R&D-commissions from SMEs. They cover 25 per cent of the costs of the order. The outcome has not yet been evaluated and the measure is currently only due to continue until 2009. Increased cooperation between universities and enterprises is a positive development (cf. C6). However, care should be taken that the research premiums do not introduce distortions to the disadvantage of private institutions providing research services under market conditions.

Recommendation

We welcome the measures adopted by the German federal government to streamline and expand the promotion of SMEs. However, it is doubtful whether the existing measures alone constitute a fully-formed strategy to support R&I in medium-sized enterprises. In order to establish a simple form of R&D state aid for companies in Germany which will allow long-term planning, we advise that fiscal R&D-measures should be developed like those which have meanwhile been successfully implemented in many OECD member countries. In view of the declining innovation contributions of SMEs in Germany, preferential aid for SMEs seems advisable. This would also be appropriate for other reasons. Financing restrictions and the above-mentioned asymmetries in the treatment of equity capital and loan capital have an impact in particular on SMEs and new enterprises. If appropriately structured, broad support for R&D through the tax system could represent an important addition to the targeted R&D project aid, which should still be provided for specific cases. The two instruments could complement one another. In addition, fiscal R&D support could provide an important impulse for achieving the three-percent target.

C 4 EDUCATION, THE LABOUR MARKET AND INNOVATION

In the globally-integrated society, knowledge is being generated, distributed, used, and devalued with increasing rapidity. This brings with it the growing need for constant technological and institutional renewal and innovation. In the current knowledge society, products with shorter life-cycles are growing in significance, and knowledge-intensive services are becoming increasingly important for the economy.

Education, vocational training, and further training – in other words forms of human capital – are becoming increasingly important for innovations. The expansion of communications and information technology and the associated modern forms of organisation in companies bring with them changes which exert a considerable influence on the availability of new recruits and the demands on the labour market. Employees need to have a higher and broader qualifications profile as well as key soft skills such as team and communications abilities.

Innovation and qualifications are in a dynamic interrelationship.[28] Innovations have serious implications for the levels of qualification required, and at the same time the level of qualification plays a key role for the innovation process. Innovation and the effective use of new technologies are not possible without education.

The importance of education, vocational training and further training for the innovation process is indicated by the fact that all indicator systems (see Box 08) to determine the innovative ability of a country always includes corresponding parameters. But whereas Germany ranks highly for various criteria such as the transfer into production or networking between companies and research institutions, in the field of education, vocational training und further training Germany is way behind the leading group.

BOX 08

Composite innovation indicators

It is not easy to register the complexity of innovation processes, particularly for a comparison between countries or over time. The complexity can be reduced by forming composite indicators – such as the 'European Innovation Indicator' of the European Commission[29] or the Innovations index of BDI, Stiftung Telekom, and DIW.[30]

Rankings on the basis of an interest-led selection of indicators can vary considerably, and they can be more than misleading. Without specification of the underlying complexities there is considerable scope for manipulation by means of selection, weighting, and aggregation. We therefore generally avoid using composite indicators.

This is a bad sign for the innovative potential of Germany in the medium and long-term, because education und vocational training play a lead role for innovations. The full consequences of the low levels of education, vocational training, and further training will only become apparent in some years time. Then, however, the low level of education will also result in deteriorating innovation performance. Well-educated specialists are a necessary precondition for innovations, both for inventions and for the implementation of innovative products and marketable services. If specialists are not available, then the entire innovation system in Germany will suffer.

Germany faces considerable challenges. Problems which are becoming obvious today will grow rapidly in importance in the coming years as a result of the demographic development and the significant changes in the skills requirements.

