# 5.1 Education Structures and Highly Skilled Employment in Europe – A Comparison

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**Abstract.** Economic structural change and pressure to generate innovation enormously pushed a need for highly qualified personnel, especially for scientists and engineers, which is still increasing. As a consequence, a skill-biased technological change and a rising importance of high formal qualifications can be found all across Europe, with some countries starting to catch up and even overtake the established ones. But demography has put some obstacles in the way towards the European Research Area. The future demand for highly skilled employees might be covered by the increasing supply, due to an on going qualification and knowledge intensification. But a growing share of these individuals will be needed for substitution and a shrinking share will be available for the intended goal of increasing total qualification levels. Shortcomings seem unavoidable, at least at selective and crucial points.

## Introduction and Study Goal

Experiences and analyses of globalisation indicate that the global economy has entered an innovation-oriented phase which is characterised by, firstly, intensifying competition and digitalisation in the global market. Secondly, the crucial role of research and development nationally as well as in enterprises grows, so that, thirdly, human capital is becoming one of the most central factors of competitive and innovative ability, growth, income and employment, not only in manufacturing industries, but also in the service sector.[1]

This makes education and skills of growing relevance, both from an entrepreneurial and from the individual point of view, for higher levels of qualification induce higher productivity and thereby higher earnings and a lower unemployment risk (Reinberg & Hummel 2002; OECD [ed.] 2003d). This trend is commonly summarised under the headings knowledge intensification *or* shift towards knowledge societies. From a labour market perspective it can be called *skill-biased technological change* and is induced by the structural shift towards more knowledge-intensive sectors or branches and by the increasing internationalisation of markets, hence a stronger competition between economies (Kölling & Schank 2002; Machin 2005; Stadler & Wapler 2004).

All industrialised countries follow a similar trend characterised by a kind of double structural change (see Chapter 4.1):

[1] See European Council (2004), OECD (ed.) (2001a), de la Fuente and Ciccione (2002), BMBF (2002).



*U. Schmoch, C. Rammer and H. Legler (eds.), National Systems of Innovation in Comparison,* 187–204.

- Knowledge- and research-intensive industries perform much better than others.
- New jobs mainly arise in the service sector, and particularly in those knowledge-intensive fields in which high technologies create new markets. Industry and services are growing closer and closer together via their reciprocal market ties; and service providers mainly act as customers and suppliers to industry (Klodt et al. 1997). One prominent example is the IC sector (Information and Communication Technologies and Services),[2] which had the highest share in productivity and growth during the 1990s and from which many new, mostly highly skilled jobs in and outside the IC sector emerged.

On top of that, due to changes in organisation structures and production processes, advanced services (like R&D, planning, consultancy) become more and more important economy-wide, also in manufacturing industries. This requires new skills for the employees and therefore has immense consequences for the educational system:

- On the one hand, demand for qualified labour is just increasing because knowledge-based industries play an expanding role for economic production.
- On the other hand, pressure to generate innovation is significantly higher in knowledge-based branches. This intensifies the demand for top qualifications like natural or information scientists and engineers (S&E) representing the core competence for technical innovations.

By this means, the technological performance of Germany and other European economies is decisively influenced by the availability of a sizable and continually growing pool of highly qualified employees. Shortages, particularly in S&E, may induce restrictive impacts on innovation, growth and employment – as could be seen in Germany in the late 1990s.

Discussions about these shortages of qualified personnel at the end of the 1990s, closely connected to that, and the establishment of the 'green card' aiming at getting highly qualified people to Germany, plus the bad results of German pupils in the PISA study, raised Germany's eyes across borders and across educational systems. The question, if other countries actually face or formerly faced similar problems and challenges, makes international comparisons even more attractive and more important. The age structure of the population and especially of the employable population plays a special role in this international comparison, as the other nations cannot only be seen as 'suppliers' of highly qualified human capital, but also as 'competitors' on the world market for qualified personnel, if they also show positive human-capital-intensive developments of the economy and the labour market and/or a similar demographic 'misfit' in their age structure leads them to the same intention, namely, covering the demand by international migration.

Section 2 gives an overview of the indicators and data applied in this study. Section 3 analyses the education standards of the European population and workforce in a regional and temporal comparison, focussing on demographic aspects as well as on technical and management occupations. As a supplement to this supply-side approach, Section 4 deals with the sectoral demand for highly skilled (academic) manpower in

[2] On the level of NACE divisions available here, the IC sector encompasses Computers and Electronic Components (30), Radio, Television and Communication Equipment and Apparatus (32), Telecommunication Services (64) and Software Development and Data Processing (72).

European regions against the background of structural change and economic trends in the period from 1995 to 2003. Special attention is thereby paid to Germany. Conclusive remarks are drawn in Section 5 (see in detail Frietsch & Gehrke 2004).

## Methodological Aspects and Data

Two data sources are used for the analyses in this section. The first is the German *Mikrozensus*, which is an annual census that surveys one per cent of all inhabitants and that covers, first and foremost, questions of social structure and labour market participation. The second dataset is the Community Labour Force Survey, provided by Eurostat and covering data on EU-15 countries, the ten new members of the European Union as well as some further candidates and the associated EFTA countries. Both sources used here start in the mid-1990s and point to the most recent past for which data was available (2003).

In a first step of the analyses, the German situation is addressed and the specific educational system is taken into account, focussing exclusively on vocational qualifications, as these are the relevant ones for the labour market. This is not to neglect that especially the secondary school leaving certificates – and here first of all the *Abitur* – have gained importance in the last 30 years. The German system of vocational qualifications is built on several different school types and degrees, which can be aggregated to at least three groups.

First, vocational training in the so-called 'dual system' (*Duales System*), where young people of usually 15 years and more receive a training on the job in a firm or company and in parallel go to school, where they are taught the more theoretical framework of their occupations (see Chapter 5.2). Some occupations and some schools also offer a purely school-based vocational training, which is summarised together with the certificates from the dual system as *vocational training* here (containing groups 3b and 4b of the International Standard Classification of Education: ISCED[3]). Second, master/technician *(Meister/Techniker)* diplomas (ISECD 5b) can be reached by people – mostly in blue-collar, technical occupations and by workmen – who already served a vocational apprenticeship and who have some experience in their job. These qualifications are taught in full-time schools or in part-time schooling. The duration is between six months and three years for full-time schooling. For many occupations it is still mandatory to hold a master craftsman's diploma to run his/her own firm. But it is still a very important qualification also in the German manufacturing sector. Third, academics (ISCED: 5a or 6) in Germany can receive their degrees at universities, where next to diplomas (and comparable degrees) also doctoral degrees can be awarded. Though this degree mostly qualifies directly for some occupation, the universities have a clear and strong theoretical orientation and should also qualify for a scientific career. The universities of applied sciences (*Fachhochschule*) are more practically oriented, but also supply a sound academic qualification. That is why these two grades are summarised as *Academics*.

