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DIW Berlin—Deutsches Institut
für Wirtschaftsforschung e.V.
Mohrenstraße 58, 10117 Berlin
T +49 30 897 89 -0
F +49 30 897 89 -200

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Alfred Gutzler

Press office

Renate Bogdanovic
Tel. +49-30-89789-249
Nicole Walter
Tel. +49-30-89789-252
presse@diw.de

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Engineers in Germany: No Shortage in Sight

by Karl Brenke

There is no let up in complaints about a potential lack of engineers in Germany. The Association of German Engineers (Verein Deutscher Ingenieure, VDI) recently declared that because of the high average age of engineers working in Germany (50 to 51), there will soon be a huge demand for a new generation of engineers.

Upon closer examination, these fears prove to be unfounded. Although there has been a slight increase in the average age of engineers in employment over the last decade, it is still well below the level quoted by the VDI. Accordingly, demand for new engineers in the medium term will be much lower. On average, engineers are in fact slightly younger than other academics in employment, and the percentage of older employees is not unusually high compared to other professions.

Since, on the one hand, the demand for new engineers to replace those leaving the profession is unlikely to be exceptionally high, at least this decade, and, on the other hand, there is currently a run on university places to study engineering, it is a surplus of these specialists that is to be expected rather than a shortage. A more realistic view of the future demand for engineers is urgently needed so that large numbers of young people are not encouraged to study subjects that might make it difficult for them to find a job in Germany.

For a country such as Germany with a focus on technology, it is crucial that steps are taken early to avoid demographically induced shortages in human capital resources. However, this long-term outlook should not be mistaken for what lies ahead on the market for engineers in this decade.

The Association of German Engineers (VDI) has been reporting a lack of engineers for years now.¹ It has already been shown elsewhere that complaints about a lack of these specialists are exaggerated.² An average age of 50 to 51 is now being cited for engineers. This would lead us to expect half of all engineers currently in employment will retire in the next 10 to 15 years. Even now, this would result in an annual demand for 40,000 new engineers.³

If these figures prove to be accurate, a considerable exchange of personnel among engineers would indeed be imminent, which would present companies with major challenges. The most problematic aspect of the feared wave of retirements would be very little time left for professional and practical knowledge to be passed on from those leaving the labor market to younger colleagues, or new entrants to the profession.

The following examines whether the data provided by the VDI are accurate. Here, the focus is on engineers who are normally employed in manufacturing⁴ or its suppliers⁵. The complaints voiced in the public debate are essentially only about a labor shortage of this particular type of engineers. The further analysis largely ignores construction-related engineers, that is, architects, interior designers, regional planners, civil engineers, structural engineers, and surveyors.

¹ See, inter alia, VDI, Ingenieurmonitor. Der Arbeitsmarkt für Ingenieure im Januar 2012 (in cooperation with the Cologne Institute for Economic Research, 2012). Available on the Internet at www.vdi.de/fileadmin/vdi_de/redakteur_dateien/dps_dateien/SK/Ingenieurmonitor/2011/Ingenieurmonitor_2012-02.pdf (accessed on February 22, 2012).

² K. Brenke, "Fachkräftemangel kurzfristig noch nicht in Sicht," Wochenbericht des DIW Berlin, no. 46 (2010).

³ See, for instance, an interview with the Chair of the VDI published in Spiegel Online on 15 February 2012. Available on the Internet at www.spiegel.de/karriere/berufsleben/0,1518,805470,00.html (accessed on February 22, 2012).

⁴ Including mining and energy management.

⁵ Temporary employment agencies, for instance.

Number of Engineers Employed in Germany

Information about the number of engineers in employment⁶ is essentially provided by two sources.⁷ The Federal Employment Agency's employment statistics show the number of people working as engineers and paying social security contributions. Since this applies to most engineers, the employment statistics provide information about the vast majority of this professional group. In June 2011, the date for which the most up-to-date information is currently available, there were 577,000 manufacturing-related engineers recorded as paying social security contributions.⁸

In addition, we can also use the German Microcensus, a regular official survey of the population based on a very large sample (one percent of the total population). However, for the purposes of the present study, it was only possible to use Microcensus data up to 2008. But since the prime concern here is the age of the engineers, this is not particularly problematic since age structures normally change at a very slow rate. Although, in exceptional cases, extraordinary events (age-selective mass redundancies or politically initiated early retirement schemes) can also heavily impact employment structures in the short term, nothing of this kind has occurred in the recent past.

Data from the Microcensus survey for 2008 allows us to calculate that 738,000 people claimed they worked as engineers. This is a third more than the total number of engineers in employment and paying social security contributions (June 2008: 551,000). This can be partially accounted for by the fact that the self-employed are also recorded in the Microcensus. These made up nine percent of all engineers on the labor market in 2008. Another four percent identified themselves as employees who are not subject to social security contributions—these primarily include civil servants.⁹ However, differences in the survey groups do not sufficiently explain the discrepancies between the employment statistics and the Microcensus. Apart from a certain sta-

tistical error tolerance and measurement inaccuracies, there were people who specified their occupation as engineers in the Microcensus and also indicated that they had the relevant qualifications, while their actual occupation was managing director, sales representative, teacher, or specialized journalist. In some cases, training as an engineer is required for this group of people, but not in all cases.

Not all engineers in gainful employment have a higher education degree. In West Germany, up until the 1970s, the title could also be acquired through years of experience in a technical profession; in addition, there were—as in the GDR—special vocational schools. Special vocational training academies still exist to this day. According to the 2008 Microcensus, a good sixth of those employed as engineers did not have a degree, while according to employment statistics for mid-2011, this applied to one-quarter.

