R&D in enterprises in Austria accounted for 6.4 per cent of expenditure, but including tax aid it amounted to 17.4 per cent. In Great Britain the figures were 8.6 per cent and 12.9 per cent, and in the USA 9.7 per cent and twelve per cent, respectively. The conclusion is that in recent years the state R&D aid for SMEs in other countries has progressed more than in Germany.

D 4 INNOVATION AND PATENT BEHAVIOUR IN THE GERMAN ECONOMY

D 4 – 1 INNOVATION BEHAVIOUR IN THE GERMAN ECONOMY

In the context of companies the concept of innovation refers to bringing new goods and services to the market and introducing new processes. Whereas research and development generate new knowledge, innovations involve the development of market-relevant products and their marketing. This section presents key results of a recent annual company survey.[85]

Innovator rate in long-term decline

Despite improving economic conditions, there was no increase in the proportion of companies in Germany with product or process innovations in the manufacturing and services sectors in 2006, and the figure remained at about 46 per cent. Differentiated in terms of sectors, the innovator rate was highest in the manufacturing industries at 58 per cent (Figure 15). For the knowledge-intensive services it fell to 52 per cent (from 55 per cent in the previous year). Here the innovation participation of companies has been very irregular in recent years, which is an indicator perhaps of a shorter-term orientation of innovation activities. For other services the innovator rate rose slightly, but at 33 per cent it is much lower in this sector than in manufacturing or the knowledge-intensive services. Many companies can obviously achieve market success without continuous innovation activity.

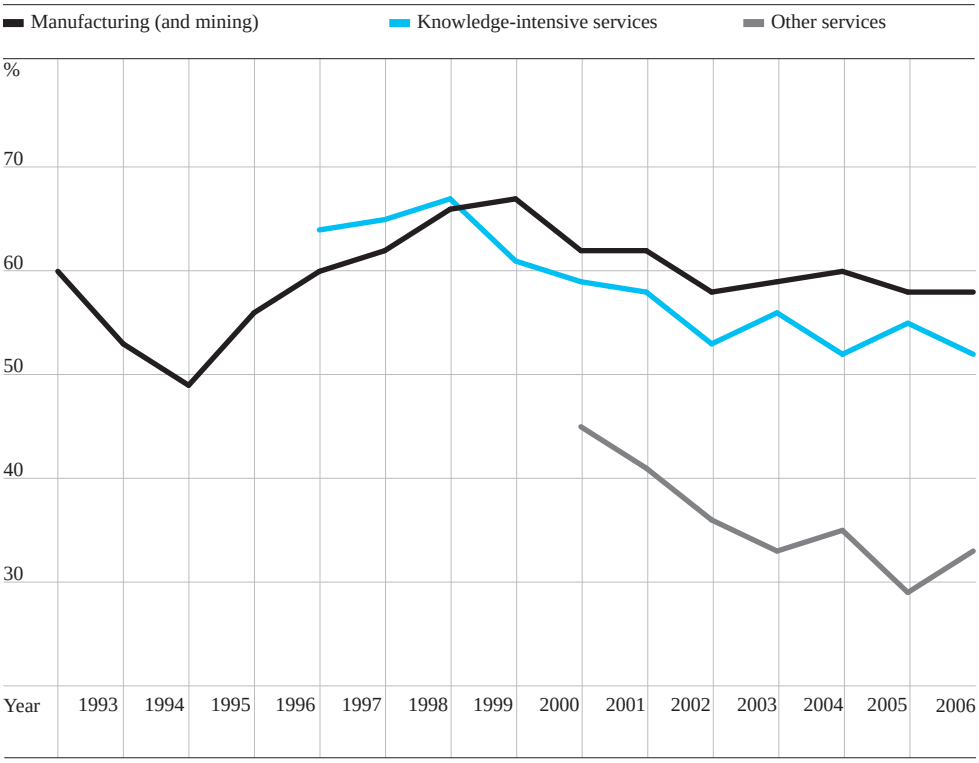
Innovation activities can either aim at introducing new products or new processes within the company for production, service provision, or marketing. Within a three-year period, a considerable proportion of the innovators – 47 per cent in the industry sector, and some 40 per cent in the services sector – realised both product and process innovations. 20 per cent to 25 per cent of the innovators introduced only process innovations, and 35 per cent to 40 per cent are solely product innovators.

Decline in innovations after the New-Economy boom

For the first time in some years, a slight rise could be observed in 2006 in the numbers of companies introducing products new to the market. These are companies launching at least one innovation on the market which none of their competitors had previously offered in this or a similar form. It is not sufficient for the commodity in question to be a novelty for the company in question. The proportion of product innovators rose to 47 per cent in the manufacturing sector and to 31 per cent for other services; in the case of knowledge-intensive services it fell slightly to 33 per cent.

