tensive sector is even declining. This clearly reflects the shortage of qualified personnel.

A recent study on graduate careers[112] shows that highly-qualified professionals are increasingly deciding to work for large companies, and that particularly in recent years there has been a clear shift to the disadvantage of small and medium companies. One reason for this is that incomes at a small company can be 15 000 euros per annum less than at a large company. And the income disadvantages for women are even greater. A further important reason for preferring to work in a large company is the expectation of greater job security. The reasons given for working in a small or medium company are often defensive, such as the lack of an alternative, the threat of unemployment, and above all limited mobility. But the preference for large companies has little to do with the contents of the work: the work in SMEs and large companies is thought to be similarly interesting.

In summary, small and medium-sized enterprises are already at a disadvantage when it comes to recruiting academics, and in particular natural scientists and engineers in manufacturing. Given the clear preference of university graduates to join large companies this situation will in all probability grow worse.

Further details about the structures and development of small and medium companies are provided in the Studies on the German Innovation System.

C 5 NEW ENTERPRISES

New enterprises promote the technological structural change by using new business ideas to expand or modernise the existing products and services, challenging existing companies. New enterprises in the research- and knowledge-intensive sectors are particularly important in this respect. In new fields of technology, when new consumer trends emerge, and in the early phase of transfer of scientific knowledge through to the development of new products and processes, new enterprises open niche markets and help innovative ideas to achieve a breakthrough if they have not been picked up by large companies. The following results about company dynamics in research- and knowledge-intensive sectors of the economy are based on an evaluation of the ZEW-Start-up Panel and the Mannheim Company Panel (MUP).[113]

Every seventh start-up is in research- and knowledge-intensive sectors

Start-up activity in Germany bottomed out after the collapse of the New Markets in 2002, but in the following two years there was a marked rise in the numbers of new companies being started up. The development was boosted in part by the labour market reforms in 2003/2004. Since 2005, the numbers of start-ups have begun to decline again. In 2007 there were 226 000 start-ups, which is 16 percent below the level of 2004.

In the research- and knowledge-intensive sectors, start-up activities in 2003 and 2004 were less dynamic than for the economy as a whole. But in turn, the decline in start-up numbers from 2004 to 2007 was 11 percent compared with 16 percent overall.

In 2007, there were 31 400 start-ups in the knowledge-intensive services and the R&D-intensive manufacturing sector. Every seventh newly started company is in research- and knowledge-intensive sectors:

– In 2007 nearly 13 percent of all start-ups were in the knowledge-intensive services. 14 000 companies were started in knowledge-intensive consultancy and 15 000 companies in technology-oriented services.
– More than 1 percent of all start-ups in 2007 were in the R&D-intensive manufacturing sector: 1 700 start-ups in high-value technology and 700 in cutting-edge technology.

Low start-up rates in the R&D-intensive manufacturing sector …

The number of start-ups related to the overall number of companies gives the start-up rate. It is a measure of the renewal of the stock of companies. The average start-up rate in the research- and knowledge-intensive sectors in 2007 was 6 percent, which is close to the average for all start-ups, which is 6.5 percent. For the knowledge-intensive services the start-up rates were 6.5 percent (technology-oriented services) and

7 percent (knowledge-intensive consultancy). The values for the R&D-intensive manufacturing sector was clearly lower – 3.5 percent for cutting-edge technology and 4 percent for high-value technology.

The discrepancy between start-up rates in the research-intensive and knowledge-intensive sectors is because the market entry barriers in the R&D-intensive manufacturing sector are higher than in the knowledge-intensive services. Factors include a need for a high level of finance, high demands for human resources, the need for specific market knowledge, and a dominance of large companies.

… combined with lower closure rates

While new enterprises are starting up, other companies are closing down. The number of company closures has been declining since 2004, after it had previously been on the increase for several years in a row. In 2007, there were 215 000 company closures, either voluntarily or due to insolvency – 10.5 percent of these were in the research- and knowledge-intensive sectors.

