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**Article**

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Weekly Report

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# Weekly Report

## Germany's Technological Specialization Assures Growth Opportunities

*Germany's economic profile gives reason to believe that the country will emerge strengthened from the current economic crisis.*

*Germany boasts the world's highest share of value-added output attributable to (R&D) intensive goods and knowledge intensive services. At the same time, Germany possesses an extremely broad range of economic sectors that rely on R&D intensive goods and knowledge intensive services. German firms have strong competitive advantages in numerous industries, including vehicle manufacturing, chemicals, machine building, measurement and medical technologies, as well as business oriented services. Moreover, in relation to its important trading partners, Germany has a unique production portfolio.*

*Although Germany's dependence on exports and specialization in the production of capital equipment has led to a sharp decline in demand in the current crisis, the country's orientation in R&D intensive technology represents a strong foundation for renewed growth as soon as the global economic climate improves. However, continued business investment in R&D during the recession is necessary if Germany hopes to emerge the crisis on sound footing—even if such investment does not generate revenues over the near term.*

A strong focus on R&D intensive and knowledge intensive industries is a comparative advantage essential for high-wage countries such as Germany. This was a key finding of the research and innovation report released by the German government's Commission of Experts for Research and Innovation (EFI). The report's data was drawn from several sources, including a study conducted by DIW Berlin, which also serves as the basis for the present article.<sup>1</sup> The study analyzes and compares growth trends in R&D and knowledge intensive economy in a variety of countries on a sector-by-sector basis (see Box). The US, Japan, and several other EU member countries were evaluated in the study. These countries are responsible for the majority of worldwide production of R&D intensive goods and knowledge intensive services sectors. While Asia's emerging countries—particularly India

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<sup>1</sup> Belitz, H., Clemens M., Gornig, M.: Wirtschaftsstrukturen und Produktivität im internationalen Vergleich. Studien zum deutschen Innovationssystem Nr. 2/2009, Experts for Research and Innovation, Berlin March 2009. See: <http://www.e-fi.de/indikatorenstudien.html?L=1>

**Box****Classification of R&D Intensive Industries and Knowledge Intensive Services**

The R&D intensive manufacturing industries are the producers of cutting edge and high level products, defined as follows:

The category of "cutting edge includes goods for which internal R&D expenditures comprise over 7 percent of revenues.

The "high level sector consists of good for which R&D expenditures comprises 2.5 to 7% of revenues.

This categorization relates to the intensity of R&D and is under no circumstances based on a notion that certain goods are more "advanced" or "valuable." Cutting edge goods are more often subject to government intervention in the form of subsidies, government contracts, and

non-tariff barriers to trade. Government intervention is aimed not only at pursuing technological goals, but also national goals in areas such as defense, health care, and aerospace.

Within the service sector the percentage of highly qualified employees as well as the number of individuals engaged in R&D planning, design, and engineering are used as criteria to classify knowledge intensive services. Within the knowledge intensive service sectors the percentage of the workforce with a university degree is above average (over 11 percent). The knowledge intensive service sectors also employ an above-average number of engineers and natural scientists (over 4.5 percent).<sup>1</sup>

<sup>1</sup> The basis for these business sector separations is the NIW/Fraunhofer ISI-Listen of 2006. Legler, H., Frietsch, R.: Neuabgrenzung der Wissenswirtschaft - forschungsintensive Industrien und wissenintensive Dienstleistungen (NIW/ISI-List 2006). German Innovationssystem Studien Nr. 22/2007, NIW/Fraunhofer ISI, Hannover/Karlsruhe.

and China—have increased their involvement in technology intensive sectors, their share in world production is still relatively small.<sup>2</sup>

For the sake of simplicity the present article will not focus on each individual EU country, but rather, divide the EU into two groups—the EU-14 (consisting of the original EU member states aside from Germany) and EU-10 (the new member states).<sup>3</sup> The significance of each individual sector is compared internationally according to its relative share in nominal value added.<sup>4</sup>

**Germany Leads in R&D Intensive and Knowledge Intensive Production**

In 2006 Germany led all other countries in the share of value-added attributable to R&D intensive and knowledge intensive goods and services (see Figure 1). This was a new development. In 2000 the US was the clear forerunner. Germany was able to assume the leading position thanks first and foremost to continued strong growth in the category of high level

technology—already an area of marked strength. Progress was also made in the machinery and automotive manufacturing industries.

