C THE CURRENT SITUATION AND DEVELOPMENTS

C 1 THE CURRENT SITUATION

In comparison with other OECD member countries, Germany can look back on impressive successes. This is considered further in Section D and also in the separate studies of the German innovation system issued by the Expert Commission for Research and Innovation. Positive factors include:

– The willingness of German companies to pursue innovation,
– The extensive patenting of German discoveries not only in Germany and Europe, but also in the triad (Europe, Japan, USA),
– The considerable exports of technological products from German suppliers.

German companies are very active in innovation. Various studies on the basis of the Community Innovation Surveys have shown that the proportion of innovative companies in Germany is higher than in all other EU member states. In 2004 almost 65 per cent of German industrial companies carried out innovation activities. The comparison shows that in almost all sectors Germany is one of the three leading countries in the EU in terms of innovation tendencies.[3]

Relative to the numbers of people in gainful employment, Germany ranks second internationally behind Switzerland for patent applications. Another positive factor is the patent position of Germany in special fields such as nanotechnology, fuel cells, and wind energy. However, all these fields are still relatively small. In the major field of information and communications technology, Germany is below average. The German patent position is unequivocally positive regarding environmental technologies.[4] Of course, patents cannot be equated with successful innovations. Patented ideas have to be utilised commercially by companies, otherwise they cannot generate any macroeconomic benefits.

Germany continues to return excellent export performance. Germany exported R&D-intensive products (Box 4) to the value of 428.3 billion euros in 2005, making it the leading technology exporter ahead of the USA and Japan. Allowing for technology imports of 264.0 billion euros, Germany was the second largest net exporter of R&D-intensive products behind Japan. Germany's per capita trade surplus for R&D-intensive products is also larger than many smaller economies such as Finland, Switzerland, the Netherlands or Sweden. However, this means that Germany is also highly dependent on its successful export activities with R&D-intensive products.

Structural changes

The studies on the German innovation system published by the Expert Commission indicate important structural changes in recent years. There has been a clear shift in value added towards R&D-intensive industry and knowledge-intensive services. These sectors contribute

BOX 03 Schumpeter goods

Innovations often require prior inputs from research and development in order to extend existing knowledge. But sometimes innovations are also possible on the basis of the current stock of knowledge, i. e. without research and development. 'Schumpeter goods' can be R&D-intensive goods (physical products) or knowledge-intensive services (services products).[5] The term 'high-technology products' is equivalent.

BOX 04

Definitions

The Expert Commission uses the following concepts:

'Schumpeter goods' are R&D-intensive goods and knowledge-intensive services.

R&D-intensive goods are goods for which the production process involves an average expenditure annually of more than 2.5 per cent of the sales revenue on R&D.

A distinction is made between: High-level technology goods: expenditure of 2.5 - 7 per cent of the sales revenue on R&D. Examples include pharmaceutical products, motors, filters, machine tools, medical technology, motor vehicles and rail vehicles.

Cutting-edge technology goods: expenditure of more than 7 per cent of the sales revenue on R&D. Examples are active pharmaceutical substances, IT devices, aircraft and space vehicles.

Knowledge-intensive services involve a high proportion of university graduates (above approximately 11 per cent) and a significant proportion of natural scientists and engineers (more than approximately 4.5 per cent).[6] These include telecommunications services, software services, insurance, architecture and engineering services, legal, fiscal, and management consultancy, veterinary and health matters, communications, libraries, archives, museums.

considerably more to the growth of production, exports and employment than other sectors of the economy. Policy-makers are therefore right to emphasise the special role of research and innovation.

The knowledge-intensive services are growing most and make the largest contribution to job creation. This is part of the on-going structural change towards a services society. But this does not mean that in future it will be possible to pay less attention to industry. In fact industry and services are closely interrelated. In particular the knowledge-intensive services provide a series of performances which feed into the R&D-intensive industries.

In the R&D-intensive industries, the cutting-edge technology has a considerably higher rate of growth than the high-level technology. However, the focus of the innovation activities and the technology exports in Germany has for a long time been on high-level technology. The proportion of cutting-edge technology is currently still so low that an appreciable structural shift will only be noticeable in some years' time.

German exporters achieve considerable success with high-level technology products. The foreign trade statistics are led by the automotive industry, followed by mechanical engineering. However, the chemical industry and pharmaceuticals, which in the past were very strong, no longer generate foreign trade surpluses.

Although Germany still has a strong position in terms of foreign trade, a long-term analysis shows that other countries are becoming stronger in the R&D-intensive industries, particularly in the German domain of high-level technology. This is already being reflected in a gradual decline in the foreign trade surplus in high-level technologies.