The overall proportion of companies innovations new to the market decreased over the past seven years – obviously it is becoming more difficult to market original new products. The high figures at the end of the 1990s are related to the dynamism of IC technology in that period. As with production, balance of trade, and R&D, the figures for innovations clearly reflect the effects of the New-Economy boom and its collapse in 2001. As already noted for

Innovator rates in the German economy FIG 15



Source: ZEW.[86]

the international comparison of labour productivity, Germany lags behind Japan and the United States when it comes to introducing original new products.

Increasing innovation expenditure

Although there has been a long-term downward trend in the innovator rate in all sectors since 1999, for some years there has been a continual increase in innovation expenditure. The value of EUR 115.5 billion in 2006 is nominally 6.3 per cent more than in the previous year, and was considerably larger than the companies had been planning at the start of 2006. This shows that they took short-term decisions to reallocate resources in favour of innovation activities. This observation corresponds to the pro-cyclical behaviour already noted for R&D activities. The increasing innovation expenditure coupled with a declining innovator rate is due to the growing concentration of innovation activities in large companies.

Nearly three-quarters of innovation expenditure, namely 72 per cent, was in the manufacturing sector, where the innovation budgets increased by more than 5 per cent over the previous year. There was the same rate of growth in the budgets for knowledge-intensive services, so that this sector accounted for 19 per cent of overall entrepreneurial expenditure on innovations. Other services experienced a jump in their innovator rate, and innovation expenditure also increased by 11 per cent, so that 7 per cent of the overall innovation expenditure came from this sector.

For 2007, the plans of the companies from the start of the year indicated a further increase in innovation expenditure of 5.5 per cent. The projected rise for the knowledge-intensive sector was higher (+7 per cent), while the innovation budgets in the other services were to

be reduced again. In the manufacturing sector, the increase of about 6 per cent corresponds roughly with the average planned growth for the total commercial economy.

Increasing innovation intensity of knowledge-intensive services

Despite the rise in innovation expenditure in 2006, there has hardly been any change in the relationship of innovation expenditure to revenue, the so-called innovation intensity. However, in the case of knowledge-intensive and other services the growth in innovation expenditure was greater than the rise in revenue. Although there has been a decline over the medium-term in the innovation intensity in the manufacturing sector and the other services, there has been continual growth in the knowledge-intensive services.

Of the innovation expenditure, 34 per cent was spent on investments in property, plant and equipment, or intangible assets. In the late 1990s this investment rate had been 45 per cent. This means that a disproportionately high amount of the additional innovation expenditure is going towards costs for personnel, materials, and preparatory performances (including outsourced work).

In general, process innovations can serve two purposes – either new processes are aimed at reducing costs through more efficient production of goods and services, or they have the goal of improving quality. In all three sectors of the economy considered here, the proportion of process innovators who achieve an improvement of quality is higher than the proportion of rationalising innovators. In the manufacturing industry, 71 per cent of process innovators produced quality improvements, 72 per cent in the knowledge-intensive services, and 54 per cent in the other services. These figures have been more or less constant since the year 2000.

Slightly increasing contribution to turnover with product innovations

The direct economic success of product innovations can be measured by the contribution to turnover achieved with the newly introduced products. In order to allow for the time lag between introducing an innovation and any increase in revenue, all products are considered which have been introduced over the previous three years. The contributions to turnover in the manufacturing sector and in the knowledge-intensive services showed slight increases in 2006, with a rate of 28 per cent for the former and 14 per cent for the latter. Other service providers achieved an increase of about 1.5 per centage points to 7.5 per cent.

The share of turnover of new products on the market, often referred to as the innovation rate, is influenced to a considerable extent by the sales of imitations. The turnover of market innovations, on the other hand, measures the contribution of original product innovations to overall turnover. This figure is much lower than the share of turnover achieved with new products. In 2006, original market innovations in the manufacturing sector generated 6.4 per cent of total turnover, slightly less than in 2005. In the knowledge-intensive services it remained constant at 4.7 per cent. A longer-term comparison shows a falling trend in all three sectors examined, as seen with the proportion of innovative companies. In other words there has been an overall drop in the level of innovation in products.