In the categories of high level technology Germany also registered strong growth between 1995 and 2006. Knowledge intensive services in 2006 comprised nearly 32% of gross value added. This was line with the EU-14 average, but less than in the US, where knowledge intensive services comprised 38% of value added (see Table 1).

Japan has a very specific structural profile. Of all countries it has the highest share of value added in high level but a very low percentage in knowledge intensive services. Although Japan was able to narrow the gap to other countries in knowledge intensive services over the surveyed period, it still has significant catching up to do.

While knowledge intensive and R&D intensive industries comprised the lowest share of total value added in the new EU member countries (EU-10), these countries witnessed an above-average rate of growth in the category of knowledge intensive services and R&D intensive industries between 1995 and 2006. The share of value added attributable to high level technology was even larger in the EU-10 than in the US, and was almost as high as that of the EU-14 countries. By contrast, growth in knowledge intensive services in the EU-10 over the surveyed period was stagnant.

On the whole, all geographic regions witnessed an expansion of their research and knowledge based

<sup>2</sup> Compare OECD Reviews of Innovation Policy. China. OECD, Paris 2008.

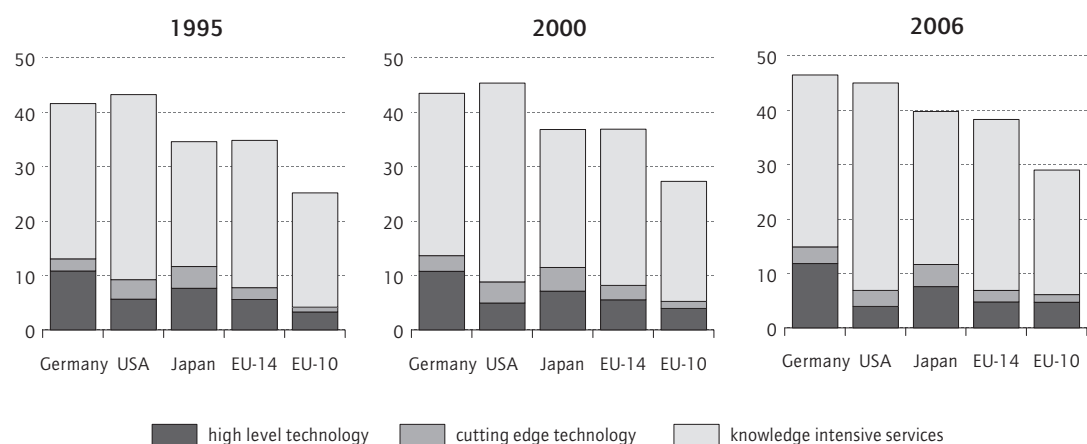
<sup>3</sup> EU-14: Belgium, Denmark, Finland, France, UK, Greece, Ireland, Italy, Luxembourg, Netherlands, Austria, Spain, Portugal, Sweden., EU-10: Estonia, Latvia, Lithuania, Malta, Poland, Slovenia, Czech Republic, Hungary, Cyprus. Rumania and Bulgaria who became member states in 2007 were not considered in this research.

<sup>4</sup> As a data basis for the years between 1995-2005 the Productivity in the European Union: A comparative Industry Approach (EU KLEMS) report is used, for the year 2006 the OECD (STAN) is used. In the March 2008 EUKLEMS Version the data is declared in a sectoral classification till 2005. For 2006 the Germany's, US's and EU-member states data is estimated on the basis of the most recent OECD STAN data.

Figure 1

**R&D Intensive and Knowledge Intensive Industries in Selected Countries**

Share of value added in percent



Sources: EUKLEMS-Datenbasis 3/2008; OECD STAN 2008; calculations by DIW Berlin.