Research and development

Regarding the proportion of research and development in the gross domestic product, Germany lagged behind the leading countries for many years, but in 2006 had again reached a level of 2.3 per cent, and had thus achieved a relatively good position in comparison with other large industrial countries such as France (2.12 per cent) and Canada (1.97 per cent). However, Sweden (3.2 per cent), Finland (3.5 per cent), Japan (3.3 per cent), Korea (2.8 per cent), Switzerland (2.0 per cent) and the USA (2.2 per cent) are still ahead of Germany. The

distance to the target of three per cent by 2010 agreed by the EU member states in Lisbon is also still considerable.

Until the end of the 1980s, Germany's R&D expenditure relative to the GDP was about 30 per cent above the OECD average. This advantage had shrunk by 2005 to twelve per cent. This was due among other things to the growing R&D expenditure of many smaller countries, which invest preferentially in advanced technology. In Germany, the research-intensity in most sectors of cutting-edge technology has declined, with the exception of pharmaceuticals, for which the research intensity has increased further.

In high-level technology, the German dynamic also lags behind the international level. The most important exception from this trend is the automotive industry, which has considerably improved its position regarding the level of R&D expenditure (nationally und internationally). Research intensity in the chemical industry continues to decline steadily.

A remarkable trend is the increase in research and development in Germany's services sector, although in an international comparison there is still much catching up to be done. There has also been a considerable expansion in commissions placed with external research and development institutions, which can be interpreted as businesses concentrating increasingly on their core competence. Most R&D-orders are placed with other companies, but scientific institutions have also benefited greatly.

A phenomenon internationally and also in Germany is the increasingly pro-cyclical behaviour of companies regarding their R&D activities. For some years they have been increasingly orienting themselves towards short-term requirements. R&D seems in part to have lost its proactive, longer-term character. This could indicate that part of the increase in German R&D expenditure in 2006 was relating to the economic developments and was not structural in nature.

Increasing R&D expenditure

R&D expenditure by German companies in 2006 amounted to 51.98 billion euros, which represents an increase of 7.4 per cent over 2005. Whereas approx. 304 500 personnel (full-time equivalence) were employed in R&D in 2005, this rose to about 312 000 in 2006. The personnel level for 2007 is expected to be about 320 000. Company projections for R&D are also available for 2007 and 2008. According to these unconfirmed estimates, R&D expenditure for R&D in 2007 will have been 54.34 billion euros, and for 2008 will be 55.51 billion euros, with corresponding estimated growth rates of 4.5 per cent (2007) and only 2.2 per cent (2008).

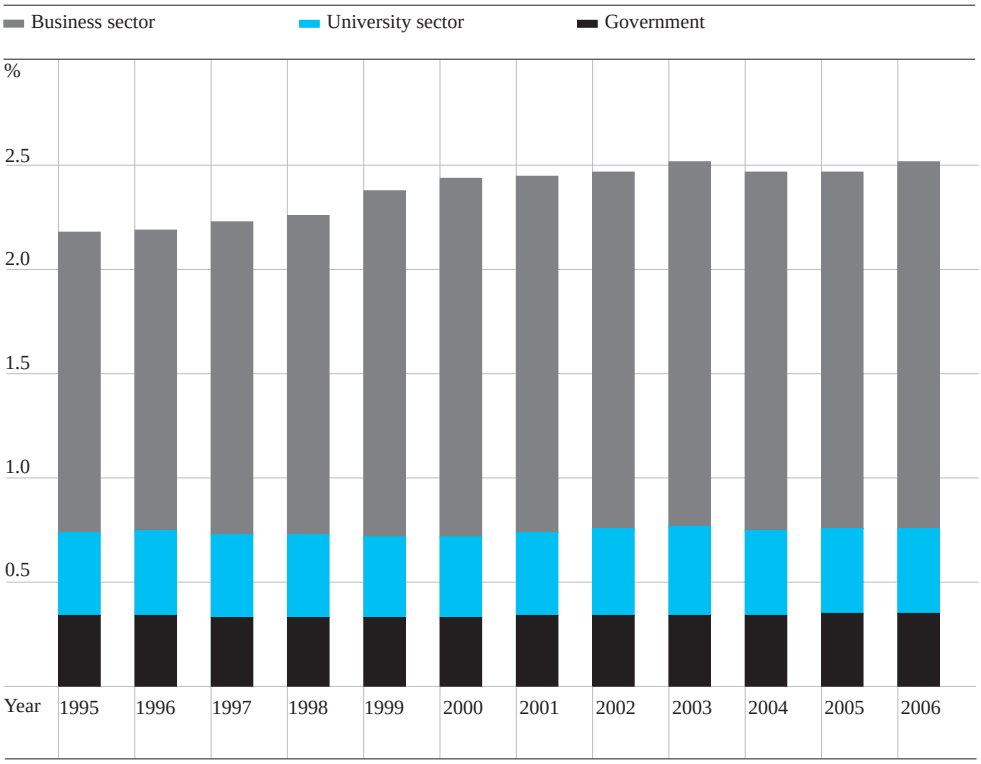
R&D expenditure of the companies developed better than expected in 2006 and totalled 1.77 per cent of GDP. Exact figures are not yet available for R&D expenditure in the university and the state sectors, but taking 0.76 per cent on the basis of 2005 as reference, overall R&D expenditure in 2006 increased to 2.53 per cent of GDP (Figure 01).

