

Research and Development in Multinational Companies from a German Perspective

Within the framework of its annual report to the Federal Ministry for Education, Science, Research and Technology (BMBF) on the technological performance of the Federal Republic of Germany, the DIW and the Centre for European Economic Research (ZEW), Mannheim have analysed the nature, extent and international distribution of the research and development (R&D) activities of multinational companies operating in Germany.¹ This analysis reveals, both for Germany and the other industrialised countries, a close correlation between foreign trade and the internationalisation of production and R&D. German companies² are increasingly producing and researching abroad in order to stabilise and improve their competitive position. This is also the leading motive for foreign companies undertaking operations in Germany, whose research and development activities there are, on average, just as intensive as those of comparable German concerns. The proportion of manufacturing turnover and employment in Germany accounted for by foreign companies has, however, remained stagnant for some years now. Indeed, in terms of the volume of foreign trade, it is actually lower than in other industrialised countries. Thus a substantial expansion of industrial R&D activities by foreign companies is only to be expected if it proves possible once again to attract more productive capital to Germany.

Output and R&D of German firms abroad

The internationalisation of R&D, not least in German-based multinational companies, to which increas-

¹ The full report is available in German: Marian Beise, Heike Belitz, Internationalisierung von Forschung und Entwicklung in multinationalen Unternehmen, in: *Materialien zur Berichterstattung zur technologischen Leistungsfähigkeit Deutschlands 1996*, Berlin, Mannheim, March 1997.

² In this report "German" ("foreign") companies are understood to mean multinational companies whose parent company is based in Germany (outside Germany). This distinction is based on the idea that multinational companies initially develop in their country of origin and that, even in the process of internationalisation, their activities are steered by company headquarters.

ing attention has been paid in recent years, is often seen in terms of a trend towards a relocation of R&D potential abroad. This "emigration" is perceived as a threat to the longer-term technological strength of the German economy, particularly when it affects new technologies, such as semi-conductor and biotechnology. It has been claimed that the increasing importance of research by German companies abroad is evidence of Germany's weaknesses as a location for R&D.

Direct investment and employment abroad

Since the start of the 1980s German manufacturing companies have created more jobs abroad than corresponding foreign companies in Germany (cf. figure 1).³ The most important target regions for direct investment by German manufacturing firms are the industrialised

³ The statistics of the German Bundesbank on capital relations between Germany and the rest of the world cover all companies in which more than 20% of equity capital or voting rights belong to German (or foreign) firms or individuals.

Figure 1
Employees of German Companies Abroad and of Foreign Companies in Germany in Manufacturing Industry,¹ 1976 to 1995



1) Until 1990 West Germany
Sources: German Bundesbank.

Table 1

Employees of German Companies Abroad as a Proportion of Employees in German Companies, 1980 and 1995

Branch	SYPRO ¹⁾	WZ 93 ²⁾	1980 ³⁾	1995
			%	
Manufacturing industry			17.1	25.1
of which:				
Non-R&D-intensive branches			9.6 ⁴⁾	15.4
R&D-intensive branches			24.1 ⁴⁾	32.8
of which:				
Chemical industry	40	24	42.1	48.8
Engineering	32	29	13.1	18.0
Office machinery/EDP	50	30	24.4	22.4
Automobiles	33	34	25.2	40.5
Electrical engineering	36		22.7	–
Electricity generation and distribution appliances		31	–	35.7
Radio, TV and communications technology		32	–	29.6
Precision mechanics, optics, chronometers	37		15.7	–
Medicinal, measuring, steering, regulatory technology, optics		33	–	23.8

1) SYPRO: a classification system of manufacturing branches. — 2) WZ 93: classification of branches, 1993 edition. — 3) West Germany. — 4) 1982.
Sources: Federal Statistical Office; German Bundesbank; DIW calculations.

countries of Europe and North America. More than 60% of the stock of direct investment is accounted for by the European Union and the USA. The stock of German direct investment in the Asian-Pacific countries (Asia and Oceania, Japan and China) is growing rapidly, but in 1995 still accounted for less than 7% of the overall stock of manufacturing direct investment abroad. The central and east European transition countries, too, despite their advantages in terms of labour costs, are still of relatively minor importance for the activities of German companies abroad.⁴ In the industrialised countries German-owned companies grow largely by virtue of the acquisition of equity stakes or of companies and divisions of companies. In many cases existing R&D divisions are also acquired in the process.

