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**Article**

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# Internationalization of Business Research: New Locations Gaining Ground

by Heike Belitz

In recent years, German and foreign companies have consistently increased their investment in Research and Development in Germany. In 2009, investment was over 45 billion euros which was a third higher than in 2001. While foreign companies have significantly expanded their Research and Development activities in Germany, German investment abroad has stagnated. Overall, Germany had a positive balance of four billion euros. There is no evidence of large-scale relocation of German Research and Development abroad. German companies' foreign research activities continue to be conducted predominantly in the US, and in neighboring European countries, but also increasingly in certain Central and East European countries as well as in China and South-East Asia. Nowadays, approximately one in ten inventions developed by German companies abroad originate at one of the new research sites although German companies are by no means more active than their competitors in these new research locations.

Research and Development (R&D) in industrialized countries is concentrated on multinational corporations (MNCs) with a strong research base.<sup>1</sup> These companies carry out not only their production but, increasingly, also their R&D activities in locations around the globe. The internationalization of research is driven by both the market and technology: MNCs must refine their products and processes in the target market countries and adapt to local conditions and customer requirements. Developing their own research laboratories abroad enables companies to acquire new technological knowledge from public institutions and competitors. Finally, the use of research personnel from the target country is also an important motive for conducting R&D abroad. To assess the impact of the globalization of R&D on Germany as a research site, the present study analyzes the research activities of German companies abroad and foreign companies in Germany over recent years on the basis of sector-specific data and using international patent applications submitted by companies with inventors located abroad.<sup>2</sup>

## Share of R&D Investment Abroad in Decline

In 2009, German companies abroad invested 11.3 billion euros in R&D which was lower than the 2001 figure of 11.9 billion euros (see Table 1). Because these companies increased their investment in domestic R&D from 22.5 billion euros to 30.1 billion euros in the same period,

<sup>1</sup> In Germany in 2009, 80 percent of R&D investment made by companies came from MNCs. Of this, 53 percent originated from German companies which also conduct R&D abroad, and a further 27 percent from foreign-owned companies.

<sup>2</sup> The results presented here are part of a study commissioned by the German government's independent Commission of Experts for Research and Innovation (Expertenkommission Forschung und Innovation, EFI). H. Belitz, „Internationalisierung von Forschung und Entwicklung in multinationalen Unternehmen“ Studien zum deutschen Innovationssystem, no. 5 (2012), (Berlin: Commission of Experts for Research and Innovation, February 2012).

Table 1

**R&D Investment by German MNCs with R&D Abroad**

In billion euros

	2001	2003	2005	2007	2009
<b>Global R&amp;D investment</b>					
Manufacturing industry	31.8	34.1	36.8	36.5	39.0
Chemical industry	-	4.6	4.2	5.3	2.9
Pharmaceutical industry	-	3.4	4.0	3.0	6.8
Mechanical engineering	1.1	1.9	2.4	2.7	2.8
Electrical engineering	7.4	6.9	7.4	5.7	5.4
Automotive engineering	-	16.4	18.1	18.9	19.7
Industry total	34.4	36.3	38.3	38.6	41.4
<b>R&amp;D investment abroad</b>					
Manufacturing industry	11.6	10.2	11.3	8.8	10.7
Chemical industry	-	1.6	1.2	1.6	0.7
Pharmaceutical industry	-	1.7	2.1	2.1	3.7
Mechanical engineering	0.4	0.6	0.7	0.8	0.5
Electrical engineering	2.8	2.5	2.3	1.2	1.8
Automotive engineering	-	3.5	4.8	3.0	3.6
Industry total	11.9	10.9	11.4	9.4	11.3
<b>Share of R&amp;D investment abroad in percent</b>					
Manufacturing industry	36	30	31	24	27
Chemical industry	-	34	30	30	25
Pharmaceutical industry	-	50	52	69	54
Mechanical engineering	39	32	27	29	20
Electrical engineering	38	36	32	20	33
Automotive engineering	-	21	26	16	18
Industry total	35	30	30	24	27

Source: SV-Wissenschaftsstatistik, calculations by DIW Berlin.