No Trend toward an Aging Population of Engineers

The exact age of respondents is established in the Microcensus survey. In 2008, the average age of people working as engineers was 43.3; for those with a degree, it was 43. The average age is also influenced by the fact that engineers enter the labor market relatively late due to the lengthy training periods. The proportion of engineers in gainful employment aged 50 or over accounted for 29 percent.

As compared to 2000,¹⁰ the average age has increased by one year. According to the Microcensus, it was 42.3 at that time (41.8 for those with a degree). The difference between the two years is explained by the fact that the group of younger engineers played a greater role in 2000 than eight years later (see Figure 1). In 2008, the structure was more strongly marked by middle-aged cohorts, that is, by persons aged from 40 to 54. However, there were no considerable differences for older engineers, that is, those aged 55 or over: Their significance was even slightly higher in 2000 than in 2008.

In comparison to similar professional groups, the average age of engineers in 2008 was not particularly high. The average age of those with an academic education in gainful employment in other professions was 43.6. This is 0.3 years older than for all engineers and 0.6 years older than for engineers with a degree. The proportion of

⁶ For the sake of simplicity, the group comprising industry-related engineers will be referred to as "engineers".

⁷ The author would like to thank Matthias Klumpe and Anja Hlawatsch of the Research Data Centres of the Federal Statistical Office and the statistical offices of the Länder, the Statistical Office of Berlin-Brandenburg, as well as Jochen Kiwitt, the Federal Employment Agency, and the Central Statistics Service for their kind support and assistance in providing data.

⁸ Calculations made on the basis of the statistics of the Federal Employment Agency, Arbeitsmarkt in Zahlen. Sozialversicherungspflichtig Beschäftigte nach Berufen (Klassifizierung der Berufe 1988) (Nuremberg: 2012).

⁹ Presumably mainly civil servants who are responsible for testing and inspections.

¹⁰ The year 2000 was chosen not only because of the time interval, but also because the economic situation on the labor market was similar to that in 2008.

older people in employment is lower among engineers than among other academics (see Figure 2).

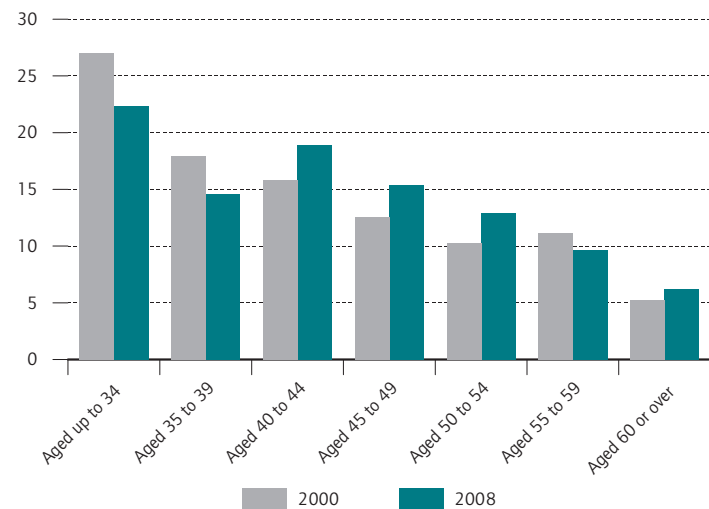
More recent figures are available for engineers in employment and subject to social security contributions. These also show that not even half of all engineers are aged over 50, and that their average age is not 50 to 51 (see table). This applies to all groups of engineers. Distinctions should be made here, however. The older age groups are relatively well represented by electrical engineers as well as mining and metallurgical engineers. These are professions where employment has been gradually declining over the past few years (see Figure 3). Companies have apparently not filled all the vacancies—which automatically leads to an aging of the personnel. Yet, the picture is different for mechanical and automotive engineering, as well as in particular for the large group of other engineers (including industrial engineers, REFA engineers,¹¹ and engineers working in specific fields), where employment has grown. Here, employment development has apparently been shaped to a large extent by the recruitment of young personnel. The older age groups are hardly higher represented among mechanical, automotive and other engineers than they are among technicians or skilled workers in the industrial sector, as well as with the average of all employees subject to social security contributions. With comparatively lengthy training periods, the low numbers of engineers representing the younger age groups is certainly not indicative of excessive aging among engineers.

These findings differ significantly from the VDI's calculations on the age structure of engineers. This is already clearly evident from the Microcensus data. Considering that there have been no extraordinary developments on the labor market for engineers since 2008 that might have led to a distinct structural shift toward older engineers, the age structure will have only shifted slightly since then—if indeed there has been any change at all. It is inconceivable that from 2008 to date—in other words, over a period of about four years—the average age has increased by seven years to 50 to 51. The data of employees subject to social security contributions also reveal no excessive aging among engineers.

Figure 1

Age Structure of People Employed in an Engineering Profession¹

Share in percent



¹ Excluding architects, regional planners, civil engineers, and surveyors.

Sources: 2008 Microcensus; 2000 Microcensus (Scientific Use File), calculations by DIW Berlin.