DIW Berlin 2009

Table 1

**International Comparison of Value Added and RVA Specialization (Relative Share of Value Added) in R&D intensive and Knowledge Intensive Industries in 2006**

|  | Germany     |     | USA         |     | Japan       |      | EU-14       |     | EU-10       |      |
|--|-------------|-----|-------------|-----|-------------|------|-------------|-----|-------------|------|
|  | Anteil in % | RVA | Anteil in % | RVA | Anteil in % | RVA  | Anteil in % | RVA | Anteil in % | RVA  |
| <b>R&amp;D Intensive Industries</b>                              | 14.9        | 60  | 6.9         | -17 | 11.6        | 35   | 6.9         | -18 | 6.1         | -29  |
| High end Technology  | 11.8        | 78  | 4.0         | -31 | 7.6         | 33   | 4.8         | -13 | 4.7         | -14  |
| Chemicals Excluding Pharmaceuticals                              | 2.0         | 37  | 1.5         | 8   | 1.1         | -21  | 1.2         | -11 | 0.9         | -44  |
| Machinery  | 4.0         | 77  | 1.2         | -44 | 2.4         | 27   | 1.9         | 5   | 1.5         | -22  |
| Other Electrical Machinery                                       | 1.9         | 102 | 0.4         | -63 | 1.0         | 34   | 0.6         | -12 | 1.1         | 48   |
| Motor Vehicles, Trailers and Semi-Trailers                       | 3.8         | 98  | 0.9         | -50 | 3.0         | 73   | 0.9         | -45 | 1.2         | -20  |
| Motor Vehicles Excluding Aircraft and Spacecraft                 | 0.1         | 51  | 0.1         | -13 | 0.1         | -18  | 0.1         | 7   | 0.1         | -23  |
| Cutting Edge Technology  | 3.0         | 9   | 2.9         | 6   | 4.1         | 39   | 2.1         | 28  | 1.4         | -66  |
| Pharmaceuticals  | 0.6         | -2  | 0.6         | -4  | 0.6         | -4   | 0.7         | 12  | 0.4         | -61  |
| Office, Accounting and Computing Machinery                       | 0.2         | 1   | 0.2         | -18 | 0.5         | 90   | 0.1         | -41 | 0.1         | -49  |
| Telecommunication Equipment                                      | 0.7         | -28 | 0.8         | -14 | 2.4         | 98   | 0.5         | -56 | 0.6         | -35  |
| Scientific Instruments   | 1.2         | 55  | 0.8         | 18  | 0.5         | -31  | 0.5         | -32 | 0.3         | -80  |
| Aircraft and Spacecraft  | 0.3         | -4  | 0.6         | 48  | 0.1         | -117 | 0.2         | -49 | 0.0         | -268 |
| Knowledge Intensive Services                                     | 31.6        | -6  | 38.1        | 13  | 28.1        | -17  | 31.4        | -6  | 22.8        | -38  |
| Publishing   | 1.2         | 6   | 1.3         | 13  | 1.1         | 1    | 0.9         | -17 | 0.7         | -46  |
| Post and Telecommunication                                       | 2.3         | -20 | 3.1         | 9   | 2.3         | -23  | 3.2         | 10  | 0.9         | -115 |
| Financial Intermediation, Except Insurance and Pension Funding   | 3.6         | -35 | 5.3         | 4   | 5.8         | 12   | 5.1         | 0   | 4.0         | -24  |
| Insurance and Pension Funding, Except Compulsory Social Security | 1.1         | -65 | 3.0         | 37  | 2.0         | -3   | 1.3         | -50 | 1.1         | -69  |
| Other Financial Services   | 0.8         | -36 | 1.7         | 41  | 0.0         |      | 1.0         | -12 | 0.6         | -69  |
| Computer and Related Activities                                  | 1.8         | -27 | 2.4         | 5   | 2.6         | 14   | 2.3         | -1  | 1.3         | -61  |
| Research and Development   | 0.4         | -16 | 0.5         | 16  | 0.5         | 1    | 0.4         | -17 | 0.3         | -30  |
| Other Business Services  | 10.3        | 21  | 9.5         | 12  | 4.8         | -56  | 8.3         | -1  | 5.2         | -47  |
| Health and social work   | 8.1         | 2   | 9.1         | 13  | 6.9         | -14  | 7.0         | -12 | 6.9         | -15  |
| Media Activities   | 2.0         | -2  | 2.1         | 3   | 2.3         | 11   | 1.9         | -8  | 1.9         | -10  |
| <b>Total Economy</b>   | 100.0       | 0   | 100.0       | 0   | 100.0       | 0    | 100.0       | 0   | 100.0       | 0    |

Sources: EUKLEMS-Datenbasis 3/2008, OECD STAN 2008; calculations by DIW Berlin.

