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Article

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DIW Economic Bulletin

Provided in Cooperation with:

German Institute for Economic Research (DIW Berlin)

Suggested Citation: Belitz, Heike; Eickelpasch, Alexander (2016) : Medium-sized foreign-owned German enterprises heavily involved in R&D, DIW Economic Bulletin, ISSN 2192-7219, Deutsches Institut für Wirtschaftsforschung (DIW), Berlin, Vol. 6, Iss. 22/23, pp. 263-273

This Version is available at:

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Medium-sized foreign-owned German enterprises heavily involved in R&D

By Heike Belitz and Alexander Eickelpasch

In Germany, the share of private investment in research and development (R&D) by foreign-owned companies from the beginning of the millennium to 2011 remained virtually unchanged at around one-quarter. From 2011 to 2013, this share fell slightly, and for the first time since the mid-1990s also the absolute amount decreased. Growth in domestic firms, however, was so high that there was an increase in the overall R&D of firms in Germany. The decline in investment by foreign companies is likely to reflect strategic decisions in some major enterprises; medium-sized foreign companies have in fact expanded their R&D activities. In the present study, no evidence was found that Germany has become less attractive as a location for research.

Research locations can benefit from the globalization of R&D and associated transnational knowledge transfer between the globally distributed research units of multinational companies. The scope and development of R&D activities by foreign companies are frequently seen as a sign of the attractiveness of a country's research conditions. First, foreign companies investing in R&D creates attractive employment opportunities for R&D employees. Second, the research units of foreign companies also benefit from the inflow of knowledge from associated companies abroad. Empirical studies on developed countries show that R&D in foreign subsidiaries also benefits local businesses through knowledge spillovers.¹

Consequently, attracting foreign R&D investment is a priority for economic and technology policy in many OECD countries.² In Germany, too, the Expert Commission on Research and Innovation (EFI) has called for initiatives to create incentives for internationally operating companies to become involved in cutting-edge technology.³

However, the data basis for measuring the effect of globalization of R&D in firms on research locations is poorly developed in most countries.⁴ In Germany, the Wissenschaftsstatistik of the *Stifterverband*⁵ has provided special evaluations of R&D data in companies biennially since the mid-1990s. These are recorded according to the owner principle. In addition, microdata from the cost structure survey from 2009 are used in the manufacturing sector (see box).

¹ See also H. Belitz and F. Mölders, "International Knowledge Spillovers Through High-Tech Imports and R&D of Foreign-Owned Firms," *The Journal of International Trade & Economic Development*, vol. 25 (4) (2016): 590-613.

² See also OECD, *Science, Technology and Industry Outlook*, (Paris: 2014), 126 ff.

³ See Expert Commission on Research and Innovation, *Jahresgutachten zu Forschung, Innovation und technologischer Leistungsfähigkeit Deutschlands 2014* (Berlin: 2014), 43

⁴ OECD, *Science, Technology and Industry Scoreboard*, (Paris: 2015), 135.

⁵ The Wissenschaftsstatistik of the Stifterverband annually collects data on research and experimental development (R&D) of the German Business enterprise sector. The survey is part of the official EU Community statistics and enters into national and international reporting systems.

box

Sources of owner-related R&D data

The Wissenschaftsstatistik of the *Stifterverband (SV)* has provided German researchers with data on the R&D activities of companies under German and foreign ownership biennially since the mid-1990s. For the period from 2008, R&D data on foreign-controlled and domestic enterprises in the manufacturing sector can be determined from the annual cost structure survey conducted by the Federal Statistical Office.

Since 1993, the *Stifterverband* has recorded figures on R&D involvement by foreign enterprises in special evaluations for the "National report on Germany's technological performance." The findings have been published in the *Stifterverband's* own publications since 2003,¹ and have also been made available to international organizations such as the OECD, the research community, and policy-makers.² Data on the R&D of foreign companies are based on the responses of research-based enterprises to the national R&D survey. Information from an external database on the "ultimate owner" is attributed. This allows the R&D data (R&D spending, R&D personnel) and company data (employees,

turnover) to be analyzed by sector and size in relation to the individual countries or regions of origin. This is only possible using a full survey of research-based enterprises in the odd years.

The second data basis is the German Federal Statistical Office's cost structure survey of the manufacturing industry.³ The statistics captured annually since 1999 from enterprises in the manufacturing sector include the number of R&D employees and in-house R&D spending (personnel, material costs, and investments). The survey design, like the *Stifterverband* itself, follows internationally binding definitions and boundaries documented in the OECD's Frascati Manual. It also records information, among other things, about production and turnover, costs and cost types, and number of employees. Information in the cost structure survey is extrapolated from a representative sample survey. The total sample in the cost structure survey for 2015 included almost 18,000 companies or 45 percent of the population. A sample is taken from the group of companies with up to 499 employees; data from companies with 500 or more employees are recorded in full. Participation in the cost structure survey is mandatory for the companies contacted. The disadvantage of the cost structure survey is that very small industrial enterprises with fewer than 20 employees and conducting contract research are not recorded. Another

¹ Most recently in a:ran'di, *Zahlenwerk 2015 – Forschung und Entwicklung in der Wirtschaft 2013*, published by the *Stifterverband Gesellschaft für Wissenschaftsstatistik mbH* and earlier publications.