Threats for the innovation location Germany – Stagnating levels of education and poor further training

Educational expansion in Germany has come to a stop and for more than a decade there has been education stagnation. The proportion of an age cohort attending upper secondary schools (*gymnasium*) and obtaining the qualifications required to go on to higher education has hardly changed since 1995, and is about 32 per cent. The proportion of school students attending general secondary school (*hauptschul*e) has remained at 23 per cent over the past ten years.[31]

It is difficult to compare national school systems on the basis of the educational qualifications, and as a result the abilities of school students are increasingly being measured, for example in the Programme of International Student Assessment (PISA). Since the year 2000 this has been comparing the abilities of 15-year-olds from all types of school in reading, mathematics, science, and other topics. For the sake of simplicity, the following figures refer only to reading comprehension, but the results differ little from those for mathematics and other skills. A comparison is made between the results for the group of the competency rich (PISA-Level 5), and the competency poor (below PISA-Level 2), using absolute definitions in both cases.

Fewer than ten per cent of the 15-year-olds can be classed as competency-rich, against more than 20 per cent who are competency-poor. In the course of three surveys over six years there have hardly been any changes. Over-represented in this group are: boys, children from socially disadvantaged strata, and children with a migration background.[32] It will be difficult to integrate most of them in the labour market permanently, in particular in areas with a high innovation dynamic. An international comparison shows clearly that things can be different. In other countries, such as Finland or Korea, the proportion of competency-rich is about 20 per cent, while there are less than five per cent competency-poor. These differences point to

considerable challenges, while at the same time highlighting a large unused potential.

The proportion of those with poor levels of education must be drastically reduced if a pool of people is to be available in future with the necessary propensity for vocational training or further education. It can no longer be tolerated that 20 per cent of all school-leavers still have considerable deficits and will not be able to take part in innovations. At the same time, work is also needed to achieve a significant increase in the proportion of those with higher levels of education.

In order to achieve this goal it is important not to address measures only at the schools and universities. The promotion of innovative ability in Germany, which in the end comes from well-educated individuals, requires consideration of the development of abilities, and this involves starting early in life. The quality of child care should be increased and more all-day schools need to be set up. This would make it easier for both parents to enter into employment and also fit in better with the steps being introduced to shorten secondary education by one year. Competition between schools improves the performance of the students, and this requires a transparent record of school performance.[33] In addition, the allocation to one of three types of secondary school at a young age often leads to a number of errors being made.

