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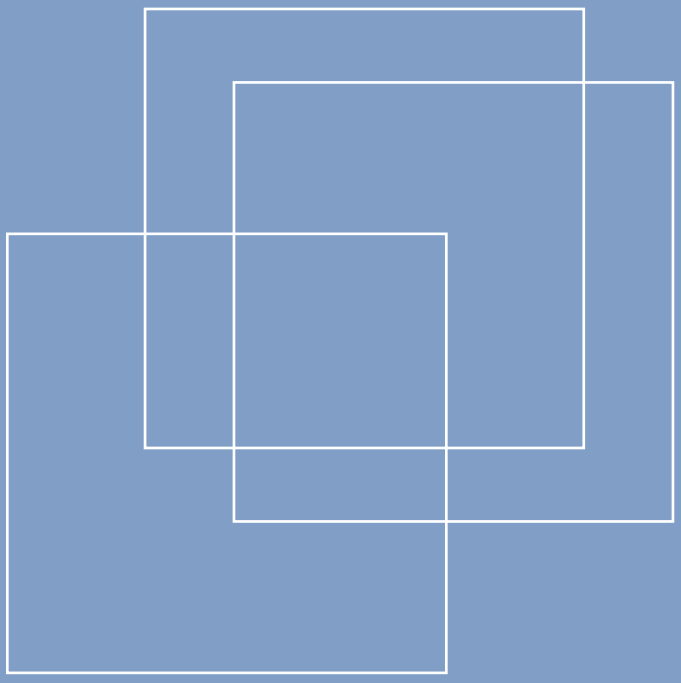
The case of Germany

Ulrich Walwei



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Abstract

The future of work depends upon several factors, long-term competitiveness and the demographic developments, etc. However, one of the main drivers of technological change in the foreseeable future is digitalization and central to this development is the production and use of digital logic circuits and its derived technologies, including the computer, the smart phone and the Internet. Smart automation will perhaps not cause overall job losses but may lead to considerable shifts in the structure of employment, e.g. regarding industries, occupations, skills and tasks. Taking the case of Germany the paper indicates that in the future it will be difficult to tackle structural labour market issues such as skill shortages, the persistence of unemployment or inequality with regard to forms of employment. Due to the increasing demand for new tasks, skill gaps between job requirements and the abilities of workers can also occur to a greater extent. Prerequisites (e.g. concerning the level of qualification) to re-enter the labour market will probably be higher in the future. However, due to lack of solid evidence, policy implications can only address more general issues. The case of Germany highlights four main areas of concern that need focus: continuous skill development, intelligent employment regulations, more preventive labour market policies and a complementary role of social dialogue.

Keywords: Digitalization, forms of employment, persistence of unemployment, technological change, skill shortages

JEL classification: J08; J23; J24; J63; J64; O33

1 Introduction

In recent years many Western countries have been confronted with severe labour market problems, and in many of these countries levels of unemployment are significantly higher than a decade ago. In addition, these countries face several structural labour market problems. Firms frequently report difficulties to fill vacancies requiring workers with highly specialised skills. For individuals belonging to the "hard core" of unemployed, it has become rather difficult to find a job. And there are workers for whom the quality of their current employment is not fully satisfying either in terms of stability or in terms of wage levels. Such structural labour market problems can be found to a greater or lesser extent in all Western countries. These problems are partly interrelated with the particular labour market performance of a country because they may either slow down a recovery of the labour market or may prevent further improvements.

The future of work depends on several factors, and the issues that are relevant in this context are the long-term competitiveness and the demographic development of a country. One of the important determinants for future labour market trends is technological change and since the beginning of industrialization two questions have always been raised. First, whether and to what extent technological change may actually destroy or create jobs; and second, what the impacts of technological change on the composition of employment are, e.g. regarding certain industries and occupations. Economic literature has pointed out that technological change is also important in many respects, e.g. economic growth, structural change and productivity (Solow, 1956; Romer, 1990; Grossman and Helpman, 1991).

Digitalization is one of the main drivers of technological change in the foreseeable future and central to this development is the production and use of digital logic circuits, and its derived technologies, including the computer, the smart phone and the Internet. Digital technologies affect the computerisation of production, service delivery and even the private sphere. Connectivity leads to completely new dimensions, as electronic devices and microprocessors connect people with each other, machines with workers, and machines with machines.