² They are also prepared for studies on the German innovation system for the Federal Government's independent Commission of Experts for Research and Innovation, most recently in U. Schasse, H. Belitz, A. Kladroba, G. Stenke, and M. Leidmann, "Forschung und Entwicklung in Staat und Wirtschaft," *Studien zum deutschen Innovationssystem 2–2016* (Berlin: 2016).

³ Federal Statistical Office, ed., *Qualitätsbericht. Kostenstruktur-erhebung im Verarbeitenden Gewerbe sowie des Bergbaus und der Gewinnung von Steinen und Erden* (Wiesbaden: 2015).

R&D investment by foreign companies overall ...

According to data from the *Stifterverband*, in 2013, foreign subsidiaries in Germany spent a total of 11.9 billion euros internally on R&D (2011: 13.2 billion euros). Thus, for the first time since records began in the mid-1990s, the R&D activities of foreign companies have not only declined proportionally but also in absolute terms. Measured in full-time equivalents, in foreign companies 80,800 persons were employed in R&D in 2013 compared to 90,900 in 2011. The share on total personnel decreased to almost 23 percent in 2013. According to data from the German Federal Statistical Office's cost structure survey (KSE), the share in the manufacturing industry fell from almost 23 percent in 2011 to 19 percent in 2013 (see Table 1).

Here, medium-sized foreign companies account for a significantly higher share of internal R&D spending. This reaches around 40 percent in companies with 250 to 1,999 employees. In contrast, among small firms with fewer than 50 employees and major companies with more than 10,000 employees, foreign research companies have a lower than average share (see Figure 1).

The extent of the decline in R&D personnel among foreign subsidiaries from 2011 to 2013 was 10,100 individuals and therefore fewer than the growth in German companies at 12,800 individuals—consequently R&D employment rose overall. The changes are concentrated in major enterprises (see Figure 2). It was mainly foreign companies in the information and communications, aerospace, and automotive engineering

shortcoming is that only the number of R&D employees is captured and not the number of hours worked.

The data presented here for the manufacturing sector are based on special analyses of the cost structure survey microdata provided by the Research Data Centre of the Statistical Offices of the federal and state governments. Since 2008, information about foreign-owned companies in the official statistics has been included in the microdata.⁴ Foreign-owned companies are therefore domestic companies that are more than 50-percent owned by a foreign company. The data basis and method for determining the ownership of domestic enterprises were changed in 2012. Survey-related changes in the population of foreign-owned companies may occur as a result of this.⁵

The cost structure survey data are not fully comparable with those of the *Stifterverband*, partly because of the different definitions used by the reporting units and the different survey methods.⁶

⁴ The legal basis for these statistics is European Regulation no. 716/2007.

⁵ M. Nahm and R. Söllner, "Die wirtschaftliche Bedeutung auslandskontrollierter Unternehmen in Deutschland 2012," *Wirtschaft und Statistik* (December 2014): 754-763.

⁶ Haug, H. and C. Revermann, "Statistik für Forschung und experimentelle Entwicklung im Vergleich" *Wirtschaft und Statistik*, (December 2003): 1130-1136.

sectors that were affected by this decrease in personnel. These are not only particularly R&D intensive; research here is also conducted predominantly by multinational companies.

The countries of origin of foreign companies with R&D in Germany have remained largely constant in recent years (see Figure 3). At 50 percent, European companies account for the largest share of all internal R&D spending in Germany by foreign subsidiaries. The main countries of origin are Germany's immediate neighbors, the Netherlands, Switzerland, and France, with a total share of almost one-third. The share of US companies is around 37 percent and, for Japanese companies, the corresponding figure is five percent. The decline in internal R&D spending between 2011 and 2013 was almost entirely attributable to European companies.

Table 1

Foreign companies' share of R&D in Germany 1995-2013

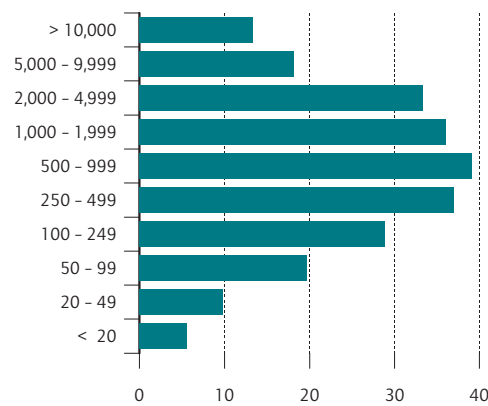
	1995	2001	2007	2009	2011	2013
Source: SV-Wissenschaftsstatistik						
Industry total						
R&D personnel	15.7	24.2	25.5	25.8	25.7	22.8
Internal R&D investment	16.1	24.8	26.3	27.3	26.1	22.6
Manufacturing industry						
R&D personnel	15.9	25.2	27.2	26.8	26.5	23.8
Internal R&D investment	16.4	25.6	27.4	27.6	26.4	23.1
Source: Cost Structure Survey						
Manufacturing industry						
R&D personnel	-	-	-	23.3	22.9	19.1
Internal R&D investment	-	-	-	19.9	20.1	15.7

Source: SV-Wissenschaftsstatistik, Cost Structure Survey.- Calculations by DIW Berlin.