The closure rate expresses the number of closures proportional to the number of companies in the sector. In the research- and knowledge-intensive sectors in 2007 this was below 5 percent, and some 1.5 percentage points lower than in the economy as a whole.

In the R&D-intensive manufacturing sector, closure rates were particularly low: 2.5 percent (cutting-edge technology) and 2 percent (high-value technology). Closure rates in the knowledge-intensive services sector were considerably higher, at 4.5 percent (technology-oriented services) and nearly 6 percent (knowledge-intensive consultancy). The closure rates in the research- and knowledge-intensive sectors from the year 2000 show the various effects of the domestic economy on the individual sectors (Fig. 25):

– In the research-intensive industrial sector the closure rates increased quite slowly until 2002 (and not at all in the high-value technology) and declined again after 2002. The weak domestic economy after the collapse of the New Markets did not affect the closure rates due to the strong export-orientation of rthe R&D-intensive manufacturing sector. In addition there is the high level of fixed assets in comparison to the services sector, so that the companies tend to react to economic downturns by "submerging".
– The closure rate in the knowledge-intensive services decreased disproportionately from 2001 and only really began to rebound after 2004. The modest demand after the end of the New Economy Boom impacted on the many small knowledge-intensive service providers with their relatively low export rates, and caused more closures than in the R&D-intensive manufacturing sector. In addition, the market exit barriers are very much lower than for cutting-edge technology and high-value technology, due to the lower levels of sunk costs.

Growing numbers of companies during the economic upswing

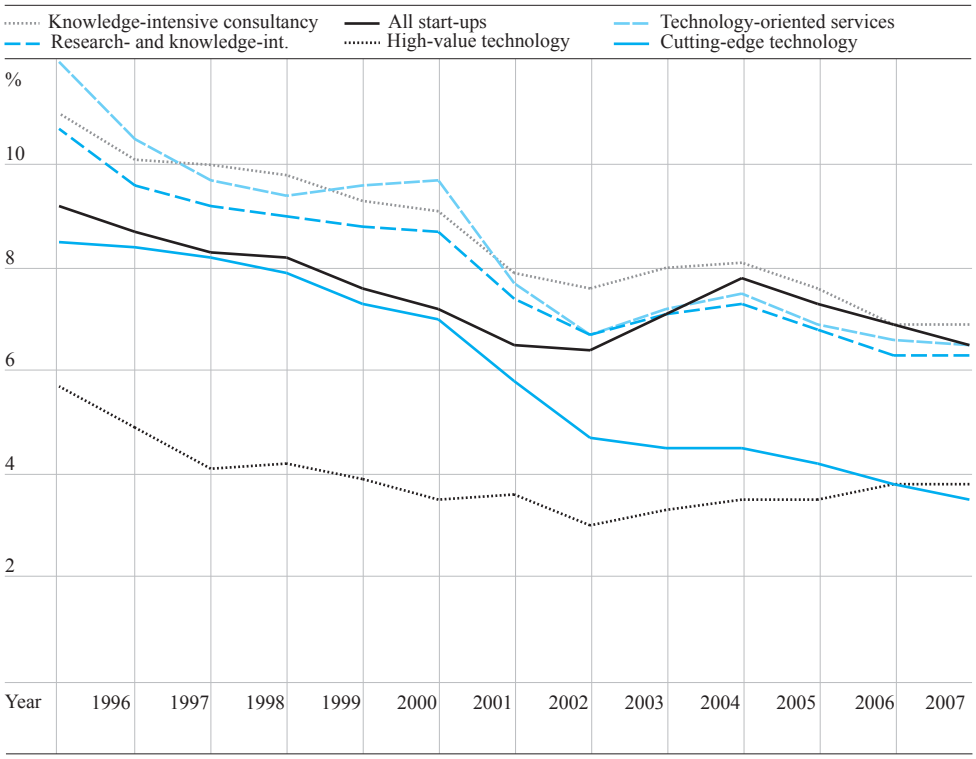
The balance between start-ups and closures shows the change in the company stock and thus the dynamic in a given economic sector. In the general economy, the number of economically active companies decreased between 2002 and 2005, after having increased for many years in sequence. Then in 2006 and 2007 the start-up rate exceeded the closure rate again.