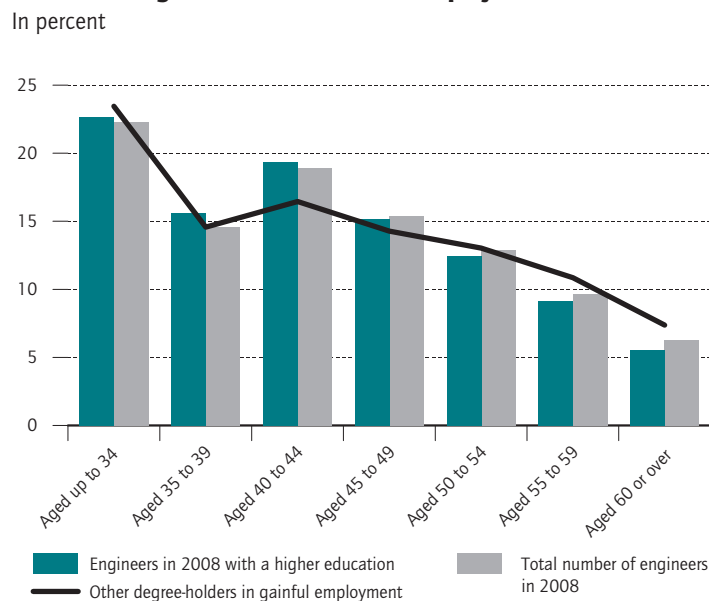
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Shift in the structure toward the middle-aged cohorts.

Figure 2

Age Structure of Persons Employed in an Engineering Profession¹ and Other Degree-Holders in Gainful Employment²

In percent



¹ Excluding architects, regional planners, civil engineers, and surveyors.

² Universities of applied sciences and other universities (excluding degrees from a university of administrative sciences).

Sources: 2008 Microcensus; 2000 Microcensus (Scientific Use File), calculations by DIW Berlin.

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The proportion of older persons is lower among engineers than among other academics.

¹¹ Translator's note: REFA was founded as the Reichsausschuss für Arbeitszeitermittlung (Reich Time and Motion Study Committee) and is now the Verband für Arbeitsstudien und Betriebsorganisation e.V. (Work Study and Work Organization Association).

Tabelle

Age Structure of Persons Paying Social Security¹ and Employed in the Engineering and Selected Other Professions in June 2011

	Total	aged ... (in percent)				
		Under 25	25-34	35-44	45-54	55 or over
Industry-related engineers						
Mechanical and automotive engineers	157 353	1.6	23.7	29.1	30.4	15.2
Electrical engineers	150 310	0.9	16.2	29.7	36.2	17.0
Mining, metallurgical, and foundry engineers	5 454	0.6	15.8	21.6	37.4	24.6
Other manufacturing engineers	25 459	0.8	17.0	29.1	35.4	17.7
Other engineers	238 800	1.5	29.5	30.7	25.9	12.4
Total	577 376	1.3	23.8	29.9	30.3	14.7
Construction-related engineers						
Architects and civil engineers	128 207	0.9	21.9	30.5	29.7	17.0
Surveyors	9 054	0.8	16.5	27.9	33.5	21.3
Other professions in the natural sciences						
Chemists	42 096	1.2	22.9	29.5	29.3	17.1
Physicists, physics engineers, and mathematicians	24 497	1.1	28.9	27.6	25.5	16.9
Technicians						
Mechanical engineers	110 512	3.3	20.8	27.0	31.4	17.5
Electrical technicians	155 616	6.0	18.7	27.3	32.0	16.0
Laboratory technicians	26 924	3.9	15.5	24.4	35.5	20.8
Other manufacturing technicians	30 273	5.2	17.9	27.8	33.2	15.9
Technicians, not further specified	366 782	2.3	16.8	28.2	34.5	18.2
Industrial/production foremen	108 300	1.2	7.6	23.5	42.7	25.0
Common occupations in the manufacturing sector						
Chemical plant workers	165 746	8.1	17.5	25.9	33.1	15.3
Plastics processors	163 793	9.4	18.5	25.5	32.0	14.7
Lathe operators	114 014	16.5	18.4	21.8	27.4	15.9
Welders and flamecutters	79 554	5.8	18.1	24.9	33.2	18.0
Pipefitters	196 259	18.8	20.5	23.3	25.8	11.5
Toolmakers	108 131	17.2	17.7	22.2	26.4	16.5
Electricians and electrical fitters	445 553	16.9	21.0	22.2	25.3	14.5
Locksmiths, machinery fitters, and workshop fitters	524 067	14.7	18.3	22.7	28.3	15.9
All employees subject to paying social security contributions	28 381 343	11.2	21.3	24.3	28.2	14.9

¹ Including trainees.

Source: Federal Statistical Office, calculations by DIW Berlin.

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No Particular Problems in Meeting Current Demand

The future demand for employees is dependent on two factors at the macroeconomic level: on the one hand, the demand for new engineers to fill the gap left by those retiring or those leaving a particular profession, on the other hand, overall employment or that in a particular profession which is growing or declining. The number of engineers has increased recently; the number of employees subject to social security payments among these increased by an average of 1.5 percent annually from

2008 to 2011. Although this increase is not insignificant, it is not much higher than the growth rate for all employees subject to social security contributions (1.1 percent). In absolute terms, the number of engineers paying social security rose by almost 9,000 per year from 2008 to 2011. Assuming there was a similar development for engineers who are not subject to social security contributions, this means an average annual growth for all engineers of around 11,000 to 12,000 people. This equates with the demand for expansion.

Solely on the basis of retirement, the VDI expects 40,000 engineers per year will need to be replaced at present and in the coming years. The evaluation using employment statistics has shown that last year there were 577,000 engineers recorded as paying social security contributions. According to the results of the Microcensus—generously calculated—this figure increases to around 750,000. Here, however, the self-employed are also included, as well as employees who, although trained as engineers, are practicing other occupations which do not necessarily match their qualifications. According to the information provided by the VDI, for the group of engineers as a whole about five percent would need to be replaced each year.