Based on the Community Labour Force Survey, this national differentiation of educational qualifications cannot be kept. Instead, the ISCED is applied that was created

[3] For a description and explanation of the ISCED, please refer to OECD (1999), UNESCO (1997; 1999).

to compare educational programmes between countries. For the purpose of the analysis of the supply, a further aggregation is used that differentiates between low, medium and high levels. Low level in this case means people without any school certificate or only a primary degree (ISCED groups 0–2). High level covers academic and similar degrees (ISCED 5 and 6), whereas medium refers to the other categories of upper secondary and the post-secondary non-tertiary degrees (ISCED 3 and 4).

*Research-intensive industries and knowledge-intensive services*: the analysis is performed on the basis of the definition presented in Chapter 1 and on the basis of employment and occupation data on a two-digit level of the NACE stemming from the Community Labour Force Survey (LFS), which is provided by Eurostat.

*Demand for highly skilled employees*: the presence of research- and knowledge-intensive industries effectively represents a country's or region's industrial innovative potential. To what extent this is ultimately exploited can be measured by the share of highly skilled academic manpower, here determined:

- at first, by the share of employees working in science and engineering professions (group 21 in the International Standard Classification of Occupations: ISCO) being particularly relevant for R&D and technical innovations in Manufacturing but also in the IC sector;
- furthermore, by the share of total academic occupations (ISCO group 2 in total) to allow for the fact that innovations in the service sector are often of non-technical nature and require other than technical or scientific qualifications.[4]

## Educational Structures in Germany

In this section the questions that are addressed concern the distribution of educational degrees and qualifications in European countries and in selected sectoral groups, with a special focus on Germany. These are compared over time and also between countries. In a second part, this section deals with the age structure of the qualified people and the implications that arise for the future development of the European Research Area and by that, for the substitutional demand of highly skilled workers.

### Structures of Educational Supply in Germany and Europe

Since the late 1960s and early 1970s, several reforms of the education system in Germany led to a changed and still changing behaviour of children and their parents in the selection of school types. A clear and steadily increasing trend towards higher education is visible and the effect of all this is called 'educational expansion' (*Bildungsexpansion*), see also Chapter 5.4. Even within the short period of time

[4] Thus, this approach forms a compromise between OECD's concept 'Human Resources for Science and Technology by Occupation (HRSTO)' as a whole and its so-called 'core' concept, the first including all people employed in occupations classified in ISCO major groups 2 (professionals) or 3 (technicians and associate professions) even if they do not have a third level education, the second only considering the subgroups 21 (natural and engineering scientists) and 22 (life science and health professions) (OECD 1995).

analysed for the purpose of this study, this development becomes evident. When looking at age cohorts, it can be shown that even between the beginning of the 1990s and the beginning of the new century, the shares of employees with an academic degree increased in Germany from some 12 per cent to more than 15 per cent and together with the masters/technicians, more than 26 per cent are among the highly qualified. And these shares increased more among the employed persons than among all inhabitants, which indicates that the use and application of the higher qualifications in the labour market also increased. At the same time, persons without any formal training are more likely to drop out of the employment system.

Table 1 displays the vocational qualifications in manufacturing and service sectors in Germany for the year 2003. It can be seen that the high-technology sectors are above the average of the total manufacturing sector as well as above the total average concerning academics as well as masters/technicians. In detail, the leading-edge technologies employ a very large share of highly qualified personnel, similar to the knowledge-intensive services and – interesting, though not surprising – the non-industrial economy which is dominated by the public sector also has a high demand for these qualifications. In contrast, the less R&D-intensive and the 'other service' sectors reach very low shares of highly qualified staff and very high shares of people with no formal vocational training. And this latter group has lost ground in the recent past especially in the service economy, whereas the structure in the manufacturing sectors is rather stable, with slight advantages for academics.

**Table 1.** Vocational qualifications in manufacturing and service sectors, 2003 (in per cent)

| | Less R&D-intensive manufacturing | Leading-edge technology | High-level technology | Total manufacturing | Knowledge-intensive services | Other services* | Total services* | Non-industrial economy | Total** |
|---|---|---|---|---|---|---|---|---|---|
| No formal qualification | 19.3 | 12.2 | 15.1 | 17.3 | 10.3 | 20.8 | 16.5 | 14.0 | 15.8 |
| Vocational training | 63.8 | 51.9 | 58.6 | 61.1 | 51.9 | 65.2 | 59.8 | 48.4 | 57.9 |
| Master/technician | 9.7 | 11.0 | 11.7 | 10.5 | 11.7 | 7.6 | 9.3 | 12.9 | 10.8 |
| Academic | 7.2 | 24.9 | 14.6 | 11.1 | 26.0 | 6.4 | 14.4 | 24.6 | 15.5 |

* Commercial business
** Additionally includes the sectors Construction and Energy
Source: Mikrozensus 2003 – Fraunhofer ISI computations

The share of persons with the highest educational degrees in Germany are among the largest in Europe, and the older generations especially reached a higher educational level than the people of the same age in other European countries. This points to the fact that the educational expansion started earlier in Germany (see Table 2). But the trend is the same in all countries; the share of people with low formal qualifications decreases whereas the relative number of medium and highly qualified people increases, especially among the employed. The largest growth rates in the 1990s can be found in the United Kingdom and central Europe, whereas Germany, France and northern Europe reached a high level earlier and therefore show only smooth growth rates. From the German perspective, two results are very interesting. First, Germany has the