In the research- and knowledge-intensive sectors, a net increase in company stock could already be observed in 2003. Since then, the technology-oriented services have developed most dynamically in the research- and knowledge-intensive sectors. In 2007, the number of companies grew by more than 2 percent. The increase in company stock in knowledge-intensive consultancy was more modest than in previous years. In cutting-edge technology the decline in company numbers in 2002 was followed by a three year stagnation phase. It was only in 2006 and 2007 that the number of companies increased again. In the high-value technology the company stock hardly grew at all in 2003 and 2004. But then the start-up rates were considerably above closure rates, and in 2006 and 2007 the number of companies increased by nearly 2 percent each year.

Every 50th employee in the business economy works in a new enterprise

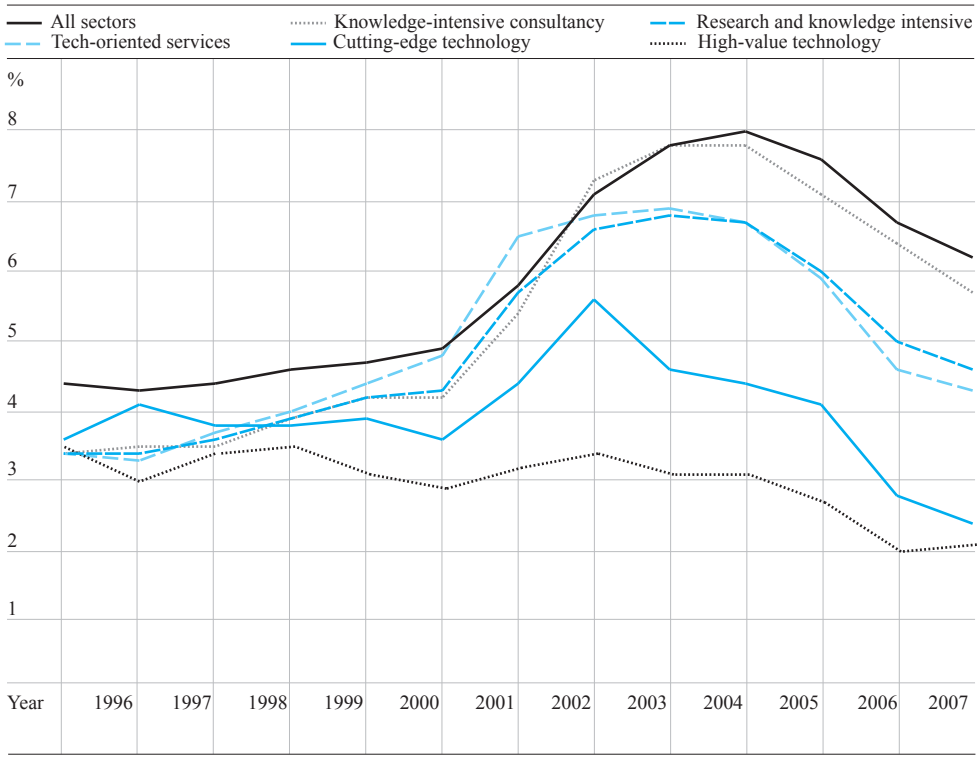
In addition to the development of company start-ups and closures, the direct contributions to employment

Start-up rates in the research- and knowledge-intensive business sectors in Germany FIG 24



No. of start-ups in a year as percentage of annual average of stock of companies. 2007: provisional values.
Source: ZEW-Gründungspanel. Calculations by ZEW.

Closure rates in the research- and knowledge-intensive sectors in Germany FIG 25



No. of closures in a year as a percentage of the annual average stock of companies. 2007: provisional values.
Source: ZEW, Mannheimer Unternehmenspanel. Calculations by ZEW.

of the start-up cohorts 1997 to 2003 were analysed on the basis of the ZEW-Start-up Panel and the Mannheim Company Panel (MUP). For methodological reasons, the survival probability and employment development could only be determined through until 2005.