In an international comparison, Germany is therefore in the leading group of OECD member countries, but remains behind Sweden, Finland, Japan, Korea, Switzerland, and the USA. But Germany has a considerably higher R&D intensity than the average for the EU-27 member states, or than France and Great Britain (Figure 02).

The recent figures on innovations expenditure confirm these conclusions. German companies increased their innovations expenditure in 2006 by about 6 per cent to 115.5 billion euros.[7]

R&D expenditures in Germany as per cent of GDP

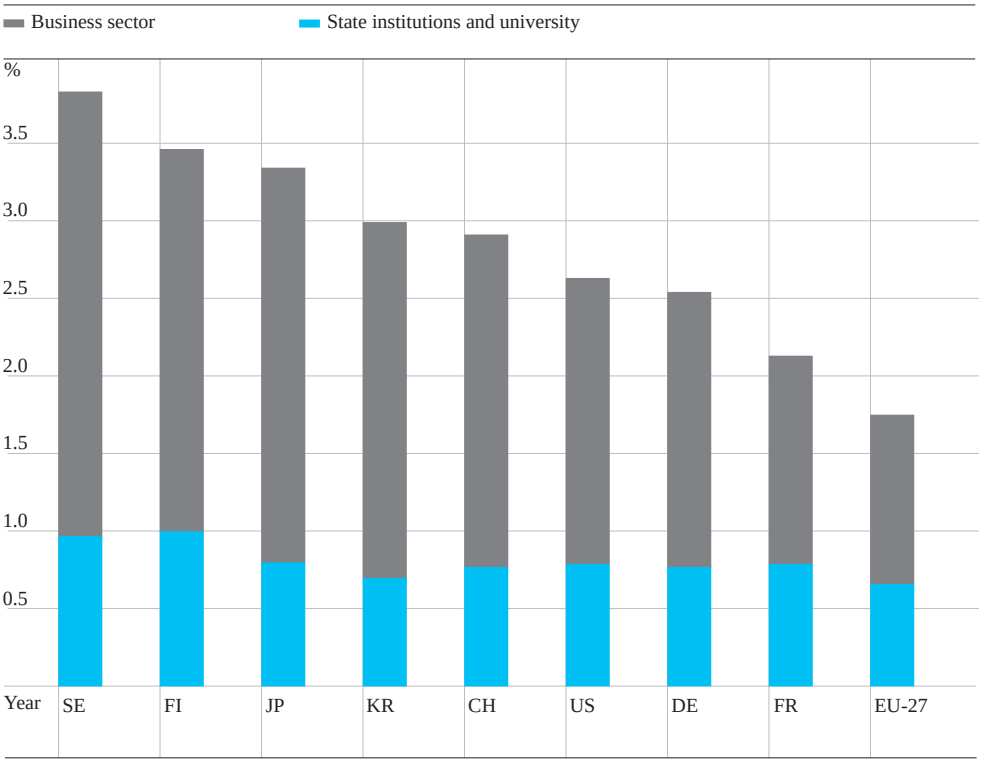
FIG 01



Source: Stifterverband (2008).

R&D intensity of selected countries 2006

FIG 02



Source: Stifterverband (2008).

Company revenues increased by about the same amount. The estimates of the companies for 2007 indicate a further increase of 5.5 per cent, and for 2008 they expect a lower increase of two per cent.

In all, it seems that there was healthy growth in 2006 and 2007, both in R&D expenditure and also in innovations expenditure. However, we view the projected figures for 2008 with some concern.