In 1995 1.87 million employees – and thus two-thirds of all employees of German companies abroad – worked in manufacturing industry. The proportion of the overall workforce of German companies working abroad rose from 17% in 1980 to 25% in 1995. The degree of internationalisation is particularly highly developed in the R&D-intensive branches. In the case of German-based companies in the chemical industry, half

of the overall work force is employed abroad; in the automobile industry the figure is around 40% in 1995; (cf. table 1).

R&D expenditure abroad

On the basis of figures provided by German parent companies, it was possible to estimate current R&D expenditure by their subsidiaries located abroad at around DM 8.8 billion (1995), of which around 95% is accounted for by manufacturing firms (cf. table 2).⁵ R&D expenditure by German companies abroad corresponds to around 15% of the total R&D expenditure realised within Germany.

The internationalisation of R&D has gone furthest in the chemical industry. With expenditure of around DM 4.5 billion in 1995, more than half of the R&D expenditure of all German-owned companies abroad is accounted for by this industry. The R&D expenditure of the subsidiaries abroad represented 50% of the R&D expenditure by the parent companies in Germany. Ger-

⁴ Cf. Siegfried Schultz, Direct foreign investment in the transition countries, in: *Economic Bulletin*, vol. 34, no. 4, April 1997.

⁵ The first comprehensive survey of R&D expenditure by majority-owned German companies abroad has been conducted for 1995 by SV-Wissenschaftsstatistik GmbH.

Table 2
R&D Expenditure by German Companies Abroad 1995

WZ 79 ¹⁾	Branch	Subsidiaries abroad	Ratio of subsidiaries abroad to	
			Parent companies in Germany	Companies in Germany
		in DM millions	in %	
1	Energy, water, mining	7	2	1
2	Manufacturing industry	8 400	22	15
	of which:			
20	Chemicals	4 500	50	43
24	Steel construction, engineering, automobiles	2 200	12	8
242	Engineering	260	11	5
25	Electrical engineering, precision mechanics, sheet metal goods	1 400	15	10
250	Electrical engineering	1 300	15	10
0, 3 to 8	Remaining branches	350	35	15
	Total	8 800	22	15

1) WZ 79: classification of economic branches, 1979 edition.
Sources: SV-Wissenschaftsstatistik; DIW/ZEW estimations.

man electrical engineering companies spent around DM 1.3 billion abroad on R&D in 1995, representing 15% of their domestic R&D expenditure.

The R&D activities of German companies abroad are concentrated on Europe and the USA (cf. figure 2). In recent years, however, electrical engineering companies, in particular, have increasingly been performing R&D in the expanding south-east Asian countries. There are two decisive reasons for this: firstly, they produce goods there; secondly, the context for R&D activities in the region has improved markedly in recent years. Newly industrialising countries such as South Korea, Taiwan and Singapore already have a relatively high R&D intensity (R&D expenditure as a proportion of turnover) and now have a good human capital endowment.

Besides pharmaceutical and chemical products, R&D activities by German firms abroad are also conducted primarily for automobiles and auto components (cf. figure 3). These are products in which Germany's foreign trade is also specialised and are produced in those branches accounting for the largest proportion of employment by German subsidiaries abroad. This serves to confirm the close relationship between conducting R&D and producing goods abroad.

