ECONOMIX Research & Consulting

The German Labour Market 2030
Economy and labour market in the digital age

2016 forecast
Executive Summary

On behalf of the
German Ministry for Labour and Social Affairs

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cambridge econometrics | Fraunhofer IAO | ISF MÜNCHEN | ZEW

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Abbreviations

BA	German Federal Employment Agency
BIP	Gross Domestic Product
BMAS	German Federal Ministry of Labour and Social Affairs
CE	Cambridge Econometrics
EGS	German Job Vacancy Survey
ERC	Economix Research & Consulting
IAO	Fraunhofer-Institut für Arbeitswirtschaft und Organisation Stuttgart
IER	Warwick Institute for Employment Research
ISF	Institut für Sozialwissenschaftliche Forschung e.V. München
KB92	German Classification of occupations 1992
KB10	German Classification of occupations 2010
PP	Percentage points
VGR	German national accounts

Executive Summary

Tasks and methods

This report is the third long-term forecast for the German labour market up until 2030 carried out by Economix Research & Consulting (Munich, Germany) on behalf of the German Federal Ministry of Labour and Social Affairs (BMAS).[1] Its main focus lies on the estimation of the effects of the accelerating digitisation in company with the effects of refugee immigration. Two scenarios were developed, quantified by the corresponding econometric models[2]:

- In the *baseline scenario,* recent developments in labour supply, in particular the increase of refugee immigration, are taken into account. After the peak in 2015 refugee immigration is assumed to fade away by 2020. As the skills structure of immigrants is different from the resident population, a long-term challenge will be their integration on the labour market. The scenario of refugee immigration is compared to the scenario of immigration from EU countries. It suggests a continuation of structural trends towards knowledge-intensive, cultural and social services which are already in effect today.
- In the "*accelerated digitisation scenario*", business and policy actors prioritize intensive use of digital technologies to promote economic competitiveness on the word markets and to improve labour productivity. This scenario shows opportunities for economic and productivity growth induced by digital technology and serves to answer the question if accelerated promotion of technological change could contribute to the task of overcoming skills shortages.

The two scenarios represent different strategies for coping with demographic change. In the baseline scenario, the policy emphasis is on immigration, as it was the case several times in the past decades. Attempts are made to compensate for the declining national labour supply by workers from abroad. Specific challenges arise in the course of the refugee crisis concerning controlling immigration and promoting vocational integration. In the *accelerated digitisation scenario* an additional focus is set on technological leadership, particularly in the field of networked industrial production (the Internet of Things or "Industry 4.0" as it is called in Germany). This requires a focus on the development of digital technology in many upstream and downstream sectors, not least by focusing educational and infrastructure policies on these issues. From a structural policy point of view, both scenarios share the decisive question if the German economy will be able to

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1 The project had been started in 2011. The results were published by W. Bertelsmann Verlag as three main reports, a methodology report, and two supplementary reports (http://www.economix.org/en/projects/forecast-2030.html).

2 Basis of the quantitative forecast is the G3M-model developed for the German labour market by Cambridge Econometrics (Cambridge, UK). In addition, a forecasting model for occupational structural change was build up by Warwick Institute for Employment Research (Coventry, UK). Economix Research & Consulting (Munich) was responsible for the management of the project and created models to estimate skill-specific structural change, labour supply, and shortage of skilled workers. All individual elements were interlinked, allowing to estimate supply and demand interdependently. The models distinguish 44 sectors, 147 occupations, and 29 categories of vocational training.
A key feature of the projections is the methodological link of qualitative scenarios with quantitative-econometric models. Thus, fundamental changes induced by structural change can be simulated in a better way than by conventional quantitative models based on historical trends. Basis of the scenarios were expert assessments about the main determinants of the forecasts. For that purpose, the Zentrum für europäische Wirtschaftsforschung (Mannheim, Germany) created a comprehensive study of the digital economy. The Fraunhofer Institut für Arbeitswirtschaft und –organisation (Stuttgart, Germany) and the Institut für sozialwissenschaftliche Forschung (Munich, Germany) submitted supplementary studies.
Another feature of the forecast is its strategic orientation. Since the future is open and can be shaped with considerable degrees of freedom, the forecasts describe feasible strategies for economic and political action instead of a deterministic vision of the future. They do not consider the question where we will be in 2030, but where we want to be and where we will be able to be in 2030 while taking into account various constraints. This means they also deal with the identification of alternative action plans, policy design, and economic and political change.

maintain its leading position in the digital world by ensuring to invest a significant amount of resources, or if it prefers to develop into a diversified knowledge economy with a focus on the application and implementation of digital technology instead of technological leadership of the industrial sector.

The labour market in the course of immigration

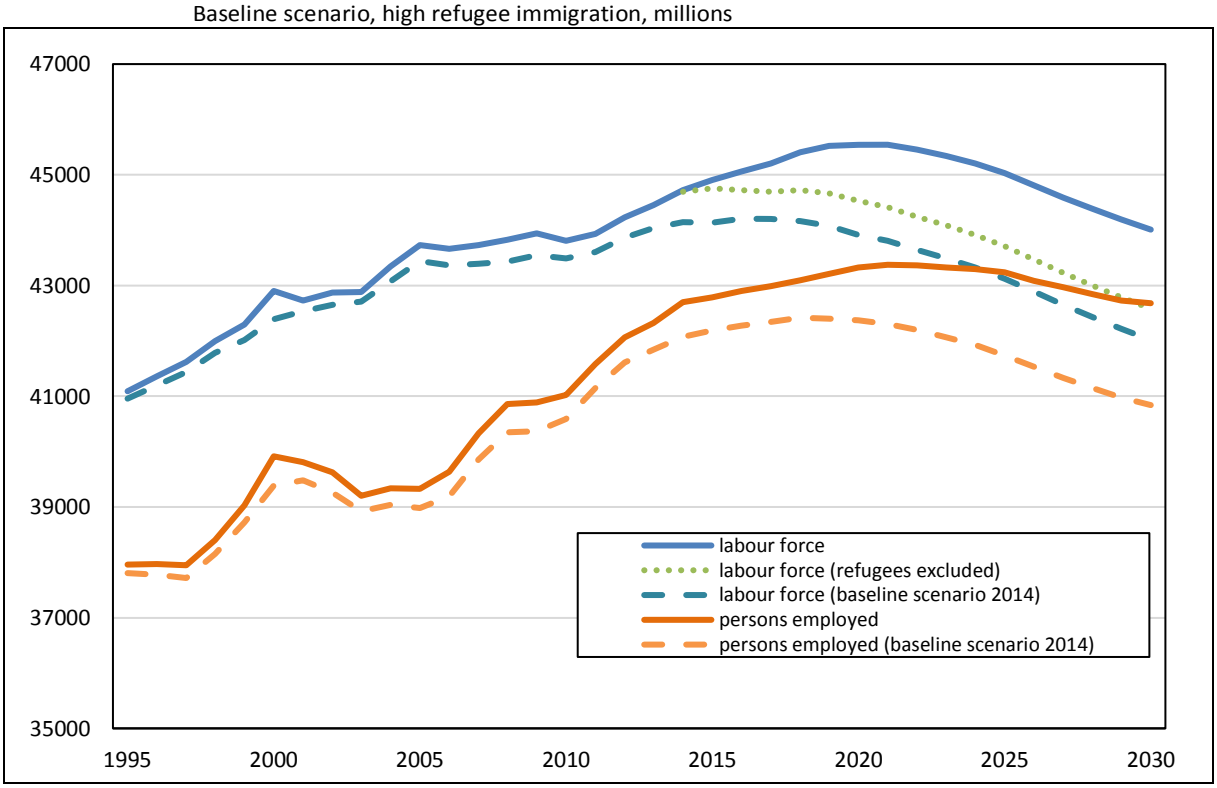
(baseline scenario)

Macroeconomic effects of refugee immigration

The number of refugees living in Germany aged 15 years and older will be rising to 1.4 million or 2.1 million by 2030 – depending on the development of the refugee influx. This will be between 2 and 3 % of the population. On average, we expect an immigration of 360,000 persons annually. During 2015-20, refugee immigration will considerably contribute to this development. After 2020, immigration will solely come from non-refugee countries.