Commitment to the three-percent target

The German federal government has variously expressed its commitment to the EU's Lisbon target of achieving an R&D intensity of three percent. The three-percent target acts as a clear signal, and with their decision the German government underlines the importance of research and innovation. However, it will require considerable efforts from all sides if the target is to be reached.

The projections for R&D and innovation expenditure for 2008 indicate that additional impulses will be needed in order to reach the three-percent Lisbon target. The German government estimates that R&D expenditure by state, universities and business will have to be increased to approx. 79 billion euros in 2010. We calculate that some 70 000 additional R&D personnel will be needed.[8] Given that there is already a shortage of skilled personnel, it is clear that achieving the three-percent target will not be easy. In the following sections we present various ways to increase R&D expenditure and to avoid emerging bottle-necks in the availability of skilled personnel.

Research and innovation in small and medium-sized enterprises

Small and medium-sized enterprises (SMEs) do not carry out much of the research in Germany, but they play a central role in the dissemination of innovations. The involvement of SMEs in on-going research is therefore an important indicator. There has been a clear reduction over the past decade in the R&D involvement of SMEs (D 3–3). This also affects the innovation expenditures of the SMEs, which are also in decline.

At the same time, the level of state subsidies for companies in Germany has halved since the start of the 1990s, which has also impacted on the research involvement of SMEs. This declining state involvement corresponded to an international trend. In many OECD countries, however, there has been a renewed increase in support for industrial R&D since the mid-1990s, especially through indirect instruments such as tax rebates. These are of benefit above all to SMEs, and they increase the volume of R&D subsidies considerably. Possible effects of the increased support for R&D in Germany since 2006 are not yet visible in the statistics.

Innovator rates and innovations expenditure

The proportion of companies introducing new products and processes, which had declined consistently from the year 2000 onwards, is now increasing slightly again. The situation

BOX 05 **Innovation and imitation**

Successful innovations are soon copied. From the point of view of the innovator such imitations reduce the private earnings from an innovation. But imitation processes also have certain macroeconomic benefits, for example preventing the development of monopolies. Dynamic competition is not imaginable without both innovation and imitation.

is similar for the revenue generated with innovations. Like R&D expenditure, innovation expenditure is procyclical. In times of economic growth it tends to increase, and then declines again in economic downturns. It is also noticeable that since 2000 there has been a marked decline in the proportion of original new products among the innovations, which now more frequently involve imitations or have a more reactive character.

The innovation expenditure relating to services as a proportion of turnover is increasing appreciably, which corresponds to the observation for research and development.

Patent applications

For patents with an international orientation, which have been increasing again in recent years, high-level technology predominates. The German share of patents in cutting-edge technology is small in global comparison, and has been declining since the year 2000. Germany has a strong position for patent applications in high-level technology, which it has been able to maintain. The numbers of applications in this field of technology in Germany are increasing to about the same extent as the overall figures for worldwide applications. Regarding high-level technology patents, Germany specialises primarily in automotive construction und mechanical engineering, whereas patenting in biotechnology, information technology and telecommunications is still much less important than in other countries.

New enterprises

New enterprises make an important contribution to economic competition. New, efficient companies replace older, less efficient ones. In Germany, both the relative numbers of new enterprises founded and the proportion of all companies closing down remained below comparable figures for most other countries. The structure of entrepreneurial activity in Germany is also less strongly directed towards research-intensive and knowledge-based sectors of the economy than in other highly developed countries. After the collapse of the New Economy, overall entrepreneurial activity in this sector weakened. With fewer new enterprises being set up and fewer closures, the innovation pressure on existing companies in Germany is comparatively low, with fewer innovation impulses. Relative to the size of the economy, fewer innovative ideas are tested for their market relevance than in many other industrialised countries.

Training and qualifications

The innovation pressure in the knowledge-based economy has raised the demands on the qualification profile of the workforce; highly qualified personnel play a key role in innovation competition. The inexorable intensification of knowledge calls for advanced academic qualifications, and for high-quality vocational training in the middle layers.

Annually, an additional demand for up to 50 000 graduates is to be expected, not even allowing for any increase in demand generated by economic growth. In particular in the natural sciences, engineering and computer sciences this is leading to severe shortages, and will act as a constraint on innovation and thus also on economic growth.

The numbers of students starting university courses, which had declined steadily in all disciplines since 2003, began to rise again in 2007. Numbers of students are expected to continue to rise until 2012, boosted also by the shift from 13-years schooling to 12 years in many areas. However, in the longer term, demographic developments will lead to a reduc-

tion in cohort sizes. This makes it all the more important to reduce the excessive numbers of student currently dropping out of engineering and the natural science courses without a qualification.