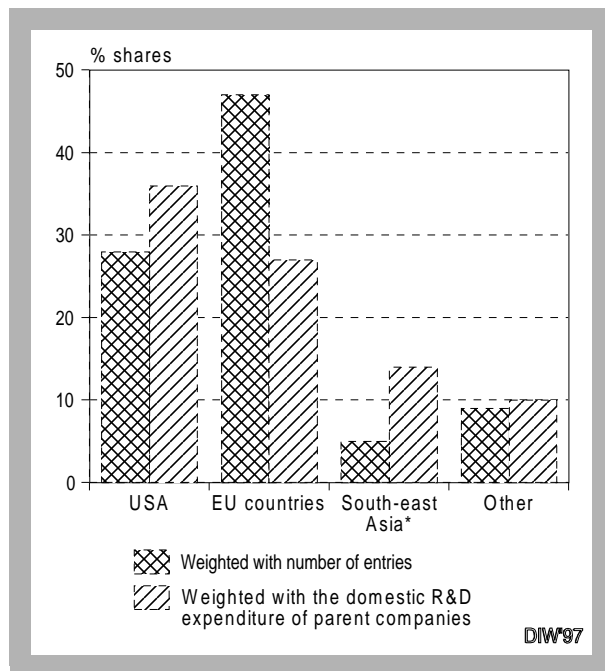
USA the most important location for German R&D abroad

In 1994 German companies invested US-\$ 2.45 billion in R&D activities in the USA. Measured in terms of

purchasing power parities, this represented more than half of total R&D expenditure abroad by German firms and one-tenth of total R&D expenditure in the domestic German economy. Since the end of the 1960s German firms have steadily expanded their R&D potential in the USA. Between 1980 and 1994 their R&D expenditure there grew at a real annual rate of just under 10%, slightly less than that by all foreign companies in the USA (cf. table 3). Alongside Switzerland and Great Britain, Germany has the largest R&D potential in the USA of all the foreign companies. With respect to R&D expenditure in the economy of the country of origin, however, R&D spending by Swiss and British firms in the USA is substantially greater than that of German companies (cf. table 3). Thus in these terms majority-owned German companies are in no way particularly active in expanding R&D abroad.

More than half of R&D expenditure by German firms in the USA is accounted for by the chemical industry (including pharmaceuticals) and around a quarter by electrical engineering. Representing less than 3% of R&D expenditure in the USA, automobile construction plays only a subordinate role in the R&D activities of German companies there. Computer technology and office machinery (less than 1%) and electronic components (1.5%) account for a very low proportion of R&D expenditure by German firms in the USA. Despite the favourable context for R&D activities in the USA, only individual German firms from these branches have managed to gain a foothold there (and indeed internationally).

Figure 2
Regional Structure of R&D Expenditure
by German Companies Abroad, 1995



*) Taiwan, Hong Kong, South Korea, Singapore, Malaysia, Indonesia, Philippines.
Sources: SV-Wissenschaftsstatistik.

In leading new technological fields multinational companies conduct R&D in their own research centres, often situated in high-tech regions located near renowned universities. The aim of these centres is to follow technological developments in the USA, to acquire technology and to open up markets. Many German pharmaceutical companies, for instance, maintain biotechnology laboratories in the USA. Of a total of 95 research centres run by German companies identified in the USA in a 1994 study, 28 were in the fields of chemicals and new materials, 18 in the area of pharmaceuticals and biotechnology, 15 in electronics (semi-conductors, optical electronics and high-definition television), 11 in the automobile sector and 8 in the fields of computer hardware and software. The German parent companies with the greatest number of research centres in the USA are Siemens (24), and the three large German chemical concerns Bayer (13), BASF (12) and Hoechst (10).⁶

European countries – Great Britain and France, in some cases also Austria – represent additional important locations for R&D by German companies abroad. In

⁶ Donald H. Dalton, Manuel G. Serapio, Globalising Industrial Research and Development, U.S. Department of Commerce, Office of Technology Policy, Washington 1995.