Figure 1 **Labour supply and demand**

Baseline scenario, high refugee immigration, millions



Source: CE, Economix (forecast 2016; T04 K1)

Following these assumptions, labour supply will expand to 45.5 million (+2 %) until 2020. However, demographic change will prevail thereafter and lead to a decline of total labour force by 1.5 million. Despite immigration there will be around 700,000 workers less in 2030 compared to 2014 (Figure 1).

Given successful vocational integration of refugees, annual economic growth will be increased by ¼ percentage points until 2030 compared to the situation without such immigration. In the case of high immigration, 1.2 million jobs will be created, however the unemployment rate will rise by 0.8 percentage points due to the remaining integration problems. We assume that refugees will integrate in the labour market increasingly, but not fully. In this respect the second generation of refugees might be more successful.

The macroeconomic impact during the phase of high refugee migration until 2020 differs significantly from the subsequent period. Due to the long five-year integration phase of refugee cohorts, unemployment will increase during the first period and the growth effects of immigration will be absent. Consequently, labour productivity and average per-capita income will decrease by about 0.2 percentage points. In the 2020-30 period, the growing and exceedingly integrated labour supply will have rising positive effects: Real economic growth will increase by around 0.4 percentage points per year. Productivity and per-capita income will rise again.

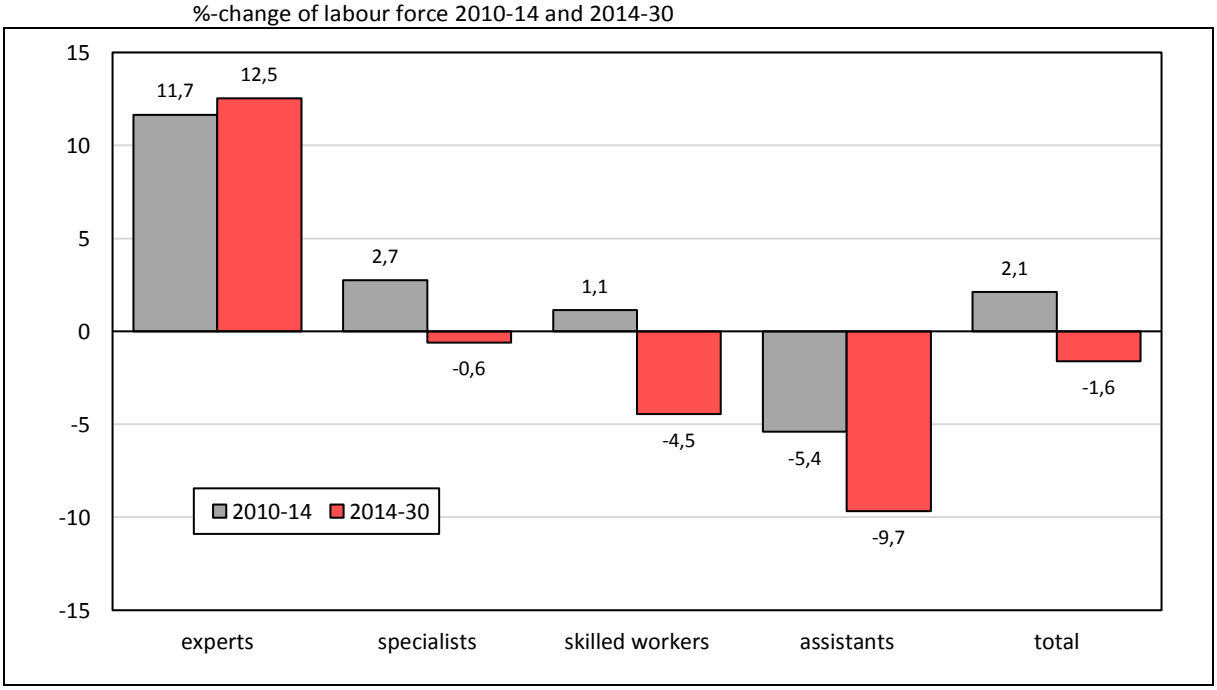
Our model calculations show that there is no alternative to the comprehensive vocational integration of refugees. We assume that, after an integration period of five years, 70 % of the refugee labour force will possess vocational qualifications usable on the German labour market. Under favourable conditions, refugee immigration will support growth development of the German economy and mitigate negative effects of the demographic change at least temporarily. Along with migration from non-refugee countries it causes a clear improvement in the age structure of the labour force. If unfavourable conditions hamper the successful integration of refugees, significant distortions have to be expected on the German labour market. It must be assumed that one third of the refugees will remain unemployed. Beyond the risks associated with the present refugee inflow, it has to be stated that immigration can neither fully compensate for population aging, nor for the long-term decrease of labour supply.

Qualification trends

The German labour market is characterised by a continuous reallocation of labour supply and employment. On one hand, labour is shifted towards high skilled jobs, on the other it is moving into service sector occupations. This trend will continue during the forecast period 2014-30 (Figure 2). According to our model calculations, the number of experts (with a minimum of four year tertiary education) will increase sharply while the number of specialists (with bachelor, master craftsman or technician qualification) will stagnate. The number of skilled workers available on the labour market (with industrial, commercial or other vocational training, many of them with dual training) will decline, similar to the number of assistants (with a maximum of one-year training).

Figure 2 **Labour supply by vocational qualification**

%-change of labour force 2010-14 and 2014-30



Source: German Federal Statistical Office (Mikrozensus), Economix (forecast 2016; T07)

These reallocations are the statistical counterpart to technological and structural change on the German labour market, which could not be achieved without the continuous improvement of skill levels. The introduction of new technological and organisational concepts is just as dependent on the availability of better-qualified workers as the development of a majority of knowledge-intensive service markets. Unlike other industrialised countries, Germany has broadly maintained its quality-oriented strategy in international competition, and labour supply has followed this trend by greatly increasing the number of university graduates. In our view, this is unlikely to change in the future.

Refugee immigration will expand labour supply in the low qualification segment and result in a relative decline of the high qualification segment. This is revealed by the comparison with the 2014 forecast where we expected immigration mainly from EU countries. The number of persons employed without formal qualifications will be by 2 % higher than in the forecast 2014, the number of persons employed with tertiary education will however be 1 % lower. For the 2016 forecast, we estimate a higher number of workers with technical college degrees (+1 %). Persons employed with dual vocational training will increase by 0.4 %. Current immigration will thus move the labour supplies skills structure a little further away from the skills oriented labour demand that was envisaged in our 2014 estimations, even if we assume successful integration of immigrating refugees. This again underlines the necessity to integrate refugees comprehensively and rapidly.