On the basis of the sources available, it can be assumed that currently less than one-third and, therefore, no more than around 220,000 of all those employed as engineers or in a similar occupation are aged 50 or over. The number of working engineers who have reached the age of 55 is 110,000. A demand of 40,000 generated by those leaving the profession cannot realistically be derived from these figures. This would mean all engineers in employment currently aged 50 or over would have to retire within five and a half years. And those who are aged 55 or over at present would all have to give up work within less than three years.

If one age cohort of engineers who have turned 55 retires each year, this would comprise 11,000 people. Although it is probable that a higher number of older engineers might retire (if it were one and a half age cohorts, that would be 16,500 people each year), the demand generated would be 20,000, which should be taken as an absolute upper limit. Therefore, the need for expansion together with the need for new engineers due to retirement reaches 28,000 to 32,000 people each year. It also has to be considered that precisely for those engineers in the fields with employment growth, the proportion of older persons and thus the need for replacements is comparatively low.

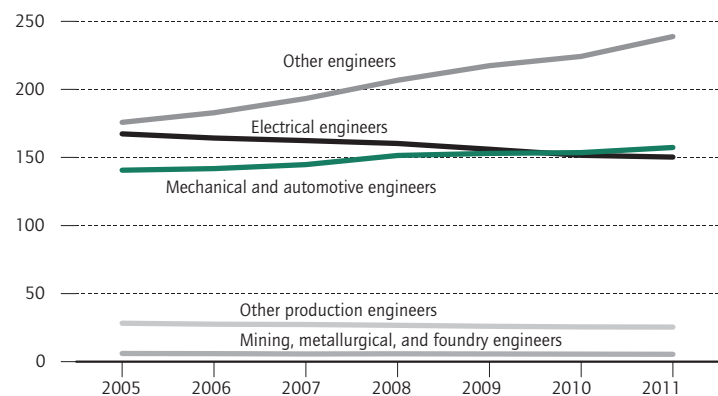
But even if the VDI's estimates were accurate, the demand generated from engineers leaving the profession and also any additional demand could be covered without any difficulty by the influx of university graduates onto the labor market. In 2010, over 50,000 students passed their final exams in a manufacturing-related engineering subject.¹² Over the next few years, the number of graduates will continue to grow, as there has been a re-

¹² Excluding student teachers. Excluding industrial engineers with an economics degree, there are 45,000 graduates. See Federal Statistical Office, "Prüfungen an Hochschulen 2010," Bildung und Kultur Fachserie 11, series 4.2 (Wiesbaden: 2011).

Figure 3

Development of the Number of Engineers in Gainful Employment and Paying Social Security

In thousands



Source: Federal Employment Agency.

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Strong growth only for other engineers, for example, industrial engineers.

gular run on the universities in the past few years, particularly on engineering subjects (see Figure 4). This trend has been continuing recently. For example, in 2011 the number of first-semester students studying mechanical/manufacturing engineering only was 58,600.¹³ Of course, many of those who begin their studies will not successfully complete them.¹⁴ Nevertheless, the number of students starting university is enormous when measured against the number of engineers in employment. In the same year, there were 157,000 employees subject to social security contributions working as mechanical and automotive engineers, 123,000 of whom had a university degree. There would also be about another 40,000 self-employed people and other employees in addition to this group.

Conclusion

The information presented above shows that the VDI's calculations concerning the average age of engineers in employment are greatly exaggerated. According to the

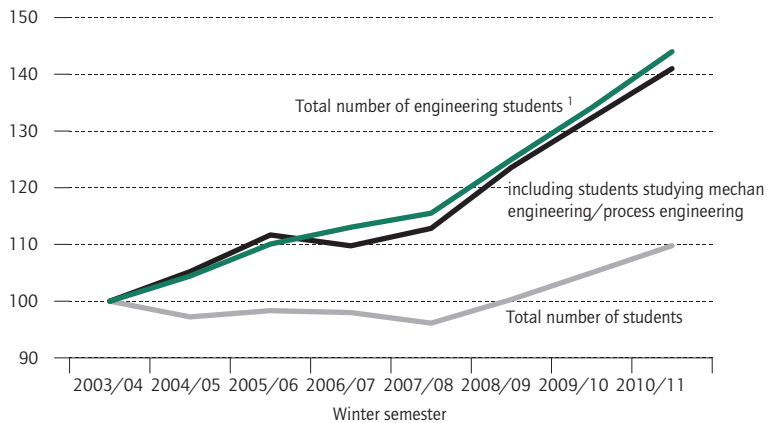
¹³ Federal Statistical Office, "Schnellmeldungsergebnisse der Hochschulstatistik zu Studierenden und Studienanfänger/-innen – vorläufige Ergebnisse. Wintersemester 2011/12," Bildung und Kultur (Wiesbaden: 2011).

¹⁴ The proportion of successful students of engineering calculated for the year 2009 shows values of slightly over 70 percent. Federal Statistical Office, "Erfolgsquoten 2009. Berechnung für die Studienanfängerjahrgänge 1997 bis 2001," Bildung und Kultur (Wiesbaden: 2011).

Figure 4

Development of the Number of Engineering Students¹ and All Students in Germany

Index: Winter semester 2003/04 = 100



¹ Excluding subjects of the subjects architecture, interior design, regional planning, civil engineering, surveying; including students of industrial engineering.
Source: Federal Statistical Office, calculations by DIW Berlin.

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The number of engineering students shows a clear above average increase.

Microcensus, less than one-third of all those working in an engineering profession in 2008 were aged 50 or over, and half of these were in the age group 55 or over. The same can be seen from the current employment statistics data. These also reveal that the proportion of older engineers is no higher than for technicians, some skilled workers in the industrial sector, or for the average of all those in gainful employment and subject to social security contributions—although the age structure of engineers is largely determined by their entering the labor market comparatively late due to the lengthy periods of training.

