C STRUCTURE AND TRENDS

C 1 EDUCATION AND QUALIFICATIONS

The structural transformation to a knowledge and services economy is not without effects for the qualification requirements of the workforce. Knowledge-intensive sectors are becoming increasingly important for the production of the economy as a whole, and at the same time innovation pressure is rising in these sectors. Both developments lead to a rising demand for qualified personnel, mostly university graduates.[92]

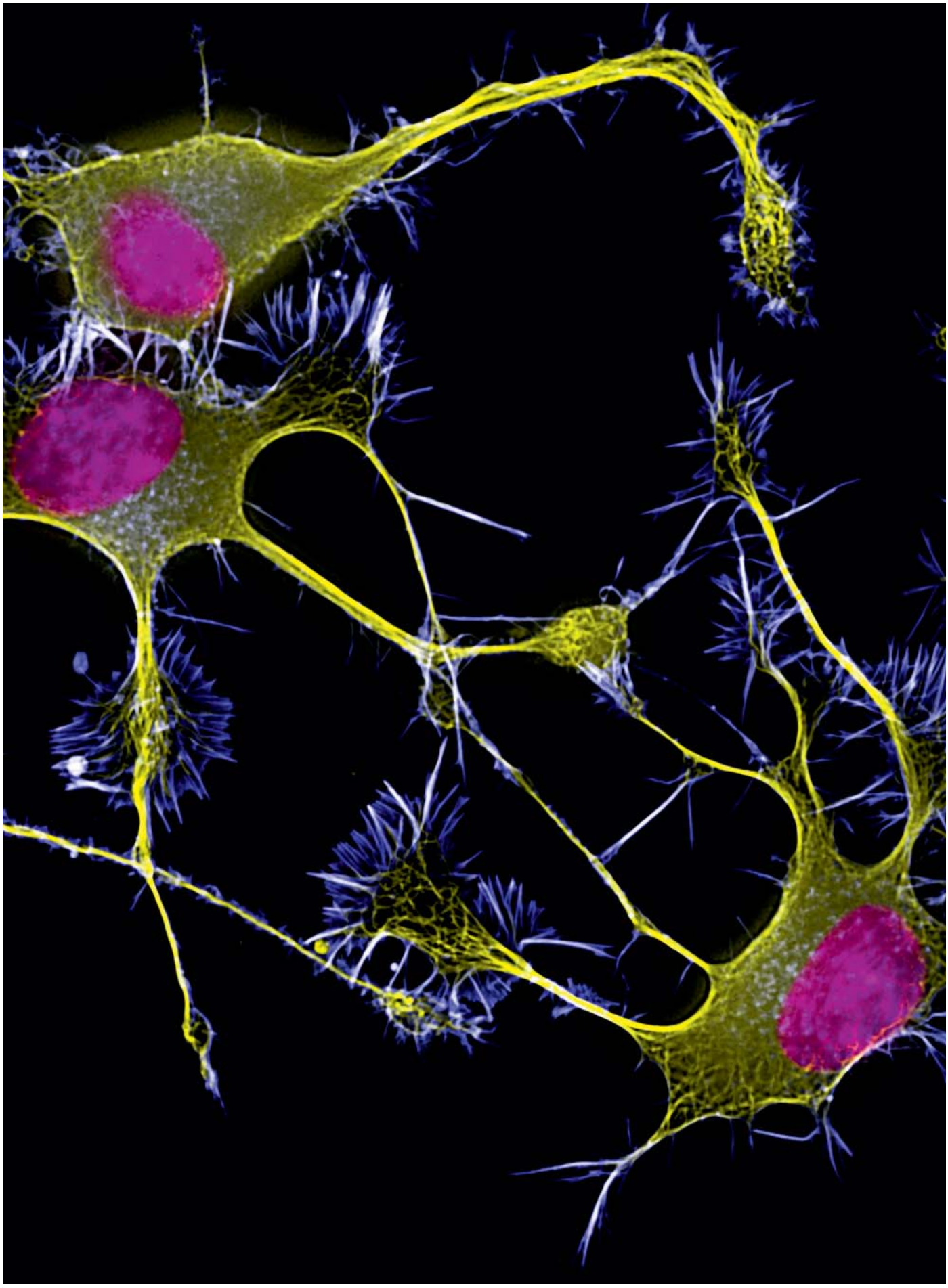
This development presents the education system with considerable challenges, especially because Germany has meanwhile lost the comparatively good position it had. In the following, based on a study commissioned by the Expert Commission on the German innovation system No. 8-2009,[93] current trends of key education indicators are presented and interpreted. First, the demand for highly-qualified professionals on the job market is considered. The analysis then shifts to the supply side, to concentrate on numbers of young people qualifying for and completing higher education, and also on vocational training and further training behaviour.