**Table 2.** Educational levels in manufacturing and service sectors in Europe, 2003 (in per cent)

| | Less R&D-intensity | High-techno-logy | Total manu-facturing | Know-ledge-intensive services | Other services* | Total services* | Non-industrial economy | Total** |
|---|---|---|---|---|---|---|---|---|
| Germany | | | | | | | | |
| Low | 20.6 | 14.2 | 17.5 | 13.7 | 17.5 | 15.7 | 10.1 | 15.0 |
| Medium | 64.0 | 58.3 | 61.3 | 52.9 | 67.8 | 60.9 | 48.2 | 58.9 |
| High | 15.4 | 27.5 | 21.2 | 33.4 | 14.8 | 23.4 | 41.7 | 26.1 |
| France | | | | | | | | |
| Low | 35.9 | 24.8 | 31.7 | 25.3 | 29.6 | 27.4 | 29.1 | 29.1 |
| Medium | 50.7 | 50.0 | 50.5 | 37.4 | 51.0 | 44.1 | 40.2 | 45.0 |
| High | 13.3 | 25.3 | 17.9 | 37.3 | 19.4 | 28.5 | 30.7 | 25.9 |
| United Kingdom | | | | | | | | |
| Low | 48.6 | 44.0 | 46.6 | 28.8 | 44.6 | 36.9 | 29.2 | 38.7 |
| Medium | 31.0 | 24.1 | 28.0 | 27.2 | 38.9 | 33.2 | 23.5 | 30.0 |
| High | 20.4 | 31.9 | 25.3 | 44.0 | 16.5 | 29.9 | 47.2 | 31.4 |
| Northern Europe (DEN, SWE, FIN, NOR, IRL, excl. ISL) | | | | | | | | |
| Low | 27.9 | 16.6 | 23.4 | 13.1 | 24.3 | 18.0 | 15.9 | 19.0 |
| Medium | 57.2 | 56.4 | 56.9 | 47.5 | 58.3 | 52.3 | 37.8 | 50.9 |
| High | 14.9 | 27.0 | 19.7 | 39.5 | 17.4 | 29.7 | 46.3 | 30.1 |
| Southern Europe (POR, ESP, GRE, ITA, CYP) | | | | | | | | |
| Low | 63.8 | 44.2 | 58.1 | 25.8 | 51.2 | 42.2 | 45.3 | 49.1 |
| Medium | 27.0 | 37.5 | 30.1 | 36.0 | 36.4 | 36.3 | 27.7 | 31.4 |
| High | 9.1 | 18.3 | 11.8 | 38.2 | 12.3 | 21.6 | 27.1 | 19.5 |
| Central Europe (BEL, AUT, SUI, excl. LUX, NED) | | | | | | | | |
| Low | 28.8 | 20.4 | 25.6 | 15.4 | 22.9 | 19.5 | 17.6 | 20.8 |
| Medium | 57.3 | 52.8 | 55.6 | 45.6 | 61.0 | 54.0 | 46.1 | 53.0 |
| High | 13.9 | 26.8 | 18.8 | 39.0 | 16.1 | 26.5 | 36.3 | 26.2 |
| Eastern Europe (BUL, CZE, EST, HUN, LAT, LTU, ROM, SVK, SLO, excl. POL) | | | | | | | | |
| Low | 13.9 | 10.2 | 12.9 | 7.4 | 7.5 | 7.4 | 21.3 | 16.4 |
| Medium | 78.8 | 78.4 | 78.7 | 64.6 | 80.1 | 74.4 | 60.9 | 67.7 |
| High | 7.2 | 11.5 | 8.4 | 28.0 | 12.4 | 18.2 | 17.7 | 16.0 |
| EU-15 | | | | | | | | |
| Low | 43.9 | 28.3 | 37.9 | 22.0 | 36.6 | 30.0 | 29.8 | 33.0 |
| Medium | 42.9 | 46.3 | 44.2 | 39.6 | 48.4 | 44.4 | 34.7 | 41.9 |
| High | 13.2 | 25.4 | 17.9 | 38.4 | 15.1 | 25.6 | 35.4 | 25.2 |

Source: Eurostat, Labour Force Survey 2003 – Fraunhofer ISI computations

lowest shares of people with only a low educational level,[5] which can be explained by high shares of medium-level qualifications. These are, first of all, the result of the

[5] Together with eastern Europe, where the medium level qualification is the standard, but which does not have a similarly high share of highly qualified people.

dual system, which emphasises the importance of this kind of training for the still favourite German position and which is a specific German strength (for a closer discussion of the vocational system in Germany, please refer to Chapter 5.2 in this book). Second, the shares of highly qualified persons have been above the European average for a very long time, but the other countries were able to expand massively. This means that Germany was overtaken by many countries, though it is still ahead of the EU-level.

Concerning the highest educational level as defined here, the United Kingdom reaches the highest shares, followed by northern Europe, central Europe, Germany, and France. At the same time, the British also have the largest shares of lowly qualified personnel and only a few middle-range positions. As already stated, only small numbers of the German employees are trained on a low level. This also holds for eastern Europe and to some extent for northern Europe, so that the medium qualifications play a very important role in all of these countries.

The structural differences between the less R&D-intensive and the high-technology sectors are very similar across Europe and can be calculated as being about 12–13 per cent. The knowledge-intensive services reached the highest shares of highly qualified personnel in any country and higher shares than in high-technology sectors, which is consistent with the results we already found for Germany. However, it can be assumed that the leading-edge technologies – which cannot be separated on the basis of this data – also reach high shares of highly qualified degrees, similar to that in the knowledge-intensive services. It is also interesting to note the high qualificational needs of the non-industrial economy that is above the average in nearly all countries, except eastern Europe, where the public sector seems to have lower needs, or – what is more probable – is less attractive for people with medium and high qualifications.

The trends are very similar in all countries or regions and across all sectors: the low qualifications are losing ground, whereas the highly qualified have gained in importance since 1995.[6] This is extremely positive in southern and central Europe, which show an enormous development. While in France, northern and southern Europe, the service sectors profited most from this trend, it is the other way around in the United Kingdom and central Europe, where the manufacturing sector gained higher shares of highly qualified employees. A statement that holds for all countries is that the knowledge-intensive sectors intensified their needs above average since the mid-1990s and thereby became even more knowledge-intensive.

### Age Structure in Technology-oriented Sectors

In the recent past, the present and future influence of the changing age structure of societies on the social and political framework has been broadly discussed. In this context, the impacts of these structural changes for example on the pension and health-care systems play an important role. For the analysis of the technological competitiveness, by contrast, it has to be acknowledged that more and more employees will retire and (at least the largest share) have to be substituted by young people entering the employment system. But as the numerical relation of older and younger

[6] For details, please refer to Frietsch and Gehrke (2004).

people has changed, this development also influences the perspective of educational research with respect to economic and technological performance.

The qualification level of the total German population has changed, due to several reforms of the education system in the 1960s and 1970s and by the accompanying relative change of costs and returns of higher education. This awakens the expectation that the older people who end their working life can be replaced by at least equally or even more highly qualified personnel. No immediate shortages should arise. On the other side, the demand for more highly qualified personnel has also increased, due to the already mentioned skill-biased technological change. The good news for Germany is that the demographic change will show a negative effect on the number of students and graduates with a certain delay not before 2010, as until then the increase in the number of entitled students keeps the absolute number on a persistently high level, due to on-going expansions of the number of secondary school leavers. Beyond 2010, it can be assumed that even the total number of people of employable age in Germany will shrink (Buck et al. 2002; Fuchs et al. 2004; Grömling 2004).

Besides, the demographic factor plays a crucial role for the actual and future demand, if in the short- to mid-term perspective the high birth rate cohorts of the post-war period drop out of the labour system due to their age and at the same time in fact more highly educated, but numerically smaller cohorts enter the system.