Occupational trends

The growing significance of services and the importance of knowledge-intensive tasks at work are reflected in occupational structures. According to our model calculations, employment in the occupational category “health, social matters, training, and education“ will increase by +743,000. In parallel, employment in the occupational groups „natural science, geography, computer science“ and “humanity, social and economic sciences, media and culture” will increase by around 150,000 each (Table 1). Employment in production and manufacturing related jobs as well as agricultural occupations will decrease significantly. In addition, the occupational field “commercial services, commodity trading, sales, hotel and tourism” will be characterised by declining employment.

Table 1 Persons employed by occupational groups
baseline scenario

occupational field	2014	2030	2014-30 change	
	1000s		1000s	%
1 agriculture, forestry, animal husbandry and horticulture	1041	892	-149	-14.4
2 raw material extraction, production and manufacturing	8086	7439	-647	-8.0
3 construction, architecture, surveying and building technology	2535	2489	-45	-1.8
4 natural science, geography and computer science	1509	1656	147	9.7
5 transport, logistics, protection and security	5698	5700	1	0.0
6 commercial services, commodity trading, sales, hotel and tourism	5359	5154	-204	-3.8
7 business organisation, accounting, legal and administrative occupations	8803	8835	32	0.4
8 health, social matters, training, education	8228	8971	743	9.0
9 humanity, social and economic sciences, media and culture	1270	1405	135	10.6
0 military	174	139	-35	-20.3
total	42703	42680	-23	-0.1

Source: Economix (Forecast 2016)

It should be noted that occupations identified according to the German classification of occupations (edition of 2010) include all skill levels. Therefore, employment trends of high and low qualified compensate each other in a variety of ways. This is particularly true for the occupational field "transport, logistics, protection and security" in which only transport and logistics occupations (except vehicle drivers) grow, while vehicle drivers, monitoring and cleaning professions are decreasing. In the occupational segment "business organisation, accounting, legal and administrative occupations", employment will increase in particular due to financial service, accounting and tax consultancy occupations while it will decrease in administrative occupations.

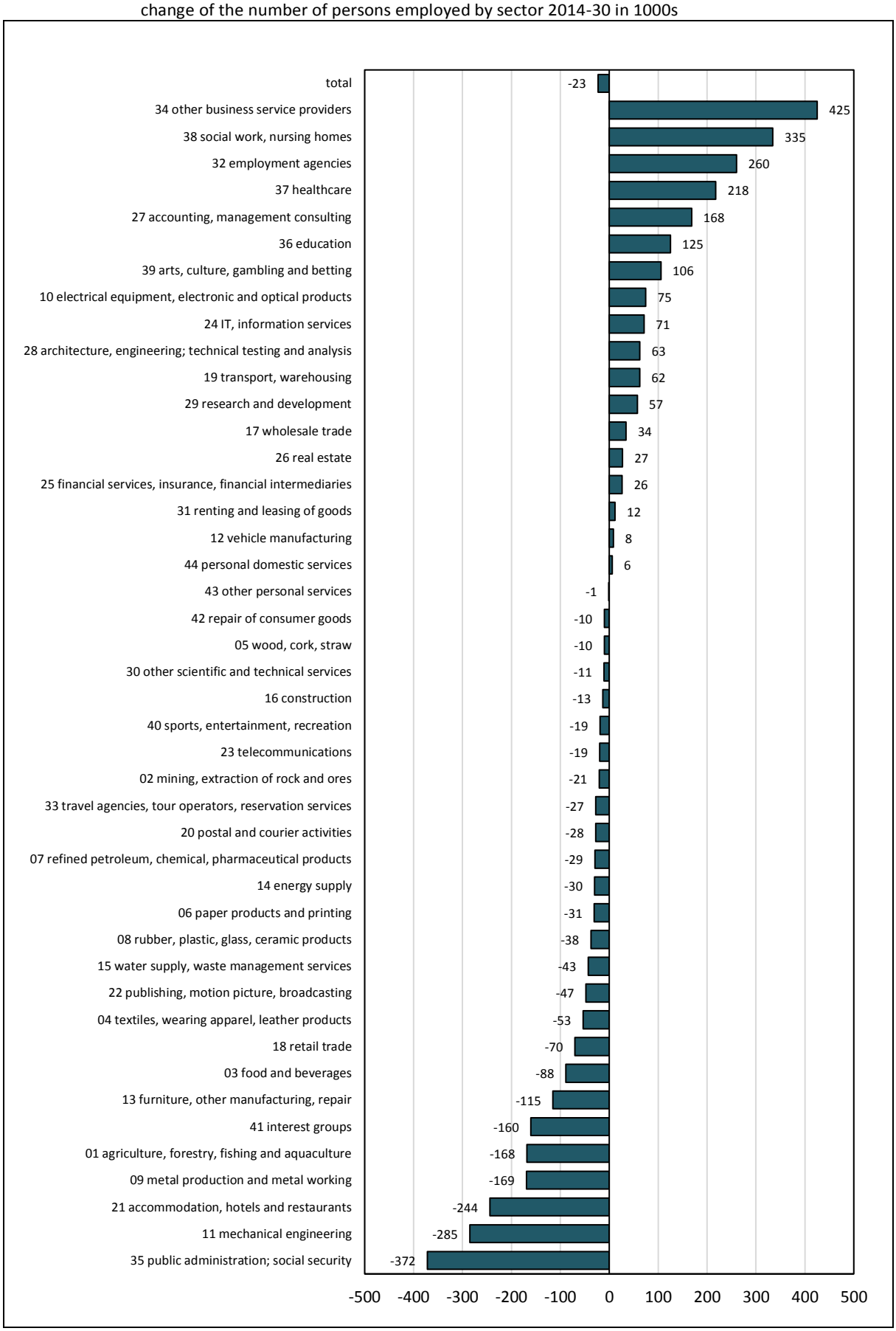
Employment by sectors

In the baseline scenario of our forecast 2016, the German economy is focused on its core competencies and will achieve market success above all in knowledge-based, creative, and social services. This will result in an employment decrease in agriculture, industrial production of commodities, and simple services and in an employment increase in knowledge-based and social services (Figure 3). The strongest employment gains by 2030 are expected within the so-called other business services (+425,000), social service and residential care (+335,000), personnel leasing (+260,000), and healthcare (+218,000). The number of jobs will decrease in public administration (-372,000), mechanical engineering (-285,000), and in the hotel and restaurant industry (-244,000).

Immigrants will mainly find employment in social services. Trade and transport as well as personnel services will increase their employment share slightly. However, in production of commodities and business or financial services, employment will shrink due to immigration. In other words: refugee immigration probably favours social and personal services, while production of commodities and business services will benefit more from the immigration of skilled labour.

Figure 3 Sectoral employment development: baseline scenario

change of the number of persons employed by sector 2014-30 in 1000s

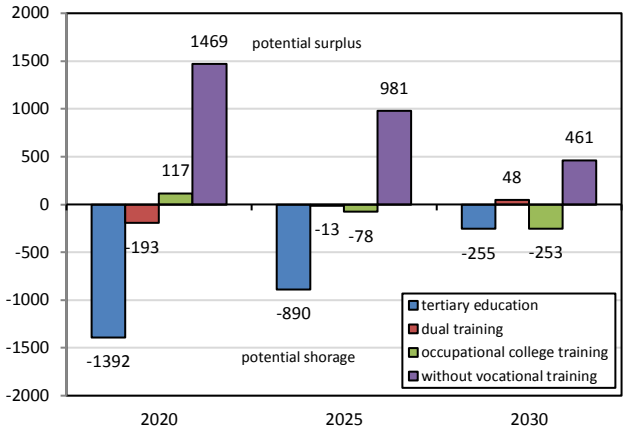


Source: CE, Economix (forecast 2016; T08)

Skills shortages

Compared to our 2014 forecast, the estimated skills gap did not decrease. On the contrary, imbalances in 2020 of both persons with tertiary education and persons without vocational training are 5 to 7 % higher than in the baseline scenario 2014. This means, firstly, that there hasn't been a sufficient adaptation of labour supply towards expected skill-specific changes. Secondly, it becomes apparent that immigration of a larger number of low-skilled workers will increase these imbalances.