Unbroken trend to more highly-qualified employees in the business economy

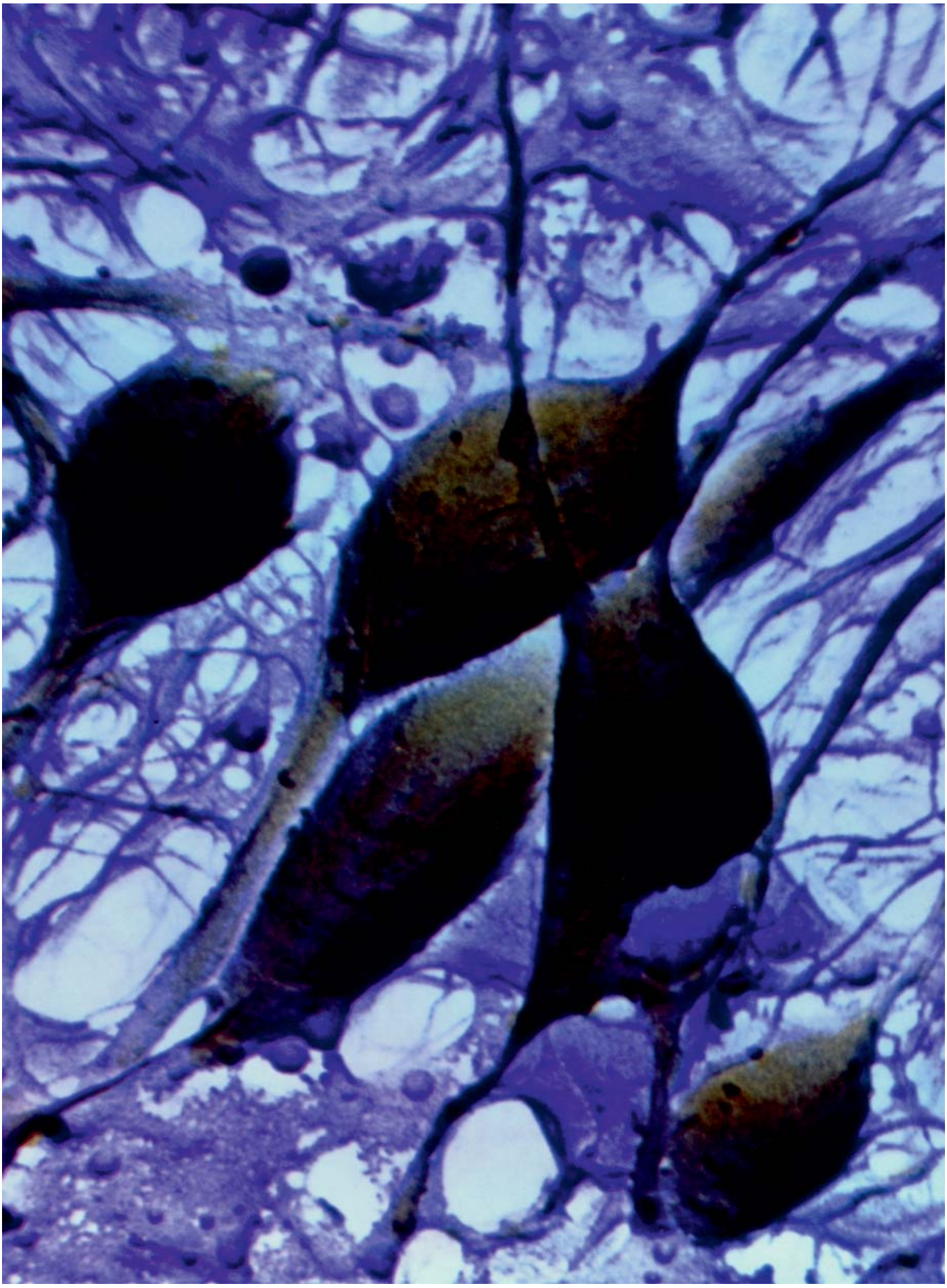
In 2007 a total of more than 1.9 million graduates were in employment and liable to make social security contributions in the business economy in Germany.