At least for Germany it can be shown that the qualification level of the pensioners clearly increased since the beginning of the new century, as these are already the foothills of the qualification expansion after the Second World War. And this puts further pressure on the new entrants, as many more people are needed just for substitution and a smaller share can be devoted to skill-biased technological change. Furthermore, the evidence is that the share of working people among the total population grows with an increasing level of education. And this implies that the demographic development shows more favourably in the books of qualified employees than in the books of the total population.

**Table 3.** Share of 57–64 year old employees in manufacturing and service sectors in Germany by vocational qualification, 2003 (in per cent)

| | Less R&D-intensive manufacturing | Leading-edge technology | High-level technology | Total manufacturing | Knowledge-intensive services | Other services* | Total services* | Non-industrial economy | Total** |
|---|---|---|---|---|---|---|---|---|---|
| No formal qualification | 9.9 | 9.1 | 10.2 | 9.9 | 11.7 | 9.2 | 9.9 | 12.4 | 10.4 |
| Vocational training | 7.6 | 6.0 | 6.4 | 7.1 | 6.4 | 7.7 | 7.2 | 8.6 | 7.4 |
| Master/technician | 11.5 | 8.0 | 9.8 | 10.5 | 7.2 | 11.6 | 9.3 | 10.1 | 10.0 |
| Academic | 9.3 | 6.0 | 7.6 | 7.9 | 9.7 | 7.9 | 9.3 | 13.2 | 10.5 |

* Commercial business – ** Additionally includes the sectors Construction and Energy
Example: 9.9 per cent of the employees in the less R&D-intensive sectors without a formal qualification are 57–64 years old
Source: Mikrozensus 2003 – Fraunhofer ISI computations

Table 3 displays the shares of 57–64 year old employees in industry and service sectors in Germany by vocational qualification. In the total workforce – depending on their

level of education – between 7.4 and 10.5 per cent of the personnel is at least 57 years old. The share of this age group among all employed persons in the leading-edge technologies is lowest, followed by high-level technologies. The less R&D-intensive part of the manufacturing sector shows higher shares, respectively. The respective picture in the service sector is less clear. Whereas people with a vocational training or masters/technicians in the knowledge-intensive services are less often 57–64 years old, the share of academics is rather high at 9.7 per cent. The highest shares of people between 57 and 64 years can be found in the non-industrial economy. This means that in this area, but also in broad areas of the industrial economy, most exits of the workforce due to old age will result in necessary replacements in a mid-term perspective.

In absolute terms, the substitution of working people in the manufacturing sector is about 610,000 people. In the service sector, including the non-industrial economy, even two million people have to be replaced between 2003 and 2010. From these results a necessary number of 890,000 highly qualified people can be derived – on average 110,000 persons per year – of which about 40 per cent hold a master's or technician's degree and about 60 per cent attained an academic degree. In the period 1993–2000 the number of necessary entrants was 500,000 highly qualified people. This means: whereas between 1993 and 2000 1.5 per cent of all employees and 6.7 per cent of all academics had to be replaced, these shares increased to 2.7 per cent and 10.4 per cent, respectively, in the period 2003–2010. This simple comparison emphasises the increasing necessity for substitutional personnel – if productivity is maintained at the same level – and a decreasing share that is available for knowledge intensification.

**Table 4.** Absolute number of 57–64 year old employees in the industrial economy in Germany by occupation and vocational qualification, 2003 (in thousand)

| | No formal qualification | Vocational training | Master/ technician | Academic |
|---|---|---|---|---|
| Metal and Mechanical Engineering | 19 | 86 | 29 | 2 |
| Occupations in Electronics | 6 | 24 | 19 | 1 |
| Natural Science | 4 | 11 | 2 | 8 |
| Engineers/technicians/master | 16 | 37 | 36 | 72 |
| IC | 3 | 10 | 2 | 6 |
| Consulting and Management | 22 | 68 | 25 | 68 |
| Other occupations | 340 | 862 | 139 | 132 |
| Total | 410 | 1098 | 252 | 289 |

Source: Mikrozensus 2003 – Fraunhofer ISI computations

Looking only at the industrial economy, a need for more than two million people can be calculated, among whom more than 250,000 have an master's/technician's degree and nearly 290,000 hold an academic degree (see Table 4). A further qualification of these results can be reached by the differentiation of occupational groups. More than half of the 540,000 highly qualified persons have technology- and knowledge-oriented occupations. The largest groups are engineers (108,000) and consultants (93,000), whereas natural scientists and IC staff are of limited absolute numbers. In contrast, in the year 1993 these numbers were 359,000 highly qualified people in the industrial economy and about 178,000 in technology- and knowledge-oriented occupations. Also, the number of engineers has increased from 79,000 as well as the number

of consultants (64,000), which raises the expectation of high future needs. The substitutional demand is about 37 to 54 per cent higher than ten years ago.

**Table 5.** 50–64 year old employees in manufacturing and service sectors in Europe by qualification level 2003 (in per cent)