Although developments in digital technologies have already gained momentum, the main impacts of this new era of technological change remain to a large degree uncertain and still ahead of us. In order to deal with such a rather complex issue, the paper will take the case of Germany as an example to understand the potential impacts of digitalization on the labour market. Germany represents an interesting case with respect to potential impacts of digitalization, as a substantial share of employment is engaged in manufacturing. As digitalization may impact the production process, the potential implications of it for the economy and for the labour market are of particular interest. Nevertheless, digitalization in the service sector and transformation of these jobs is also relevant for Germany and it may affect the number of available jobs in the future.

The main purpose of the paper is not to generate additional evidence on jobs that may particularly be at risk through digital technologies. Such investigations have already been undertaken for Germany (Bonin et al., 2015; Brzeski and Burk, 2015; Dengler and Matthes, 2015; Lorenz et al., 2015). The paper will also not carry out new long-term scenarios concerning the implications of the digital revolution on employment. Projections focussing on impacts of digitalization within manufacturing (Industry 4.0) and a prognosis covering all German industries have already been undertaken (Vogler-Ludwig et al.,

2016; Wolter et al., 2015). These findings will be used as a starting point for the discussion on digitalization in this paper.

The paper will go beyond these studies and focus on structural labour market issues referring to the case of Germany. The main question is how emerging digital technologies may influence the quality of job matching in the future. The answer might allow a tentative assessment whether the spread of skill shortages and the persistence of unemployment will be decelerated or intensified by digitalization. The additional structural issue in this context deals with different forms of employment and the paper will analyse how far previous shifts towards non-standard work might be reversed or accelerated through the spread of digital technologies. Therefore, the main aim of the paper is to give at least a tentative answer to the question of to what extent digitalization will induce either a worsening or an improvement of structural labour market problems.

The paper comprises three main parts. Section 2 looks at the determinants of the future of work and particularly at the role of digitalization and its consequences for work-related issues. Section 3 outlines characteristics and recent developments of the German labour market. Section 4 presents relevant evidence and potential implications of digitalization for the German labour market. This section will begin by looking at jobs, which are potentially at risk as well as the results based on long-term scenarios. It will then assess the relevance of digitalization for structural labour market issues focussing on skill shortages, the persistence of unemployment and forms of employment. For each of these issues the relevant drivers will be identified and based on this possible implications of emerging digital technologies will be discussed. The final section concludes and provides a basis to deduce rather general and tentative implications for labour market policies in Germany.

2 Digitalization and the future of work

The present as well as the future performance of the labour market depends on various factors. The competiveness of the national economy is of key importance at any point of time. This includes an institutional setting that secures property rights, strongly supports structural change and offers an efficient system of education, training and social security (North, 1990; Acemoglu and Robinson, 2012). In addition, various long-term trends affect the performance of the labour market and need to be addressed properly. Demographic developments determine the level and composition of the labour force. Globalization forces countries to specialize on products and services, which has, e.g., implications for their particular skill formation. Technological change is one of the main determinants of productivity and economic growth.

2.1 The digital revolution

The digital revolution started with the invention of the microprocessor and it has led to steadily increasing performance. It has enabled the production and use of digital logic circuits and its derived technologies, including the computer, the digital cellular phone, and the Internet. The digitalization of information and communication processes has led to an explosion of information (so-called “Big Data”) and has driven the computerisation of production, service delivery, and even the private sphere. Advances in areas such as Machine Learning, Artificial Intelligence, and Mobile Robotics as well as the increasing usability of Big Data will further facilitate a computerisation of the economy (Frey and Osborne, 2013). Brynjolfsson and McAffee (2011) identified an increased speed of innovation in the

area of digital technology that is no longer confined to routine manufacturing tasks but may spread to numerous non-routine tasks in different parts of the economy. "Smart" automation may, therefore, also affect high skilled jobs such as those of lawyers, accountants and doctors.

The Internet connectivity will obviously reach completely new dimensions and we are in a process in which the "real" world will continuously be linked to the "virtual" world. Due to comprehensive connectivity even distance seems not to be a relevant problem anymore. Digitalization facilitates a more knowledge-based and decentralized production. It also offers the opportunity to develop technologically advanced services ("smart services"). The number of robots is rather small till now but "smart" automation is spreading fast. However, for economic, legal, and social reasons not everything that can potentially be automated will actually be automated.