Figure 4 **Potential skills gap**
Shortage indicator II (baseline scenario); persons employed in 1000s



Source: Economix (forecast 2016)

This points to the need for comprehensive and systematic continuing training. On one hand, initial vocational training of the younger generation is not sufficient to achieve the increase of skills needed in our forecasts. Without adult vocational training the adaptation will not succeed. On the other hand, immigration of refugees degrades the skills structure of labour supply and therefore requires the development of special educational efforts towards this target group. Nevertheless, imbalances will be considerably reduced over the forecasting period since we assume that labour supply and labour demand will react to existing bottlenecks (Figure 4). Here, we have already included an expansion of initial training and further training.

The labour market in the course of digitisation

(Accelerated digitisation scenario)

When forecasting future economic and labour market effects of digital technologies in Germany, the core question of technology assessment needs to be examined: How will the overall impact between job losses and gains caused by digitisation turn out and how will the framework of the economic and labour market system change during the digital revolution? Indeed, from the current perspective it may be called a revolution, because high rates of innovation and rapid diffusion of information technology change markets, companies and jobs on a so far almost unprecedented scale. Even more so, the potential of digital technology is considered limitless by some experts and thus may affect all areas of economic, social and private life. This could lead into a new phase of technologically-induced unemployment or – in a more positive perspective – will create new market opportunities with more growth and more jobs.

From the German perspective, the acceleration of productivity growth has to be evaluated against the background of demographic change. Under the conditions of declining population and labour force digital technology could mitigate the expected supply gap by increasing productivity. This reduces the risk of technological unemployment in general, but puts high demands on the flexibility and adaptability of companies and workers.

Principals of the digital economy

The diffusion of digital technologies is mainly driven by two factors: firstly by the extraordinary pace of technological progress – as described in the so-called Moore's law, and secondly by the fact that marginal costs of dissemination of information are close to zero. While Moore's law has correctly predicted the annual doubling of storage on electronic chips in relation to their costs

and thereby the extraordinary cheapening of hardware, the zero marginal cost hypothesis points to negligible or low costs of information sourcing. Although these are not laws in the strict sense, they however describe key advantages of digital technology compared to its analogue counterparts: Digital technology is not only better, faster and cheaper now, but will also become better and better, faster and faster, as well as increasingly cheaper in the future. This explains the high growth rates of the digital economy and the ubiquitous presence of digital technology in the present and future world.

From an economic point of view, the world of information differs from the "analogue" world of commodities in some key aspects:

- The production of information goods provides enormous economies of scale, which are enhanced by network effects that occur on information platforms. This leads to the rise of economic concentration in information industries which is – however – counteracted by significantly lower market entry barriers in various markets and results in a rising number of suppliers.
- Falling prices for hardware, software and especially the fact that marginal costs of information sourcing are close to zero weaken the power of prices to steer market behaviour and to exclude parts of total demand. Thus, demand for information assets is growing at exceptional rates and digital technology increasingly displaces parts of "analogue" production.
- The rapid growth of digital information, together with improved analytical techniques, enables an increasing number of combinations of existing knowledge. This accelerates the potential for scientific and technical progress. If this can be exploited productively, high "real" rates of progress are likely.

So far, Germany has benefited from information technology primarily as operator and user. In IT-sectors, however, production and employment is declining. Only IT-services showed a positive development. Considering the enormous competitive advantages of foreign – especially Chinese – providers, there is hardly any prospect of a revival of the hardware industry in Germany, especially since Chinese competitors are gaining an increasing share of the world market themselves. The same applies to the development of advanced technology and software, which is largely in the hands of US-American companies. Significant growth and employment stimuli are therefore only expected if Germany will be able to emerge as a world leader in the "Internet of Things" area (Industry 4.0) through a strategy of reinforced digitisation.

Future paths of digital technology

The *accelerated digitisation scenario* is based on a development strategy, which relies on intensive use and application of digital technologies by the population, the economy, and the public sector. It targets a technological leadership in the field of Industry 4.0, and aims at spreading digitisation to all spheres of work and life in order to remedy the impact of demographic change by establishing the highest possible level of productivity. This includes, firstly, high redundancies in activities put at risk by digitisation and, secondly, an increasing need for all activities related to coordination, research, communication, creativity, and decision-making.

Above all, it means the use of market opportunities by focusing activities on the development and marketing of digital technology, particularly in the field of Industry 4.0. In our scenario we consider the following trends for the period up until 2030:

- *Population:* high acceptance of digital progress; rapid spread of sharing culture; minor importance of data protection; high participation in IT-specific further training; dissemination of digital learning and teaching; expansion of IT-related university courses and integration of digital competencies in vocational and educational training;
- *Companies:* technological leadership of the capital goods industry is maintained by developing Industry 4.0-technologies; high willingness to invest; high R&D expenditure; less protec-

tion of market competition for analogue markets; strong boost in demand for business services due to the central role of software and business organisations in the field of Big Data; self-propelled vehicles; rationalisation of administration; Industry 4.0 etc.;

- *Trade and services*: trade and service platforms lead to high concentration among platform operators and to a strong diversification and fanning out of direct service providers; print media are increasingly replaced by digital media;
- *Transport*: by 2030, self-propelling cars are standard; fully automated warehousing; car sharing prevails; digital traffic management systems at many nodes;
- *Public and social services*: strong promotion of digital technologies; internet-based public administration; increasing intensity of technology in social services; digital medical technology is developed strongly; digital home technology is widely used;
- *IT industries:* strong growth impetus from technological change; specialisation in production management, logistics, network engineering; accelerated expansion of telecommunication;
- *Labour market:* greater division of labour in simple, greater specialisation in complex activities; more intensive interlinking of professional domains; increasing flexibility of working hours and employment relationships; more solo self-employment; use of digital technologies for the integration of persons with low economic performance;

Positive macroeconomic effects

In contrast to frequently expressed expectations that digitisation threatens jobs on a large scale, our model calculations show that it will be possible to generate economic growth and employment through accelerated digitisation. The crucial difference to respective studies by Frey/Osborne (2013)[3], Bonin/Gregory/Zierahn (2015)[4] or the German Institute for Employment Research IAB (Dengler/Matthes 2015)[5] is the fact that we do not only quantify potential job risks of digital technology, but also consider positive demand effects of product innovation as well as cost and price reductions. This turns the tide and opens the prospect of an employment increase of around ¼ million. According to our estimates, real gross domestic product will be 4 % higher in 2030 than without accelerated digitisation, and unemployment will drop by 20 %. Per capita income will also be higher by 4 %. The maximum increase in employment will result in around 370,000 additional jobs around 2025. Afterwards, the sinking labour supply enforces a decrease by 0.7 million to 43 million (Figure 5).[6]

The productivity effects of digitisation are even more important. According to our model calculations, productivity growth will increase significantly in particular in the phase 2025-30. With an annual growth of 2.4 % during that period, the increase in productivity will not only compensate the decline in labour supply, but also accelerate annual economic growth by 0.3 percentage points.