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Figure 1

Share of foreign companies in R&D personnel by company size 2013



Source: SV-Wissenschaftsstatistik, calculations by DIW Berlin.

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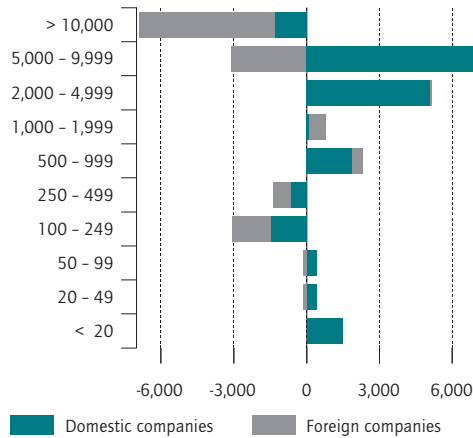
The highest proportion of foreign R&D are to be found in medium-sized companies.

In terms of R&D personnel intensity, the R&D behavior of foreign and domestic companies is virtually unchanged (see Figure 4). The differences between the sectors are greater than the differences between German and foreign companies in the same sector.

The share of spending on research contracts by other companies and research institutes is only slightly high-

Figure 2

Change of R&D personnel in foreign and domestic companies by company size 2011–2013
In full-time equivalents



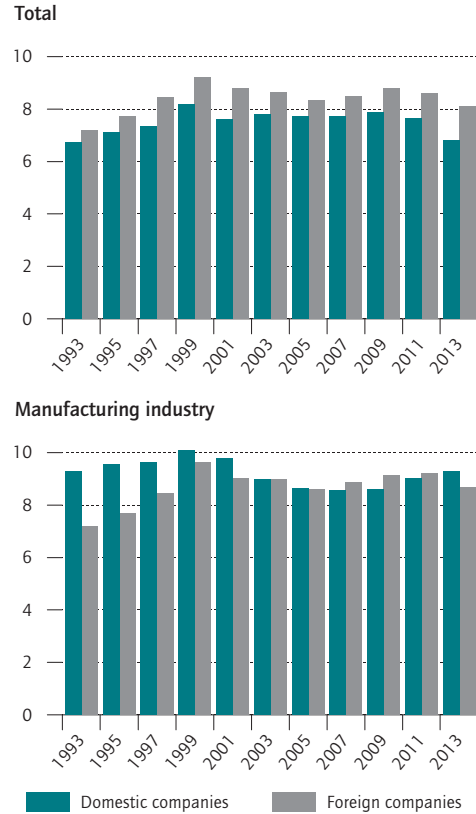
Source: SV-Wissenschaftsstatistik, calculations by DIW Berlin.

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The decrease and growth of R&D personnel took place primarily in large companies.

Figure 4

R&D intensity of foreign and domestic companies in Germany 1993–2013
In percent



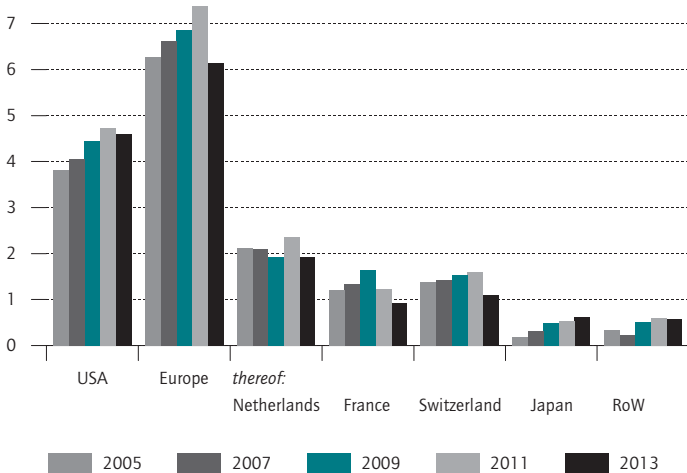
Source: SV-Wissenschaftsstatistik, calculations by DIW Berlin.

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The R&D behavior of foreign and domestic companies is quite similar.

Figure 3

R&D expenditure of foreign companies in Germany 2005–2013
In billion euros



Source: SV-Wissenschaftsstatistik, calculations by DIW Berlin.

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European companies account for a half of the R&D expenditure of foreign-controlled companies.

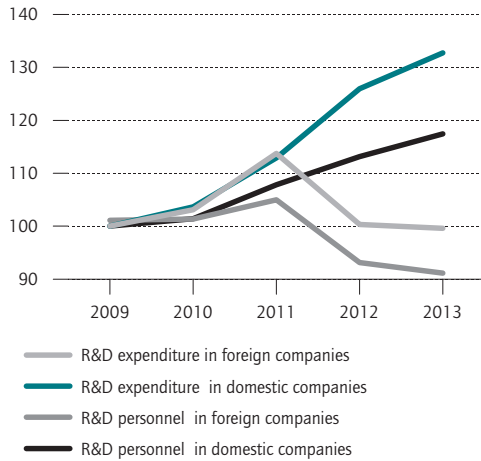
er among German companies than it is among foreign companies on average. In the sector “other transport equipment” and the service sectors, however, foreign companies spend more externally on R&D than domestic ones (see Table 2).