Digitalization will – like any other type of technological change – drive the progress of the technical equipment of an economy. It potentially increases productivity in general and labour productivity in particular. This implies that either a given output can be produced with less input or with a given input a higher level of output can be achieved. Digital technologies could also trigger product and process innovations, and push new products to enter the market. At the same time increases in productivity will facilitate lower prices. Both strengthen the competitiveness of the innovator and weaken the market position of competitors.

Such changes typically generate a process of creative destruction (Schumpeter, 1912) and this causes a permanent incentive for economic agents to be innovative. Therefore, according to standard growth theory technological change is an important source of productivity increase and economic growth (Solow, 1956). Endogenous growth theory even postulates that it is technological change that creates long-term economic growth (Romer, 1990; Grossman and Helpman, 1991). Simulation models indicate that digitalization is already an important driving force for economic growth. It is estimated that between 1998 and 2012 on average 0.6 percentage points of average growth in Germany were due to new digital technologies (Bornemann, 2015).

As already mentioned, digitalization is only one of the major long-term trends that is relevant for the labour market. One has to bear in mind that trends may interact, i.e. one can assume certain interferences. Long-term trends can have cumulative or even contrary impacts on certain outcome variables. The combination of digitalization and globalisation may further increase competition. Fewer restrictions on trade and the availability of information at any point and at any time can force national economies to specialise even more (Petersen, 2015). There might also be an interaction between digitalization and demography, as due to demographic change and potential shortages of labour may be compensated by technological progress (e.g. labour-saving machines).

2.2 Consequences for work-related issues

Digital technologies will most probably push economic growth, but their potential impact on employment is less clear. In this context, BHWW (2015) have discussed three scenarios. A rather optimistic scenario is a "land of milk and honey" in which mainly machines will ensure the continuous well-being of people in the long-run. A more pessimistic scenario is a "20/80-society" in which only a minority of the population will generate high income and own most of the capital. The scenarios differ regarding distributional impacts. Workers who are replaced by machines can under certain circumstances even benefit from new technologies. However, this implies them owning part of the

capital (Freeman, 2014). The third scenario describes a fundamental structural change, wherein total labour demand may not necessarily decrease but will strongly change in structure, e.g. concerning industries, occupations and tasks.

The question is which of these scenarios might be realistic? New technologies substitute labour if we assume that more productive workers generate a given level of production. For example Rifkin (2014) argues that in the long-run the digital revolution will significantly reduce employment because marginal costs of production are assumed to be close to zero. This implies that even a low-paid worker will be more expensive than the additional cost of using an intelligent machine. However, this pessimistic scenario may only become reality if the level of output remains unchanged.

There are several arguments questioning this simplified view. The increase of productivity due to new technologies affects processes, products and prices. More efficient processes are more likely to cause rationalization and job reductions, while the emergence of new products is often associated with new jobs. Price reductions derived from technological change have the potential to create new demand in two ways. First, one can argue that because of lower prices economic agents can spend money elsewhere, which may generate demand in other areas of the economy. Secondly, depending on the particular demand elasticity a price reduction of a certain product may have contrasting impacts (Applebaum and Schettkat, 1990). For innovative products and services one can expect an increase in labour demand while the opposite is expected in the case of more standard products.

Generally, these considerations imply that employment impacts of technological change can either be positive or negative. Companies using computers efficiently will substitute competitors not exhausting the full potential of computers. Machines may replace jobs or certain tasks but there might be new opportunities for affected workers instead. Needs of mankind are infinite and, therefore, products and services are not limited in their evolution and innovation. Hence, digital technologies have to be regarded as an advantage as they are an important source of future productivity gains. This negates the threat of massive technological unemployment due to digitalization in the near future and instead the obsolescence of (technological) skills may be much more realistic.

Technological change in general and digitalization in particular will most likely induce structural change. If we assume a large impact of digitalization on the technical equipment of the economy in the future, then considerable effects on the composition of employment can be expected. Digitalization may – if everything is assumed equal – increase job turnover and, in doing so, facilitate an even more efficient division of labour within the economy. Occupations that use new technologies (e.g. graphic designers) may take over other occupations (e.g. typographers) as technology encourages substitution. Economic literature would suggest that either "capital-skill complementarity" or a polarization of skills could be possible results of technological change (Krusell et al., 2002; Autor et al., 2003). In the case of capital-skill complementarity the demand for highly skilled workers performing creative tasks will increase further, while low-skilled workers in comparison are most likely to lose their job ("skill-biased technological change"). By contrast, the polarization hypothesis (Goos et al., 2014) implies more risks for workers with medium skills assuming that non-manual routine tasks are more threatened by digital technologies than low-skilled workers often performing manual non-routine tasks ("routine-biased technological change").