These included nearly 700 000 natural scientists/engineers and more than 1.2 million other graduates. Some three quarters of each sub-group worked in knowledge-intensive sectors of the economy. From 1998 to 2007 the number of regularly employed graduates in the business economy in Germany rose by 355 000; the number of natural scientists and engineers increased by 50 000. At the same time the number of other employees fell by some 770 000, so that the proportion of highly-qualified professionals has clearly increased.

Between 2005 and 2007, a broad upswing in employment could be observed in all European sub-regions. Relative to the EU-15 average, the trend towards academisation has continued. The number of highly-qualified professionals rose in only two years by nearly 1.1 million (4.9 percent), and of these nearly 400 000 were natural scientists and engineers (6.9 percent). Some 80 percent of the additional demand for graduates is attributable to the general employment trend, while the demand for natural scientists and engineers has benefited disproportionately from the fact that services and knowledge-intensive areas have developed better than the rest of the economy (structural effect). In individual sectors, the proportion of these professional groups in the workforce has increased further (knowledge intensification effect). In contrast to the previous period considered, Germany and France are at the peak of a dynamic of growth in overall employment in this period. Nevertheless, in Germany the number of highly-qualified professionals grew by only 3.7 percent between 2005 and 2007 which for the first time is less than for the workforce overall (5.6 percent). This is in part because the labour market reforms introduced in this period favoured the creation of jobs for people with lower qualifications. At the same time it is also a sign of a growing shortage of qualified personnel.



Nerve cell growth



Neurones from the cerebral cortex

Proportion of highly-qualified employees according to sectors - 2007 TAB 01

	Manufacturing sector		Services	
	Knowledge-intensive	Others	Knowledge-intensive	Others
Belgium	17.9	8.6	25.5	7.8
Bulgaria	16.4	8.2	41.3	14.9
Denmark	17.8	7.5	35.6	7.3
Germany	**18.5**	**5.5**	**21.9**	**6.6**
Estonia	19.9	9.4	39.3	16.9
Finland	29.5	9.8	27.0	8.3
France	17.1	7.8	22.7	9.6
Greece	16.1	5.7	36.1	8.0
Great Britain	22.2	10.9	31.7	10.3
Ireland	30.3	11.9	37.3	10.9
Italy	10.1	4.4	31.1	6.1
Latvia	25.6	10.6	33.3	15.1
Lithuania	20.4	11.0	41.5	18.0
Netherlands	30.2	14.2	37.9	11.9
Norway	27.7	10.8	46.1	14.9
Austria	10.7	3.3	19.7	4.7
Poland	18.4	8.9	41.0	14.6
Portugal	9.0	2.4	28.5	5.9
Romania	13.3	6.7	30.4	10.6
Sweden	16.8	5.8	29.2	9.0
Switzerland	21.5	7.3	27.5	9.5
Slovakia	9.1	5.9	27.6	8.1
Slovenia	6.7	4.2	21.5	5.9
Spain	17.4	9.4	39.8	12.1
Czech Republic	9.0	4.5	24.8	6.6

ISCED 5a and 6. In percent.
Source: EU-Labour force survey. Calculations by Fraunhofer ISI.