Even now, the demand for suitably trained and qualified skilled personnel is considerably higher than the available supply. Given the long reaction times involved with measures in the educational sector, appropriate steps are urgently necessary.

Germany as a research location and German research in other countries

Germany is the second largest research location for foreign companies after the United States of America. In all about a quarter of the research in Germany is attributable to the subsidiaries of foreign companies.

Conversely, German companies carry out a quarter of their R&D at foreign locations. In the past, United States and Great Britain were the preferred location for the research and development work of German companies. Increasingly, research is now being carried out in Asian newly industrialising countries and in eastern European countries. The re-location of German R&D activities is currently rare, but will probably become more common in the medium-term. This is due less to wage differences than to the availability of specialised personnel.

The growing economic power of the Asian newly industrialising countries, in particular China and India, is meanwhile common knowledge. However, these countries are still often regarded as producers of cheap imitations which do not represent any real competition for the high-technology producers of the leading industrialised nations. The figures on publications, patents, foreign trade or R&D, however, show that these countries are making considerable efforts to provide large numbers of highly qualified personnel and are initiating rapid growth in all the sectors mentioned.

The newly industrialising countries now account for a quarter of worldwide expenditure on research and development, a doubling over the past decade. The patent profile shows that countries like China are increasingly orienting themselves towards high-level technology and even cutting-edge technology.

Summary

Germany is well positioned in many areas in research and innovation. This applies in particular for foreign trade with high-level technology products and the numbers of patent applications. Public and private expenditure for research and development is increasing again, and the innovator rate is stable at a relatively high level.

BOX 06 Equity and loan capital

Equity is the capital provided by the owners of a company plus any retained profits. The owners of the company are entitled to the earnings remaining after the payment of all liabilities to the employees, external investors and other creditors. Should the company become insolvent, the equity serves to meet the claims of creditors. In this sense, equity bears the risk of the company. Loan capital must be repaid after a specified period, and in addition interest must be paid. In order to ensure that loan capital will be repaid, banks require sufficient prospects of future company profits or the provision of securities. This means that young, innovative companies are often only able to draw on equity financing. The equity is regularly put up by the founders of the company or by investors (shareholding).

However it is important to note a number of critical points:

– The foreign trade balance for R&D-intensive products shows a negative trend, attributable to the growing international competition from other industrialised and newly industrialising countries.
– The increase in patent applications and in research and development activities has not yet led to a relative improvement in Germany's position, because corresponding activities have also been increased in other countries.
– The concentration on high-level technology has in the past been a central advantage for Germany over its international competitors. However, in the medium-term it will be necessary to shift the emphasis to cutting-edge technology. Such a change is taking place in Germany, but from a very low base and much more slowly than in most other countries.
– The Asian newly industrialising countries are very involved in high-technology and have meanwhile reached an impressive level. This is also a reason for further increasing the innovation activities in Germany.
– The numbers of new enterprises being established in Germany is relatively low in an international comparison. This applies in particular in the research-intensive sector and in knowledge-based services. In Germany, not enough research results and new ideas are tested on the market.
– A particularly grave problem for R&I in Germany is the growing shortage of qualified personnel. With the continual structural change towards a knowledge-intensive economy and a services society, the demand for specialist personnel is increasing. The qualification initiative finally started by the German federal government in January 2008 is therefore most welcome. The supply of highly qualified personnel will become an important factor influencing the choice of research locations for companies within the framework of globalisation.

This assessment of the situation will now be analysed on the basis of the financial, fiscal, and educational framework conditions as well as the Hightech strategy and the growth potential of the German economy.

CONDITIONS FOR FINANCING INNOVATIONS C 2

Equity essential for innovations

Adequate financing is essential for successful innovations, and in most cases this involves equity (Box 6). However, for various reasons, German companies have relatively low equity ratios – on average 11.7 per cent for medium-sized companies and 26.8 per cent for large ones.[9] This financing structure is considered to be a constraint on innovation.

Whereas the equity market is very important for the financing of innovations in Germany, in comparison to the size of the economy it is still underdeveloped.[10] Not only is the absolute level of the capital invested lower than in comparable European industrialised countries[11] – but also equity holdings are still inadequate in an international comparison. The result is that there are persistent gaps in the supply of financing for young, smaller companies.[12]

In view of the importance of equity for financing innovations, the fiscal framework conditions are of considerable importance both for the companies as well as for providers of loan capital – fiscal policies are thus always an element of innovation policy.