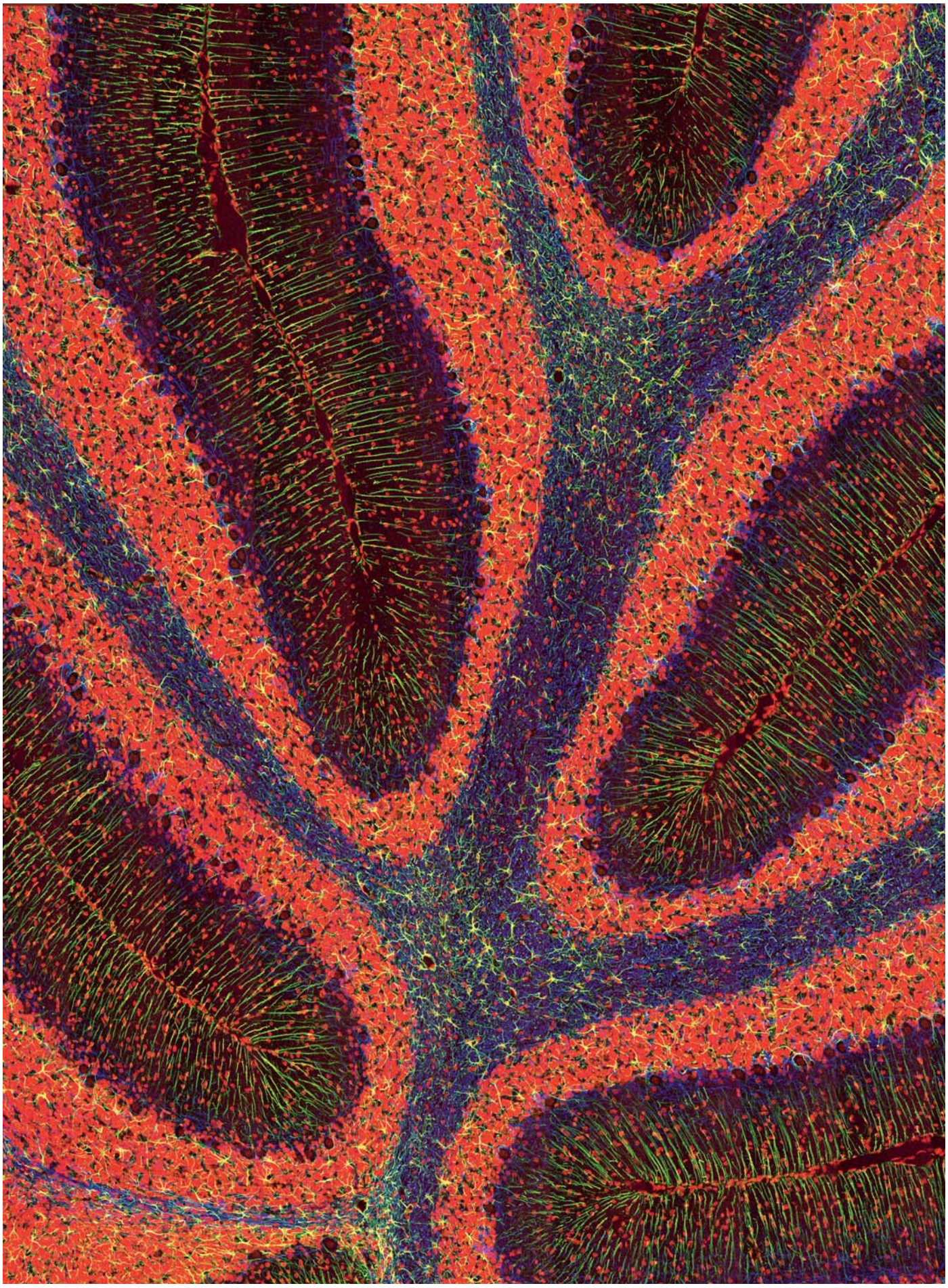
In additional to school education, steps also need to be taken for vocational training. The low proportion of school students in Germany going on to higher education has already been mentioned. But there has also been a decline in the proportion of 18-21-year-olds participating in the dual system of theoretical and practical vocational training, from 64.1 per cent (1993) to 53.6 per cent (2006). In contrast to the declining proportions of students and those signed on for vocational training, there has been an increase in the proportion participating in the so-called transition system, which does not lead to a full vocational qualification. In addition, the numbers of repeat applicants for apprenticeships after one year have been increasing successively. All in all, the fear is that the stagnating proportions of students and the vocational training rates will have a negative effect on the innovative potential, on the one hand because too few people will be available to develop the innovations (above all university graduates), and on the other hand there will not be enough people who can cope with them (people with vocational qualifications). In future it will be important not only to have a higher proportion of people going into higher education[34] but also to minimise the numbers who have not acquired some vocational qualifications.

Further training measures are also important. In Germany, only twelve per cent of all employees participate in further training over the course of a year. In the Scandinavian countries, the USA, and Switzerland the level of participation is three times higher. And when it comes to the number of hours invested in the further training, Germany is once again way behind in an international comparison (OECD, 2007b). The proportions taking part in further training are particularly low for those who have a poor level of education and for older employees. The special programmes offered by the Federal Labour Agency are only infrequently drawn on by the enterprises (IAB, 2007a). It has rightly been remarked that the German companies are themselves partly to blame for the creation of the shortage of specialised personnel.