According to the data available, in the years to come, the demand for new engineers to replace those leaving the profession is expected to be only approximately half as high as that calculated by the VDI (around 20,000 instead of 40,000). Not least because of the economic upswing following the most recent financial crisis, additional demand rose from 11,000 to 12,000 persons. The high number of graduates coming out of the universities is certainly more than sufficient to meet the overall annual demand for engineers. It is to be expected that in view of the run on the universities in engineering subjects, the number of university graduates will continue to grow, and this will lead to a surplus. Of course, the-

re would be consequences for the labor market. It could become difficult for young engineers to enter the profession, which in turn could result in others being pushed out—the older engineers, for instance.

Another question is how the demand for engineers will develop in the very long term—also under the influence of demographic change. Undoubtedly, it makes sense for a country such as Germany with a focus on technology to take early precautions to meet resulting challenges. However, this long-term outlook should not be mistaken for what lies ahead on the market for engineers in the current decade.

Karl Brenke is a Scientific Advisor to the Executive Board of DIW Berlin | kbrenke@diw.de

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Karl Brenke, Scientific Advisor to the Executive Board of DIW Berlin

SIX QUESTIONS TO KARL BRENKE

»University Graduates Alone Meet Demand«

1. Mr. Brenke, the Association of German Engineers (Verband Deutscher Ingenieure, VDI) estimates there will soon be huge demand for engineers because the average age of today's engineers is now very high. Does this coincide with your observations? No, VDI's figures clearly include engineers who have already retired. The VDI claims that the average age of engineers is 50 to 51. That only applies if retirees are counted as well. The average age of engineers currently in employment is 43. That may sound high, but the average age of academics is generally high due to the lengthy training periods.
2. So which engineers are we talking about here? Primarily about manufacturing-related engineers. Construction-related engineers such as architects, interior designers, structural engineers, and surveyors are excluded because there's obviously no demand there. But we need to take a closer look at manufacturing-related engineers because we've had very different developments in recent years. For example, the number of electrical engineers has been declining for years. We have seen slight increases in the number of mechanical and automotive engineers; there has also been a boom in the number of industrial engineers.
3. But are there really more engineers leaving the profession than joining it? No, the opposite is true. If you calculate the figures realistically, you get about 20,000 engineers retiring from the workforce each year due to their age. But the number of university graduates is somewhere around 45,000 to 50,000. This means the number of graduates currently leaving university is more than sufficient to meet the demand generated by engineers leaving the profession and to cover any additional demand.
4. Where does this false perception that we need more engineers come from? Is it based purely on their average age or are there other arguments? The VDI has conducted regular studies, but their methods are flawed. It determines how many vacancies there are for engineers at Federal Employment Offices, then multiplies this figure by a factor of seven because it says that not every vacancy for an engineer is registered at the Federal Employment Office, which is certainly true. The number of vacancies is compared to the number of unemployed, and then they record the difference. That does not surprise me at all, as large parts of the job market are hidden. The large majority of engineering positions are not filled through employment agencies. Vacancies are filled by an engineer going from one firm to another, or by university graduates entering the labor market—that plays a much more important role.
5. The call for more engineers is not new. Is the VDI simply mistaken or is it more calculated than that? Well, of course, that's difficult to say. On the one hand, I think the industry association has got somewhat on the wrong track. On the other hand, of course, it's true that if you keep saying that we need this or that labor, then you will encourage the younger generation to study certain subjects. The consequence is that the supply of labor will be more than ample, and that automatically drives wages down.
6. What is the actual demand for engineers? According to what we can deduce from the figures, we need around 30,000 a year. But we easily meet that demand with university graduates.

Interview by Erich Wittenberg.

German Manufacturing Withstands the Rise of Emerging Economies

by Martin Gornig and Alexander Schiersch

Between 2000 and 2009, China became the second largest industrialized nation, while manufacturing industries in other emerging and many Eastern European countries also experienced very strong growth. However, Germany was largely able to maintain its share of global industrial output. In 2009, as in 2000, Germany's value added share represented around 6.5 percent. This shows that Germany as an industrial location had benefited from the 50-percent increase in global industry far more than the USA, Japan, and other Western European industrialized nations.

The decisive factor here was that, despite the onset of the financial and economic crisis in 2008, German research-intensive industry was able to develop a leading position among the established economies. Sectors which particularly profited from this development include the manufacture of road vehicles, machinery, electrical machinery, and chemicals.

Emerging countries and particularly the BRIC nations (Brazil, Russia, India, and China) are always the first to come to mind when the discussion turns to the global economy or markets of the future. Alongside the potential arising from the strong economic growth and integration of these countries into the global economy, the resulting increase in competition is also highlighted, as is the danger that domestic value added will migrate to those very future markets.

In this year's report to the German government, the Expert Commission on Research and Innovation (EFI) focused on China's development and its impact on Germany.¹ DIW Berlin regularly conducts studies on the current state and outlook of Germany's technological capacity which act as a basis for the EFI report. The current article will outline the key findings of this report.²

Global Industrial Production Sees Significant Growth

Discussions on the risks and opportunities resulting from the dynamic development process in the BRIC countries focus in particular on the manufacturing industry. First, it should be noted that, despite the upheaval of the financial and economic crisis, overall industrial production has experienced significant growth in the last decade. Between 2000 and 2009, the manufacturing industry's global nominal gross value added—calculated in current US dollars—grew by more than

¹ Expert Commission on Research and Innovation (EFI), Jahresgutachten zu Forschung, Innovation und technologischer Leistungsfähigkeit Deutschlands 2012. 2012, www.e-fi.de/gutachten.html.