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While global expenditure on research is increasing, research abroad is stagnating.

the share contributed by investment abroad fell from 35 percent in 2001 to 27 percent in 2009. R&D investment by German companies abroad concentrated on two sectors. In 2009, the pharmaceutical industry and automotive engineering each received just under a third of total investment. The share of German companies' R&D investment flowing into the pharmaceutical industry abroad has already been over 50 percent for some time. The proportion received by automotive engineering fell from over a quarter in 2005 to 18 percent most recently.

If total R&D investment by German MNCs is considered by sector, significant fluctuations become apparent, both in Germany and abroad, even before the financial and economic crisis (see Figure 1). The volatility of R&D investment is primarily the result of restructuring due to mergers and acquisitions of companies and parts of

companies.<sup>3</sup> These transactions may sometimes result in a company being classified under a different sector in statistical data. This is probably of particular relevance for the chemical and pharmaceutical industries.

Between 2005 and 2009, global R&D investment by German companies in the computer and electrical engineering sectors fell by two billion euros, 1.5 billion of which was domestic investment.<sup>4</sup> This cut in domestic R&D investment from German companies was not offset by an increase in investment in Germany from foreign companies, and consequently, total domestic R&D investment in the computer and electrical engineering sectors was almost 1.4 billion euros lower in 2009 than in 2005.<sup>5</sup> This indicates a weakening of Germany's position as a research site for this sector. What must be borne in mind here is that relocations abroad may also have played a role. After 2007, German computer and electrical engineering MNCs further cut their R&D investment in Germany, but at the same time expanded R&D investment abroad. The sector-specific R&D statistics provide no evidence that a similar relocation of R&D activities from Germany to other countries is taking place in other sectors.

### US and Austria Most Important Foreign Research Locations

In some target countries, national surveys provide information on the scope of R&D activities conducted by German companies there. With over 3.8 billion euros of investment in 2009, the US remains the most important foreign research site for German companies, although R&D investment has fallen significantly since it peaked in 2006. The US is followed by neighboring European countries, Austria (1.3 billion euros) and France (0.9 billion euros) and, considerably further down the list, the UK (0.4 billion euros) and Switzerland (0.3 billion euros). However, as only a few countries actually publish the relevant data, and also the definition of both a foreign company and R&D investment differs between surveys, there is no complete picture showing the regional distribution of R&D investment abroad. Particularly for

<sup>3</sup> Thus, in 2009, the German BASF group acquired Ciba Holding AG (Ciba), Basel, Switzerland. Ciba was a leading global speciality chemicals company which, in 2008, had a turnover of around 5.9 billion Swiss francs and invested 230 million Swiss francs in Research and Development. BASF press information, June 23, 2009.

<sup>4</sup> This decline was probably primarily due to the restructuring of Siemens and Infineon. Between the 2005 and 2009 financial years, their joint global R&D investment fell by approximately 1.7 billion euros (more than a quarter). The EU Industrial R&D Investment Scoreboard, various editions.

<sup>5</sup> SV Wissenschaftsstatistik, FuE-Datenreports (R&D Data Reports), 2009 and 2011. Tables and data.

countries of South-East Asia, Central and Eastern Europe, and also South America where new markets and research sites are developing particularly rapidly, there is an absence of national data about the R&D activities of foreign companies. In order to at least partially fill this gap, data on international patent applications are used for these countries (see box).

### Traditional Research Locations Dominate...

In Germany, the share of patent applications filed with the EPO in 2005 where the inventors were based abroad was over 15 percent and thereafter experienced no further increase. Other home countries of significant research-intensive MNCs experienced a decline in the share of investment in R&D abroad after 2005, with only Finland and the US continuing to increase. This indicates that the internationalization of R&D in MNCs has recently experienced a significant loss of momentum (see Table 2).

The regional distribution of inventors from German companies abroad is very similar to the corresponding distribution of inventors in all selected countries (see Table 3). German companies' inventive activity abroad, as with its competitors, is concentrated at the traditional research sites, i.e., the US and Europe, which together made up a share of approximately 85 percent in 2007/2008. Although recently European countries (14 old EU member states, Switzerland, and Norway) accounted for 62 percent, i.e., the majority of inventions, and North America (US and Canada) for only around 20 percent, which corresponds to a decline of ten percentage points.