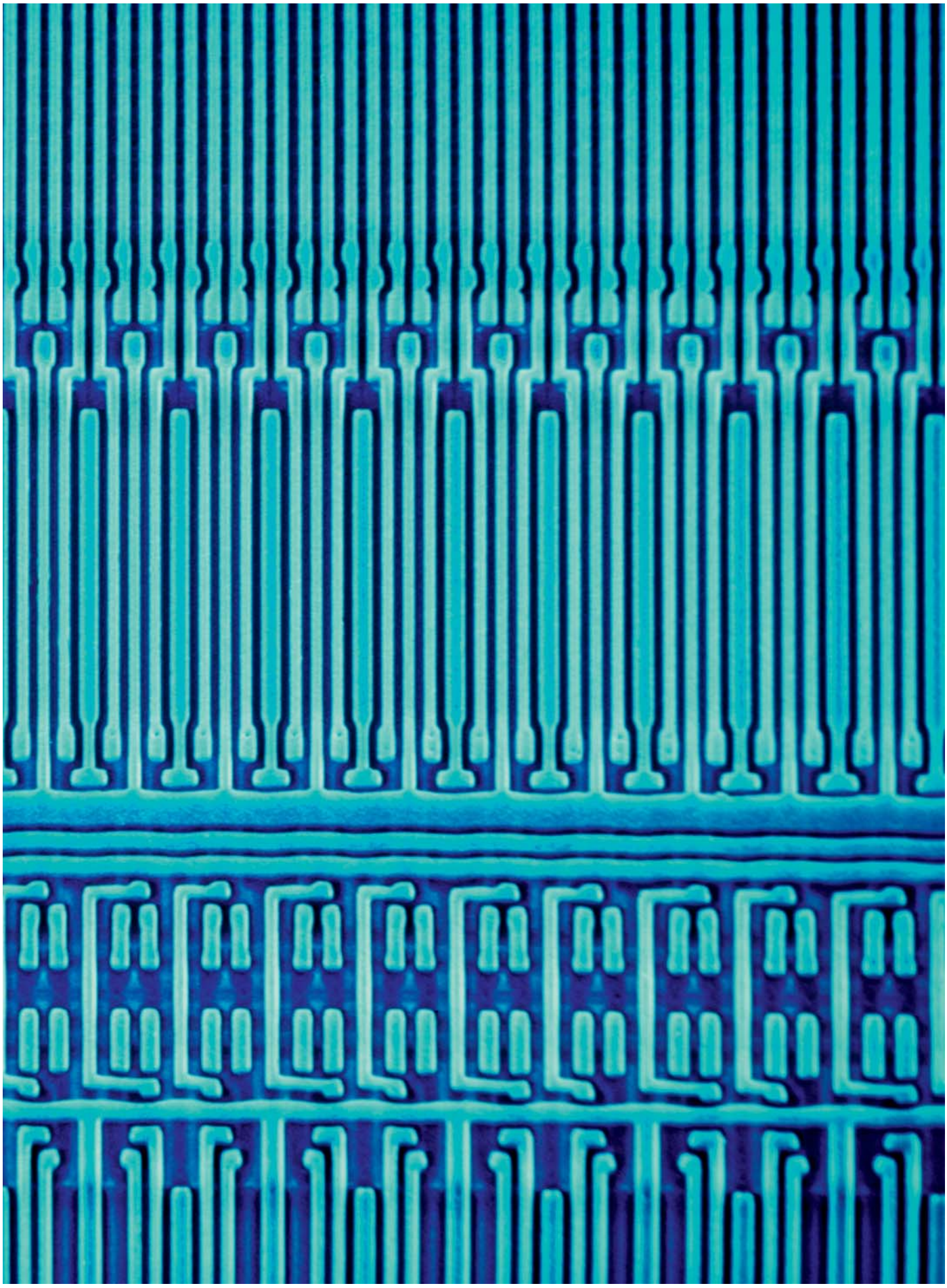
Employers and employees in Germany should increasingly regard further education as an investment in the future, as has long been the case for example in Finland, Sweden, Denmark, the USA and Switzerland. Measures for further training should be a key element in tariff agreements negotiated between employers and employee representatives. Knowledge is becoming outdated increasingly quickly, and people will find themselves working longer. Employers and employees can no longer rely on what they learnt the first time round if they want to keep up with the global competition. We therefore regard the increase in the rates of further training as essential for innovation in Germany.

Education problems exacerbated by demographic developments

The demographic development of Germany has significantly changed the relationship between old and young. At the end of 2005, 19.3 per cent of the population were older than 65 years, 60.8 per cent were aged between 20 and 65. By 2050 only about half the population will be of working age and a third of the population will be older than 65. A wave of well educated personnel will be going into retirement in the coming years without sufficient numbers of replacements with the same levels of education. In other



Structure of the cerebellum



Surface of a microchip

words, even if the relative proportions of people with various levels of education remain constant (education stagnation), the demographic development will mean that the absolute number of well educated will decline. According to ZEW projections[35] in 2014 there will be a shortage in Germany of between 23 000 and 95 000 engineers and between 155 000 and 397 000 others with academic qualifications.