Certainly, such a development is not self-evident, but relies – as described in our conclusions – on a variety of political decisions. Methodologically, the positive economic development is a result of increased investment, particularly in research and development and physical capital, as well as higher education expenditures. Market success in export and domestic markets follows not before a ten years investment and restructuring period. Then, however, digitisation will result in

3 Frey, C.; Osborne, M.A. (2013): The Future of Employment: How Susceptible are Jobs to Computerization? Online: http://www.oxfordmartin.ox.ac.uk/downloads/academic/The_Future_of_Employment.pdf.

4 Bonin, H.; Gregory, T.; Zierahn, U. (2015): Übertragung der Studie von Frey/Osborne (2013) auf Deutschland. Kurzexpertise Nr. 57 an das Bundesministerium für Arbeit und Soziales, Mannheim.
Online: .http://ftp.zew.de/pub/zew-docs/gutachten/Kurzexpertise_BMAS_ZEW2015.pdf.

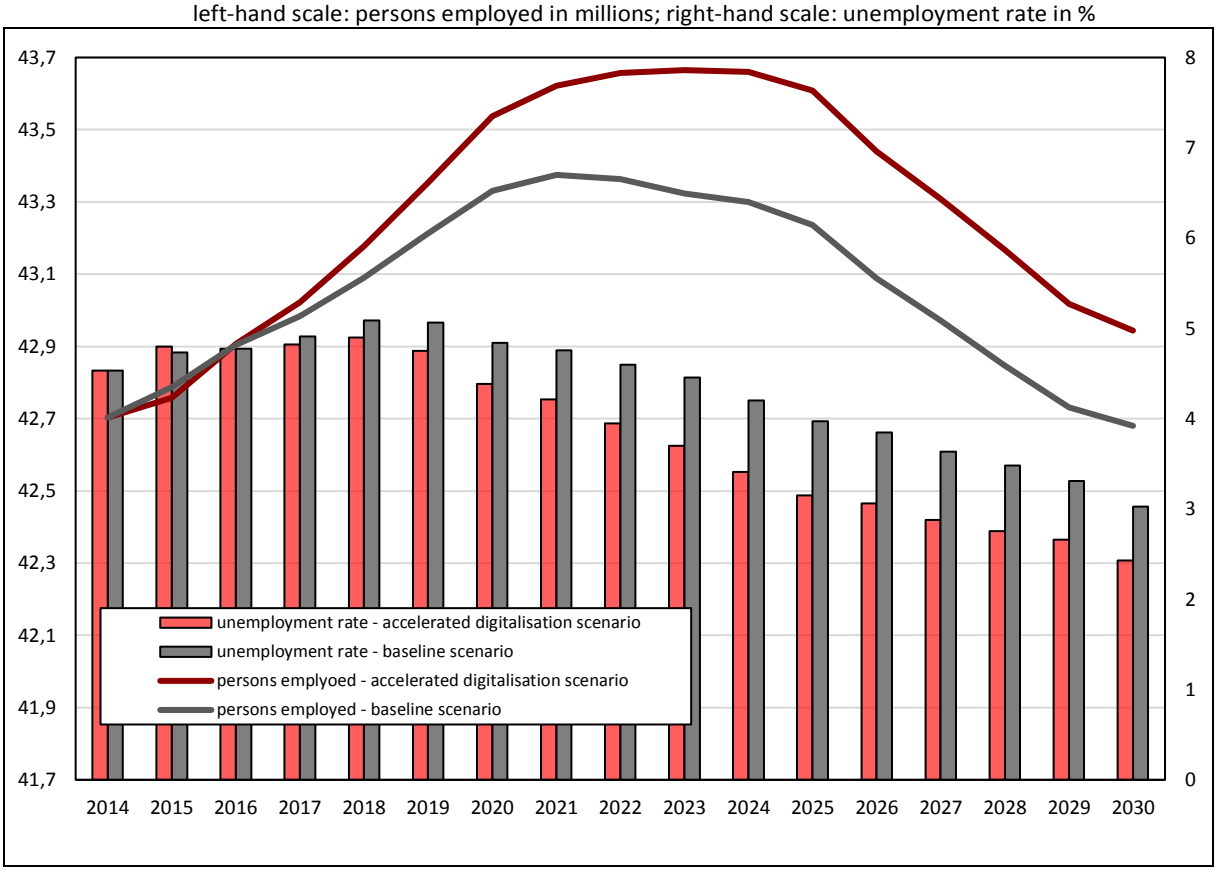
5 Dengler K.; Matthes B. (2015): In kaum einem Beruf ist der Mensch vollständig ersetzbar. IAB Kurzbericht 24/2015. Online: http://doku.iab.de/kurzber/2015/kb2415.pdf.

6 In its scenario calculations, the German Institute for Employment Research (IAB) undertakes similar calculations, resulting however in a slightly negative effect on total employment (Wolters et al. 2015).

higher economic and productivity growth, which is able to counteract negative effects of technological redundancies and demographic change.

Figure 5 Employment effects of accelerated digitisation

left-hand scale: persons employed in millions; right-hand scale: unemployment rate in %



Source: CE, Economix (Forecast 2016)