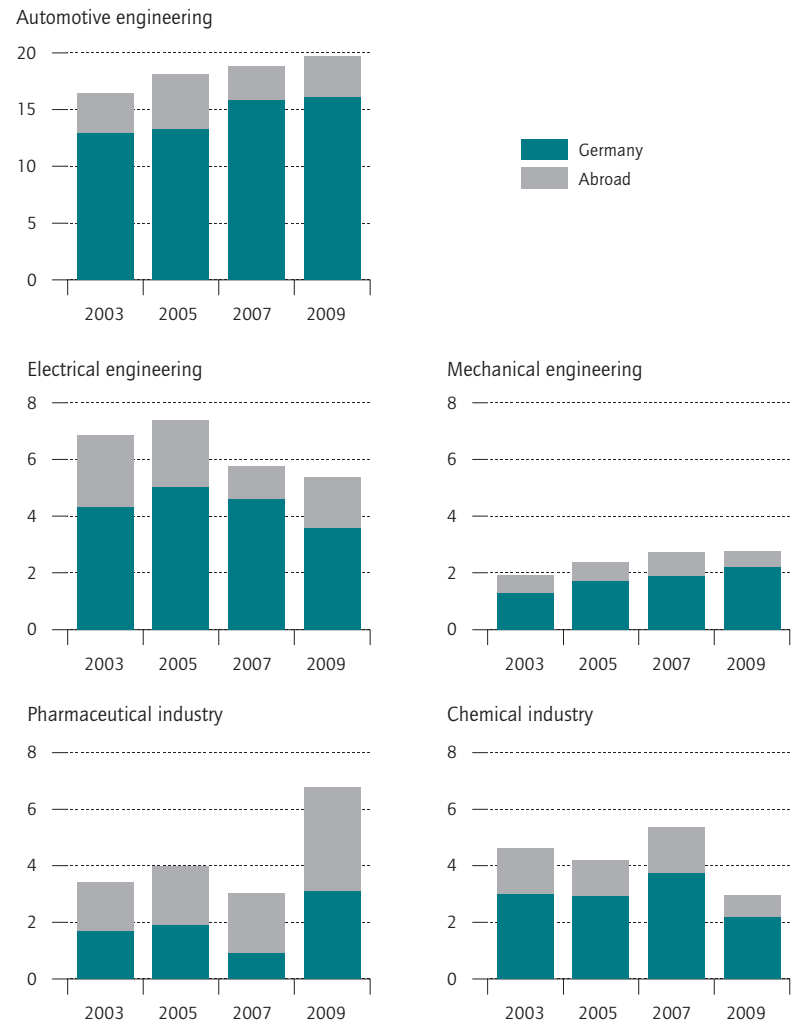
### ... But New Locations Gaining Ground

Measured using this patent indicator, North America's importance as the main research site for German companies has decreased considerably since the year 2000. Japan's significance has also declined. Conversely, inventive activity in European countries has recently gained momentum once more. Just over eleven percent of inventions by German companies abroad are now carried out in the new R&D sites (BRIC countries,<sup>6</sup> Israel, South Korea, Central and Eastern European, and South-East Asian countries), while the corresponding figure in 1995 was only four percent. In 2007/2008, the largest share of inventive activity at German companies' new research sites was accounted for by Central and East-

Figure 1

### R&D Investment by German Companies in Selected Sectors at Home and Abroad

In billion euros



Source: SV Wissenschaftsstatistik, calculations by DIW Berlin.

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R&D investment and its distribution between Germany and abroad has been fluctuating.

tern European countries and China, each with around three percent, and South-East Asian countries with almost two percent. Over the past few years, the significance of China and the Central and Eastern European countries in particular has increased. Nevertheless, their share of the inventive activity of German companies abroad remains very low.

Patent data can also be used to investigate how German companies make the most of opportunities to expand their innovation potential at the new research sites in comparison to their competitors. Do they conduct

<sup>6</sup> Brazil, Russia, India, and China.