Companies starting up between 1997 and 2003 had on average a staff of 2.3 (including the founder) in the first year of business, or 2.5 in the research- and knowledge-intensive sectors. The contribution to employment was highest in the research- and knowledge-intensive start-up companies with 5.7 jobs. Start-up rates were comparatively low because high initial investments in fixed assets represent barriers to market entry, but at the same time the minimum competitive size at the start is higher than in the services sector. In the sectors of knowledge-intensive services, new companies in their first year created on average 2.3 jobs for technology-oriented services and 2.1 jobs for knowledge-intensive consultancy.

Taking all branches of the business sector (without agriculture and forestry, public administration, education and health service, churches, and associations) start-up companies and existing companies created on average some 625 000 jobs annually. This is more than 2 percent of the workforce in the business economy. Of the newly created jobs, 38 000 were in knowledge-intensive consultancy and 43 000 in technology-oriented services. In all, 14 000 jobs were attributable to cutting-edge technology and high-value technology.

Above-average employment development in research- and knowledge-intensive start-ups

The net contribution to employment for most cohorts of young companies founded between 1997 and 2003 increased in the first and second year after starting up. The contribution fell again in the third year because the jobs lost by companies shrinking or closing down were greater than the extra jobs created in expanding companies. None of the cohorts of companies was able to maintain the initial employment level. By the fourth or in part the fifth year after starting up, the total workforce in the surviving companies fell below the size of the combined workforce of a start-up cohort in the first year of business. And in the following years a continual reduction could be observed. The employment effects of new enterprises are thus neutral when viewed in the long term. The job losses of the older start-up cohorts are balanced out by the jobs created by the newly established enterprises. New start-ups can drive older companies out of the market, or cause them to reduce their business activity as they lose increasing shares of the market. At the same time, new start-ups can also compensate for jobs lost by the closure of older companies whose products are no longer competitive on international markets.

Job creation by start-ups in the research- and knowledge-intensive sectors has special characteristics (Fig. 26). Here, only the 1997 start-up cohort fell under the employment level of the first year of business in the period until 2005. This is due less to differences in the probability of survival of the companies and more to the vigorous growth of the surviving companies. For each of the cohorts, the start-ups in the research- and knowledge-intensive sectors were able to increase employment in the first two to three years of operation by 15 percent, which is quicker than the average for all sectors of about 10 percent. In the favourable economic climate of 1999 to 2000, the new companies grew particularly strongly in the first two to three years; in particular the 1999 cohort benefited from this.

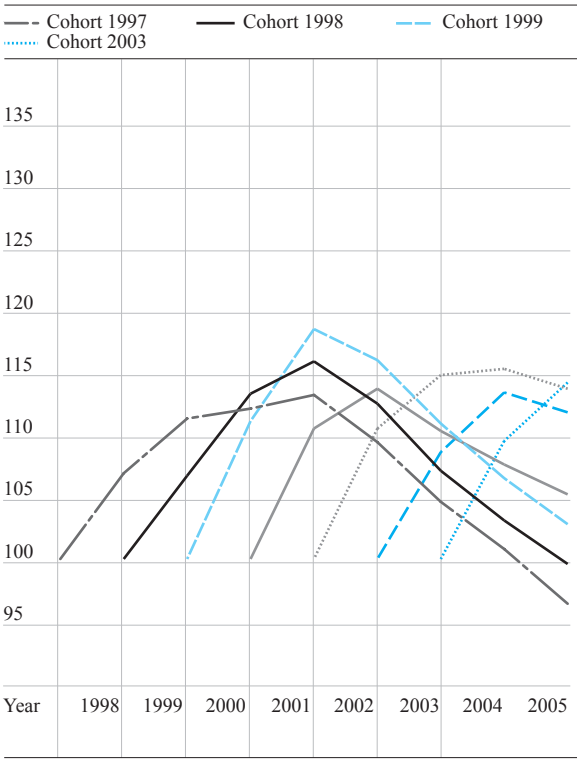
Mainly complementary start-ups in the R&D-intensive manufacturing sector

In the research- and knowledge-intensive sectors, the R&D-intensive manufacturing sector shows the most favourable employment development. This results from a rapid growth of the companies and their high rate of survival. The 1997 cohort was still showing a higher level of employment in 2005 than in the first year of business. The results indicated that in the cutting-edge - and high-value technology, new enterprises mainly offer products which are complementary to those already on the market and so they tend not to displace existing companies to any great extent.