In Germany, the majority of private R&D activities take place in the manufacturing sector: in 2013, internal R&D spending was 88 percent among private foreign companies and the corresponding figure for German companies was 86 percent. Here, domestic and foreign companies focused on R&D intensive industries which account for over three-quarters of R&D spending in each case. However, at 37 percent, foreign companies invest a considerably higher share of their R&D spending on cutting-edge technology sectors such as the pharmaceu-

Figure 5

R&D expenditure and R&D personnel in manufacturing industry

Index 2009 = 100



Source: Research Data Centres of the Federal Statistical Office and the statistical offices of the Länder, calculations by DIW Berlin.

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Domestic companies' R&D activities reached their peak in 2013.

tical industry and the manufacture of aircraft and spacecraft—German companies are only investing 21 percent in these sectors, however (see Table 3).⁶

... and in manufacturing

In addition to data from the *Stifterverband*,⁷ the Federal Statistical Office's cost structure survey also provides an in-depth insight into the R&D activities of foreign-owned industrial enterprises. However, the cost structure survey data only allow analyses for the period between 2009 and 2013. According to this data, spending on research by foreign-owned industrial enterprises from 2009 to 2011 increased by 14 percent but, by 2013, had declined to the level it had reached in 2009.⁸The trend among domestic enterprises was much more pos-

⁶ R&D intensive industries include cutting-edge technology sectors with R&D spending in relation to sales of over nine percent and advanced technology sectors with three to nine percent R&D in relation to sales,

⁷ See *an'di: Zahlenwerk 2015 – Forschung und Entwicklung in der Wirtschaft 2013*, published by the *Stifterverband Gesellschaft für Wirtschaftsstatistik mbH* and earlier publications.

⁸ In the 2012 reporting year, the German Federal Statistical Office changed the procedure for determining owner status of an enterprise. As a result, time comparisons are not necessarily possible. See M. Nahm and R. Söllner, "Die wirtschaftliche Bedeutung auslandskontrollierter Unternehmen in Deutschland 2012," *Wirtschaft und Statistik* (December 2014): 754-763.

Table 2

Share of extramural R&D expenditure in foreign and domestic companies 2013

In percent

		Domestic companies	Foreign companies
C	Manufacturing industry	24.0	19.3
10-12	Food, beverages, and tobacco	8.2	7.3
13-15	Textiles, apparel, and leather	8.7	4.7
20	Chemical industry	15.5	8.3
21	Pharmaceutical industry	36.3	26.2
22	Rubber and plastic products	3.7	5.2
24	Basic metal industries	12.2	8.8
25	Fabricated metal products	9.0	11.9
26	Computers, electronics, optics	9.2	10.4
27	Electrical equipment	11.1	7.4
28	Mechanical engineering	7.9	11.7
29	Motor vehicles	34.2	20.5
30	Other transport equipment	17.6	34.1
J 58-63	Information und communication	8.3	16.3
M 69-75	Professional, scientific, and technical activities	9.9	18.1
71	Architectural and engineering activities and related technical consultancy	8.6	15.4
72	Scientific research and development	10.9	13.7
Total		22.4	19.2

Source: *SV-Wissenschaftsstatistik*, calculations by DIW Berlin.

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Table 3

Share of R&D intensive industries in R&D expenditure of foreign and domestic companies in Germany 2013

In percent

	Domestic companies	Foreign companies
R&D intensive industries	75.6	76.6
Cutting-edge technologies	20.8	37.2
High-level technologies	54.8	39.3
R&D intensive services	11.4	5.5
Miscellaneous	13.0	18.0
Total	100.0	100.0

Source: *SV-Wissenschaftsstatistik*, calculations by DIW Berlin.

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itive: here, R&D spending increased from 2009 to 2011 and continued unabated after 2011, reaching its peak in 2013 (see Figure 5). It was a similar story for research personnel.