Several questions arise in this context: Will the trend towards employment in services continue or even be accelerated? Will small or large companies be winners of the structural change? Which new

occupations will be created and which known occupations may completely disappear? Which of the present occupations will increase or lose in importance? To what extent will routine tasks be affected by digital technologies and how far are even non-routine tasks endangered?

Besides structural change we can also expect other impulses of digitalization for the future world of work. Digital technologies have the potential for humanizing jobs in terms of ergonomics. Jobs associated with unpleasant conditions such as dangerous or physically demanding work may increasingly be substituted by new technologies. Intelligent machines and advanced robotics may also assist people with physical restrictions enabling them to enter a much broader spectrum of jobs and compensate for apparent productivity deficiencies. Digital technologies can also contribute to a more flexible time management of both employers and employees. Mobile work based on information and communication technology (ICT) may reach completely new dimensions in quantitative and qualitative terms. This means that digitalization has the potential to offer more opportunities for participation and that in a digital world workers are probably more in control.

The spread of digital technologies may also cause changes in the nature of work undertaken. Due to the availability of more information to all parties, at any time, specific transaction costs are substantially reduced, particularly those associated with search of potential contract partners. Transaction cost theory assumes that firms exist as an alternative system to the market-price mechanism when it is more efficient to produce in a non-market environment (Coase, 1937; Williamson, 1975; Williamson, 2002). For firms it might be very costly to engage in production when they have to hire and fire their workers depending on market conditions. It might also be costly for employees looking for better alternatives at all times. However, if opportunity costs of finding a contract partner will decrease due to lower search costs this may have one important implication, namely that of market transactions getting more attractive.

Although the digital revolution has already started, the main impacts of this new era of technological change are still ahead of us. Therefore, we have to consider multiple uncertainties, as these impacts are not limited to potential job losses or job gains. The diffusion of digital technologies may differ largely by certain categories such as industries or regions, and the speed of potential change is not easy to assess. Development can be evolutionary as well as partly disruptive, as certain technologies such as robotics might not be sensible in economic terms and might not be accepted by human beings. The speed also depends on legislation, which potentially accelerates or decelerates the speed of innovation. Different kind of opportunities or risks can occur for the parties involved. Firms may demand new forms of flexibility as well as new types of skills. Workers may be interested to improve their work-life balance as well as continuous training. Governments may, therefore, be forced to rethink institutional regimes. This does not only refer to product market regulations but also to labour law and social standards. To take a closer look at potential implications of digitalization, we use the case of Germany as an example and discuss the characteristics and recent developments of the German labour market in the next section and the potential impacts on labour markets in Section 4.

3 The German labour market – Institutions and recent performance

The period from the end of the Second World War until about the mid-1980s has to be seen as the "heyday" of employee protection in Germany (Walwei, 2015). The development of labour law between the mid-1980s until 2005, however, was characterized by deregulation. The strongest deregulation dynamics over the past two decades are found in non-standard work arrangements, which made it easier to circumvent dismissal protection. In times of high unemployment the aim of deregulation was to facilitate access to the labour market. Whereas deregulation initially focussed on fixed-term employment, the focus later shifted to temporary agency work and "marginal" part-time employment (mini-Jobs).[1] The period finally culminated with major labour market reforms between 2003 and 2005 (so-called "Hartz"-reforms) which not only paved the way for non-standard forms of employment but focussed also on activating unemployed, e.g. by reducing benefits for long-term unemployed. Since then we have observed a moderate re-regulation of labour law, wherein minimum wages were agreed upon in more than a dozen industries on the basis of the "Posted Workers Act". Of particular importance, however, is the introduction of a general statutory minimum wage of 8.50 Euros per hour for workers in Germany, which came into effect on January 1st, 2015, and is intended to eliminate extreme downward trend in hourly pay.