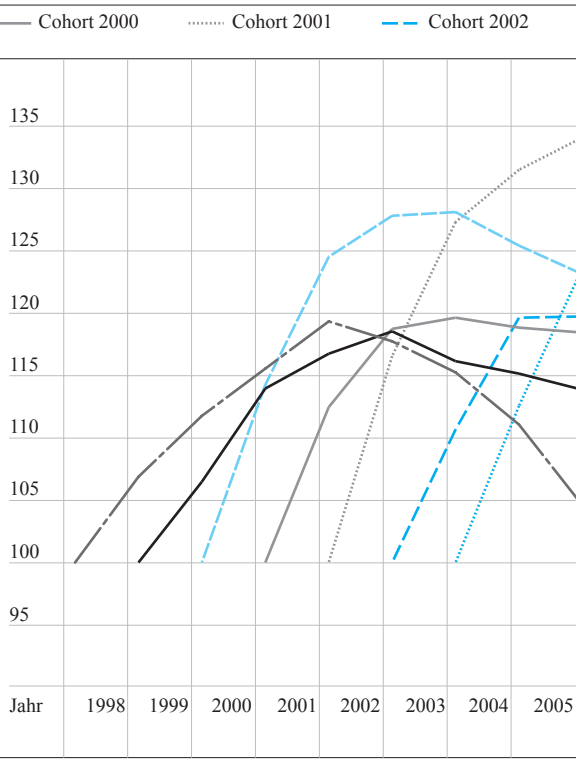
It is therefore to be expected that the support of start-ups in the R&D-intensive manufacturing sector would contribute very strongly to structural change and have positive net-effects on employment and growth. In the technology-oriented services, employment development for start-ups was also clearly better than for the business sector as a whole. In particular

Development of employment of the cohorts 1997–2003 in the research- and knowledge-intensive business sectors in Germany FIG 26