Research and development are key components of innovation expenditure

Research and development are key components of innovation activities. Almost 50 per cent of all innovation expenditure is on internal or external R&D, with a higher proportion in the

BOX 16

World market patents

These are patent applications aimed at obtaining protection in a large number of countries. For this purpose, application at the World Intellectual Property Organisation (WIPO) and additionally at the European Patent Office are evaluated.[87] Because of the complex legal procedures involved and the higher costs, international patents often cover inventions with greater technological and economic relevance than is the case for national applications.

manufacturing sector and a lower proportion in the services sectors. The proportion of companies which continually run in-house R&D is a measure of the innovation activities aimed at the creation of new knowledge and is thus an indicator of the need to develop new technologies and methods for innovative projects. The R&D involvement of German businesses fell in 2006. In the manufacturing sector the proportion of continually researching companies was down slightly at 23 per cent. For the knowledge-intensive services the downward trend which had been observed since 2004 was not continued, and 15 per cent were involved in R&D in 2006.

Importance of innovations for marketing and organisation

The OECD redefined the concept of innovation in 2005 so that in addition to product and process innovations it also covered new methods of marketing and organisation. The Mannheim Innovation Survey in 2007 took these innovation activities into account for the first time in Germany, and reported that 56 per cent of manufacturing companies had made marketing innovations in 2006, and 60 per cent had made organisational innovations (Figure 16). Each type of innovation is thus about as prevalent as product and process innovations are together. The proportion of companies who have introduced at least one marketing or organisational innovation is 73 per cent, which is considerably higher than the conventional innovator rate of 58 per cent (Figure 16).

For these new types of innovation, the ranking of the three main sector groups considered here is research-intensive manufacturing, followed by knowledge-intensive services, and then other services. This is the same as for the product and process innovations, but the gaps between the sectors are smaller.

GERMAN PATENTS IN INTERNATIONAL COMPARISON

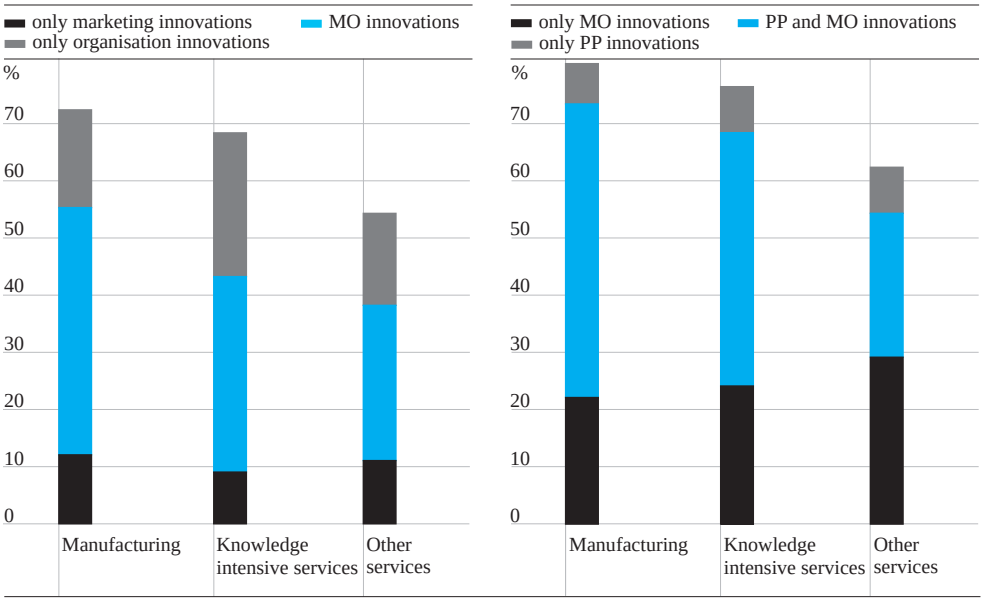
D 4 – 2

Patents are innovation indicators which reflect primarily the output of technological activities, that is of the research and development and innovation activity. Patents serve to protect market advantages over competitors and their numbers are therefore always linked to the strategic importance of a national market sector. Therefore it is significant where an application is registered. The following sections consider world market patents.