Knowledge intensification in Germany is not keeping up with the international dynamic

In 2007, 8.6 percent of regular employees in the business economy in Germany had a higher education qualification – in 1998 the proportion was 6.9 percent. The proportion of graduates in the knowledge-intensive sectors of the economy, which employs nearly half the workforce in central Europe, is particularly high, with 18.5 percent in the knowledge-intensive manufacturing sector and 21.9 percent in knowledge-intensive services. This is on average some four- to five-times higher than in the other branches of the economy (Tab. 01)[94]

In a European comparison of the proportion of graduates in the workforce, Germany has a lower-middle ranking. Norway and Denmark excel with about 25 percent. The Netherlands and the Baltic States are in the leading group with some 20 percent. There are also a large number of highly-developed countries in which 12 to 18 percent of the workforce have a university qualification.

Germany finds itself in the company of countries such as Spain, Finland, France, and Sweden. Commentators quite rightly draw attention to the importance and high quality of vocational and professional education in Germany. But this alone does not explain the relatively poor position regarding the numbers of academically educated employees, which is particularly striking in the area of knowledge-intensive services – and nor does it explain the worsening position in an international comparison. The limited knowledge dynamic in Germany is based on the relatively low employment effect of knowledge-intensive

services, and also its comparatively weak "innovative orientation". In other European regions, as well as in the USA and Japan, there is a greater demand above all in IC-services for technical and scientific expertise than in Germany. This suggests that there are also more technological developments in these countries.

Increasing numbers of school-leavers qualified to apply for higher education

With the demographic decline in the size of the active population and at the same time a growing need for highly-qualified professionals, the levels of education of successive population cohorts are very interesting. The number of students leaving the general secondary school system has increased fairly continuously between 1992 and 2006, from 760 000 to 942 000 per annum. Over the same period the number qualified to go on to higher education increased by 35 percent, and the increase has continued through to 2008 – totalling 44 percent overall since 1992. In the future development, figures will decline slightly overall, but with two peaks anticipated in 2011 and 2013 due to overlaps as students begin to take their final school examinations one year earlier. Germany also has vocational secondary schools, which are increasingly conferring qualifications entitling students to go on to higher education. In 2007, 160 000 school-leavers from the vocational secondary schools were thus qualified, or 37 percent of all those with higher education entrance qualification. Most of them obtained an entrance qualification specifically for the universities of applied sciences *(fachhochschule)*.

The total number of students leaving school each year with a higher education entrance qualification increased almost continuously between 1992 and 2007 to 434 200. Correspondingly, the proportion qualified to go on to higher education[95] increased to 44.5 percent in 2007 (of which: 31 percent from general upper secondary education; 13.5 percent with a vocational school qualification). This is the central indicator for the quantitative realisation of the demographic potential for academic education. There has been a considerable increase in the number of potential higher education students. This is a precondition if the growing demand for highly-qualified professionals is to be met in the future. By international standards, the proportion of school-leavers qualified for higher education in Germany is still low. Finland, Canada, Italy and Sweden achieve rates of between 75 percent and 95 percent, and the OECD-average is 63 percent.[96]

Even though the reservoir of potential students is growing, the potential for the science subjects (mathematics, engineering, natural sciences, and computer science) is not growing to the same extent. This is primarily because more and more women are gaining qualifications to attend higher education, but they are then significantly less likely to opt for one of these subjects.

A considerable role is also played by the subject preferences at school, which have a strong influence on what is subsequently studied at university. With mathematics and natural sciences chosen less often as special school subjects, it remains the case that only a minority of school students are predestined to go on to study these science subjects. More than half of all students in the upper secondary schooling are no longer being taught physics or chemistry.