| Qualification level | Less R&D-intensity | High-technology | Total manufacturing | Knowledge-intensive services | Other services* | Total services* | Non-industrial economy | Total** |
|---|---|---|---|---|---|---|---|---|
| Germany | | | | | | | | |
| Low | 21.4 | 20.8 | 21.2 | 19.7 | 17.5 | 18.4 | 28.9 | 20.1 |
| Medium | 22.6 | 20.7 | 21.7 | 19.3 | 22.2 | 21.0 | 25.7 | 21.8 |
| High | 24.8 | 23.4 | 23.9 | 22.9 | 25.6 | 23.8 | 34.0 | 27.0 |
| France | | | | | | | | |
| Low | 27.4 | 33.8 | 29.3 | 31.8 | 28.0 | 29.8 | 38.0 | 31.8 |
| Medium | 16.9 | 18.9 | 17.7 | 17.8 | 16.3 | 17.0 | 23.8 | 18.9 |
| High | 12.8 | 12.8 | 12.8 | 17.4 | 12.0 | 15.6 | 22.2 | 17.1 |
| United Kingdom | | | | | | | | |
| Low | 33.9 | 34.1 | 34.0 | 31.5 | 24.2 | 27.0 | 32.3 | 29.4 |
| Medium | 14.0 | 15.7 | 14.6 | 19.8 | 12.9 | 15.6 | 21.5 | 16.0 |
| High | 17.8 | 18.1 | 18.0 | 20.5 | 13.5 | 18.5 | 27.6 | 21.2 |
| Northern Europe (DEN, SWE, FIN, NOR, IRL, ISL) | | | | | | | | |
| Low | 37.5 | 37.5 | 37.5 | 36.3 | 30.8 | 33.0 | 46.9 | 36.7 |
| Medium | 23.2 | 21.3 | 22.4 | 25.7 | 19.8 | 22.8 | 31.0 | 23.9 |
| High | 23.5 | 15.0 | 18.8 | 24.5 | 19.2 | 23.2 | 34.0 | 26.0 |
| Southern Europe (POR, ESP, GRE, ITA, CYP) | | | | | | | | |
| Low | 22.1 | 25.6 | 22.9 | 28.0 | 26.7 | 27.0 | 36.6 | 27.3 |
| Medium | 11.6 | 12.9 | 12.0 | 12.7 | 12.4 | 12.5 | 19.8 | 13.9 |
| High | 12.2 | 12.8 | 12.5 | 15.1 | 13.0 | 14.3 | 22.8 | 16.9 |
| Central Europe (BEL, LUX, NED, AUT, SUI) | | | | | | | | |
| Low | 20.7 | 21.8 | 21.0 | 23.4 | 22.0 | 22.5 | 35.6 | 24.4 |
| Medium | 17.5 | 18.8 | 17.9 | 18.5 | 18.1 | 18.2 | 24.8 | 19.3 |
| High | 22.5 | 19.4 | 20.8 | 18.2 | 17.4 | 17.9 | 23.9 | 20.2 |
| Eastern Europe (BUL, CZE, EST, HUN, LAT, LTU, POL, ROM, SLO, SVK) | | | | | | | | |
| Low | 22.7 | 24.3 | 23.1 | 38.1 | 26.4 | 30.6 | 40.8 | 36.8 |
| Medium | 14.4 | 17.7 | 15.4 | 21.2 | 14.5 | 16.6 | 17.1 | 16.8 |
| High | 20.5 | 20.4 | 20.4 | 24.1 | 17.9 | 21.4 | 20.2 | 20.7 |
| EU-15 | | | | | | | | |
| Low | 24.8 | 28.1 | 25.7 | 28.9 | 25.4 | 26.5 | 36.1 | 27.9 |
| Medium | 17.6 | 18.1 | 17.8 | 18.2 | 16.8 | 17.4 | 23.3 | 18.5 |
| High | 18.0 | 18.0 | 18.0 | 19.5 | 16.3 | 18.4 | 27.1 | 21.1 |

* Commercial business – ** Additionally includes the sectors Construction and Energy
Example: 21.4 per cent of the employees in the less R&D-intensive sectors in Germany with a low qualification level are 50–64 years old
Source: Eurostat, Labour Force Survey – Fraunhofer ISI computations

Due to methodological restrictions of the underlying database, similar analyses can not be conducted for European countries. However, Table 5 displays the shares of 50–64 year old employees by educational level in selected European countries and

regions. As already discussed, the educational expansion started earlier in Germany than in other European countries. Derived from this observation, a higher substitutional demand can be expected within the next years. The United Kingdom and northern Europe show a similarly high level of highly qualified people among the 50–64 year old employees and this also increased in the recent past. Compared to that, southern Europe shows a large backlog concerning the highest degrees among this age group and also only a slow upward trend.

Looking at Germany, first and foremost, the unfavourable age structure holds for nearly all sectors and branches under observation here. Besides, similar values are partially reached only by northern and eastern Europe, which means that in a mid-term perspective in most of the other European countries no similar substitutional demand will arise. The problem for Germany is even exacerbated by the fact that the shares of 50–64 year old people with medium level degrees in the workforce are above the average values of other countries, too. One exception here is again northern Europe.

Furthermore, the differentiation by occupations reveals that the engineers and natural scientists are much older in Germany than in the other European countries. In France, in contrast, the IC employees – especially in high-technology areas and 'other services' – are older than in other nations. In the United Kingdom, persons with a technical occupation (Metal Engineering, Electronics, Natural Sciences and Engineering, see Table 4) are older than their colleagues in other European countries. For northern Europe it has to be acknowledged that a similarly unfavourable age structure as in Germany exists for nearly all occupational groups, but especially the shares in some technical occupations are clearly above the European average. Whereas southern and central Europe show low shares of older employees in all occupations, people in eastern Europe with occupations in Electronics and Engineering very often belong to this age group. This means for Germany, but also for other European countries with shortages in qualified personnel, that these eastern European countries can hardly be used as a source of human capital to solve the problem of a lack of employees in neuralgic occupations like Engineering and Natural Sciences, as long as they are not attracted simply by higher wages, though the bureaucratic hurdles have been lowered for those who are willing to move to other countries. But the readiness and willingness to emigrate might be reduced against the backdrop of the expectancy of economic impulses for their domestic market due to the recent EU membership.

The just described analysis of the highest formal qualifications revealed that, next to Germany, the demographic pressure on the labour market exists first of all in northern Europe, where the number of people aged 50 and more is five times higher than about ten years ago. Absolutely, this does not mean that other countries will not run into trouble due to age-driven demand for qualified labour. A comparison of the first half of the 1990s and the first half of the new century reveals clearly increasing numbers of persons aged 50–64 in nearly all occupations and in all countries. For example, in France the numbers nearly doubled and in central Europe these figures even tripled (see in detail Frietsch & Gehrke 2004).

As a consequence, the demand for highly qualified personnel will clearly increase all over Europe within the next years, due to retirement. This development first of all hits the social and health-care services, where the respective numbers doubled within the last ten years. Furthermore, natural scientists and engineers as well as consultants and managers are 50 per cent more likely to be in the oldest age group. The clearest

effect can be seen in the IC occupations, where the numbers in Europe tripled since 1995. If these shares are converted into absolute numbers, the demographic problem might not become that evident. But it has to be kept in mind that this only reflects the substitutional demand. The room to manoeuvre for a further skill-biased technological change will become narrower at the same time.

## Components of Highly Qualified Employment Growth in Europe

In 2003, about 130 million people were employed overall throughout the *EU-15* in the business sector.[7] Of these, nearly 12 million had an academic profession, nearly one in four of these in a science and engineering (S&E) profession (4.75 million, which means 3.7 per cent of total employment).

European employment patterns follow global trends. Industrial employment is shrinking, new jobs with often higher skill requirements arise in services (see Chapter 4.1). Research and knowledge-intensive branches are gaining in importance, both in manufacturing and in the service sector, to the detriment of those less dependent on highly skilled labour. Thus knowledge-intensive services (at 18 per cent) and research-intensive industries (11.5 per cent) employ much higher shares of academic personnel than less research-intensive industries (4.3 per cent) and non-knowledge-intensive services (2.1 per cent). Beyond this, the pressure to innovate (new products, processes or services) is increasing, giving additional impetus to the demand for academic qualifications, whereas job opportunities for less skilled persons fall short: while total EU-15 employment achieved positive growth rates of above 1 per cent on average per year between 1995 and 2003, the demand for academic graduates grew above 3 per cent, for S&E professions even more sharply (4 per cent). In absolute terms, employment in S&E fields rose from 3.8 million in 1995 to 5.2 million in 2003, being of particular relevance for research-intensive industries (9.3 per cent of total employment) and the IC sector (19 per cent on average, nearly 40 per cent in Software Development and Data Processing).