Peak of patent applications in the year 2000 exceeded again

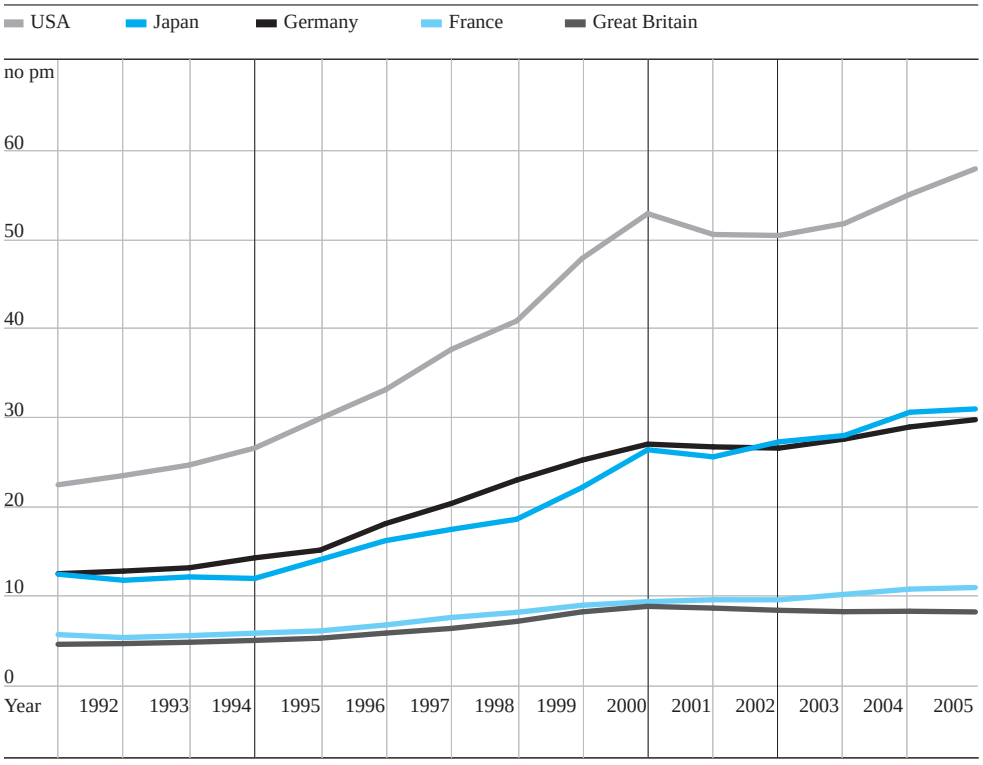
There have been three key phases of development since the mid-1990s. Firstly, there was a period of growth in the second half of the 1990s (Figure 17). This was related to the increasing relevance of technology in the competition between high developed countries and the growing strategic importance of patents. In addition to the protection which patents offer to inventions, they can also block the technological activities of competitors, secure an institution's expertise in cooperation projects, provide motivation for personnel, or increase creditworthiness. At the same time the euphoria of the New-Economy boom also stimulated patent applications, so that in this phase patent applications were increasing at a faster rate than research and development.

FIG 16 **Companies with marketing and organisation innovations**



PP: Products and processes, MO: Marketing and organisation.
Source: Rammer und Weissenfeld (2008).[88]

FIG 17 **International patent applications for selected countries**



Source: EPPATENT and WOPATENT databases (Questel-Orbit). Calculations by Fraunhofer ISI.

When the New-Economy boom collapsed, patent applications stagnated or even declined slightly, like other innovation indicators. Since 2003 there has been another phase of less dynamic growth, so that in most countries the level of 2000 has meanwhile been exceeded again.

Strong position of Germany for international patents

A comparison of absolute figures of large countries shows the leading position of the United States, which has been going through a dynamic phase of patenting recently. Germany and Japan have also shown a rising trend in the past few years. Japan would have been expected to show a stronger increase in patent applications in view of the considerable growth in research and development. At first sight it may seem surprising that Germany and Japan have very similar levels, because the Japanese economy is about twice the size of Germany's. But Japan is less strongly export-oriented than Germany and is also linked quite closely with the American market. German companies, in contrast, trade with a broad spectrum of countries, and therefore are more interested in broader patent protection. In recent years, France has shown a slight upwards trend, whereas the numbers for Great Britain have fallen slightly, even after 2002 in a period when most countries recorded a growth in patent activity.

If the national patent statistics are adjusted to take into account the size of the country, Switzerland has a clear lead in international comparisons (Table 04), followed by Germany, Sweden and Finland, with Japan and the USA ranking lower. These figures demonstrate the technology-orientation of Swiss companies, and they also show that the Swiss are more directed towards the global market than German companies. In the cases of Sweden and Finland, the specialisation in the cutting-edge technology of telecommunications plays a role. The position of the USA may seem at first sight to be surprisingly low, but much of its technological activities are directed primarily towards the domestic market and less towards exports. If only patents in the high-technology sector are considered, the ranking is the same, but the differences between countries are smaller.

In general, there has been less growth in high-technology patents than in the total number of patents since 2000, and in Sweden, Finland, and Great Britain there has actually been a clear decline. Here we can still see the damping effect of the collapse of the New Economy boom.