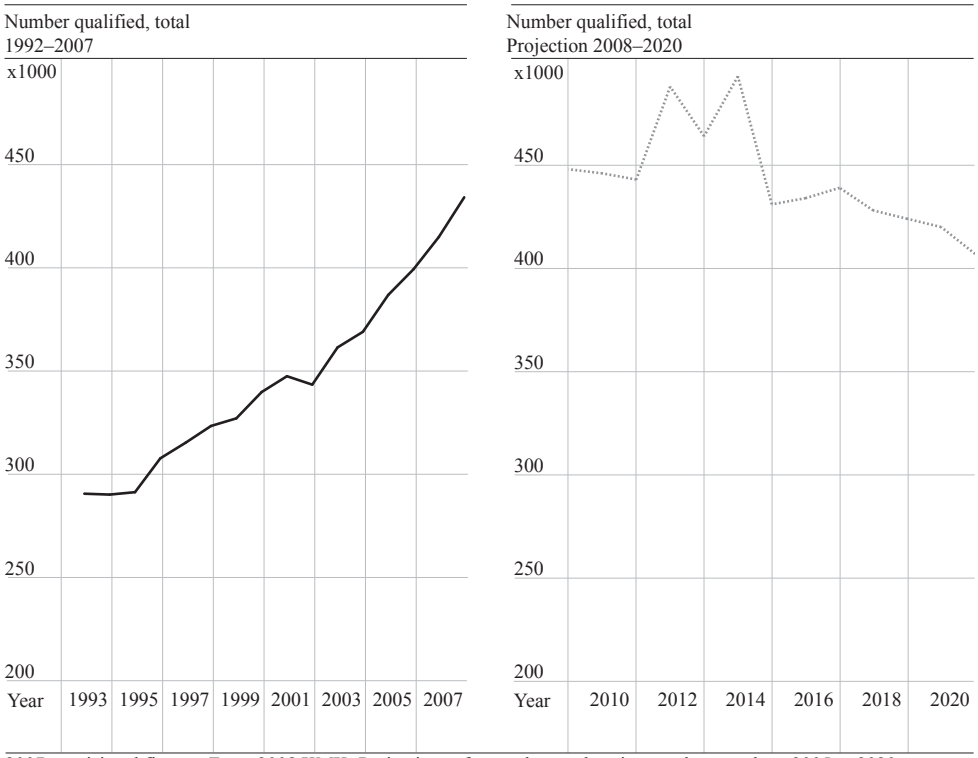
Declining interest in higher education in Germany

Not all school-leavers who have gained a qualification which entitles them to go on to higher education actually choose this option. There seems in fact to be a declining interest in higher education, and this trend is likely to continue in the future. Of those qualified to go on to higher education the large majority of those who choose not to do so see the highest school qualification as "uncoupled" from going to university. Their interests are more in non-academic training, or having a job and their own income. However, there are signs that financial constraints are an increasingly important reason for not pursuing an initial interest in going on to higher education. Young people are increasingly less prepared to take on the loan part of the university grant *(BaföG)*, or they are unwilling or unable to finance university fees.

Traditionally, qualified women are less likely to start a higher education course than qualified men. Of those women who choose not to go on to higher education, nearly a third feel unable to shoulder the financial burdens associated with the university fees. One fifth of those surveyed never had an intention to study. In addition, a tenth cited the unclear and unforeseeable requirements as a reason for deciding not

School students qualifying for higher education in Germany 1992 to 2020

FIG 11



2007 provisional figures. From 2008 KMK: Projections of secondary and tertiary student numbers 2005 to 2020.
Source: Statistisches Bundesamt, Kultusministerkonferenz.

Overall changes of numbers studying selected subjects at universities

TAB 02

	Drop-outs	Net subject switches	Overall change
Mathematics, Natural sciences	**−28**	**−11**	**−39**
Mathematics	−31	−22	−53
Computer sciences	−32	−7	−39
Physics, earth sciences	−36	−16	−52
Chemistry	−31	−18	−49
Pharmacy	−6	+1	−5
Biology	−15	−9	−24
Geography	−15	−1	−16
Engineering	**−25**	**−12**	**−37**
Mechanical engineering	−34	−12	−46
Electrical engineering	−33	−15	−48
Construction	−16	−19	−35