² H. Belitz, M. Gornig, F. Mölders, and A. Schiersch, „FuE-intensive Industrien und wissensintensive Dienstleistungen im internationalen Wettbewerb,“ Studien zum deutschen Innovationssystem, no. 12, (Berlin: Expert Commission on Research and Innovation, 2012).

50 percent.³ Real value added increased by more than 20 percent. The »cake« to be portioned out thus increases in size with the integration and growth of emerging economies. At the same time, however, this will also cause a shift in the balance of power.

The most striking trend here is the increased significance of the Chinese manufacturing industry, with a real value added that more than doubled between 2000 and 2009. Nominal growth up until 2009 was even over 200 percent. As a result of this above average growth, Chinese manufacturing also experienced a dramatic increase in its share of global value added during the period analyzed. In 2000, China accounted for approximately eight percent of industrial value added. By the end of the decade, however, already almost a fifth of global industrial value added originated in China (see figure).

The other BRIC countries have also experienced above average growth rates, both nominal and real. However, in comparison with China, development there is more modest. Despite very dynamic growth, in 2009 India and Brazil only accounted for 2.4 and 2.1 percent of global industrial value added, respectively. Russia's contribution was even as low as 1.7 percent.

The majority of the more established industrialized nations have experienced developments in contrast with China's ascent (see figure). The loss in shares observed in Japan and the US were particularly significant. Whereas in 2000 the US and Japan accounted for around a quarter and almost a fifth of global nominal industrial value added, respectively, by 2009 these values had fallen to just under 20 percent (US) and approximately ten percent (Japan). Nonetheless, the US's value added (both real and nominal) still increased slightly whereas Japan experienced a drop in both real and nominal value added.

Developments in the European Union varied widely. Eastern European countries that acceded to the EU in 2004 such as Poland, Hungary, or the Czech Republic realized a significant increase in their industrial value added shares. Between 2000 and 2009, on average, these accession countries (EU-10) almost doubled their share of global industrial production. Nonetheless, the overall contribution of these countries in 2009 was still under two percent.

³ The most recent available data on sectoral value added is for the years up to and including 2009. At the time of going to print, more recent sectoral data had not yet been published. Our analysis of industrial sector shares is, therefore, also limited to the period from 2000 to 2009.

Figure

Global Share of Value Added of Manufacturing Industry by Country

In percent



Source: United Nations Statistical Division (UNSD 2012), calculations by DIW Berlin

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Strong growth of China's share.

Some Western European countries (EU-14), on the other hand, experienced a drop in their global industrial value added shares.⁴ This includes large traditional industrialized nations such as France and the UK in particular. However, in comparison with the US and Japan, the drop in shares experienced by these countries was insignificant.

The same also applies to Germany. Despite China's ascent to second largest industrialized nation and the dynamic growth experienced by other emerging economies and many Eastern European countries, Germany's share of global industrial production barely changed.

⁴ This includes the countries of the old EU-15 excluding Germany.

Table

Value Added Shares in Research-Intensive Industries and Rates of Change

Shares in percent and rates of change in percentage points

Economic sector according to ISIC Rev. 3 ¹	Germany		USA		Japan		EU-14		EU-10	
	Value added shares in 2009 in percent	Change from 2000 to 2009 in percentage points	Value added shares in 2009 in percent	Change from 2000 to 2009 in percentage points	Value added shares in 2009 in percent	Change from 2000 to 2009 in percentage points	Value added shares in 2009 in percent	Change from 2000 to 2009 in percentage points	Value added shares in 2009 in percent	Change from 2000 to 2009 in percentage points
Chemicals and chemical products 24ex2423	12.2	1.6	41.6	2.3	14.6	-7.5	28.6	2.7	2.9	0.8
Pharmaceuticals 2423	10.0	3.7	46.7	3.0	10.7	-8.4	29.7	0.6	3.0	1.1
Machinery and equipment n.e.c. 29	19.5	4.3	27.3	-4.0	17.8	-8.0	30.4	4.9	5.0	2.8
Office, accounting and computing machinery 30	6.2	1.1	43.5	-2.0	31.0	-3.1	16.2	2.4	3.0	1.7
Electrical machinery and apparatus 31	18.8	2.1	24.7	-5.6	19.7	-8.1	27.8	5.8	9.1	5.9
Radio, television and communication equipment and apparatus 32	5.7	2.0	40.9	-5.5	31.2	-2.0	18.4	2.8	3.7	2.8
Medical, precision and optical instruments, watches and clocks 33	12.7	-0.1	46.0	6.7	10.5	-10.2	27.4	2.1	3.4	1.5
Motor vehicles, trailers and semi-trailers 34	21.6	7.7	24.4	-12.6	30.5	2.0	17.9	-1.0	5.6	3.9
Aircraft and spacecraft 353	8.9	2.4	63.6	-2.6	4.1	0.4	22.5	-0.4	0.8	0.3
Railway and tramway locomotives and rolling stock; transport equipment n.e.c. 352. 359	10.5	2.3	31.1	-12.1	9.8	-3.7	42.2	10.6	6.4	2.8

¹ Statistical classification of economic sectors according to the International Standard Industrial Classification of All Economic Activities (ISIC) Revision 3

Sources: EUKLEMS database (2012), OECD STAN (2012), Eurostat (2012), calculations and estimates by DIW Berlin.

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The 2009 share of 6.4 percent was only marginally lower than in 2000 (6.7 percent), demonstrating that Germany as an industrial location profited more or less proportionally from global industrial growth.