The ageing of the population indicates a second area in which action is needed. In future many people will be willing and able to work longer, and by no means only because they cannot afford to retire. With a longer working life, the necessity for continuous training is even greater. Phases of further training must be integrated in business organisations and included in life planning. This also means that additional further training must be offered by universities and the vocational training system, together with an increase in company budgets for further training investments. Taking time out for further training must become the rule rather than the exception. Only then will the reluctant attitude of many towards further training be overcome.

In addition to better vocational training and further training of the labour force, there are also opportunities for increasing the absolute number of well-trained personnel and thus supporting innovation in Germany, namely the increase in the numbers of women who are in employment and the relaxation of the work restrictions on foreign graduates from German universities, and finally the recruitment of well-trained specialists from other countries.

Increasing the rate of employment of women

The rate of employment of women in Germany is 66 per cent, which is rather low in an international comparison. The figures for the Scandinavian countries (76 per cent) and Switzerland (73 per cent) show how much unused potential there is here, also in view of the fact that women are on average better educated than men.[36] The recent introduction of parent benefits and extended day care provisions has provided important signals for an improved compatibility of occupation and family. However, women who have been away from the labour market for some time do not benefit from these measures. More incentives and further training provisions are needed in order to reintegrate these women in the labour force. We will return to this group in our next report.

Apart from increasing the general rate of employment of women, efforts are also required to increase the proportion of women, involved in research and development. Women are considerably under-represented in research science, which is an important field for innovation of (only 21.4 per cent). Parity is not achieved anywhere, but most countries achieve a rate above 30 per cent. The southern and eastern European and the Scandinavian countries deserve mention, in particular Portugal (44 per cent) and Slovakia (42 per cent).

Increasing the employment of foreign specialists

Another way to redress the shortage in specialists is through migration from other countries. The German federal government has recently made initial decisions to ease the employment of foreign specialists and to monitor the shortage of skilled personnel. Foreign students who graduate from German universities should in future also face fewer constraints if they wish to work in Germany.

Some 80 to 95 per cent of foreigners who graduate from German universities then leave the country almost immediately because their visa expires. Winning these graduates for the German labour market would seem to be very attractive, because they will mostly be well integrated and as a rule will have learnt German. Additionally, many of the foreign students study technical subjects – in 2005, a quarter (about 2 500) graduated in engineering. Their profiles would fit in well with the needs of the labour market.

Restrictions are to be relaxed on foreign engineers in fields which are in demand. However, the highly-qualified personnel who are not from EU member states must still exceed an earnings threshold of 85 000 euros per annum in order to receive a work permit in Germany.[37]

We recommend that these minimum salary levels should be lowered significantly. Even then it should not be expected that increased migration alone will solve the specialist shortages in Germany.

In the past, high bureaucratic barriers have made Germany relatively unattractive for highly-qualified immigrants.[38] This probably explains at least in part why the numbers recruited in the relevant target groups have hardly increased, despite various programmes which have been introduced.

A successful migration policy requires that migrants are integrated better than they have been in the past. Looking at people currently living in Germany with a migration background, it is shocking how many have very low levels of education and vocational training. In all, 17.2 per cent leave school without any qualification. This is 2.5-times higher than in the comparable German group. And only 23 per cent of young people with a migration background are participating in vocational training.[39] Other differences are also stark. Compared with their German peers, only half as many young people with a migration background attend upper secondary schools (*gymnasium*) and almost four times as many go to general secondary schools (*hauptschule*). These figures cannot be explained either by difference in the social status of the parents, or by performance. For the same school results and social origins, children whose parents were born in Germany have a 1.7 times higher chance of being recommended for the upper secondary level than children whose parents both have non-German origins.[40]

We recommend that efforts should be continued in Germany to recruit highly-qualified specialised personnel from other countries, while at the same time better use should be made of the existing potential in the parts of the population with migration background. The innovation system in Germany cannot continue to allow itself to neglect the potential of 15 million people.