In percent. For school-leavers in 2006. Note: The net subject switches show the difference between the number of students switching to a subject and those choosing to study something else. The overall change is the sum of the net number of switches and the number of drop-outs.
Source: HIS-Studienabbruchuntersuchung 2008. Calculations by EFI.

to go to university. Significantly fewer men named any of these reasons[97] This has important consequences, because in the past 15 years the proportion of women among those qualified to proceed to tertiary education has risen so that they now constitute a clear majority. Taken together, the two phenomena have the effect that equal numbers of men and women begin higher education courses, while also accounting for the increasing divergence between the numbers qualifying for university and those actually starting courses.

Social background and the family's educational background exercise a very selective effect. Eighty percent of those with academic parents who were qualified to study in higher education went on to do so, but the corresponding figure for those without this family background did not exceed 67 percent. Similar phenomena can be observed through all stages of the educational system. The EFI Report 2008 went into this at some length. In Germany, children of highly-educated parents are four-times more likely to go on to higher education than children from a family without an educational background. The occupational status of the parents, in contrast, has less influence. If the parents have obtained school qualifications, or even a degree, then irrespective of their occupational position there is an above-average probability that their children will begin higher education. Removing this imbalance is necessary simply for reasons of social fairness. Against the background of the long-term rise in the need for highly-qualified professionals, the increased integration in academic education of young people from social strata without an educational background and also of women would have a positive effect on the economic and technological potential.

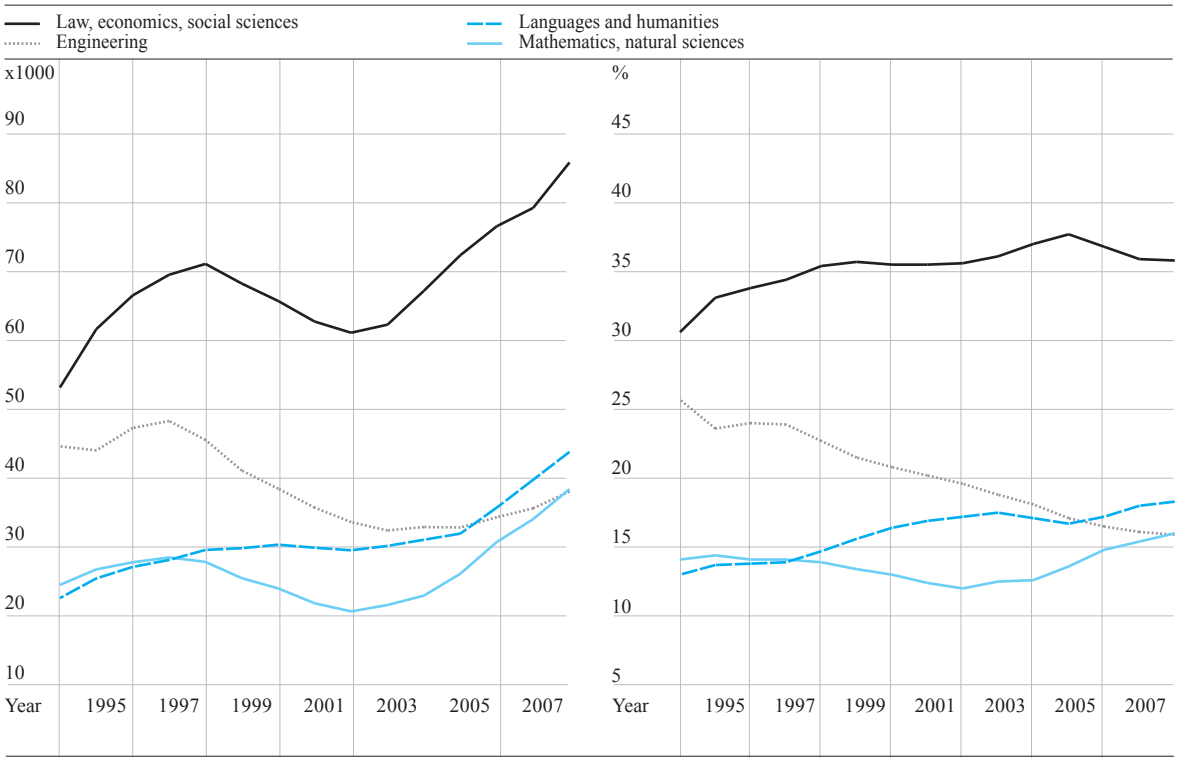
There has been a marked increase in the numbers of new students enrolling at the 400 universities and research institutions in Germany, in particular between 1998 and 2003. After a dip between 2004 and 2006, the figures rose again in the following two years and in 2008 reached 385 500 first-time enrolments (provisional figures) – the highest number to date. In view of demographic factors and overlapping of cohorts taking final school examinations after 12 and 13 years, this trend is expected to continue until 2013, but then to be reversed. Meanwhile in Germany nearly two fifths of the population of the appropriate age go on to higher education, nearly reaching the 40 percent minimum target set by the Science Council. Nevertheless, with this proportion of higher education enrolments, Germany is still considerably below the OECD country mean of 56 percent (2006).