## Box

**Patent Applications from Companies with Inventors Abroad**

The OECD provides data on patent applications received by the European Patent Office (EPO) for inventions where at least one of the inventors was based abroad. The relevant indicator »domestic ownership of inventions made abroad« reflects the extent to which companies from a particular country monitor inventions carried out under the auspices of R&D in their subsidiaries in the respective other country.<sup>1</sup> The share of patent applications submitted by domestic companies (applicants), in which foreign inventors also participated, roughly corresponds to the share of researchers based abroad of all researchers in these companies. The indicator, therefore, supplements the R&D data for subsidiaries of domestic companies abroad.<sup>2</sup> However, the suitability of patent applications as a measure of R&D activities is limited as patents are only registered for some R&D results and with

a certain time lag.<sup>3</sup> R&D investment by companies abroad is also likely to be somewhat underestimated as, in comparison with the home country, there is a higher share of development activities abroad where the results are not patentable.<sup>4</sup>

The following analysis of EPO patent applications is concentrated in the eleven countries in which the majority of research-intensive MNCs are resident: the US, Japan, Germany, France, the UK, Switzerland, Sweden, the Netherlands, Italy, and South Korea.<sup>5</sup> The study refers to the period from 1995 to 2008 although the OECD data (last updated in August 2011) do not yet capture all applications for 2008.

<sup>1</sup> The vast majority of international patents are registered by companies and only a small proportion by research institutions, for example, or by the inventors themselves. Therefore, 90 percent of patents received by the EPO from Germany in the period from 1978 to 2005 had at least one company applicant. L. Abramovsky et al., »The location of innovative activity in Europe,« IFS Working Papers 08 (Institute for Fiscal Studies: July 2010).

<sup>2</sup> OECD Patent Statistics Manual (OECD: 2009), 127.

<sup>3</sup> Different analyses conclude that the time lapse between research and patent registration is typically approximately a year. J. Danguy, G. de Rassenfosse, and B. Van Pottelsberghe, »The R&D-Patent Relationship: An Industry Perspective,« Working Papers ECARES 2010-038 (Université Libre de Bruxelles: 2010).

<sup>4</sup> Ultimately, it is also to be expected that European companies will register a patent with the EPO sooner than a non-European company which is more likely to submit a patent application to their own regional patent offices. Therefore, it is likely that the patent indicators on the basis of EPO applications will be biased towards European companies.

<sup>5</sup> European Commission, Joint Research Centre, The 2010 EU Industrial R&D Investment Scoreboard (Luxembourg: 2010).

Table 2

**Patent Applications<sup>1</sup> with Inventors Abroad**

In percent

	1995	2000	2005	2007/2008
Finland	16	25	29	40
France	13	19	22	21
Germany	10	13	15	15
Italy	5	7	6	5
Japan	4	4	5	5
South Korea	9	7	6	4
Netherlands	41	34	44	36
Sweden	21	30	36	34
Switzerland	44	51	56	55
UK	21	21	22	19
US	14	18	18	19

<sup>1</sup> Filed with the European Patent Office (EPO). The shares are an indicator of the internationalization of a country's business research. Source: OECD patent data, calculations by DIW Berlin.

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Only in Finland R&amp;D abroad has increased significantly.

more or less R&D activity than their competitors from other countries?