DIW Berlin 2009

orientation in their economies. Between 1995 and 2006 the percentage of value added revenues generated by research intensive industries rose in Germany and the EU-10, remained essentially unchanged in Japan and the EU-14 (excluding Germany), and fell in the US. In the category of cutting edge technology Germany registered in importance and the US registered the largest decline.

### A Diversified High Level Technology Sector in Germany

Differences and changes in the structural composition of the surveyed economies can be quantified based on each sector's relative share of nominal value added (so-called relative value added, or RVA). A positive value designates an above-average share on an international basis. A negative value, on the other hand, represents a below-average share. In this way, a high positive value indicates that a country is relatively specialized in a given sector.<sup>5</sup>

An international comparison reveals Germany's strong and growing specialization in research-intensive industries, particularly in the category of high level technology (see Figure 2). In each technological sector Germany has a large value-added percentage. This indicates that Germany has distinct competitive advantages alongside a broad spectrum of technological industries.

The new EU member states (EU-10), by contrast, rank below average in the highlevel sectors. They are particularly specialized in areas in which also Germany has a comparative advantage, including electrical devices and equipment as well as machinery and automotive engineering.

Aside from the sub-category of measurement and medical technologies, Germany is not specialized in the high level sector. The nature of Germany's specialization was one reason why the country did not experience a falling share of value added in this sector in the wake of the tech bubble crash in 2001, as was the case in the US and Japan, where a greater impact was felt by plunging revenues in the IT and communications industries.

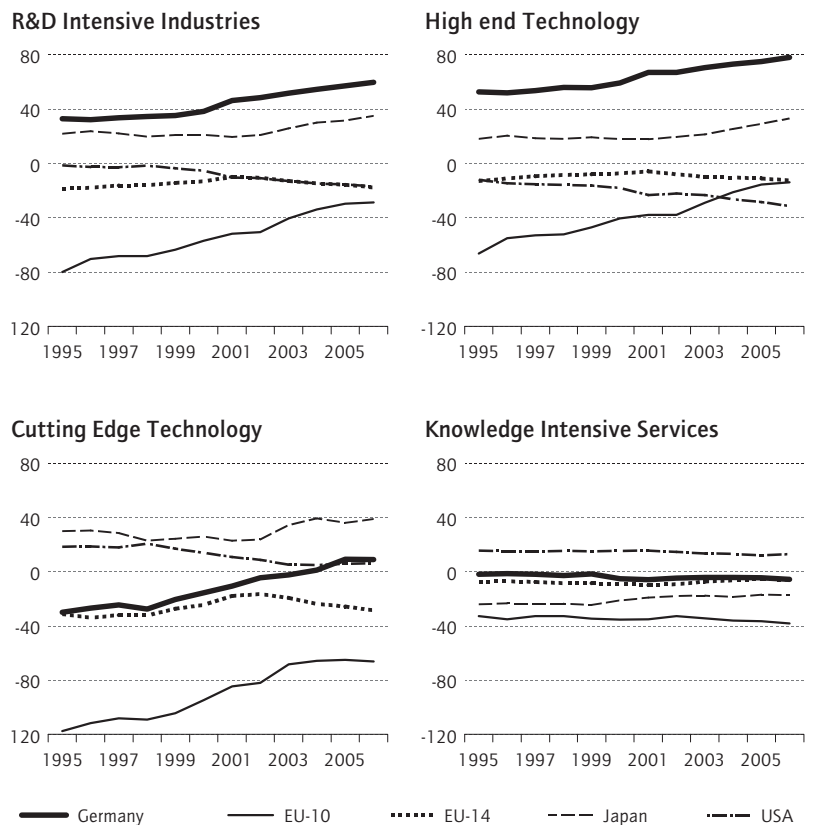
The US is the only country/region specialized in knowledge intensive services (such as finance and health-care services). Germany and the EU-14 do not have an above-average share of value added in this sector. In Germany, however, busi-

<sup>5</sup> The comparison is on the basis of PPP that considers the sum of the nominal value added of the US, Japan and the EU-25. The RVA values are natural logarithms multiplied by 100.