Table 4

R&D expenditure in manufacturing industry

Rate of change in percent

	2011 compared to 2009		2013 compared to 2011		2013 compared to 2009	
	Research-based foreign companies	Research-based domestic companies	Research-based foreign companies	Research-based domestic companies	Research-based foreign companies	Research-based domestic companies
Manufacturing, overall	13.8	12.9	-12.4	17.6	-0.4	32.8
R&D intensive branches of industry	16.9	12.8	-15.4	19.0	-1.2	34.2
Chemical and pharmaceutical products ¹	-8.5	11.0	14.9	-4.2	5.1	6.3
Mechanical engineering ²	9.0	10.3	22.6	14.5	33.6	26.2
Manufacture of motor vehicles ³	26.3	14.4	-31.0	38.7	-12.9	58.7
Data processing equipment, electronic, optical and electrical products ⁴	15.9	13.6	-5.8	4.2	9.1	18.4
Other branches of industry	-6.7	14.7	11.8	2.7	4.2	17.7
Food industry ⁵	-36.9	73.8	31.2	-25.0	-17.2	30.4
Textiles, wearing apparel, leather ⁶	21.1	31.9	8.7	12.1	31.6	47.8
Wood, paper, printing ⁷	-2.9	-18.2	0.0	-24.6	-2.9	-38.3
Rubber, plastics, non-metallic mineral products ⁸	3.5	11.6	-2.3	6.4	1.1	18.7
Metal production and processing, and manufacture of metallic products ⁹	49.5	3.4	-20.1	17.6	19.5	21.7
Petroleum products, furniture, other manufacturing, repair and installation ¹⁰	-33.2	23.1	57.6	-1.6	5.3	21.1
Companies with... employees						
up to 49	87.1	-2.2	-17.2	13.7	54.8	11.2
50 to 99	7.5	15.7	14.0	-10.6	22.5	3.4
100 to 249	10.2	8.2	-18.4	4.1	-10.1	12.7
250 to 499	17.1	16.8	33.6	22.5	56.4	43.1
500 to 999	-1.5	20.4	4.1	-3.1	2.5	16.7
1,000 or more	15.8	12.5	-18.9	20.3	-6.1	35.3
Companies located in ...						
West Germany	12.8	13.0	-10.4	18.9	1.1	34.3
East Germany	26.5	12.5	-38.2	-2.9	-21.8	9.3

1 WZ 2008: 20, 21.

3 WZ 2008: 29, 30.

5 WZ 2008: 10 to 12.

7 WZ 2008: 16 to 18.

9 WZ 2008: 24, 25.

2 WZ 2008: 28.

4 WZ 2008: 26, 27.

6 WZ 2008: 13 to 15.

8 WZ 2008: 22, 23.

10 WZ 2008: 19, 31 to 33.

Source: Research Data Centres of the Federal Statistical Office and the statistical offices of the Länder, calculations by DIW Berlin.

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Foreign-owned companies in research intensive industries barely changed their research spending from 2009 to 2013, while foreign-owned companies in other economic sectors slightly increased their R&D by around four percent. This is mainly due to the sharp decline in vehicle construction from 2009 to 2013 (just under 13 percent). R&D spending among domestic vehicle manufacturers has increased by almost 60 percent. One explanation for this discrepancy might be specific measures to reduce research capabilities in individual multinational automotive companies. This impression is also consistent with the fact that among major enterprises, the research tasks of foreign-controlled companies declined while those of domestic companies rose sharply (see Table 4). Among medium-sized in-

dustrial enterprises (20 to 499 employees) under foreign ownership, research spending developed more favorably than in the corresponding domestic enterprises.

The differences in the development of research activities have led to the importance of foreign companies in industrial research declining slightly in Germany. In 2013, just under 16 percent of all industrial research spending was by foreign companies, compared to almost 20 percent in 2009. Foreign companies' share of total R&D spending decreased in the research intensive industries from 19 percent in 2009 to 15 percent in 2013 and in other sectors from around 28 to 26 percent. In contrast, the foreign share among small enterprises (20

Table 5

R&D expenditure in foreign and in domestic companies in the manufacturing industry

Structure in percent

	2009		2011		2013	
	Research-based foreign companies	Research-based domestic companies	Research-based foreign companies	Research-based domestic companies	Research-based foreign companies	Research-based domestic companies
Manufacturing, overall	100.0	100.0	100.0	100.0	100.0	100.0
R&D intensive branches of industry	86.7	91.6	89.1	91.5	86.0	92.6
Chemical and pharmaceutical products	14.2	15.3	11.4	15.1	15.0	12.3
Mechanical engineering	7.9	19.2	7.5	18.7	10.6	18.2
Manufacture of motor vehicles	46.7	36.7	51.9	37.2	40.9	43.9
Data processing equipment, electronic, optical and electrical products	17.9	20.4	18.2	20.5	19.6	18.2
Other branches of industry	13.3	8.4	10.9	8.5	13.9	7.4
Food industry	1.3	0.5	0.7	0.7	1.1	0.5
Textiles, wearing apparel, leather	0.2	0.2	0.2	0.2	0.3	0.2
Wood, paper, printing	0.4	0.6	0.3	0.4	0.4	0.3
Rubber, plastics, non-metallic mineral products	4.1	2.0	3.8	2.0	4.2	1.8
Metal production and processing, and manufacture of metallic products	2.2	2.5	2.9	2.3	2.7	2.3
Petroleum products, furniture, other manufacturing, repair and installation	5.0	2.6	3.0	2.9	5.3	2.4
Companies with... employees						
up to 49	0.3	0.9	0.6	0.8	0.5	0.7
50 to 99	1.3	1.7	1.3	1.7	1.6	1.3
100 to 249	6.5	4.4	6.3	4.2	5.9	3.7
250 to 499	7.0	5.0	7.2	5.2	11.1	5.4
500 to 999	11.0	6.2	9.5	6.6	11.3	5.5
1,000 or more	73.8	81.8	75.1	81.5	69.6	83.4
Companies located in ...						
West Germany	93.5	94.0	92.7	94.0	94.9	95.0
East Germany	6.5	6.0	7.3	6.0	5.1	5.0

Definition of sectors see table 4.

Source: Research Data Centres of the Federal Statistical Office and the statistical offices of the Länder, calculations by DIW Berlin.