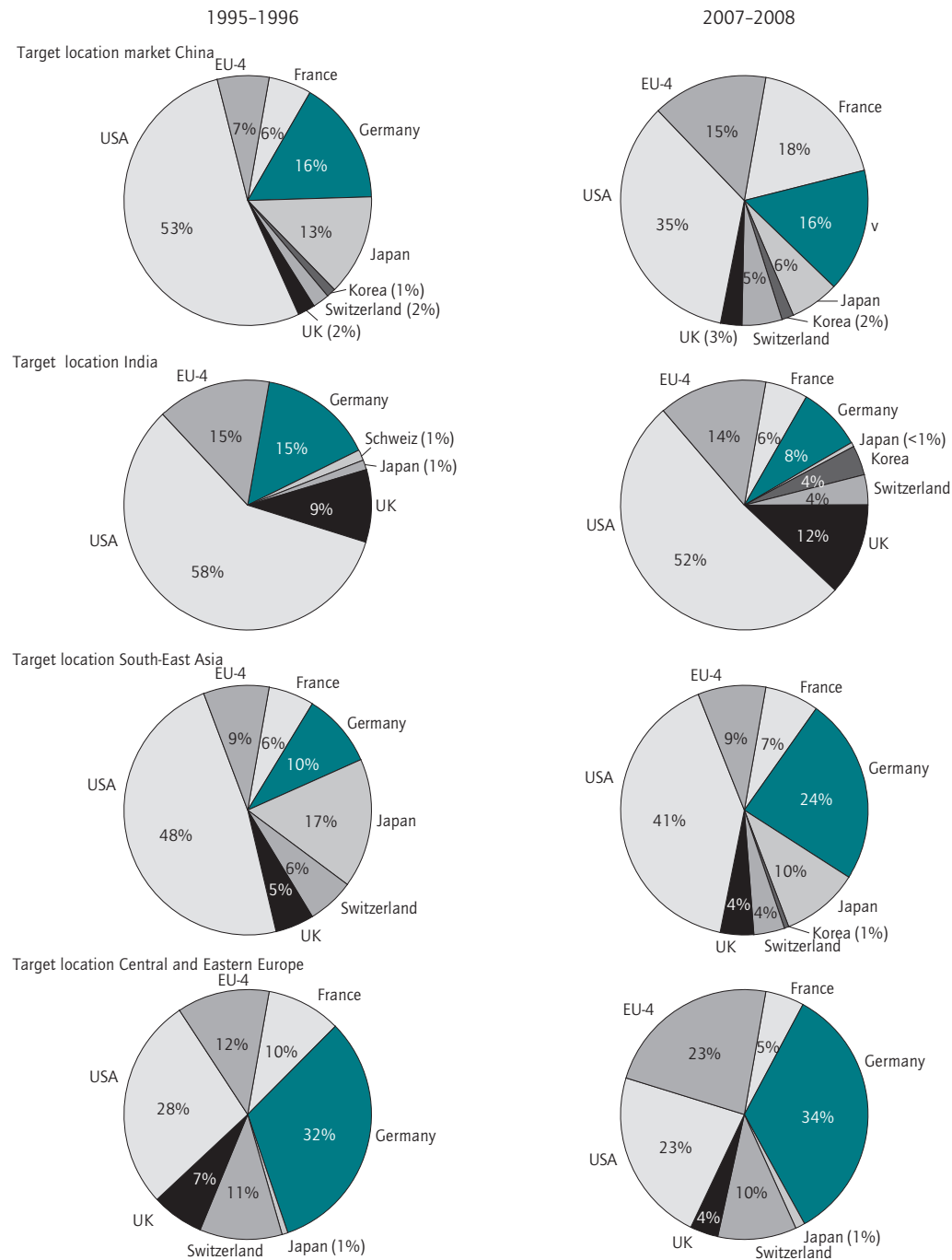
In Central and Eastern European countries, a third of all EPO patent applications for inventors in foreign companies in 2007/2008 were submitted by German companies (see Figure 2). Even back in the mid-1990s, German companies in this region held the leading position among the foreign companies with almost one-third of the R&D. In China, the dominance of US companies declined significantly. While companies from most European countries have increased their share in the R&D activities of foreign companies in China since the mid-90s, German companies have »only« maintained their share of 16 percent. Consequently, the R&D activities of German companies in Central and Eastern European countries, and in China also increased at the same average rate as all foreign companies.

Conversely, German companies' share of R&D conducted by foreigners in India fell sharply, while companies

Figure 2

### Patent Applications<sup>1</sup> with Inventors at New Research Sites

In percent



<sup>1</sup> Patent applications submitted to the European Patent Office (EPO) by companies from the eleven most important countries of origin of research-intensive MNCs. Central and Eastern European countries: Czech Republic, Hungary, Poland, Slovakia, and Slovenia; South-East Asia: Malaysia, Singapore, Taiwan, and Thailand.