### Continually Rising Demand for Highly Skilled Staff in Spite of Cyclical Fluctuations

Academic employment increased in all European regions, both in cyclical upturn 1995–2000 as well as during the economic downturn 2000–2003.

During *1995–2000* the number of employees with higher education in the EU-15 totally arose by 2.85 million people, i.e. nearly 17.5 per cent. General employment growth can only explain about 7 per cent of this, whereas the significantly greater impact (each with more than 5 per cent or 860,000 additional jobs) on demand for university graduates came from the fact that knowledge-intensive industries grew faster than others (structural effect), accompanied by increasing sector-specific skill requirements (Table 6).

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[7] Private, non-farm sector.

**Table 6.** Changes in employment of academics and S&E in Germany and Europe by sectors 1995–2003 (components of changes in percentage of the basic year)

| Regions | | 1995–2000 | | | | 2000–2003 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Total | Trend[1] | Struct.[2] | Skill[3] | Total | Trend[1] | Struct.[2] | Skill[3] |
| All academic occupations | | | | | | | | | |
| Germany | Business sector | 12.6 | 1.5 | 5.3 | 5.8 | 7.6 | –1.1 | 4.5 | 4.1 |
| | Manufacturing | 17.2 | 1.5 | –1.6 | 17.3 | 5.8 | –1.1 | –2.9 | 9.8 |
| | Research-intensive | 20.9 | 1.5 | 0.9 | 18.5 | 7.6 | –1.1 | –2.5 | 11.1 |
| | Less research-intensive | 7.9 | 1.5 | –7.8 | 14.2 | 0.7 | –1.1 | –4.1 | 5.9 |
| | Services | 27.0 | 1.5 | 17.6 | 8.0 | 10.9 | –1.1 | 9.4 | 2.6 |
| | Knowledge-intensive | 31.7 | 1.5 | 21.5 | 8.7 | 13.1 | –1.1 | 11.1 | 3.1 |
| | Non-knowledge-intensive | 3.6 | 1.5 | –2.3 | 4.4 | –3.2 | –1.1 | –1.4 | –0.7 |
| | Other sectors | 0.6 | 1.5 | –1.8 | 0.9 | 5.0 | –1.1 | 2.5 | 3.6 |
| | IC sector[4] | 64.1 | 1.5 | 36.4 | 26.2 | 15.6 | –1.1 | 13.0 | 3.7 |
| EU-15 | Business sector | 17.4 | 6.8 | 5.2 | 5.3 | 7.9 | 3.5 | 2.8 | 1.5 |
| | Manufacturing | 16.1 | 6.8 | –3.8 | 13.2 | 6.8 | 3.5 | –7.5 | 10.8 |
| | Research-intensive | 19.3 | 6.8 | –2.6 | 15.0 | 5.2 | 3.5 | –8.3 | 10.0 |
| | Less research-intensive | 11.1 | 6.8 | –5.9 | 10.2 | 9.6 | 3.5 | –6.1 | 12.2 |
| | Services | 31.5 | 6.8 | 15.4 | 9.3 | 8.9 | 3.5 | 5.5 | –0.1 |
| | Knowledge-intensive | 34.6 | 6.8 | 17.8 | 9.9 | 8.9 | 3.5 | 6.2 | –0.8 |
| | Non-knowledge-intensive | 10.1 | 6.8 | –1.4 | 4.7 | 9.2 | 3.5 | –0.1 | 5.7 |
| | Other sectors | 7.3 | 6.8 | –0.3 | 0.8 | 7.1 | 3.5 | 2.7 | 0.9 |
| | IC sector[4] | 73.2 | 6.8 | 42.4 | 24.0 | 12.4 | 3.5 | 4.8 | 4.0 |
| Natural or information scientists and engineers | | | | | | | | | |
| Germany | Business sector | 22.6 | 1.5 | 3.9 | 17.2 | 2.2 | –1.1 | 2.1 | 1.2 |
| | Manufacturing | 16.1 | 1.5 | –1.7 | 16.3 | 2.5 | –1.1 | –2.9 | 6.5 |
| | Research-intensive | 20.7 | 1.5 | 0.7 | 18.5 | 3.8 | –1.1 | –2.7 | 7.6 |
| | Less research-intensive | –1.8 | 1.5 | –11.0 | 7.7 | –3.9 | –1.1 | –4.2 | 1.4 |
| | Services | 36.4 | 1.5 | 19.4 | 15.5 | 8.8 | –1.1 | 12.4 | –2.5 |
| | Knowledge-intensive | 48.3 | 1.5 | 25.9 | 21.0 | 9.7 | –1.1 | 15.5 | –4.7 |
| | Non-knowledge-intensive | –2.2 | 1.5 | –1.6 | –2.1 | 4.4 | –1.1 | –2.5 | 8.0 |
| | Other sectors | 14.2 | 1.5 | –7.9 | 20.6 | –7.8 | –1.1 | –6.2 | –0.5 |
| | IC sector[4] | 73.6 | 1.5 | 41.1 | 31.0 | 14.0 | –1.1 | 14.4 | 0.7 |
| EU-15 | Business sector | 28.9 | 6.8 | 9.9 | 12.2 | 5.9 | 3.5 | 1.5 | 0.8 |
| | Manufacturing | 14.1 | 6.8 | –3.6 | 10.9 | 6.3 | 3.5 | –7.6 | 10.3 |
| | Research-intensive | 18.0 | 6.8 | –2.6 | 13.8 | 4.1 | 3.5 | –8.5 | 9.0 |
| | Less research-intensive | 3.2 | 6.8 | –6.6 | 3.0 | 13.2 | 3.5 | –4.9 | 14.5 |
| | Services | 46.5 | 6.8 | 26.6 | 13.0 | 7.2 | 3.5 | 6.9 | –3.3 |
| | Knowledge-intensive | 54.1 | 6.8 | 31.8 | 15.5 | 7.1 | 3.5 | 7.9 | –4.4 |
| | Non-knowledge-intensive | 6.1 | 6.8 | –0.7 | 0.0 | 7.9 | 3.5 | –0.8 | 5.2 |
| | Other sectors | 15.2 | 6.8 | –4.1 | 12.6 | 2.2 | 3.5 | 0.4 | –1.8 |
| | IC sector[4] | 77.2 | 6.8 | 48.0 | 22.3 | 12.0 | 3.5 | 5.5 | 2.9 |

[1] Trend effect: change in occupation due to general growth

[2] Structural effect: change in occupation due to structural change to research- and knowledge-intensive industries

[3] Skill effect: change in occupation due to increasing sector-specific skill requirements

[4] IC Technologies (30 + 32) and Services (Post/Telecommunications: 64; Software and Data Processing: 72)

Sources: Eurostat, CLFS – NIW calculations and estimations

**Box 1.**

Changes in the demand for highly skilled employment (here: S&E or all academic occupations) can be divided into three components: the '*trend effect*' describes the part depending on general growth and its impact on employment. The '*structural effect*' is caused by changes in employment patterns in favour of research- and knowledge-intensive industries which induce growing demand for highly skilled labour. Finally, the '*skill effect*' is the result of increasing sector-specific requirements of skills.