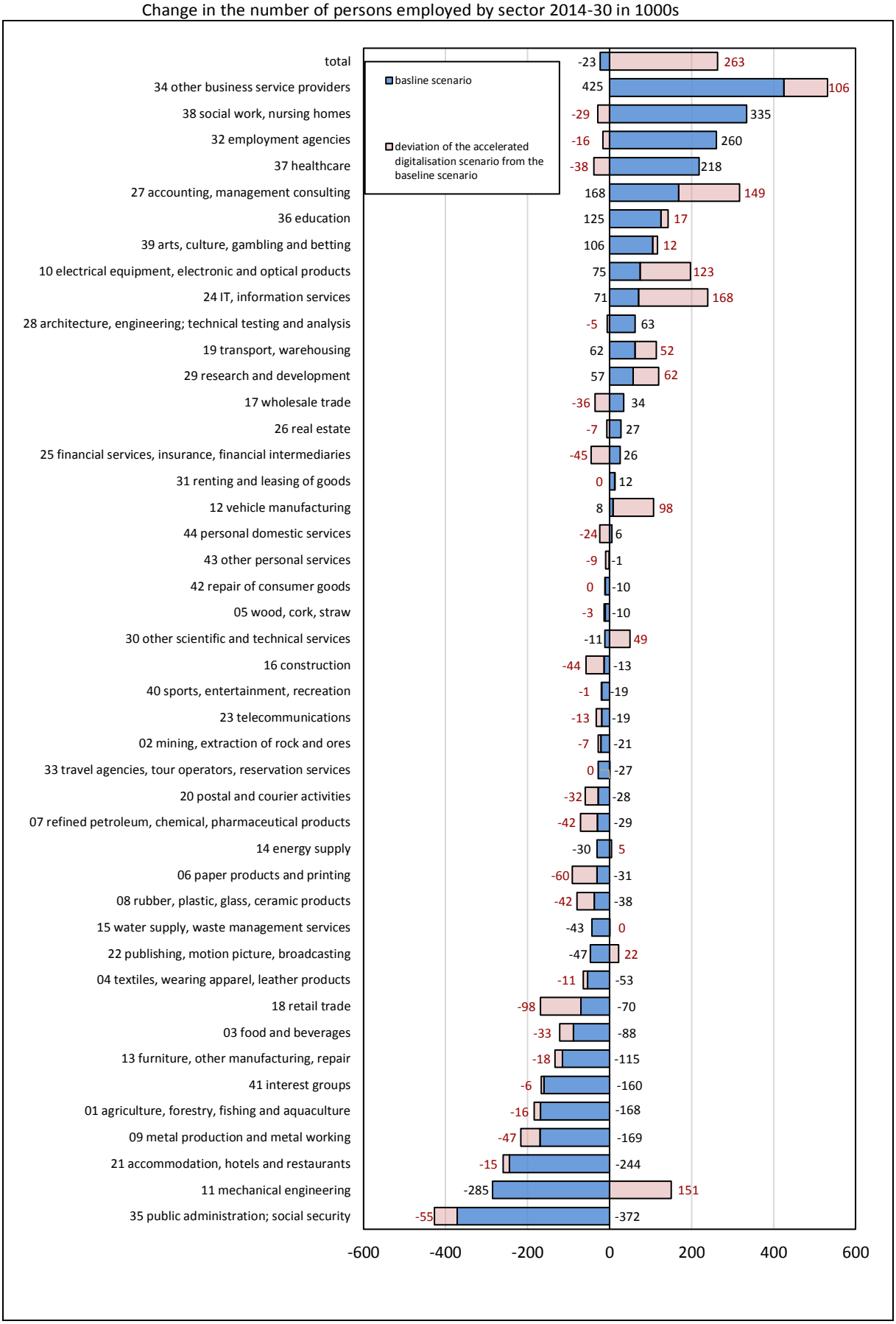
Restructuring effects

Accelerated digitisation leads to strong employment effects especially in the IT-related sectors (Figure 6). In the world of the Internet of Things they comprise traditional industrial sectors like mechanical engineering, automotive and electronics industries, as well as IT-services, business services and research and development. In our model calculations, a total of 13 sectors will record increasing employment due to an accelerated digitisation. Their employment gains will amount to one million by 2030. In IT-application industries, however, digital technology will release work. This is especially true for the retail sector, the paper and printing industry, and public administration. The loss in employment in these sectors will amount to 750,000 persons.

Accelerated digitisation mainly increases the demand for IT occupations, business management and management occupations, as well as occupations related to advertising and marketing (Table 2). At the same time, however, the need for mechatronic technicians, mechanical engineering, and vehicle technicians increases in the course of Industry 4.0. Negative employment effects will affect a variety of manufacturing occupations such as metal production and processing, textile and clothing occupations, nutritional occupations. In addition, transport, sales and simple health occupations (e.g. laboratory, nursing) will be negatively affected. Employment growth of 580,000 persons employed in the favoured occupations is opposed to an employment loss of 310,000 persons employed in the disadvantaged occupations.

Figure 6 Sectoral employment development in the accelerated digitisation scenario

Change in the number of persons employed by sector 2014-30 in 1000s



Source: CE, Economix (Forecast 2016)

In our model calculations, the impact of accelerated digitisation on occupations remains lower than on sectors. On average, digitisation will lead to a change in employment by ±3 % in some occupations when using the two-digit level of the German occupational classification. On the three-digit-level, average change is ±5 %. This is due to the ongoing adjustment of occupational activity profiles, which, according to our assumptions, will change because of the integration of "digital" tasks into occupational jobs. Therefore, only a fraction of changes in the world of work due to progressing digitisation will be visible in occupational statistics.[7]

Table 2 Occupational impact of accelerated digitisation

Persons employed; accelerated digitisation scenario

occupational field	2014	2030	2014-30 change		Effect of digitisation*
	1000s		1000s	%	
1 agriculture, forestry, animal husbandry and horticulture	1041	884	-158	-15.1	-0.8
2 raw material extraction, production and manufacturing	8086	7557	-528	-6.5	1.5
3 construction, architecture, surveying and building technology	2535	2503	-32	-1.3	0.5
4 natural science, geography and computer science	1509	1789	280	18.6	8.8
5 transport, logistics, protection and security	5698	5550	-148	-2.6	-2.6
6 commercial services, commodity trading, sales, hotel and tourism	5359	5153	-205	-3.8	0.0
7 business organisation, accounting, legal and administrative occupations	8803	8929	126	1.4	1.1
8 health, social matters, training, education	8228	8964	736	8.9	-0.1
9 humanity, social and economic sciences, media and culture	1270	1477	207	16.3	5.7
0 military	174	137	-37	-21.4	-1.1
total	42703	42943	240	0.6	0.6
(*) deviation of change rates from the baseline scenario 2014-30 in percentage points					

Source: Economix (Forecast 2016)