Research- and knowledge-intensive sectors

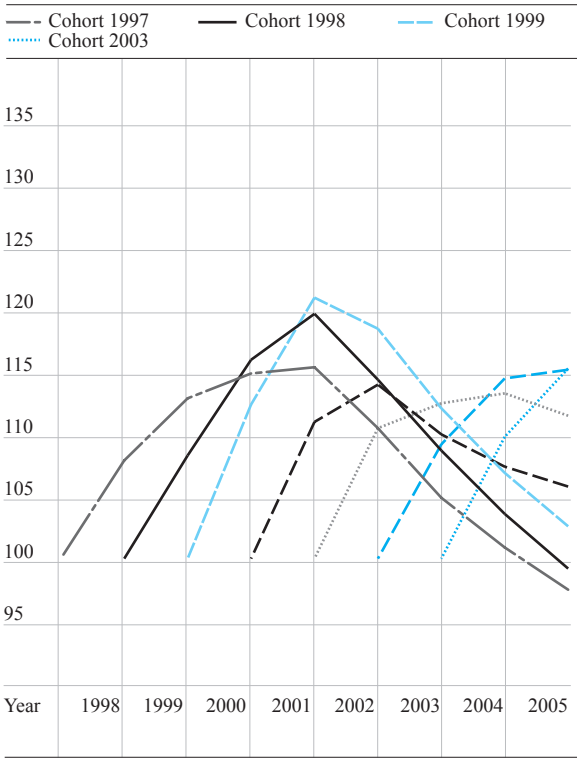


Cutting-edge- and high-value technology

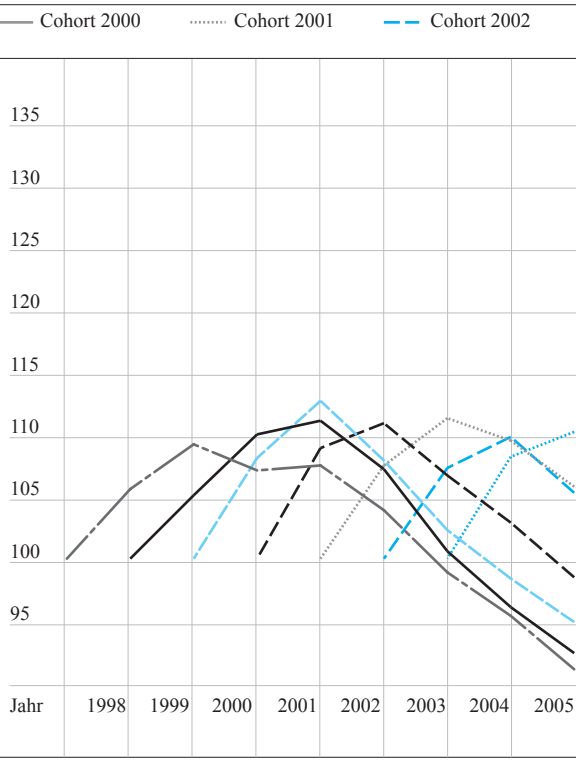


1995=100
Source: ZEW-Gründungspanel und Mannheimer Unternehmenspanel. Calculations by ZEW.

Technology-oriented services



Knowledge-intensive consultancy



1995=100
Source: ZEW-Gründungspanel und Mannheimer Unternehmenspanel. Calculations by ZEW.

TAB 06 **Employment contributions of start-up cohorts in research- and knowledge-intensive sectors of the German economy**

	Total		R&D-intensive manufacturing		Technology-oriented services		Knowledge-intensive consultancy	
	absolute	in %	absolute	in %	absolute	in %	absolute	in %
Employment in 1st year of operations	663	100	16	100	47	100	39	100
Loss of employment after market launch	−185	−28	−3	−18	−12	−25	−10	−25
Net-change in employment in surviving start-ups	182	27	7	41	17	37	12	30
Employment contribution Total	660	99	20	123	52	112	41	105

No. of jobs x 1 000 in 5th business year, Start-up cohorts 1997–2001. (Slight rounding deviations).
Source: ZEW-Gründungspanel and Mannheimer Unternehmenspanel. Calculations by ZEW.

the 1998 and 1999 cohorts were able to grow rapidly in their first years in the course of the New Economy Boom. The evaluation of the ZEW-Start-up Panel and the Mannheim Company Panel suggests that the employment effects of the start-up cohort are strongly influenced by the state of the economy. However, the observation period is too short to draw conclusions from this for economic policies.

Clear sectoral difference in the employment balance

The employment level realised in the companies of a cohort at a specific point in time is determined by:

- The employment effect due to the start-ups (i.e. the number of employees in the first year),
- The jobs lost later when companies in the cohort quit the market,
- The net-employment contribution of surviving enterprises.

Table 06 presents the mean employment balance for the 1997 to 2001 cohorts in their fifth year of business. Overall, the employment contribution of the start-up cohorts was on average 1 percent below the level in the first year of business. Job losses by closures (−28 percent) outweighed the net increase in jobs in the surviving companies (+27 percent). However, there were clear gains in employment in comparison with the first year in the research-intensive manufacturing sector (+23 percent). This was the result of relatively high increases in jobs in the surviving companies (+41 percent) and comparatively low losses of jobs due to companies leaving the market (−18 percent). The increase in the numbers of jobs can be interpreted as showing firstly that companies in cutting-edge technology and high-value technology start with fewer employees than the market potential would allow. This would point to restrictions in the start-up financing or to a level of risk aversion of the entrepreneurs. On the other hand, the marked increase in employment shows the large growth potential of successful start-ups in the research-intensive manufacturing sector.