In the interim, German industry even managed to noticeably expand its slice of the growing »cake.« Thus, in 2007, German industrial production accounted for an almost eight percent share. However, this increase in shares dropped away again due to the onset of the financial and economic crisis in 2008. However, the positive development observed in German industrial production in 2010 and 2011 gives reason to believe that this downturn was only temporary and German indus-

try is currently experiencing renewed growth in its value added shares.⁵

Research-Intensive Industries Produce Good Results

Why, however, is German industry more successful than that of many other established economies? A key factor in the long-term structural competitive strength of German manufacturing is its significant concentration on research-intensive industries such as the manufacture of electrical machinery, machinery, chemicals, or vehic-

⁵ D. Lucke, »German Industry—a Tower of Strength?« DIW Economic Bulletin, no. 1 (2012): 15–23.

le construction.⁶ The following section focuses on the position of Germany and its competitors in the individual R&D-intensive sectors.⁷

Germany accounts for a significant proportion of the value added contributed by research-intensive industries originating in industrialized countries (see table). Approximately a fifth of value added from the manufacture of machinery originates in Germany. Omitting the EU as an aggregate and conducting a country-by-country analysis demonstrates that Germany has the second largest machinery manufacturing industry of all industrialized countries. It also shows that the German motor vehicle and electrical machinery manufacturing industries occupy prominent positions. In both of these branches, almost 20 percent of value added is created by German industry. This places German motor vehicle manufacturing only marginally behind the American competition (22 percent) and electrical machinery manufacturing at almost level pegging with Japan (20 percent). It is fair to say that Germany also contributes a significant share of value added in most of the remaining sectors. This particularly applies to the manufacture of medical, precision, and optical instruments (13 percent), and aircraft and spacecraft (nine percent) in which Germany accounts for a greater share than Japan or any of its European competitors. Also with its manufacture of chemicals and pharmaceuticals, and the manufacture of other transport equipment, Germany is positioned in the top group with a share of around twelve and ten percent, respectively. However, the contributions made by German manufacture of office, accounting and computing machinery, and of radio, television and communications equipment are insignificant in an international comparison.

⁶ Research-intensive industries are defined as sectors in which the proportion of internal R&D expenditure accounts for over 2.5 percent of turnover. According to the 2006 NIW/Fraunhofer ISI list, the manufacture of chemicals (WZ (economic sector) 24ex2423), pharmaceuticals (WZ 2423), machinery (WZ 29), office, accounting, and computing machinery (WZ 30), electrical machinery (31), radio, television, and communication equipment (WZ 32), medical, precision, and optical instruments (WZ 33), motor vehicles, trailers and semi-trailers (WZ 34), railway and tramway locomotives and rolling stock; transport equipment (WZ 352, 359), aircraft and spacecraft (WZ 353) are all counted as research-intensive industries. For a more detailed description, see H. Legler and R. Frietsch, *Neuabgrenzung der Wissenswirtschaft – forschungsintensive Industrien und wissensintensive Dienstleistungen*. (2007), NIW/ISI list 2006, Studien zum deutschen Innovationssystem, no. 22, (Berlin: Federal Ministry of Education and Research (Bundesministerium für Bildung und Forschung), 2007). On the specialization of German industry, see H. Belitz, M. Gornig, and A. Schiersch, „Forschungsintensive Industrie gut aufgestellt,“ *Wochenbericht des DIW Berlin*, no. 17 (2011): 5–10.

⁷ The BRIC countries are omitted here due to insufficient available data. This is unproblematic for two reasons. First, China is the only country that plays a significant role. Second, the positions of the other countries in relation to one another do not change with the omission of China.

Strong Growth in the Manufacture of Motor Vehicles

Moreover, if development over previous years is analyzed, it becomes evident that between 2000 and 2009 Germany recorded almost continuously high share increases in the R&D-intensive sectors. The gain in the manufacture of motor vehicles of almost eight percentage points was particularly striking. This represented an increase in Germany's share of more than 50 percent since 2000 which was larger than in any of the other comparable countries and regions with the exception of the EU-10. Similarly marked increases, albeit at a lower level, can be observed in the manufacture of pharmaceuticals (3.7 percentage points) and of radio, television and communications equipment (two percentage points). Furthermore, industries manufacturing aircraft and spacecraft, with 2.4 percentage points (share growth of 37 percent), and machinery, with 4.3 percentage points (share growth of 28 percent), also experienced significant increases. Share increases were also observed in the remaining sectors. Only in the manufacture of medical, precision, and optical instruments did the value added share remain constant. Overall, it is fair to say that Germany's research-intensive industries occupy a strong position which has been consolidated over the last decade.

The US continues to maintain its dominant position in many research-intensive sectors. Thus, in 2009, American manufacturing of medical, precision and optical instruments, chemicals and pharmaceuticals, as well as of office, accounting and computing machinery and radio, television and communications equipment produced more than 40 percent of the sectoral value added.⁸ In the manufacture of aircraft and spacecraft, the American industry's value added share is as high as over 60 percent (see table).⁹ However, although the US continues to play an important role in many branches of industry, it still had to accept losses in shares in virtually all sectors with the sole exceptions of the chemical and phar-

⁸ However, what has to be borne in mind here is that the US is a comparatively large economic area which should, therefore, also be contributing a significantly larger share of sectoral value added. According to OECD data, in 2009 GDP in US dollar purchasing power parities was approximately three billion US dollars in Germany, around four billion in Japan, approximately 12.6 billion in the EU-26 (excluding Germany), and around 14 billion US dollars in the US. <http://stats.oecd.org/Index.aspx>.