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to 99 employees) and medium-sized firms (250 to 499 employees) increased.

In both company groups, 95 percent of R&D spending was in West Germany (see Table 5).⁹ It is notable that foreign companies are comparatively well represented in Hamburg, North Rhine-Westphalia, and Hesse while German companies are in the majority in Lower Saxony, Bavaria, and Baden-Württemberg.

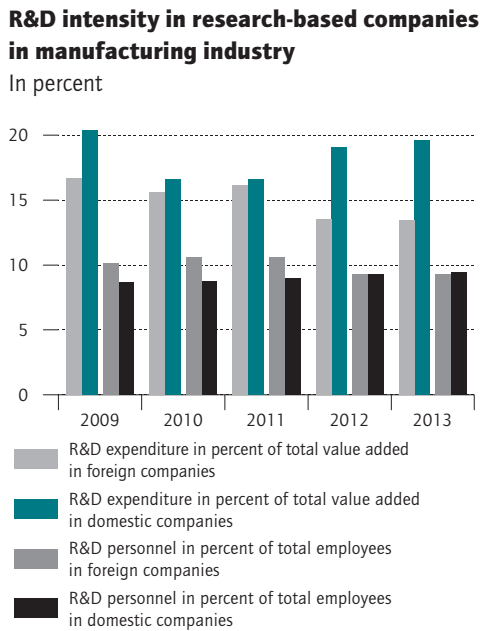
⁹ The cost structure survey collects information about businesses. If companies have legally dependent operations in other German federal states, the activities are overestimated in the state where the company is based and underestimated in the state where the operation is based. It is assumed that this effect is negligible for large-scale studies.

In order to calculate R&D spending intensity, R&D spending is set in relation to gross value added at factor cost. In 2013, R&D spending by foreign-owned companies amounted to 13.4 percent of the value added, while in 2009, this figure had still stood at 16.7 percent (see Figure 6 and Table 6). In comparison, R&D intensity among domestic enterprises remained almost constant at 20 percent. However, the differences in R&D personnel intensity are minor and have barely decreased at all.

Number of research-based foreign companies virtually unchanged

One reason for the recent decline in R&D spending among foreign-owned companies might be the similar-

Figure 6



Source: Research Data Centres of the Federal Statistical Office and the statistical offices of the Länder, calculations by DIW Berlin.

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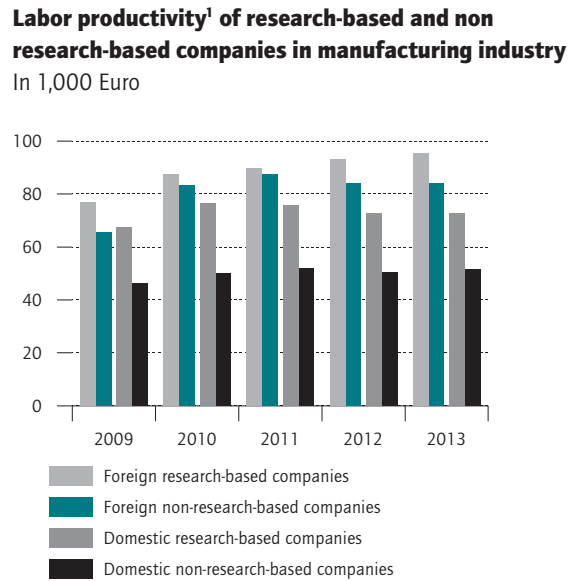
R&D expenditures in domestic companies increased recently.

ly declining number of research-based companies. In 2013, slightly more than 1,520 foreign-controlled enterprises carried out R&D. The total has therefore remained more or less constant. However, the number of domestic research-based companies rose from around 7,900 to 8,100 between 2012 and 2013.

Other reasons for the decline of R&D spending and R&D personnel among foreign-owned companies might be changes in the population of enterprise groups. It is conceivable that some companies were sold to German investors, research activities were discontinued, or businesses were closed, broken up, or rebranded as service companies. Microdata from the cost structure survey allow these changes to be analyzed.¹⁰ It can be seen that the vast majority of R&D spending has been invested by companies conducting R&D in both years and with no change in ownership (see Table 7). This group account-

¹⁰ Only those research-based and non-research-based companies for which information was available in both reference years were taken into account. In a comparison of 2013 and 2011, this was only 26 percent of all companies and 35 percent of research-based companies. However, this meant that 88 percent of R&D spending and 81 percent of R&D personnel, i.e., the majority of R&D activity in 2013, was captured.

Figure 7



¹ Value added at factor costs per employee.

Source: Research Data Centres of the Federal Statistical Office and the statistical offices of the Länder, calculations by DIW Berlin.

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The Productivity of foreign-controlled companies is higher than of domestic companies.

ed for the majority of recorded R&D spending at 96 percent, including almost 14 percent by foreign-owned companies. Research companies with a change of ownership accounted for around four percent of R&D spending. A similar picture emerges for R&D personnel. Overall, these findings show that R&D activities are taking place particularly in permanent research-based companies with stable ownership.