In Manufacturing of the EU-15, the structural effect caused a reduction of highly skilled demand by nearly 70,000 people (–3.8 per cent). The less distinct losses in research-intensive industries are ascribed to the high growth of the European automobile industry during this period. Regarding the non-public service sector, its knowledge-intensive services were exclusively and particularly favoured by structural change. This provided nearly 970,000 new jobs for university graduates (18 per cent), most of them in computer and other business activities.

*Sector-specific growing skill requirements* resulted in 575,000 new highly skilled jobs in services (focussed on IC services and financial services) and about 230,000 in manufacturing industries (particularly Transport Equipment and Chemicals/Pharmaceuticals). In Manufacturing, total demand was more strongly influenced by the skill effect than in knowledge-intensive services where structural change had a more distinct impact. This can be seen as the enterprises' answer to growing pressure to innovate, especially and broadly concerning Manufacturing rather than Services and more than ever the non-business sector.

*Europe-wide* employment of scientists and engineers (S&E) rose more sharply (29 per cent) than those of other university graduates (13 per cent, all academics: 17.4 per cent) from 1995 to 2000. Almost 90 per cent of those additional 1.1 million S&E jobs were created in research- and knowledge-intensive industries (Table 6).

Comparing *Germany* to other European regions, one has to consider that general employment growth had the lowest impact on the demand for highly skilled labour (Table 7) during this period. Yet, structural and skill effects on all university graduates were at least as effective in Germany as in the rest of Europe. With reference to S&E, a broad extension of sector-specific requirements of skills compensated for the lack of dynamics in structural change.

In the German manufacturing industry the additional demand for S&E professions was nearly exclusively attributed to sector-specific growing requirements of skills (Table 6) during the upturn. Similar effects could be observed for its neighbour countries (in 'central' Europe) and in the United Kingdom.

Research-intensive industries accounted for nearly one-quarter of additional S&E jobs, on the EU-15 average only for 14 per cent. The small structural effect for Germany was the result of comparably weaker employment growth in knowledge-intensive services, particularly in the IC sector.

During the economic downturn period *2000–2003*, the proportion between additional demand for S&E and other academic graduates decisively changed (Table 6 and 7). In total, throughout the EU-15 the number of S&E employees arose by 290,000 people (nearly 6 per cent) and thus at a lower rate than total demand for highly skilled employment (8 per cent). Unfavourable and insecure market and sales

prospects and restricted R&D activities affect S&E more than other academic personnel (see Chapter 2.1). This is particularly obvious in Germany. During the upturn in the second half of the 1990s there was a near-balance proportion between additional jobs for S&E and other academic graduates (1 : 0.9) whereas during the following economic slump only one out of ten additional jobs for academic graduates required S&E competence.

Thus, the trend of an increasing demand for higher qualifications is continuing regardless of cyclical fluctuations. Nevertheless, its composition is different. Downturn and recessive periods hand in hand with unfavourable market prospects induce shrinking R&D activities and a relatively weaker demand for S&E graduates. Provided that market and sales prospects will approve presently, this situation may reverse quickly.

**Table 7.** Changes in employment of academics and S&E in European regions 1995–2003 (components of changes in percentage of the basic year)

| | 1995–2000 | | | | 2000–2003 | | | |
|---|---|---|---|---|---|---|---|---|
| Regions | Total | Trend[1] | Struct.[2] | Skill[3] | Total | Trend[1] | Struct.[2] | Skill[3] |
| All academic occupations | | | | | | | | |
| Germany | 12.6 | 1.5 | 5.3 | 5.8 | 7.6 | –1.1 | 4.5 | 4.1 |
| France | 8.4 | 6.1 | 2.4 | –0.1 | 13.2 | 3.7 | –0.8 | 10.3 |
| United Kingdom | 17.5 | 7.1 | 6.9 | 3.5 | –4.4 | 3.4 | 2.2 | –10.1 |
| North | 27.3 | 12.0 | 7.3 | 8.1 | 11.7 | 2.7 | 5.6 | 3.4 |
| Central | 23.6 | 7.2 | 6.2 | 10.1 | 10.4 | 0.9 | 3.3 | 6.2 |
| South | 20.6 | 10.0 | 4.1 | 6.5 | 12.7 | 8.1 | 2.8 | 1.8 |
| EU-15 | 17.4 | 6.8 | 5.2 | 5.3 | 7.9 | 3.5 | 2.8 | 1.5 |
| Natural or information scientists and engineers | | | | | | | | |
| Germany | 22.6 | 1.5 | 3.9 | 17.2 | 2.2 | –1.1 | 2.1 | 1.2 |
| France | 18.9 | 6.1 | 4.9 | 8.0 | 19.4 | 3.7 | 1.5 | 14.3 |
| United Kingdom | 29.7 | 7.1 | 10.2 | 12.4 | –12.3 | 3.4 | –1.5 | –14.2 |
| North | 38.0 | 12.0 | 22.9 | 3.1 | 13.7 | 2.7 | 0.6 | 10.5 |
| Central | 28.0 | 7.2 | 14.1 | 6.7 | 12.7 | 0.9 | 3.5 | 8.3 |
| South | 46.0 | 10.0 | 17.9 | 18.1 | 23.2 | 8.1 | 5.6 | 9.5 |
| EU-15 | 28.9 | 6.8 | 9.9 | 12.2 | 5.9 | 3.5 | 1.5 | 0.8 |

*NORTH*: DEN, IRL, SWE, FIN, ISL, NOR – *CENTRAL*: BEL, LUX, NED, AUT, SUI – *SOUTH*: ITA, GRE, ESP, POR

[1] Trend effect: change in occupation due to general growth

[2] Structural effect: change in occupation due to structural change to research- and knowledge-intensive industries

[3] Skill effect: change in occupation due to increasing sector-specific skill requirements

Sources: Eurostat, Labour Force Survey – NIW calculations and estimations

## New Challenges from Increasing Skill Competition in Europe

Assessed on its share of S&E employment in industrial economy (4.5 per cent), Germany still enjoys clear advantages over the European average (Table 8). The crucial factor for this is the high weight of research-intensive industries underlying an increasing pressure to generate innovations. However, these advantages evaporate

when Germany is measured against its competitors in northern and central Europe. Particularly the northern countries succeeded in catching up during the last decade.[8]

Germany's shrinking headstart is attributed to its characteristic economic structure, i.e. a strong focus on high-level technology, deficits in leading-edge technology and a comparably lower employment contribution and 'innovation orientation' (referring to S&E demand) of knowledge-intensive services (Table 8, see also Chapters 2.2 and 4.1). As a result, Germany disposes of substantial knowledge advantages only compared to southern and eastern Europe.