Figure 2

### R&D Intensive Industries, High end Technology, Cutting Edge Technology, Knowledge Intensive Services

RVA



Sources: EUKLEMS-Datenbasis 3/2008, OECD STAN 2008; calculations by DIW Berlin.

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ness services that are closely bound with research intensive industries constitute one exception to this case. Comprising just 5% of gross value added, the financial-services sector has by far the smallest significance in Germany of all countries considered. In the US this figure is twice as high. In the current financial crisis, this German disadvantage could prove to be a benefit.

### Germany's Unique Specialization Profile is an Economic Strength

Germany's specialization profile in R&D and knowledge intensive industries differs significantly from that of the US (see Figure 3 and Table 2). Germany is specialized in numerous R&D intensive industries in which the US is not specialized. Medical technologies and chemicals are the only two industries in which both countries have a distinct focus. In knowledge intensive services the US

is particularly strong, while Germany is rather weak. Yet on a general level, the sector profiles of both countries are complementary to one other—the US is more specialized in knowledge intensive services, while Germany is more specialized in research intensive industries. In terms of classic trade theory, this is an indicator of stable and advantageous trade relations.

Japan and Germany both have a strong emphasis on R&D intensive fields. In several sectors, including the automotive industry, electrical devices and equipment, as well as machine building, Japan and Germany's specialization profiles stand in competition to one other. In other R&D intensive fields, however, Germany and Japan have complementary specialization profiles, i.e. only one country is specialized in a particular sector. Telecommunications is one such sector in the case of Japan. Areas of specialization unique to Germany include pharmaceuticals, scientific instruments as well as the non automotive transport sector and railroad industries. On the whole, however, Japan and Germany cannot be said to have clearly complementary or clearly competitive specialization profiles.

Analysis of the data for the other Western EU countries also leads to the same findings. Germany is more specialized than the other EU-14 countries in R&D intensive and knowledge intensive sectors—its RVA coefficients in each sector are markedly higher. Germany's specialization advantages are particularly distinct in R&D intensive industries. In the knowledge intensive service sector, by contrast, Germany tends to lag behind, but the differences are much smaller in this area.

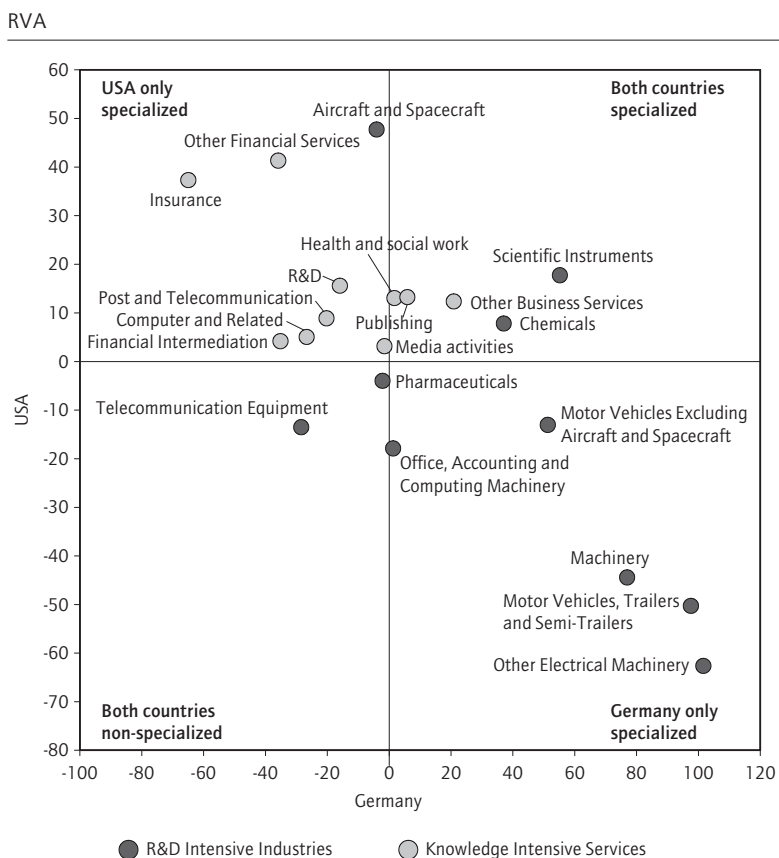
The distribution of value added output across sectors in Germany is most closely mirrored by the new EU member states. These relatively new competitors have a specialization disadvantage in all research and knowledge intensive industries aside from electrical devices and equipment. These disadvantages are less prominent in the sectors in which Germany is specialized, and more distinct in the areas in which Germany is itself at an international disadvantage, such as knowledge intensive services. In this way, the EU-10's specialization profile in R&D intensive and knowledge intensive industries stands in greatest competition to Germany's own profile.