R&D spending rose by 4.4 percent in long-term, research-based companies under foreign ownership in both reference years, while the number of R&D employees fell by 1.5 percent compared to 2011. There was a decrease in R&D spending and R&D personnel among companies that first passed into foreign ownership in 2013. In contrast, R&D spending developed positively among enterprises with permanent R&D that were German owned in both reference years. Companies that were still under foreign ownership in 2009 but which subsequently passed into German ownership spent 3.6 percent less, while the number of R&D employees rose by four percent. The findings show that R&D development in companies that had a change of ownership was less favorable.

Table 6

R&D expenditure in percent of total value added¹ of research-based companies

In percent

	2009		2011		2013	
	Research-based foreign companies	Research-based domestic companies	Research-based foreign companies	Research-based domestic companies	Research-based foreign companies	Research-based domestic companies
Manufacturing, overall	16.7	20.4	16.2	16.6	13.4	19.6
R&D intensive branches of industry	21.7	25.6	21.1	20.0	16.7	24.1
Chemical and pharmaceutical products	13.1	21.0	10.0	19.8	9.6	21.8
Mechanical engineering	9.8	18.2	8.0	15.6	9.9	17.3
Manufacture of motor vehicles	41.9	38.9	45.4	23.2	30.3	31.0
Data processing equipment, electronic, optical and electrical products	18.0	24.0	18.5	20.3	16.9	22.6
Other branches of industry	6.7	6.3	5.5	5.9	6.0	5.9
Food industry	4.4	2.6	3.4	3.9	4.3	2.8
Textiles, wearing apparel, leather	5.9	4.6	4.8	4.7	5.3	5.2
Wood, paper, printing	2.5	4.9	2.6	4.0	1.6	3.8
Rubber, plastics, non-metallic mineral products	7.6	6.7	6.7	6.2	6.0	6.4
Metal production and processing, and manufacture of metallic products	4.1	5.4	5.0	4.3	5.1	4.8
Petroleum products, furniture, other manufacturing, repair and installation	12.2	11.0	6.7	11.5	9.6	10.3
Companies with... employees						
up to 49	16.0	9.6	15.0	8.0	14.2	9.2
50 to 99	13.1	8.5	10.8	7.5	11.9	7.4
100 to 249	10.7	8.4	10.3	7.5	8.7	8.0
250 to 499	8.8	8.7	8.5	8.2	9.2	9.7
500 to 999	10.0	10.8	7.9	10.0	8.6	9.9
1,000 or more	22.0	27.9	22.4	21.3	17.0	25.5
Companies located in ...						
West Germany	17.0	20.6	16.1	16.6	13.5	19.6
East Germany	13.4	17.2	17.3	17.5	11.3	20.2

¹ At factor costs.

Definition of sectors see table 4.

Source: Research Data Centres of the Federal Statistical Office and the statistical offices of the Länder, calculations by DIW Berlin.

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Labor productivity in research-based foreign industrial enterprises significantly higher

Labor productivity in research-based companies steadily increased during the observation period. In 2013, nominal gross value added at factor cost per employee reached 95,400 euros among foreign research-based companies, one-quarter more than in 2009. In general, research-based companies are considerably more efficient than non-research-based companies.¹¹ In 2010, productivi-

ty in research-based companies exceeded that of non-research-based enterprises by just under 60 percent.¹²

Foreign research-based companies have greater labor productivity than German ones. This discrepancy is not inconsiderable at 13 percent in 2013, and can be determined in all years during the observation period (see Figure 7). This could, in part, be due to structural reasons. The labor productivity of domestic research-based companies in vehicle construction is higher than that of foreign research-based companies (see Table 8). In all other sectors,

¹¹ On the positive link between productivity and R&D, see also T. J. Klette and S. Kortum, "Innovating Firms and Aggregate Innovation," *Journal of Political Economy* 2004 112 (5) (2004): 996-1018.

¹² A. Eickelmasch, "Research-Based Companies Perform Better," *DIW Economic Bulletin*, no. 10 (2012): 3-14.

Table 7

Change in R&D behaviour and in owner status of companies in manufacturing industry 2013 compared to 2011

	Companies	R&D expenditure 2013	R&D personnel 2013	R&D expenditure 2013 compared to 2011	R&D personnel 2013 compared to 2011
	Share in percent			In percent	
Companies 2013 and 2011 foreign thereof:	12.9	13.8	17.4	3.9	-1.7
Research-based in both years	6.9	13.8	17.2	4.4	-1.5
Not research-based in both years	5.3	X	X	X	X
Companies 2013 foreign, 2011 domestic thereof:	4.7	1.7	2.7	-17.1	-4.7
Research-based in both years	2.4	1.7	2.6	-12.0	-2.0
Not research-based in both years	2.0	X	X	X	X
Companies 2013 domestic, 2011 foreign thereof:	3.0	1.9	3.0	-3.2	4.2
Research-based in both years	1.6	1.9	3.0	-3.6	4.0
Not research-based in both years	1.2	X	X	X	X
Companies 2013 and 2011 domestic thereof:	79.4	82.5	76.9	16.3	7.0
Research-based in both years	29.6	82.3	76.4	16.3	7.0
Not research-based in both years	45.3	X	X	X	X
Companies, total	100.0	100.0	100.0	13.2	4.9
<i>Memo: Share of companies under investigation in percent of all companies 2013</i>	22.4	88.3	80.8	X	X

Source: Research Data Centres of the Federal Statistical Office and the statistical offices of the Länder, calculations by DIW Berlin.

