enterprises		EU ³ enterprises	non-EU-enterprises
		1 Year	3Years	3 Years	3 Years
Motor vehicles, oth. transport. equipm.	17.169	3,8%	3,4%	3,8%	5,7%
Electronic & Electrical Equipment	5.153	-8,0%	-7,1%	-8,7%	6,5%
Chemicals	4.125	1,5%	-0,9%	-0,6%	1,3%
Machinery and equipment	1.650	-0,4%	0,8%	1,2%	1,6%
Pharmaceuticals & Biotechnology	1.268	-9,1%	4,3%	11,9%	12,7%
Software & Computer Services	1.170	0,8%	2,6%	4,0%	8,0%
Telecommunication services	900	0,0%	0,0%	1,7%	-8,2%
Health	540	5,2%	6,6%	5,8%	10,0%
Diversified industrials	414	7,7%	3,7%	0,4%	6,9%

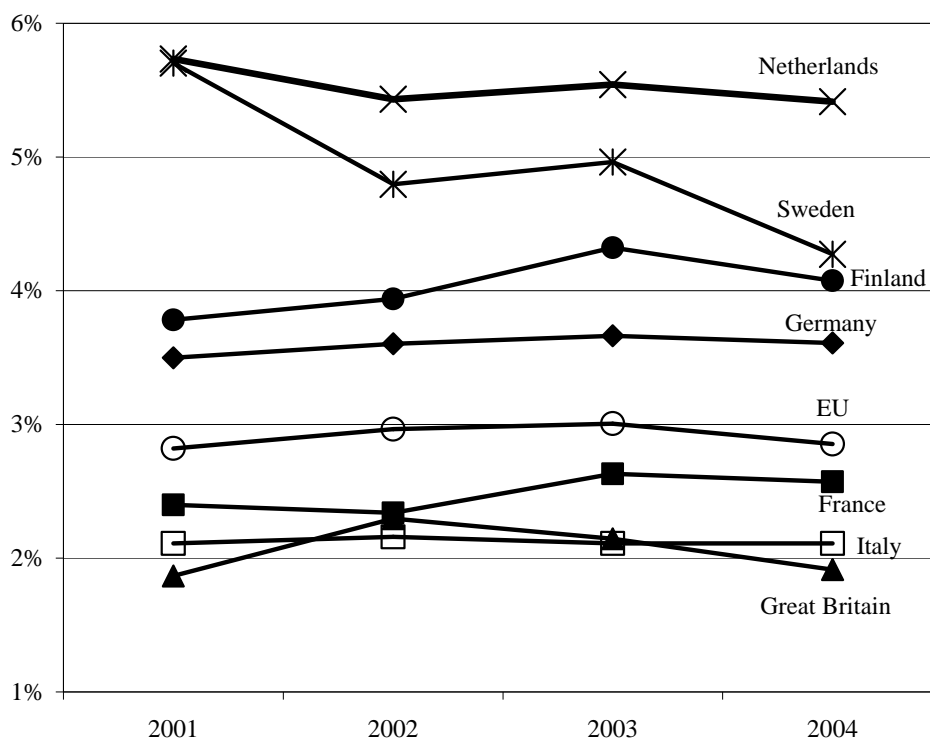
¹ those 92 enterprises (out of 135) for which a time series existed. Enterprises not taken into consideration are relatively small and sum up to less than 2% of the total R&D-expenditure; they are irrelevant for the rate of increase or R&D-expenditure; ² rate of increase for R&D as a 3-years CAGR (Compound Annual Growth Rate) ³ EU-Enterprises including German enterprises
Source: compiled from EU Scoreboard 2005.

The growth in total R&D investment of German enterprises can be explained by the following factors:

- Relatively weak growth in the most important sectors for R&D, in which German enterprises are traditionally strong (e.g. automobile and parts industry or chemicals).
- In comparison to other countries, sectors which are characterised by strong R&D growth are relatively small in Germany. Moreover, the R&D growth rates in these sectors are either significantly lower (e.g. pharmaceuticals and biotechnology or software and computer services) or, because of the small size of the sector, not sufficient to noticeably raise the overall level of R&D growth (e.g. business services or IT hardware).

The R&D intensity of the German firms in the Scoreboard in *Fig. 5* can therefore be explained by the relative strength in established sectors with medium R&D intensity. The R&D investment in these sectors is, however, only growing at a below-average rate.

Figure 5: Trends in R&D/sales ratio for EU Scoreboard companies over the period 2001 – 2004, by Member States



Source: compiled from EU Scoreboard 2005.

Résumé

Both approaches, the R&D statistics and the EU-scoreboard, give a contribution to mirror the globalisation of industrial Research and Development. From the German perspective industrial Research and Development is not a one-way-road, but a bipolar process, which is in line with the international division of Research and Development.

The R&D statistics show that roughly one quarter of the R&D expenditure is performed in foreign-controlled enterprises, counting for about € 12 thousand m. On the other hand perform multinationals with headquarters in Germany approximately € 11 thousand m abroad. Inward and outward R&D are in a long term consideration nearly in balance.

Especially the chemical industry and automotive industry is very international oriented.

The EU-scoreboard provides R&D data on the individual groups of enterprises, as published in the business reports of the companies. Therefore the data do not result from a statistical survey, but from public available information. The Scoreboard shows that more than 1/3 of the R&D performed in groups with headquarters in the EU goes to multinationals with

headquarters in Germany. In so far a high proportion of industrial R&D world- and Euro wide is controlled from Germany. The Scoreboard can not provide information whether R&D is performed in a domestic region or abroad. The scoreboard identifies the automotive branch as the one with dominant R&D activities of German multinational worldwide.

Hence one can state that both approaches lead to compatible results just observing the one object “industrial Research and Development” from different positions. Either ways provide a necessary contribution to understanding to globalisation of R&D.

References

- Belitz, Edler, Grenzmann, 2006 Internationalisation of Industrial R&D in Schmoch, Rammer, Legler (eds.): National System of Innovation in Comparison, Dordrecht NL 2006
- Belitz, 2006 Forschung und Entwicklung in multinationalen Unternehmen aus deutscher Sicht, in Materialien zur Wissenschaftsstatistik, Heft 15 Essen 2006
- European Commission, 2005 European Commission Monitoring Industrial Research: The 2005 EU Industrial R&D investment scoreboard, Brussels 2005
- Grenzmann, Jakob, Tübke, 2006 Globale FuE-Aktivitäten deutscher Unternehmen, in Materialien zur Wissenschaftsstatistik, Heft 15; Essen 2006
- OECD, 2004 Handbook on Economic Globalisation Indicators, Paris 2004
- OECD, 2002 The Measurement of Science and Technological Activities, Proposed Standard Practice for Surveys on Research and Development, Paris 2002
- OECD, 2005 Measuring Globalisation, OECD Economic Globalisation Indicators, Paris 2005
- Rose, 2006 Internationalisierung von FuE bei Klein- und Mittelunternehmen, in Materialien zur Wissenschaftsstatistik Heft 15, Essen 2006