Currently more than 50 000 university drop outs every year in Germany

A further problem is that, of the comparatively few students who start a course, one in five currently fails to complete it. This is a slight improvement over the situation at the end of the 1990s. Nevertheless, this drop-out rate and the absolute numbers involved are a cause for concern, and also an indication of the inefficiency in the higher education system. Of some 260 000 students who enrolled for the first time in 2001, about 55 000 did not finish their studies. In some subjects such as electrical engineering and mechanical engineering, one in three drops out. There is not a fundamental difference in this respect between universities and the universities of applied sciences. One of the goals of the introduction of the bachelor's and master's degree courses was to reduce the high numbers of drop-outs, but they have not yet had this effect. However, so far the statistics for drop-outs only include the very first courses to introduce the bachelor's degree. But it is postulated that with the transition to these courses the demands on students have actually increased and the conditions worsened, and a consequence could be above-average drop-out rates.

In addition, it is also necessary to consider students who switch from one subject to another, because this further reduces the numbers graduating from some degree courses. The net losses are particularly negative in the natural sciences and engineering, because fewer students are attracted to switch to them. In the case of some subjects at German universities, e.g. mathematics, physics, chemistry, mechanical engineering, or electrical engineering, between 46 percent and 53 percent of a cohort of new students do not gain a degree (Tab. 02). At universities of applied sciences *(fachhochschulen)* the situation is less dramatic. Against the background of the perceptible shortage of scientific personnel in the economy, this high level of wastage is not acceptable. However, the problem of drop-outs is more widespread. Indeed, in an international comparison, drop-out rates in Germany are at low to middling levels. But with the relatively low proportion of each cohort starting higher education, the numbers failing to complete their studies in Germany must be judged very critically.

Graduates in selected groups of subjects FIG 12



Source: Statistisches Bundesamt, University statistics. Research by HIS/ICE. Own calculations.

Record numbers of university graduates

The numbers of students graduating from university has risen considerably in Germany in recent years. From 2002 to 2007 there was an increase of 67 000 up to 240 000 students annually obtaining their first university qualification. This is a record number, which is attributable to the rise in student enrolments up until 2003 and the slight fall in the numbers of drop-outs in Germany. However, the structural reform has not had any significant effect on this development. In 2007, just less than ten percent graduated with a bachelor's degree. Only about two percent of students sitting final examinations in 2007 had already gone on to complete the second level and obtain a master's degree.[98]

The extent to which the increase in the numbers of graduates can be equated with increased participation in education is shown by an analysis of the rate of graduation. This expresses the proportion of graduates in a cohort of the population of the same age. Since the end of the 1990s this rate has risen steadily from 17 percent to 24 percent in 2006, indicating the growing importance of higher education. Since 2003 the rate for women has exceeded the rate for men. However, it must be noted that there is considerably lower education participation among people with a migration background. Also, the rate of graduation in Germany is still low by international standards.