**Conclusion**

From 1995 to 2006, the share of economic activity devoted to research and knowledge intensive goods and services continued to increase in Germany. Companies operating in the high level technology

Figure 3

**Sector Specialization in Germany and the US in Terms of Relative Value Added, 2006**



Sources: EUKLEMS-Datenbasis 3/2008, OECD STAN 2008; calculations by DIW Berlin. DIW Berlin 2009

sector constitute the most important pillar in Germany's economy. Internationally, Germany's share of value added in the cutting edge technology

Table 2

**International RVA Correlation Analysis in R&D and Knowledge Intensive Industries, 2006**

|                          | number of industries | coefficient | R <sup>2</sup> |
|--------------------------|----------------------|-------------|----------------|
| Germany in comparison to |                      |             |                |
| USA                      | 20                   | -1,17 ***   | 0,540          |
| Japan <sup>1</sup>       | 19                   | 0,11 –      | 0,014          |
| EU-14                    | 20                   | 0,20 –      | 0,009          |
| EU-10 <sup>2</sup>       | 18                   | 0,85 **     | 0,270          |

<sup>1</sup> except other Financial Activities.

<sup>2</sup> except Aircraft and Spacecraft and Post and Telecommunication.

\*\*\* significant at the 1% level; \*\* significant at the 5% level; – not significant.

Sources: EUKLEMS-Datenbasis 3/2008, OECD STAN 2008; calculations by DIW Berlin.

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and in R&D intensive service industry categories is average. By contrast, Germany's communications, IT, and financial service sectors are all smaller than average on an international basis. Outside of these sectors, two areas of particular strength are business-oriented services as well as measurement and medical technologies.

Germany has been highly successful in world markets with this specialization profile. The competitive strength of Germany's firms in conjunction with a rapidly growing world economy fueled positive GDP growth in Germany in recent years. The global economy has slowed rapidly since the fall of 2008, however. Investment demand in all branches is now in retrenchment. Sharp production declines have been witnessed in the important growth industries of the high level technology sector.

Yet Germany is still in a strong position over the mid to long term thanks to its specialization profile.

This is supported by the following observations:

1. The technological development and modernization processes underway in Eastern Europe and large parts of Asia translate into increased global demand for capital goods. In the capital goods sector Germany continues to lead internationally with a broad spectrum of technologically sophisticated products.
2. The specialization profile of the German economy is not one-sidedly focused on a few industries. Rather, it is characterized by a wide range of products from nearly every area of the high end technology sector, as well as many areas of the cutting edge and knowledge based service sectors.
3. Germany's product portfolio in R&D intensive and knowledge intensive sectors is for the most part complementary to its trading partners, especially with regard to the US and Japan.

Germany has good chances of emerging strong from the current recession thanks to the breadth and structure of its R&D intensive products and knowledge intensive services. During the recession, however, it is essential that firms maintain the same level of R&D intensive investment while striving to adapt their diverse technological know-how to changing market preferences.

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