Intensity of world market patents for selected countries, 2005 TAB 04

	Total	High-technology
Switzerland	1057	440
Germany	767	365
Sweden	765	349
Finland	762	437
Netherlands	573	238
Japan	485	234
France	436	212
United States	402	210
Korea	371	211
Great Britain	265	126
PR China	6	3

Applications per one million employees.
Source: Databases EPPATENT, WOPATENT (Questel-Orbit).
Calculations by Fraunhofer ISI.

Stagnation in Germany's specialisation in high-level technology

The analysis of German patents in terms of high-level technology, cutting-edge technology, and high technology overall shows a specialisation in high-level technology, as already noted for production, foreign trade, and research and development. In contrast to foreign trade specialisation, where there has been a slight downward trend since the start of the 1990s, there was a period of growth for patents, followed since 2000, as with foreign trade, by a period of stagnation (Figure 18). The close link between patent specialisation and foreign trade specialisation shows that the current situation can only be maintained by continuous efforts with regard to innovations. The stagnation of the patent specialisation for Germany, despite increasing numbers of patents, is due to the fact that other countries have also augmented their efforts in this sector.

For cutting-edge technology, the specialisation index is very negative, as were the specialisation indices for foreign trade, and research and development. In total, the level of German patents for high technology is close to the world average, but in contrast to foreign trade specialisation it is still slightly negative. This is because cutting-edge technology has a higher

weight in patents compared to high-level technology and therefore has a greater effect on the sum of both sectors, that is high technology (see Box 04).

Strong specialisation in automotive technology, weak values in ICT

Patents can be used to obtain a fine differentiation in terms of sub-sectors. A profile of German patent specialisation shows which fields contribute to the strengths and weaknesses in the high-technology sector. As in the analysis of research and development, the automotive sector is in first place, and engines, motors, and drive technology also ranks highly (Figure 5). These are followed by sub-sections of mechanical engineering such as machine tools or special machines. In measuring and control technology, the strength of high-level instruments is apparent, whereas the advanced instruments category has an index which is slightly below the world average. In the cutting-edge technology, the patent analysis shows negative values for computer equipment, telecommunications, radio and television technology, and also for biotechnology and pharmaceuticals, which illustrates the technology background to the relatively low values of the cutting-edge technology for other innovation indicators classified by products or economic sectors.

D 5 NEW ENTERPRISES

The entrepreneurial dynamic is an important aspect of the technological structural transformation. The foundation of new companies as well as the closure of companies which are not successful can stimulate competition for the best solutions.[89]

New enterprises with new ideas can extend and modernise the range of product and services on offer, and they are a challenge to existing companies. New enterprises in research and knowledge-intensive sectors of the economy have a special significance. However, bringing new ideas onto the market also involves risks and uncertainties. The competition among young, innovative companies and with established companies can be intense, and inevitably some of the new enterprises will not be able to survive in the long term. But even 'failed' new enterprises contribute to structural change. The business ideas they introduced and the innovative options they chose have either failed or they have been adopted more successfully by other companies, and possibly marketed in an improved form.

There have been various phases of starting up new enterprises in Germany. The numbers of start-ups remained fairly constant from 1995 to 1998. They then declined by an average of five per cent per annum between 1999 and 2002, and increased markedly in 2003 and 2004 by about ten per cent per annum, before returning in 2005 and 2006 to the level of 1995.

Fewer foundations of knowledge-intensive enterprises after the New-Economy boom

In 2006, 13 per cent of all new enterprises were involved in knowledge-intensive services, whereas the research-intensive manufacturing sector only accounted for about one per cent. From 1995 to 2000 the share of the new enterprises which were in the knowledge-intensive services had increased from 13 per cent to more than 15 per cent. There was a small surge in the foundation of new enterprises in 1999 and 2000, in particular for ICT services. This was clearly attributable to the New-Economy boom. When this collapsed, the trend was reversed and the share of the knowledge-intensive services declined significantly until 2004.

Knowledge-intensive services can involve knowledge-intensive consultancy (management, law and finances, advertising) and the technology-oriented services (telecommunications, computers, office technology, R&D-services). The technology-oriented services were affected by the New-Economy boom and bust, whereas the knowledge-intensive consultancy services proved more stable and are currently slightly ahead of the levels in the mid-1990s (Figure 19).

The proportion of the new enterprises which are in the research-intensive manufacturing sector has declined steadily since the mid-1990s, and only began to increase again slightly in 2006. But the absolute numbers of new enterprises have hardly been affected by the research-intensive manufacturing sector, i. e. the classic cutting-edge technologies such as pharmaceuticals and biotechnology, medical engineering, metrology/optics, electronics, or aeronautics and astronautics. It would be premature from the slight increase in 2006 to expect a new wave of technology start-ups, because