Structural change is worsening the education crisis

In Germany, like in other industrialised countries, the economy is going through a 'double structural change'.[41] The growth in production in the industrial sector is modest in comparison with the services sector, and the employment balance has been clearly negative since the start of the 1990s. And in the manufacturing sector and the services sector, the knowledge- and research-intensive branches of the economy are expanding. The sectors which rely less on highly qualified personnel and modern production plant are tending to decline. In the recent past it has only been the knowledge-intensive parts of the economy which have been in a position to create new jobs (Figure 03). This development can be observed in almost all industrialised countries. The greatest losses in employment are in the processing industries, in particular the non-research-intensive industries.

Increases in value added and in employment in Germany are attributable solely to the research-intensive and knowledge-intensive sectors. Technological progress is at the expense of the proportion of employees with low levels of qualification, whereas the demand for highly qualified personnel is growing.[42] Above all, company-related services, i. e. research and development, market surveys and opinion research or IT-consultancy will grow considerably in importance.

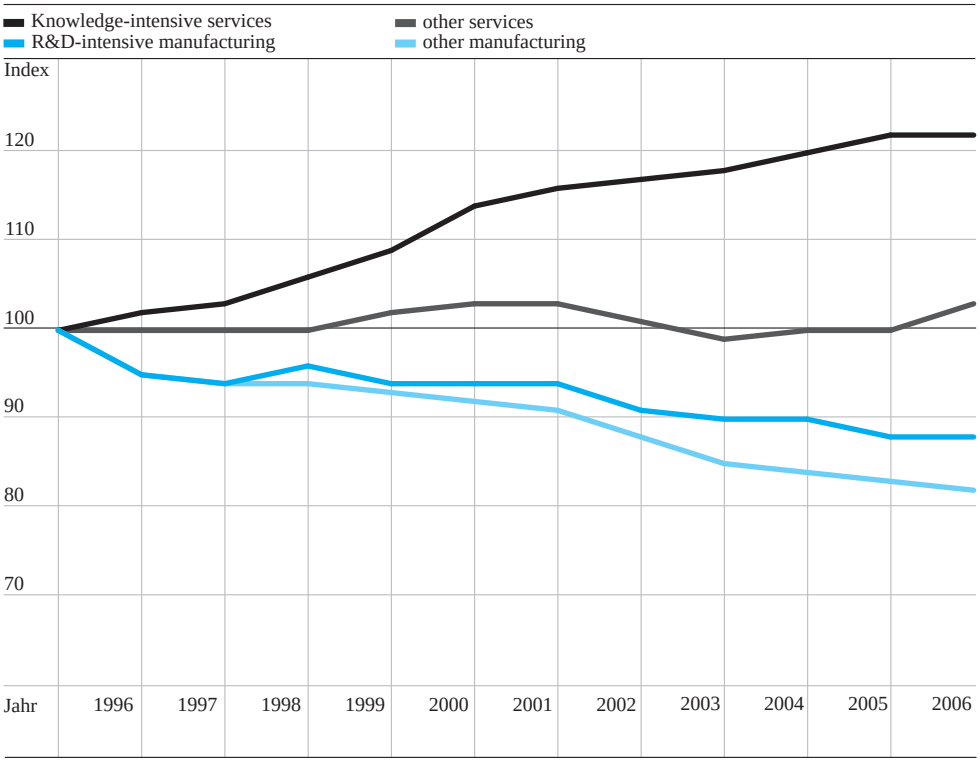
The discrepancy between supply and demand leads to a significant increase in personnel costs for knowledge-intensive industries and services. This brings with it the risk that German companies will increasingly move their innovation activities to other countries.