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however, foreign research-based companies are ahead of domestic ones. This margin is also evident when differentiating according to company size. Studies on productivity differences between foreign-owned and German companies also show that foreign-controlled companies have greater productivity.¹³ This may be due to foreign-owned enterprises often being part of multinational companies that benefit from their international presence, while this is not the case for all German research-based companies. However, the study also shows that a higher degree of internationalization among domestic companies reduces differences with foreign-owned ones.

Conclusion

The R&D activities of foreign companies declined slightly between 2011 and 2013. In contrast, German companies expanded their activities over the same period. Therefore, the share of total research and development

spending has fallen. There are, however, no clear differences in R&D behavior between foreign and domestic companies.

The decline in R&D of foreign companies is likely to be mainly due to decisions made by some major multinational companies. There was in fact an increase in R&D spending among medium-sized foreign-owned enterprises.

Labor productivity is consistently higher in research-based industrial companies than in those that are not research-based. This applies to both foreign-owned and German enterprises. However, the considerable lead research-based foreign-owned companies have over research-based domestic companies in terms of productivity is remarkable.

The decline in R&D among foreign-owned enterprises should not be interpreted as a sign that Germany is becoming less attractive as a research location, particularly since this applies mainly to major corporations, while the opposite is true for medium-sized companies. In ad-

¹³ Weche-Gelübcke, J.P., „Ausländische Unternehmen und Übernahmeeffekte – neue Fakten für Deutschland“, Wirtschaftsdienst 4 (2013): 248-251.

Table 8

Labor productivity¹ of research-based companies in manufacturing industry

In 1,000 Euro

	2009		2011		2013	
	Research-based foreign companies	Research-based domestic companies	Research-based foreign companies	Research-based domestic companies	Research-based foreign companies	Research-based domestic companies
Manufacturing, overall	76.8	65.5	89.7	87.3	95.4	84.1
R&D intensive branches of industry	77.1	68.1	90.9	95.2	99.7	90.4
Chemical and pharmaceutical products	115.8	108.1	137.8	120.6	155.4	104.7
Mechanical engineering	64.6	61.7	87.6	78.8	83.3	79.4
Manufacture of motor vehicles	65.1	59.6	70.1	112.0	83.6	105.0
Data processing equipment, electronic, optical, and electrical products	77.1	66.1	89.2	82.9	92.4	78.0
Other branches of industry	76.2	59.4	87.3	69.1	87.2	69.5
Food industry	94.1	64.2	94.7	68.7	103.8	71.6
Textiles, wearing apparel, leather	61.9	47.5	75.5	58.8	68.3	57.7
Wood, paper, printing	70.3	61.9	65.4	62.7	80.6	63.5
Rubber, plastics, non-metallic mineral products	67.5	56.5	79.0	65.6	74.7	67.0
Metal production and processing, and manufacture of metallic products	69.8	57.8	79.3	73.0	78.0	70.5
Petroleum products, furniture, other manufacturing, repair and installation	94.8	64.6	131.2	71.4	125.8	73.8
Companies with... employees						
up to 49	54.4	48.0	85.0	58.6	71.4	57.0
50 to 99	55.8	52.0	76.4	66.1	73.4	60.9
100 to 249	68.5	53.9	78.2	63.9	79.5	63.2
250 to 499	66.8	60.2	81.7	69.6	85.0	69.8
500 to 999	80.8	64.3	93.9	78.6	92.2	76.6
1,000 or more	81.3	71.8	93.6	102.3	105.3	96.8

¹ Value added at factor costs per employee.
Definition of sectors see table 4.

Source: Research Data Centres of the Federal Statistical Office and the statistical offices of the Länder, calculations by DIW Berlin.

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dition, the R&D data for 2014, which has since been published, indicate further strong growth.¹⁴

Foreign companies in Germany have a lower share of R&D spending compared to countries such as the UK

and France. However, the R&D resources of all companies in relation to GDP are considerably higher.¹⁵ The contributions of foreign companies to R&D are therefore no indication of the attractiveness of a location for research.

¹⁴ Stifterverband für die Deutsche Wissenschaft e.V., *Forschung und Entwicklung in der Wirtschaft 2014* (Essen: March 2016)—Federal Statistical Office, ed., *Kostenstruktur der Unternehmen des Verarbeitenden Gewerbes sowie des Bergbaus und der Gewinnung von Steinen und Erden, Fachserie 4 Reihe 4.3, 2014* (Wiesbaden: June 2016).

¹⁵ U. Schasse, H. Belitz, A. Kladroba, G. Stenke, and M. Leidmann, "Forschung und Entwicklung in Staat und Wirtschaft," *Studien zum deutschen Innovationssystem 2-2016* (Berlin: 2016).

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JEL: D24, F21, L60, O31

Keywords: Research and development, manufacturing, foreign direct investment, productivity



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Layout and Composition

eScriptum GmbH & Co KG, Berlin

Sale and distribution

DIW Berlin
ISSN 2192-7219

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