Source: OECD patent data, calculations by DIW Berlin.

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German companies are the biggest foreign investors in R&amp;D in Central and Eastern Europe.

Table 3

**Patent Applications<sup>1</sup> by German Applicants with Inventors Abroad by Target Region**

In percent

	1995	2000	2005	2007/2008	For info: applicants from 11 countries <sup>2</sup> 2007/2008
<b>Traditional locations</b>	93.7	89.6	85.9	84.6	84.6
Europe <sup>3</sup>	58.7	58.3	57.9	62.5	61.5
North America	30.4	29.4	24.3	19.0	20.7
Japan	4.6	3.8	3.6	3.1	2.6
New sites	4.3	7.3	10.1	11.5	11.6
Brazil	0.8	0.4	1.3	0.9	0.4
Russia	1.3	1.1	0.9	0.6	0.6
India	0.3	0.5	0.8	0.9	1.8
China	0.4	1.0	2.2	3.0	3.5
Central and Eastern Europe <sup>4</sup>	1.0	2.4	2.4	3.3	1.7
South-East Asia <sup>5</sup>	0.1	1.4	1.6	1.9	1.7
South Korea	0.1	0.1	0.2	0.6	0.7
Israel	0.2	0.5	0.6	0.4	1.1

<sup>1</sup> Filed at the European Patent Office (EPO).<sup>2</sup> Finland, France, Germany, Italy, Japan, Netherlands, South Korea, Sweden, Switzerland, UK, and US.<sup>3</sup> Old EU member states, Norway, and Switzerland.<sup>4</sup> Czech Republic, Hungary, Poland, Slovakia, and Slovenia.<sup>5</sup> Malaysia, Singapore, Taiwan and Thailand.

Sources: OECD patent data, calculations by DIW Berlin.

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One in ten inventions abroad originates at one of the new research sites.

from France, the UK, South Korea, and Switzerland gained ground. German companies significantly expanded their R&D in South-East Asian countries. After US companies, they were the second biggest foreign investors in R&D in this region in 2008.

Although German companies are increasingly active at the new global research sites in Asia and Central and Eastern Europe overall, in comparison to their competitors they are only recording a higher rate of expansion of R&D in the South-East Asian countries, while the growth rate in China and the Central and Eastern European countries is just average, and even below average in India.

Measured according to the development of the patent indicator “domestic ownership of inventions made abroad,” the new research sites are becoming more important for German companies, too. These locations show high economic growth and attract R&D activities by MNCs from all industrialized nations.

**Foreign Companies' Share of R&D in Germany Stable**

In order to evaluate the impact of the globalization of R&D on Germany as a research site, local R&D activities of foreign companies must also be taken into consideration. Since the beginning of the new millennium, over one-quarter of private R&D investment in Germany has been provided by foreign companies. Although their R&D investment is rising dramatically, their share in the total R&D expenditure is not increasing, since investment by local companies is also expanding rapidly.

In 2009, foreign subsidiaries spent 15.2 billion euros on R&D in Germany (2007: 13.4 billion euros) and 85,000 people were employed in their R&D departments (2007: 81,100).<sup>7</sup> Foreign companies therefore expanded R&D in Germany even during the global financial and economic crisis. The sectoral structure of the R&D investment by foreign companies was relatively stable at this point (see Table 4). Four sectors each account for around 15 percent of the R&D investment of foreign companies: pharmaceutical industry, automotive engineering, computers/electronics/optics, and aviation and aerospace. Just over one-tenth of R&D investment by foreign subsidiaries was in the service sectors, scientific and technical services as well as information and communication, almost as much as by German companies.

The significance of foreign companies for overall R&D varies greatly from one sector to another. Their share is the highest in vehicle construction as a whole (and almost exclusively in aviation and aerospace) at 87 percent,<sup>8</sup> followed by the pharmaceutical industry at 45 percent.

The distribution of the R&D activities across sectors is similar for foreign and German companies. The greatest differences are in vehicle construction, where German companies concentrate almost exclusively on automotive engineering, while foreign European companies also conduct extensive research in aviation and aerospace. One further major focus of research of foreign companies is in the pharmaceutical industry.