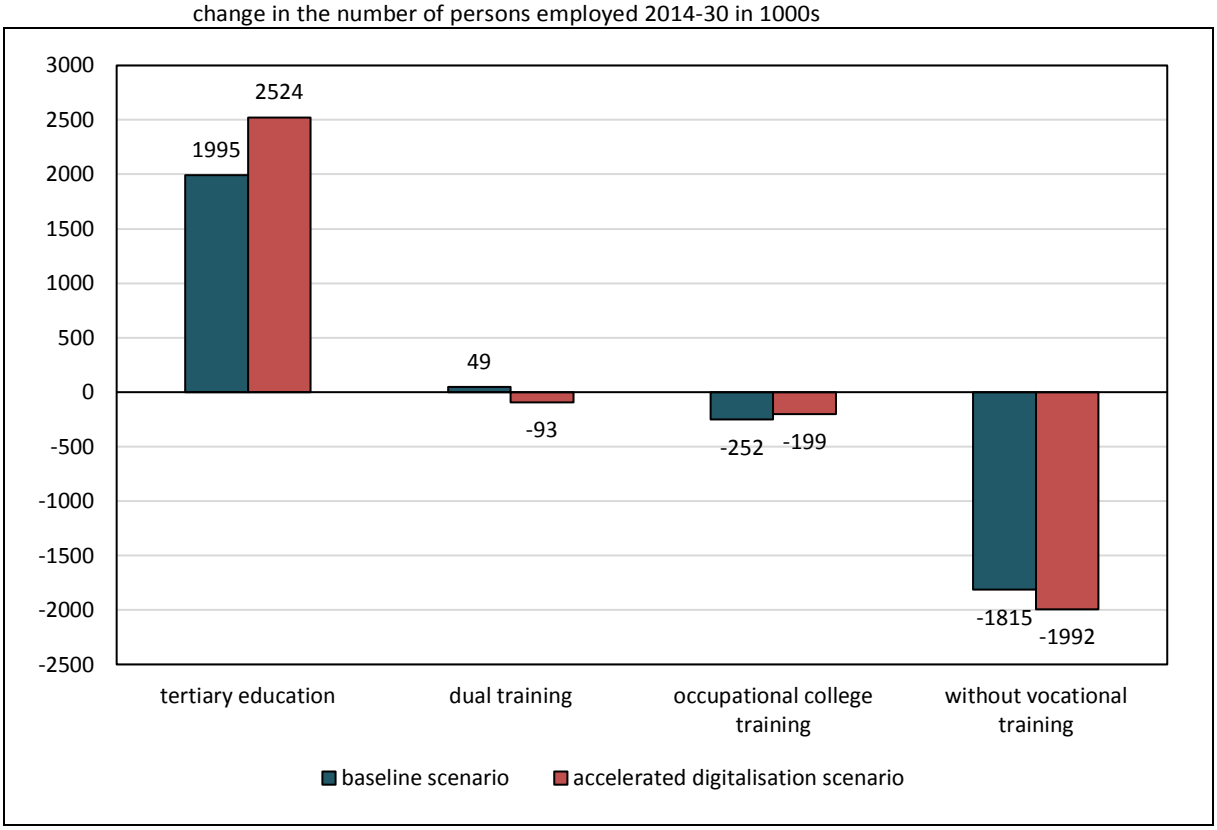
Demand for skilled labour

Labour supply of the baseline scenario will not be sufficient to meet the skill needs of accelerated digitisation. According to our calculations, accelerated digitisation will increase the demand for workers with tertiary education by 530,000 persons by 2030 in comparison to the baseline scenario (+ 5%; Figure 7). Among them are 170,000 legal, economic and social scientists, 140,000 engineers, 90,000 mathematicians and scientists, 70,000 language and cultural scientists, and 30,000 artists and art scholars. Demand for dual trained workers will decline by 140,000 (-1 %). This is caused by strong shifts within this qualification segment: workers with training in manufacturing and metalworking occupations as well as workers with office occupations will face declining demand while workers with training in technical occupations, commercial occupations, and transport occupations will see rising demand. Demand for workers with occupational college training (*Fachschule*) will decrease by around 200,000 (-1 %) in both scenarios. However, accelerated digitisation will have positive effects on this qualification group with additional 50,000 workers. Primarily, workers with a university education in technical and commercial occupations profit from digitisation, while the demand for workers with occupational college training in education or care will be slightly lower. For workers without occupational training accelerated digitisation will finally add 177,000 to the 1,8 million job losses in the baseline scenario which results in an accelerated digitisation effect of -3 %.

[7] Since the emergence of new professions cannot be mapped statistically, we assume that new job profiles emerge within existing occupations.

Figure 7 Effects of accelerated digitisation on vocational education and training

change in the number of persons employed 2014-30 in 1000s



Source: Economix (forecast 2016; T17b)

In both scenarios, the main challenge will be to mobilise the potential of low-skilled labour and people without vocational training. Overall, labour force in this educational segment was 7.8 million in 2014 and we expect two million displaced workers by 2030. It is important to move a high proportion of these workers into vocational training. On one hand, this emphasises the need for successful integration of refugees. Above all, however, it calls for a strong programme of adult vocational training – regardless of the migration history of participants. It is important to improve professional skills of the workforce at all levels at the same time, not only at the lowest level. This is the only way to ensure that the strongly increasing demand for workers with tertiary education can be satisfied. Accelerated digitisation therefore requires a further training programme with a broad and comprehensive set of measures. Simply concentrating on information technology will not be sufficient.

Conclusions and recommendations

Coping with demographic change

Our previous forecasts and simulations show that none of the investigated strategies for coping with demographic change per se will be able to minimise the negative impact of low fertility rates in Germany on labour force and employment. Anyhow, the combination of different strategies can have considerable effects:

- By increasing labour participation of women and older people, the calculated decline of the labour force by 6.1 million up until 2030, which would result from constant participation rates, can be limited to around one half (Vogler-Ludwig/Düll 2013: 104[8]). In general, this however won't suffice to stop the aging of the labour force.
- In the long term, prevention of population decline will only be possible by rising the birth rate. For this purpose, however, a fundamental shift in values is required to create a society welcoming children (Vogler-Ludwig/Düll/Kriechel 2015: 114[9]).
- Immigration will be able to reduce the labour force decline by 1.4 million – of course depending on the scope of immigration. The positive effect of immigration, however, is not only the rise of the workforce volume, but the rejuvenation of the labour force. Nevertheless, refugee immigration raises serious problems in terms of (up-)skilling of the available workforce and therefore requires significant investment in vocational education and training.
- Accelerated digitisation of the German economy can boost productivity growth noticeably. According to our calculations, this can compensate for about one-eighth of the demographically induced decline in the labour force. From a demographic perspective, this is a relatively small effect. However, its effect increases significantly over the forecast period.

Labour shortages will not disappear

The aspiration to reduce labour shortages by extending the labour force or by increasing productivity, however, will not be accomplished. This will be due to the economic feedback of such measures: the expansion of the number of persons employed will result in demand effects on the commodity markets, gains in economic growth, and thus higher employment. The macroeconomic labour market balance will therefore not be cleared, bottlenecks will remain, and labour shortages will persist. Of course, this will depend on the strength of the multiplier effects. The same will apply to both the expansion of the labour force and the increase of productivity.

Only if the economy adjusts productivity and growth targets to the development of the labour force, a position near to the equilibrium will be reached. Acceptance of demographic change, however, contradicts all known expectations, although some people welcome such developments as an opportunity for a more quiet and perhaps a more modest life. Our attempt to implement such a "low-growth" scenario resulted in significant conflicts over uneven distribution of wealth, employment opportunities, and income. Therefore, we consider this scenario of a "shrinking but happy" society as being unrealistic and we therefore did not calculate any figures to this.

Germany – an Immigration country

It is quite possible that we are too pessimistic in our forecast of labour supply and employment. Historical experience shows that ultimately, Germany has always opted for the inclusion of workers from abroad and has managed to reduce labour market bottlenecks by immigration – at least periodically. From a macroeconomic perspective, this proved useful in all cases either for overcoming labour shortages or to counteract consumer or investment slump. Against this background it is highly probable that Germany will meet demographic change with a renewed promotion of immigration in the future as well.

For a long time, Germany has fought against the possibility of being regarded as an immigration country and to see itself as such. Following the recent wave of immigration, we see a heavy protest movement against the massive integration of people from abroad. Due to the high number of immigration, this movement also appears to be exceptionally strong. Nevertheless, policy is increasingly focusing on integration, based on the obligation to help persons in need and a liberal-

8 Vogler-Ludwig K.; Düll N. (2013): Arbeitsmarkt 2030. Eine strategische Vorausschau auf Demografie, Beschäftigung und Bildung in Deutschland. W. Bertelsmann Verlag, Bielefeld.

9 Vogler-Ludwig K.; Düll N.; Kriechel B. (2015): Arbeitsmarkt 2030 – Die Bedeutung der Zuwanderung für Beschäftigung und Wachstum. W. Bertelsmann Verlag, Bielefeld.

minded self-perception which is supported by the majority of the population. We can therefore expect that protests will subside with progressing integration of the migrants and the increasing visibility of the advantages achieved by the new population.

We could therefore create a forecast in which immigration becomes more likely the more labour supply shortages show their negative impact on domestic industries. According to our forecasts, this might be the case in the second half of the twenties in this century, when labour supply shrinks due to demographic reasons, unemployment will decline again and the German economy will enter the next phase of skills shortages – further economic growth presupposed. However, as the social compromise for "Germany as an immigration country" seems not yet to be found, we did not make this scenario the basis of our calculations. Nevertheless, we see Germany on the right track, because progress has been made both in the perception of immigration as well as in integration policies.

Immigration policies

In this immigration country, the need for governing immigration will become more and more urgent. One of the important element of future immigration policies is the preparation and implementation of an immigration law that regulates immigration from all regions of the world – beyond the integration of refugees. Here, it will be important to adhere to the free movement of workers within the EU and to guarantee the right of asylum. It is therefore not a matter of restricting immigration, but of steering it. At the same time, Germany has to be an attractive location for skilled workers from non-EU-countries. With the current restrictive regulations, this is not achievable.