The composition of the subjects studied shows considerable changes. The decline in engineering is continuing, whereas mathematics and the natural sciences have been showing proportional increases for some years. This is influenced above all by the positive development of computer sciences (Fig. 12).

In view of the growing calls for increases in the numbers of students as a response to the shortage of highly-qualified professionals, it must also be noted that the capacity of the universities and research institutions is limited. Over only a few years, the numbers of enrolments have already increased noticeably. Some classes are full to overflowing. This is also linked in certain subjects to a reduction in the lectures and classes on offer. In order to increase the capacity to take on new students and to improve the quality of the teaching, in other words in order to implement the structural reforms successfully, considerable additional resources are needed. According to the Science Council[99] some 1.1 billion euros p.a. will be required

to improve the teaching. On top of this, investments would be required in buildings and infrastructure. Without doubt the Higher Education Pact 2020 is a step in the right direction. However, in some federal states such as Lower Saxony, Bremen, and Hamburg, cuts are being made to budgets in the higher education sector which are diametrically opposed to these intentions, and which will have negative impact on the technological potential of Germany.

Boom in vocational training in knowledge-intensive segments

In addition to the higher education system, the vocational training system also provides a reservoir of skilled personnel for the employment market. Some 60 percent of all those leaving general secondary school go into vocational training either in a vocational college or in a dual training course involving additional practical training. In 2006 a total of 667 813 trainees obtained a vocational qualification and made themselves available on the labour market, which was about 3 percent more than in the year 2000. Of this total, 480 000 obtained a vocational training qualification in combination with a company apprenticeship. This means at least that the potential of trainees in vocations at the medium qualification level was almost totally fulfilled. However, if the demographic developments are also taken into account then despite the slight increase in 2006 it is not to be expected that the dual system will lead to much above 500 000 young people obtaining qualifications in the foreseeable future.

Looking only at those qualifying in the core vocations or in the knowledge- and technology-intensive sectors, then there has been a clear positive trend. In 2006, 221 000 young people gained vocational qualifications, which is 22 percent higher than in the year 2000. While the overall number obtaining qualifications in the dual system in this period declined, the figure for vocations in knowledge-intensive sectors increased by 18 percent. In addition there were some 80 000 young people with qualifications from full-time vocational colleges (+29 percent) who were also available for these vocations. This favourable development is due not least to the fact that in-firm vocational training is growing in significance in the services sector.

In knowledge-intensive sectors of the economy, 26.5 percent of companies are involved in vocational training, which is slightly above the overall average (24 percent). But in addition the employees in these sectors are also more involved in further training activities. This applies above all for the older personnel. In the sectors of the economy with high knowledge intensity, more than 10 percent of staff took part in continuous learning activities in 2006 – compared with nearly 6 percent in the other sectors. There is a noticeable correlation between the qualification level and the participation in further education. One in eight highly-qualified professionals take part in measures for vocational further training – but for those with lower qualifications it is only one in thirty. In contrast, age and gender do not play a very important role.

RESEARCH AND DEVELOPMENT[100] C 2

Politicians and the public frequently question how effective investments in research and development actually are – above all when these are financed from taxation. Empirical economic research has meanwhile offered persuasive evidence that R&D-activities not only create direct benefits for private actors in the form of increased productivity, but also bring considerable social returns.[101] Research and development is not the sole cause of economic growth, but in industrialised countries it is one of the most important determinants. Research and development is systematic, creative work to generate new knowledge. The Frascati Manual of the OECD bases statistical comparisons on the financial inputs in the form of expenditure on R&D plant, materials, personnel, and orders, as well as the number of R&D employees (cf. Box 2 in EFI Report 2008). The two parameters provide a basis for the evaluation of the "innovation potential" of an economy or its sectors, because they quantify the materials and resources used for the generation of technological knowledge.

Research and development in stop-and-go

Over the past three decades there has been a clear shift in the worldwide distribution of R&D-capacities. Large economies and whole regions have gone