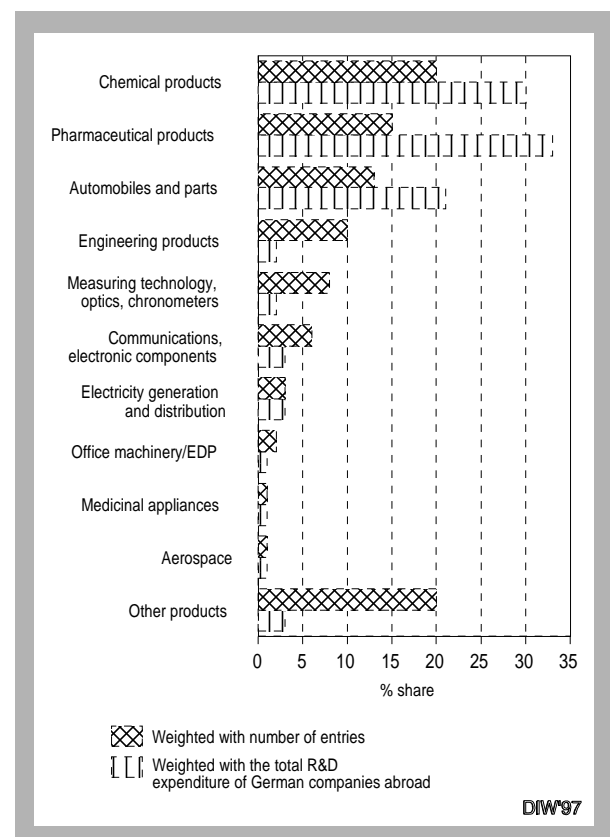
Japan – as is evident from direct investment – German companies are only just beginning, in relatively small number, and largely concentrated in the chemical industry, to start up production and R&D activities. So far, countries offering lower labour costs for development activities, such as India and a number of central and east European countries, have played only a subordinate role in the internationalisation of corporate R&D activities.

Production and research by foreign companies in Germany

Activities of foreign firms in manufacturing industry stagnant

In 1995 the more than 3 000 industrial companies in Germany with a substantial foreign capital stake employed around one million workers. The parent com-

Figure 3
Distribution of R&D Expenditure by
German Companies Abroad by Branch, 1995



Sources: SV-Wissenschaftsstatistik.

Table 3
R&D Expenditure by Majority-owned Foreign Companies in the USA

Majority ownership	Country-structure of R&D expenditure		Average annual real growth of R&D expenditure	R&D expenditure in the USA as a proportion of that at home (BERD) ¹⁾
	1980	1994	1980-1994	1994
	in %			
All countries	100.0	100.0	11.4	–
of which:				
Canada	6.9	15.1	17.8	41.7
France	7.5	8.9	12.8	8.5
Germany	19.5	15.7	9.7	9.9
Netherlands	15.4	4.6	2.3	24.0
Sweden	1.8	1.7	11.0	8.0
Switzerland	17.4	15.4	10.5	80.0
Great Britain	16.0	15.9	11.4	17.5
Japan	4.5	12.9	20.1	4.0
Other countries	10.9	9.7	10.5	–

1) Measured at purchasing power parities. BERD: business enterprise expenditure on R&D.
Sources: US Department of Commerce, OECD; ZEW/DIW calculations.

panies of these firms are largely based in the European countries and the USA. 51% of the stock of direct investment in manufacturing industry was due to companies from the European Union, 32% from the USA and just 2% from firms based in Japan.

Just under two-thirds of the employees in the foreign-owned industrial firms in Germany were employed in R&D-intensive branches in 1995, including around 15% each in the chemical industry, electrical engineering and precision mechanics, engineering and automobiles.

The quantitative importance of foreign-owned companies in manufacturing industry in Germany has remained constant on average over a long period. Overall, since the start of the 1980's firms in which foreign companies and individuals hold a substantial capital stake have accounted for around one-quarter of turnover and about 16% of employment (cf. table 4).

R&D expenditure by foreign companies in Germany

Total R&D expenditure by all majority-owned foreign companies in Germany can be estimated at DM 9.6 billion and R&D employment by such firms at 42 500.⁷

Thus in 1995 just under 17% of total R&D expenditure and rather more than 15% of the R&D staff in the German economy were accounted for by foreign firms. There has been no change in the relative importance of foreign firms for the R&D potential of Germany in 1993. Around half each of the R&D personell of foreign companies work for European and for American firms. Japanese companies, which represent a very small proportion of the stock of direct investment, conduct only a very limited number of R&D activities in Germany.

In the automobile industry around one-fifth of the R&D potential in Germany is accounted for by majority-owned US firms. In electrical engineering foreign-owned companies represented just under one-quarter of R&D potential. Thus in these branches, in particular, foreign-owned firms have made a very significant contribution to the technological potential of the Federal Republic.