Vocational training policy can make an important contribution to this purpose by a more liberal practice of recognising vocational training degrees. Still, recognition quotas are very low. Therefore, establishing vocational competence centres in which the existing skills level is determined seem to be more appropriate that detailed examination of formal education curricula. Moreover, it should be an object of educational policy to illustrate both the benefits of international cultural exchange as well as the dependence of Germany from international economic relations.

Lifelong learning as a pillar of vocational training

Immigration is an important contribution to curb the progressive ageing of the labour force, however, it cannot stop this process. In the German education system which puts a strong emphasis on initial training, this leads to imbalances in labour supply and demand, and – in particular – decelerated the adaptation speed to the technological and economic structural change. Especially in a scenario of accelerated digitisation this would be an obstacle that would put the entire strategy in question.

Since our 2012 forecast we therefore point to the need of a generally recognised, publicly certified training system. This cannot be achieved without the state setting norms and guidelines, determining organisational structures and controlling output. Moreover, higher further training participation will not be achievable without financial support. If Germany wants to maintain its competitiveness and achieve adaptation to global structural change, adult education should be made a pillar of its vocational training system. This applies not only for accelerated digitisation, but also from the perspective of the baseline scenario.

Digitisation: job opportunities rather than the end of work

From a structural policy point of view, Germany faces the alternatives to maintain its leading industrial position in the digital world by a strategy of accelerated digitisation or to promote the development of a diversified knowledge economy, in which the use of digital technology is important, but not the technological leadership of the industrial sector. According to our model calculations, the scenario of accelerated digitisation leads to higher income, more employment, and

higher productivity in comparison to the second alternative. From an economic perspective, the strategy of accelerated digitisation is therefore superior to the alternative baseline scenario. Abandoning full participation in the industrial competition in the field of Industry 4.0 would also include the risk of falling back in many areas of the knowledge economy. Fears that there would be a wave of technologically induced unemployment seem unfounded. Potential hazards of digitisation, which were addressed so often in the recent years, are compensated by the increase in potential demand which creates more jobs than rationalisation will cut. From now on it is important to take the advantages of digitisation, rather than trembling with fear.

Politics, business and trade unions have already chosen this path. As part of the "Digitale Agenda" (digital agenda) of the German Federal Government and the initiative "Arbeiten 4.0" (work 4.0) of the German Federal Ministry of Labour and Social Affairs (BMAS) dialogue processes have been started with the aim to check the strategies of action and to improve the broad impact of initiatives. Nevertheless, Germany is just at the beginning of this road, and is significantly behind the USA and the Asian countries in many IT-related areas. It might need something like a jolt through the society to see digitisation as an opportunity rather than a risk.

No labour market polarisation

Our model calculations do not support the concern that digitisation will make the professionally trained middle-class, i.e. skilled workers and mid-level employees redundant. We estimate that digital technology will – as all previous lines of technology – primarily replace unskilled labour while more demanding activities will be further developed into more complex task fields. In our view, this assumption – known as the polarisation thesis – underestimates the adaptability of occupational profiles and the flexibility of the labour market.

Also in the digital age, vocational training of the low-skilled remains the most important task. This is aggravated by immigration of low or false skilled labour. Politicians have also recognised this problem. It therefore mainly depends on finding and implementing suitable education and integration policies.

The fear that digitisation would continue to shift income distribution further in favour of the upper groups is not confirmed in our calculations. We see no connection between the change in numbers of persons employed in occupational groups and their respective income levels, especially since wages only play a relatively minor role in determining the qualification structures on the German labour market. There are many reasons for this, such as the long tradition of collective agreements, as well as the caution of companies to touch the social consensus on the skill specific, occupational or regional wage relations. Most importantly, the majority of German companies do not pursue a low-wage strategy. Business models are rather guided by the aim to improve workers' skill levels continuously to expand value added. Digitisation is no threat for this "German model of development" which is based on the qualification of its human capital. On the contrary, the model gets another chance.

For the upper segment of the income distribution in Germany, digital markets should not play a decisive role. Unlike in the USA, there is no global company that generates extraordinary gains for only a few owners. In Germany, everything remains in a much smaller scale. The development of Industry 4.0 might bring income of entrepreneurs closer to the conditions of the German capital goods industry than to the conditions in Silicon Valley.

Acceleration of structural change

Accelerated digitisation will trigger significant reallocations of employment to capital goods industries and business services, and will further shift labour demand towards tertiary education graduates at the expense of workers without vocational training. Only when these displacements do not succeed, a larger number of unemployed, growing atypical employment, and a renewed

increase in the low-wage sector might occur. In our scenario, strong demand for labour, the functioning "upgrading" of qualification profiles, and the successful integration of immigrants prevent such a marginalisation.

Nevertheless, the question of distribution of profits and adjustment costs will be a major challenge in the face of accelerated digital structure change. Only if we manage to resolve this redistribution problem, the acceptance of new technologies will be supported by a majority of the population. This includes reform considerations for further development of the welfare state in order to use the potential for flexibility of companies and, on the other hand, to provide social security for persons for whom increasing flexibility means precariousness primarily. We therefore recommend the development of a flexicurity approach which reduces risks of restructuring for persons employed while promoting structural change at the same time.

If the state and the social partners in particular are able to shape the flexibility- and productivity-enhancing potential of digitisation accordingly, and improve work-life balance and working conditions, digitisation may even extend labour supply. Especially part-time working women may enlarge their scope of hours worked and the employment rate of older workers could increase even stronger than estimated here. Finally, improved work-life balance could eventually have a positive effect on the birth rate.

Requirements for accelerated digitisation

Accelerated digitisation presupposes substantial investment in the digital infrastructure and in digital human capital. This means

- Expansion of broadband networks and improvement of their performance. The planned comprehensive geographical internet access coverage of 50 Mbit/s is likely to fall short of the demands of the concept of Industry 4.0.
- Promotion of research and development in the core segments of digital technology, that is sensor technology, robotics, artificial intelligence, image processing, data analytics.
- Reassessment of data protection taking into account the benefits of open source concepts. Data protection legislation according to the German approach is likely to rather slow down technological change.
- Promotion of digitisation of information, restriction of property rights to a necessary minimum, and improvement of the efficiency of information processing. Promotion of open-source concepts could accelerate these processes considerably.
- Expansion of vocational training in IT-occupations and promotion of IT-competences in almost all segments of vocational training. Equipment of schools with IT-infrastructure is still insufficient and the use of IT-based learning is still inadequate. The expansion of IT-based further training for the employed, unemployed, students, and pupils would be an escape from this situation which persists for years now.
- Support of the structural change in the world of work by flexicurity measures, that is linking unemployment and further training, improved social security for solo self-employed, the promotion of telework and home office, and a refocusing of companies human resource policies to long-term and development-orientated employment. The aim of these measures is a reduction of risks associated with job restructuring and the optimal use of job opportunities in the digital economy.

In a broader sense, a prerequisite of the implementation of the accelerated digitisation scenario is a widest possible social consensus which is not visible yet. However, we assess digital transformation dynamics as being so strong that even a "tentative" Germany will make increasing use of the technological possibilities. Since the pioneering role is not always advantageous, good, if not favourable opportunities arise also for "late bloomers".