⁹ However, the significant dominance of this sector must be considered in the context of high American military expenditure that is reflected in a correspondingly high value added share.

maceutical industries and the manufacture of medical, precision, and optical instruments.¹⁰

Japan finds itself in a rather different situation than the US. On the one hand, current value added shares indicate that Japan occupies a strong position in many research-intensive industries. This is particularly true for the manufacture of office, accounting and computing machinery, radio, television and communications equipment, and motor vehicles. In these sectors, Japan accounts for a third of the value added produced by industrialized countries. Japan even dominates the production of motor vehicles. Also in the remaining sectors, with the exception of the manufacture of aircraft and spacecraft, based on a country-by-country analysis, Japan occupies a strong position. In this respect, in the R&D-intensive industries, Japan's position in 2009 is similar to Germany's. However, where they differ significantly is in the dynamics. While German industries recorded increases in their shares between 2000 and 2009, almost all Japanese sectors experienced losses during the same period. Only the manufacture of motor vehicles (two percentage points) was able to increase its value added share. The losses in shares that had already been observed at the global level (see figure) are, therefore, also evident in the research-intensive industries.

Looking at the development dynamic in the EU-14,¹¹ it is evident that almost all research-intensive sectors experienced an increase in their value added shares. This particularly applies to the manufacture of other vehicles with a share gain of almost eleven percentage points or a 33-percent share increase since the starting year, 2000. However, the manufacture of machinery and electrical machinery have also recorded significant gains of 5.8 and 4.9 percentage points, respectively. Overall, the EU-14 make a significant contribution to value added in all research-intensive sectors. However, a disaggregated analysis indicates that the individual country shares are generally significantly lower than Germany's.

Similarly positive developments have been observed among the Central and Eastern European EU-10. These countries are continuing to catch up and, commencing from a low level, have, in part, managed to more than double their respective sectoral value added shares. This applies to the manufacture of machinery and motor ve-

hicles as well as electrical machinery and medical, precision, and optical instruments (WZ (economic sector) 30 to WZ 33, see table). However, in most sectors, these increases have not yet led to the EU-10 being able to lay claim to larger value added shares, with the exception of the manufacture of electrical machinery, motor vehicles, and machinery. This is evidence that the EU-10 countries are following the German specialization route without causing Germany to experience a drop in its own value added shares.

Prof. Dr. Martin Gornig is Acting Head of the Department Innovation, Manufacturing, Service at DIW Berlin | mgornig@diw.de

Dr. Alexander Schiersch is a Research Associate in the Department Innovation, Manufacturing, Service at DIW Berlin | aschiersch@diw.de

JEL: 010, 040, 057

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¹⁰ The strong increase in the manufacture of medical, precision, and optical instruments is a result of the financial and economic crisis. Up until 2007, the US had to accept sector share losses in this industry, too. Only the comparatively stronger decline in value added in Europe in 2008 and 2009 led to the share gains depicted.

¹¹ This refers to the old EU-15 excluding Germany.

Discussion Papers Nr. 1204/2012

Andreas Kappeler, Albert Solé-Ollé, Andreas Stephan, Timo Vålilä



Does Fiscal Decentralisation Foster Regional Investment in Productive Infrastructure?

The aim of this paper is to analyze the effect of revenue decentralization on the provision of infrastructure at the sub-national level. We estimate the effects of revenue decentralization and earmarked grant financing on the level of sub-national infrastructure investment in 20 European countries over the period 1990-2009. The results are interpreted in light of the predictions of the theory on fiscal federalism. We find that it is sub-national infrastructure investment that increases after revenue decentralization and not investment in redistribution. However, the effect of revenue decentralization is lower the higher the use of earmarked grants to fund infrastructure investment.

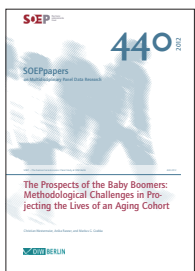
JEL-Classification: H54, H77, H76, C23

Keywords: regional investment, fiscal federalism, dynamic panel data

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SOEPpapers 440/2012

Christian Westermeier, Anika Rasner, Markus M. Grabka



The Prospects of the Baby Boomers: Methodological Challenges in Projecting the Lives of an Aging Cohort

In most industrialized countries, the work and family patterns of the baby boomers characterized by more heterogeneous working careers and less stable family lives set them apart from preceding cohorts. Thus, it is of crucial importance to understand how these different work and family lives are linked to the boomers' prospective material well-being as they retire. This paper presents a new and unique matching-based approach for the projection of the life courses of German baby boomers, called the LAW-Life Projection Model. Basis for the projection are data

from 27 waves of the German Socio-Economic Panel linked with administrative pension records from the German Statutory Pension Insurance that cover lifecycle pension-relevant earnings. Unlike model-based micro simulations that age the data year by year our matching-based projection uses sequences from older birth cohorts to complete the life-courses of statistically similar baby boomers through to retirement. An advantage of this approach is to coherently project the work-life and family trajectories as well as lifecycle earnings. The authors present a benchmark analysis to assess the validity and accuracy of the projection. For this purpose, they cut a significant portion of already lived lives and test different combinations of matching algorithms and donor pool specifications to identify the combination that produces the best fit between previously cut but observed and projected life-course information. Exploiting the advantages of the projected data, the authors compare the returns to education - measured in terms of pension entitlements - across cohorts. The results indicate that within cohorts, differences between individuals with low and high educational attainment increase over time for men and women in East and West Germany. East German boomer women with low educational attainment face the most substantial losses in pension entitlements that put them at a high risk of being poor as they retire.

JEL-Classification: C53, H55, I24

Keywords: Forecasting Models, simulation methods, SOEP, baby boomers, education, public pensions

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