The composition of the countries of origin of foreign companies conducting R&D in Germany is stable. European companies accounted for 52 percent of the R&D personnel of the foreign subsidiaries in Germany in

<sup>7</sup> Special analysis of the R&D data by Wissenschaftsstatistik GmbH im Stifterverband für die Deutsche Wissenschaft.

<sup>8</sup> This can be explained by European interconnections in this sector, meaning that almost all companies active in this field in Germany are classified as foreign. A. Kladroba, Forschung und Entwicklung in einer globalisierten Welt. FuE-Datenreport 2012. Analysen und Vergleiche, (Essen: Wissenschaftsstatistik gGmbH, 2012), 29-31.



2009 (2001: 56 percent), primarily from their immediate neighbors, the Netherlands, Switzerland, and France. 38 percent of the R&D personnel of foreign companies in Germany are employed by US companies (2001: approximately 41 percent), and only five percent by Japanese companies.

### Conclusion: Research Site Profits from Internationalization

Foreign companies in Germany have invested around four billion euros more in R&D since 2007 than German companies abroad. In 2001, when German companies recorded the highest level of R&D investment abroad to date, the overall situation was still roughly balanced. The expenditure of foreign companies in Germany has increased significantly since then, but R&D investment by German companies abroad fluctuated between 9.4 and 11.9 billion euros with no clear trend.

However, the increase in R&D investment by MNCs in Germany is a decisive factor for Germany's performance as an R&D site, irrespective of ownership. In the period from 2001 to 2009, both foreign and German companies consistently increased their research investment in Germany—despite the financial and economic crisis of 2008/2009—each by one-third overall. Therefore, there are no signs of a relocation of R&D activities to other countries. Instead, Germany is holding its own as a strong international R&D site with growth in the R&D investment by MNCs. Recent development in the US has been less favorable, also showing positive overall results in international R&D track record amounting to over seven billion US dollars. The R&D investment of US parent companies there fell after 2007. According to preliminary figures for 2009, foreign companies in the US have increased their R&D investment again, but total R&D investment by foreign and local MNCs still remains below the level of 2007.<sup>9</sup>

Although German companies conduct research abroad primarily in their traditional research sites in the US and neighboring European countries, they are also increasingly active at the new Central and Eastern European research locations, and in China, South-East Asia, and India. These new R&D sites are not only characterized by highly dynamic R&D investment, but also by strong economic growth. Just over eleven percent of the inventive activity of German companies abroad now takes place in these locations. The significance of China in particular has increased over the past few years. Cen-

Table 4

### Sectoral Structure of Internal R&D Investment by German and Foreign Companies in Germany in 2009

In percent

	German companies	Foreign companies	For info: share of foreign companies
Manufacturing industry	85.7	87.1	27.6
Chemicals	14.1	20.3	35
Chemical industry	8.4	3.6	13.8
Pharmaceutical industry	5.7	16.7	52.5
Electrical engineering	15.1	18.1	31.1
Computers, electronics, optics	12.2	15	31.7
Electrical equipment	2.9	3.1	28.7
Mechanical engineering	10.9	7.6	20.7
Vehicle construction	37	30.9	23.9
Automotive engineering	36.1	16.5	14.7
Other vehicle construction	0.9	14.4	85.9
Information und communication	6.2	4.4	20.9
Scientific and technical services	5.8	5.8	27.1
Industry total	100	100	27.3

Source: SV Wissenschaftsstatistik, calculations by DIW Berlin.

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Research conducted in Germany by foreign and German companies has a similar sectoral focus.

tral and Eastern Europe has been the most important target region for R&D by German companies to date.

Overall, German companies are focused on moving into new international R&D locations, but they are not much more active than their competitors. However, their own R&D activities in Central and Eastern Europe, and in China, South-East Asia, and India are an essential prerequisite to allow German companies to enter markets and strengthen their market position there.

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<sup>9</sup> According to data of the U.S. Department of Commerce. Bureau of Economic Analysis, [www.bea.gov/international/](http://www.bea.gov/international/).



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