Accelerating the long march: improvements in education, training, and continuous education

Many of the processes described here cannot be influenced in the short term. The demographic population trends are unalterable for decades. It will not be possible to reverse the structural change in the economy in the coming years. This means that apart from the recruitment of foreign qualified personnel, the only other option is to improve the education, training and continuous education of the German population, in order to increase the potential of the labour force. The international comparison shows that considerably more young people can be led out of educational poverty and towards better educational achievements. It also shows that in other countries offers of further training are accepted and it is possible to maintain employees at their levels of skill for longer, and even to raise these. Increasing the pool of skilled and specialist personnel by extending the working life only makes sense if more emphasis is placed on further training. But because in Germany at present only five per cent of men and three per cent of women are still working over the age of 64 years, there are still considerable reserves here.[43]

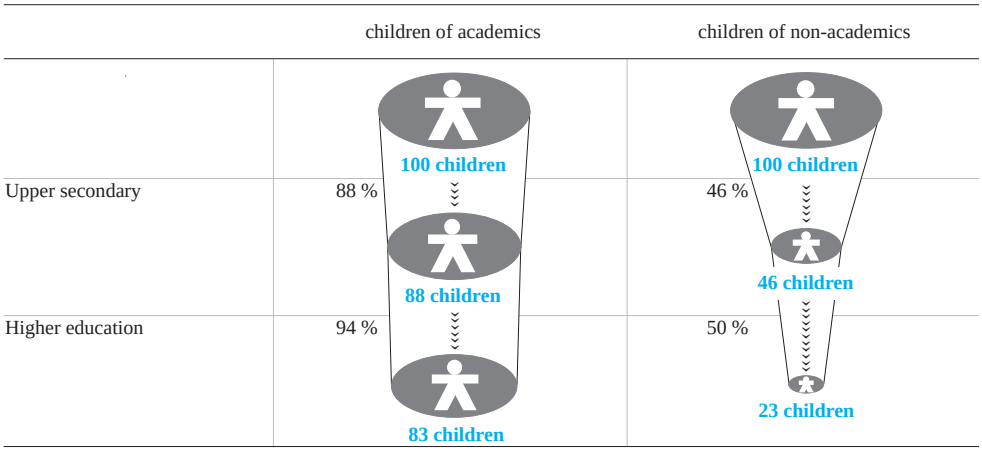
If Germany makes better use of the potential described above, this would also reduce the level of social inequality in access to education, which is relatively high in international comparison. Currently, only 23 out of 100 children from non-academic households go on to complete higher education. From families of academics it is 83 out of 100 children (Figure 04). Research has shown that this difference cannot be

Hours worked in various sectors in Germany FIG 03



Index: 1995 = 100. 2006 extrapolated from BBA statistics.
Source: EUKLEMS Database, Estimates in Belitz et al. (2008b). Calculations by DIW.

Social background, school attendance and higher education in Germany FIG 04



Source: Data from BMBF 2007b, our presentation.

explained solely by the different abilities of children when they start school or at the time of their allocation to one of the three types of secondary school in Germany. In order to receive a recommendation for the upper secondary level, children from the lower social strata have to demonstrate considerably higher abilities than children with a better social standing.[44] Furthermore, socially disadvantaged strata overestimate the costs of education, under-estimate the probability of success, and are likely also to be too pessimistic about the benefit of a given qualification, from lack of knowledge.[45] Therefore it is important also to work through the schools and not to rely on the parents.

The qualification programme of the German government, 'Upward mobility through education'[46] offers various proposals. Day care shall be made available for 35 per cent of under-threes by 2013, and a training initiative started for 80 000 small group child-minders. Funds shall be made available for universities in a 'University Pact 2020' to accommodate 90 000 new students by 2010. Grants will be made available for vocational trainees who achieve excellent qualifications. The central university placement agency (ZVS) is to become a service agency in order to provide more transparency about course places and to balance supply and demand. BMBF will work with foundations to establish regional further training structures. This initiative is to form part of an alliance of national, regional, and local governments with social partners. Also the Federal Labour Agency will monitor further training together with other actors on the labour market. Extensive measures will also be adopted in the field of dual theoretical and practical vocational training.

In order to strengthen Germany as an innovation location, the average level of education of the population must be raised. This will only be possible if early attempts are made to reduce the considerable differences arising from social origins and migration background. More emphasis will have to be placed on preventive educational policy, the deployment of social-pedagogues, and on teaching in small groups. This costs money, but it is better spent at this early stage than on 'repair measures' at a later stage or on social support for those who have not found a way to a life of gainful employment.