⁷ The estimation is based on a special evaluation for 1995 conducted by the SV-Wissenschaftsstatistik of its regular surveys of R&D expenditure by the 500 most R&D-intensive companies, disaggregated for German/foreign majority ownership. This covers around 83% of the total R&D expenditure conducted in Germany. The foreign companies included in the special evaluation spent at least DM 8 billion on R&D in 1995, employing more than 32 000 people in R&D activities (cf. table 5).

Table 4

Employees in Foreign Companies as a Proportion of Manufacturing Employment in Germany, 1980 and 1995

Branch	SYPRO	WZ 93	1980 ¹⁾	1995
			in %	
Manufacturing industry			16.4	16.0
of which:				
Non-R&D-intensive branches			14.2	12.3
R&D-intensive branches			18.5	19.3
of which:				
Chemical industry	40	24	23.7	29.2
Engineering	32	29	14.2	16.0
Office machinery/EDP	50	30	49.2	27.4
Automobiles	33	34	19.0	21.3
Electrical engineering	36		18.3	
Electricity generation and distribution appliances		31	–	10.3
Radio, TV and communications technology		32	–	37.1
Precision mechanics, optics, chronometers	37		15.7	–
Medicinal, measuring, steering, regulatory technology, optics		33	–	21.0

1) West Germany.

Sources: Federal Statistical Office; German Bundesbank; DIW calculations.

In the electrical engineering, and automobile industries there is no significant difference between the average R&D intensity of majority-owned German and foreign companies. In other industrialised countries, too, foreign companies adjust to the average R&D intensity of the host country. They are therefore adapting their R&D behaviour to the respective national context. In countries in which domestic companies perform little R&D, there is scarcely any incentive for foreign firms to conduct intensive R&D activities.

Germany: the leading R&D location for US firms abroad

Since the start of the 1980s around one-quarter of all R&D expenditure by US firms abroad has been realised in Germany. From the US perspective this means that Germany has, for many years now, been the most important R&D location abroad, followed by Great Britain. In terms of expenditure Germany is the most important location for transportation equipment and machinery R&D for US firms abroad. More than two-thirds of

US R&D expenditure abroad are dedicated to these two sectors, transportation equipment and machinery (including office machinery). Alongside Japan and the Netherlands, Germany is also among the most important research locations for US firms abroad in the field of electric and electronic equipment. The R&D intensity of US firms is higher in Germany than in any other country. The R&D intensity of US firms in Japan has increased rapidly in recent years, where research activities in the chemical industry, in particular, have been expanded (cf. figure 4).

Conclusion

R&D follows production

Foreign trade and direct investment are more complementary than substitutive, especially in R&D-intensive branches. In both the industrialised and, increasingly, the newly industrialising countries the R&D activities of multinational corporations follow on production abroad. In the host countries there is a close cor-

Table 5

**Total R&D Expenditure of 500 Selected Large Companies
in Germany, by Majority Ownership (1995)**

Branch	500 companies					memo item: all companies in Germany conducted research
	Domestic companies	of which:				
		German- owned	Foreign- owned	of which from:		
				USA	Europe	
in DM millions						
Manufacturing industry	46 568	38 583	7 986	4 332	3 542	54 900
Chemical industry	9 613	9 021	592	240	–	10 520
Engineering	2 869	2 351	518	–	443	5 490
Automobiles	12 745	9 990	2 754	2 607	–	13 100
Electrical engineering	11 470	8 739	2 731	465	2 118	13 180
All branches	47 999	39 981	8 018	4 332	3 575	57 790
% shares						
Manufacturing industry	100.0	82.9	17.1	9.3	7.6	84.8
Chemical industry	100.0	93.8	6.2	2.5	–	91.4
Engineering	100.0	81.9	18.1	–	15.5	52.3
Automobiles	100.0	78.4	21.6	20.5	–	97.3
Electrical engineering	100.0	76.2	23.8	4.1	18.5	87.0
All branches	100.0	83.3	16.7	9.0	7.4	83.1

Sources: SV-Wissenschaftsstatistik; DIW calculations.

relation between the proportion of the workforce employed in foreign-owned firms and their share of R&D expenditure in manufacturing industry.