**Table 8.** Employment of S&E in the business sector in Europe 2003

| | EU-15 | GER | GBR | FRA | North | Central | South | East |
|---|---|---|---|---|---|---|---|---|
| Share of S&E in per cent of all employees | | | | | | | | |
| Business sector | 3.7 | 4.5 | 4.4 | 4.8 | 4.5 | 4.0 | 1.8 | 2.6 |
| S&E share of all employees (EU = 100) | | | | | | | | |
| Research-intensive industries | 100 | 120 | 119 | 136 | 110 | 89 | 42 | 50 |
| Chemicals | 100 | 114 | 98 | 126 | 132 | 95 | 63 | 91 |
| Machinery and Equipment | 100 | 147 | 124 | 150 | 97 | 88 | 29 | 59 |
| Automobiles and Equipment | 100 | 134 | 103 | 90 | 80 | 48 | 51 | 36 |
| Other Motor Vehicles | 100 | 115 | 126 | 151 | 53 | 55 | 41 | 32 |
| IC Technologies (30 + 32)[1] | 100 | 108 | 94 | 194 | 119 | 87 | 49 | 35 |
| Electrical Machinery + Apparatus | 100 | 142 | 131 | 62 | 67 | 119 | 53 | 45 |
| Instruments[2] | 100 | 82 | 105 | 215 | 137 | 81 | 19 | 55 |
| *Less research-intensive industries* | *100* | *101* | *163* | *212* | *107* | *101* | *32* | *71* |
| Knowledge-intensive services | 100 | 96 | 111 | 102 | 122 | 120 | 77 | 95 |
| Air Transport | 100 | 142 | 88 | 109 | 138 | 70 | 58 | 141 |
| Post/Telecommunications | 100 | 100 | 112 | 77 | 114 | 113 | 104 | 56 |
| Financial Intermediation | 100 | 88 | 128 | 119 | 160 | 192 | 35 | 69 |
| Real Estate/Renting | 100 | 88 | 191 | 20 | 41 | 175 | 51 | 131 |
| Software and Data Processing | 100 | 87 | 112 | 139 | 141 | 116 | 44 | 90 |
| Research and Development | 100 | 149 | 88 | 64 | 115 | 75 | 95 | 88 |
| Other Business Activities | 100 | 99 | 104 | 93 | 124 | 120 | 93 | 118 |
| Health and Social Work | 100 | 148 | 100 | 14 | 99 | 163 | 72 | 144 |
| Recreation, Culture, Sports | 100 | 119 | 135 | 89 | 60 | 199 | 31 | 203 |
| *Non-knowledge-intensive services* | *100* | *159* | *63* | *232* | *136* | *140* | *26* | *87* |
| *IC sector*[3] | *100* | *94* | *112* | *123* | *150* | *116* | *51* | *55* |

*NORTH*: DEN, IRL, SWE, FIN, ISL, NOR – *CENTRAL*: BEL, LUX, NED, AUT, SUI – *SOUTH*: ITA, GRE, ESP, POR – *East*: CZE, SVK, SLO, BUL, EST, LAT, LTU, HUN

1 Office Machinery and Computers; Radio, TV and Communication Equipment

2 Medical, Precision and Optical Instruments

3 IC Technologies (30 + 32) and services (Post/Telecommunications: 64; Software and Data Processing: 72)

Sources: Eurostat, Labour Force Survey – NIW calculations

Furthermore, the EU average does not seem to be an adequate benchmark for evaluating qualification and knowledge structures of the German industries. Given the

8 In France S&E demand has risen sharply since the beginning of the new century. Following years of stagnation, this development is a result of expanding R&D activities since then.

current global economic developments, it would be much better to benchmark the European activities and qualification structures in relation to the dynamic regions in America, Asia or Oceania, which, however, do not provide comparable and reliable data. Moreover, one gets the impression that the decisive difference between Germany and other European countries was the restricted economic growth that was also induced by shortages in human capital at the end of the millennium. This particularly concerned domestic small and medium-sized enterprises, either because of missing incentives to generate innovation or because of a lack of highly skilled and affordable personnel.

## Conclusions

In sum, the skill-biased technological change and the rising importance of high formal qualifications can be found all across Europe, with some countries starting to catch up and even overtake the established ones, and eastern and also southern Europe lagging behind, but backed by positive trends. The needs and demands for employees with higher educational degrees and qualifications, particularly for scientists and engineers, will also increase in Europe in the next years. Bottlenecks must be expected here in future, particularly in Germany, which is confronted with a quite unfavourable demographic situation and comparably less young people taking up university studies, especially in fields of relevance for technology.

The countries in Europe grew closer within the European Union, especially since the new Member States joined in 2004. And this even widened the pool of skilled and qualified employees, which is an asset on the way to the European Research Area and to strengthen the competitiveness of Europe, especially with regard to the United States and Japan, but also in relation to the emerging and emerged Asian countries like Korea, Singapore or Taiwan. Furthermore, on the way to becoming the largest research area in the world, Europe also has to face the challenge of ageing societies and unfavourable demographic developments. The future demand for highly skilled employees might be covered by the increasing supply, due to ongoing qualification and knowledge intensification. But a growing share of these individuals will be needed for substitution and a shrinking share will be available for the intended goal of increasing total qualification levels. The fact that some countries within the European Union are lagging behind in their numbers and shares of highly skilled employees even increases the pressure, though this might not immediately result in substitutional demand.

Consistent with these findings, the European Commission and also many national governments laid a new emphasis on the education and qualification of the European population. In fact, the problem can only be solved internally by national and European educational programmes. An external solution, for example by migration, can only be used in addition and in parallel to these efforts. It cannot substitute the necessity of own investments in human capital, though an active, controlled immigration

policy and integration will be an important instrument to meet the decreases in the labour force and young age groups. But it is a delusion to believe that this would solve the problem, considering that all other European countries except Ireland and France, but especially the new Member States in middle and eastern Europe, are also confronted with ageing populations, declining birth rates and increasing needs for highly skilled personnel.