The initiatives of the German federal government to provide more and better crèches and kindergartens are to be welcomed. Another important step is the introduction of all-day schools, with a broader curriculum being taught in the afternoons. It will not be possible to increase the levels of employment of women in Germany unless provisions are made to care for children and young people through the day. The current school system is still largely reliant on mothers supervising homework and taking responsibility for the integration in sport groups and music lessons. But with the secondary school being shortened by one year, cuts have been made in subjects such as music, ethics, sport and art, in which the key competencies are taught which will be needed in the knowledge society. All-day schools will also be valuable because they offer the extra hours needed for these subjects.

In addition to the early streaming between school types in the German system, another problem is that the general secondary school only goes through until the ninth grade, which is not sufficient. The educational demands on the individual have risen in the modern knowledge-oriented society and can not be covered in such as short period. In addition, in some regions and cities the general secondary schools have become a collecting point for children from socially-disadvantaged backgrounds and with a migration background. As a result of this, some German *laender* have now changed to only two types of secondary school.

We also urge that universities be expanded. This cannot be a cost-neutral measure, and in addition to the federal and state governments business must also make contributions. An internati-

BOX 09

The Hightech Strategy of the German federal government – a new approach

In August 2006, the German federal government introduced a new approach to the integration of innovation support across all federal ministries. The Hightech Strategy adopts a completely new orientation for R&I policies. Particular attention is paid to the mastery of complex technological systems and the orientation to markets. The goal is to maintain and extend Germany's position in international innovation competition.

The Hightech Strategy defines five cross-sectional activities, namely science-business cooperation, new enterprises, dissemination, international cooperation, and human resource formation. At the centre of the efforts are 17 fields of innovation: Health and medicine, security, plants, energy, environment, information and communications, traffic and transport, aeronautics, astronautics, optics, materials, production, maritime technologies, services, nanotechnologies, biotechnologies, and microsystems engineering.

The strategy focuses on selected fields of innovation. A key element is the inter-departmental formulation of R&I policies, the increased market orientation of R&I and a concentration on the optimisation of the framework conditions. Responsible for the Hightech Strategy in the Federal Government is the Federal Ministry of Education and Research.

onal comparison shows that Germany's expenditure of 1.1 per cent of gross domestic product (GDP) for tertiary sector education is very low. In particular only about 0.1 per cent of this is attributable to private expenditure. The comparison with the USA is instructive: public expenditure for this sector is 1.0 per cent, but the private figure is 1.9 per cent, giving a total of 2.9 per cent. And in Korea out of a total of 2.3 per cent, public expenditure is 0.5 per cent and the private contribution 1.8 per cent.[47] Politicians should find ways to establish new forms of financing in Germany, in particular through more foundations. Enterprises must also participate more, because they have a high benefit from the development of student human resources.

IMPULSES FOR THE HIGHTECH STRATEGY C 5

Strengthening cooperation between government departments

With a complicated federal research and innovation system, it is not always easy to adapt to the dynamics of EU developments and globalisation. Therefore there are some coordination problems in Germany which need to be addressed by policy makers. The intention of political and business forces to make a bold step towards strategic renewal often comes up against a reality of narrow perspectives and institutional fragmentation.[48] Innovation topics have frequently had a hard time finding a platform, and there are no links between disparate forums such as research policy, health, traffic and transport, or agriculture. For the first time, the Hightech Strategy addresses a range of fields with its R&I measures. However, this requires improved coordination between the departments of the German federal government and the *laender*, for which only the first steps have been made.[49] In addition, increased harmonisation is needed at the level of the European Union.

More focus with the Hightech Strategy

As a result of the specific situation in Germany after World War II, the state aid policies of the federal government have taken a different course from those in many other western industrialised countries. There was an initial core of institutional promotion, and various new support instruments were added over time without completely removing the existing ones.[50]

The innovation policies in the USA and in many other countries are generally mission-oriented.[51] State aid is provided with the aim of achieving an ambitious goal. In contrast, the