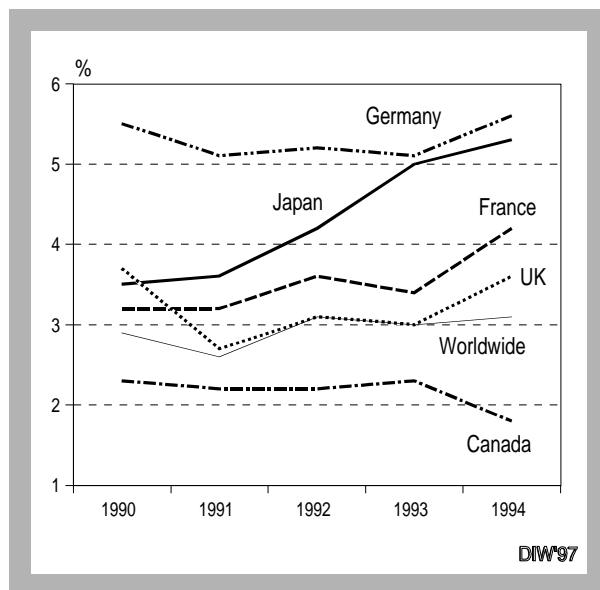
Although German firms have "caught up" in terms of establishing an overseas presence in recent years, German direct investment remains modest in terms of the volume of foreign trade compared with such countries as the USA, Great Britain and France. Multinational corporations are expanding their sales and production activities in all regions of the "triad" (North America, Europe, South-east Asia). Given their need to "catch up" and the dynamic growth of foreign markets, an increase in activities by German firms abroad is to be expected.

Although sometimes R&D divisions are relocated abroad in the course of rationalisation and reconcentration processes within the international R&D networks of multinational corporations, there are no grounds, from a German perspective, for diagnosing a general trend towards an "emigration" of R&D potential abroad. As German firms expand abroad, their research potential grows to match their increased production potential, primarily as a result of acquisitions.

From the perspective of multinational corporations, Germany occupies an important and, overall, stable position as a location for R&D. On average the R&D intensity of foreign-owned manufacturing firms in Germany is approximately equal to that of German concerns. Nor does their behaviour in terms of innovation differ significantly from firms in majority German ownership. Their cooperation links with universities and institutes abroad are stronger, however.

In the mid-1990s the expenditure by German firms abroad was approximately equal to that by foreign companies in Germany. Given that the development of the R&D potential of German firms abroad follows that of their productive capacity, R&D expenditure by German firms abroad is expected in future to grow more rapidly than that by foreign firms in Germany. Yet the acquisition and expansion of research divisions by German firms abroad in the course of a trend to increased internationalisation of capital interrelationships does not, of itself, constitute evidence of a deterioration in the conditions for R&D by multinational corporations in Germany.

Figure 4
**R&D Intensity of the US Subsidiaries
 Abroad by Host Country, 1990 to 1994**



Source: US Department of Commerce.

the health service, technical standards and conditions of market entry for products, etc.). In many cases it is not so much costs or technological potential, but rather the regulatory conditions that determine the choices made by multinational corporations regarding locations for production and research. By strengthening its lead-market functions within Europe, Germany is in a position to raise its attractiveness as a location for global centres of competence.

Heike Belitz

Expanding lead-market functions

Multinational corporations concentrate their production and research in markets they consider important for the future. In the course of the reorganisation and rationalisation of global research networks, some concerns are seeking to reconcentrate research both at home and abroad. This leads to the creation of so-called "centres of competence" in which global responsibility for marketing, logistics, production and research is concentrated for specific spheres of operation. As locations for the development of such centres of competence firms select sites in which over the medium to longer term a dynamic demand for new products and services (lead market) meets favourable conditions for research and production.

As a rule it is the domestic market that serves as a point of market entry for new products. In the wake of the process of internationalisation there is increasing scope for converting the results of research into actual production on a foreign market first, if demand conditions there are more favourable. This process has been observed in a number of cases. Firms failing to exploit a demand potential do not make full use of their growth potential at the location in question. In many cases government plays a role here that should not be underestimated: by setting the framework of conditions, and as an investor, it exerts influence on the market for high-tech products (environmental protection, infrastructure,