In the knowledge-intensive services, employment in the fifth year of business was 12 percent higher than the initial level for technology-intensive services and 5 percent higher for knowledge-intensive consultancy. This is the effect of gains in employment of surviving companies of 37 percent (technology-oriented services) and 30 percent (knowledge-intensive consultancy) set against job losses due to market exits of 25 percent in each case.

Concluding remarks about start-up support

The evaluation of the ZEW-Start-up Panel and the Mannheim Company Panel show that start-up companies in the research- and knowledge-intensive sectors show above-average employment development. Against this background, the Expert Commission recommends focussing the start-up support on research- and knowledge-intensive sectors and overcoming the well-known hurdles facing start-up companies in these sectors. In particular, the financing opportunities for innovative start-up companies should be improved.

But there is also a need to do something about the shortages of qualified personnel, because this represents a further bottleneck for research-intensive and knowledge-intensive company start-ups and restricts their possibilities.

C 6 PATENTS IN INTERNATIONAL COMPETITION

The following section draws on an international comparison of transnational patents.[114]

Long-term increase in patent applications globally

Patents are an innovation indicator which reflect the output of technological activity, being a result of research and development and innovation activity. Patents serve to secure competitive advantages, and their number is therefore also in direct relationship to the strategic significance of the market for which patent protection is sought. It is also important where a patent is registered. The following analyses draw on the concept of "transnational patents" or "world market patents". These are patents aimed at various markets and are therefore particularly significant.[115]

In the past ten years there have been three key phases of development, similar to those observed for production. In the second half of the 1990s there was a clear overall increase in transnational patent applications. This was related to an increasing relevance of technology in the competition between highly-developed countries. In parallel, the euphoria of the New Economy Boom also stimulated patent applications, so that in this phase the growth of patent applications in the individual countries was greater than that of research and development expenditures. From 2000 to 2002 there was then a decline in patent applications, especially in cutting-edge technologies such as IC technology, pharmaceuticals and biotechnology. Countries which specialised in these sectors experienced a sharp drop, in particular the United States. The fact that Germany is more specialised in high-value technology protected it to some extent. Great Britain, which is oriented towards the US market, showed a slighter but longer lasting decline; a reversal of this trend only became apparent in 2006. The numbers of British patent applications are currently at about one third of the German level. Since 2002, the numbers of applications for transnational patents from most countries have risen again appreciably.

Regarding the intensity of world market patents (patents per head of population) , Switzerland is in the lead, as in the previous year, but closely followed by Finland and Sweden. Germany is in fourth place (Tab. 07). Since 2002, Germany has experienced a gradual decline in the specialisation in cutting-edge technology relative to other countries, mainly due to the advance of China and Korea, and also of other countries such as Finland, Sweden or Canada (Fig. 27).

Rapid advance of Korea and China

A remarkable structural change in the international patent system has followed the advances made by Korea and China (Tab. 07). The Koreans already overtook the British levels in 2005 and the numbers are continuing to rise steeply. With the growth of Chinese patent applications it is to be expected that they will also reach the British level in the next year. In terms of the total number of transnational patent applications, China is behind Italy in eighth place. Looking only at applications in R&D-intensive technology, it is well ahead of Italy in seventh place (Tab. 07).

Regarding intensity,[116] China is currently far behind, because its technological activities are concentrated in a few regions and it is without a broad industrial base. This is precisely why considerable growth should be expected in the coming years. The bulk of Chinese patents in the R&D-intensive sector is supported mainly by the high specialisation in cutting-edge technology, which has developed from a negative index of −20 in 1996 to a current positive value of +40, which is considerably better than the USA (Fig. 27). This specialisation is based on patents in IC-technology and increasingly also in biotechnology and pharmaceuticals.

A comparison in the current specialisations of Japan, China and Korea in fields of R&D intensive technology shows clearly that Korea and/or China have penetrated many areas where Japan has been very strong, e.g. office equipment, electronics, optics, and entertainment electronics. Considering Germany, the United States and Japan, there is some overlap between the German and Japanese profiles, for example