Besides labour law and benefit regulations there are even more specific characteristics of the "German model" (Walwei, 2014a). Compared to other industrial countries, employment in manufacturing still plays a strong role within the German economy. Manufacturing industries are facilitated by the dual system of apprenticeships with elements such as vocational training within a particular firm, which generates general and firm-specific human capital. Like labour market regulations, product market regulations are comparatively strict. One example is the requirement of a craftsman diploma (so-called "Master"), which is intended to ensure the quality of services as well as the willingness to participate in vocational training. The German labour market is characterized by relatively low external flexibility implying a low speed of workforce adjustment in times of crisis and a fairly long tenure of workers within companies. However, there also exists comparatively high internal (within-firm) flexibility, particularly by adjusting working hours and wages to fluctuations of demand. Although the coverage of collective bargaining has decreased in recent years it is still considerably high, particularly in the western part of Germany (Ellguth and Kohaut, 2015). This is associated with a rather strong role of social partnership, co-determination and workers' participation. Labour market programmes have a long tradition in Germany and they are well-organized and sufficiently equipped. Social security is comprehensive, particularly in the case of pensions, unemployment and health, as long as workers have a standard employment relationship (i.e. dependent full-time employment). Even after the implementation of the "Hartz"-reforms social welfare benefits continue to be quite generous compared to other countries in the Western world (Möller, 2015a). An even more detailed picture of the German labour market can be drawn if we take a closer look at the structure of employment and unemployment. In order to do so we compare labour market indicators for Germany with the spread and the average of EU-28.

[1] The peculiarities of "marginal" part-time employment (mini-Jobs) in the case of Germany are twofold. On the one hand, there is a certain tax-free wage threshold, which is fixed since 2013 at 450 Euros (between 2003 and 2012, it was 400 Euros). On the other hand, although employers have to pay a flat rate to the social security system, "marginal" part-time workers earning a wage below the threshold are not necessarily eligible for benefits. Only "marginal" part-time workers who make an additional voluntary payment to the old-age insurance are entitled to receive benefits in the future.

Table 1: Labour market indicators 2014: Germany compared to the average of the European Union 28 (EU-28), percentages

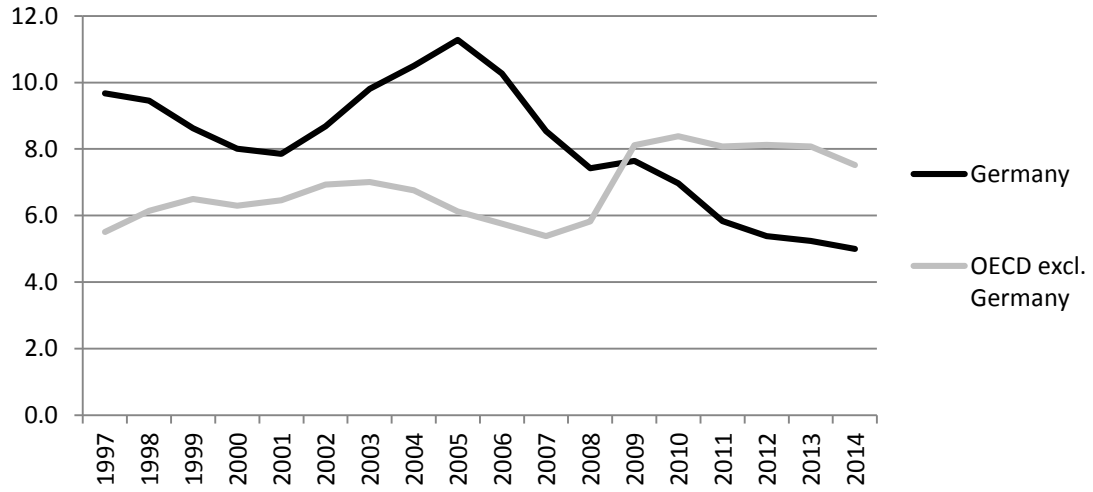
	Lowest level:	EU 28	**Germany**	Highest level:
Employment rate (per cent population aged 15–64)	49.4 (GR)	64.9	**73.8**	74.9 (SE)
Employment rate of men (per cent population aged 15–64)	58.0 (GR)	70.1	**78.1**	78.1 (DE/NL)
Employment rate of women (per cent population aged 15–64)	41.1 (GR)	59.6	**69.5**	73.1 (SE)
Employment rate (per cent population aged 15–24)	13.3 (GR)	32.5	**46.1**	58.8 (NL)
Employment rate (per cent population aged 25–54)	62.4 (GR)	77.5	**83.5**	85.4 (SE)
Employment rate (per cent population aged 55–64)	34.0 (GR)	51.8	**65.6**	74.0 (SE)
FTE employment rate (per cent population aged 20–64)	51.1 (GR)	..	**67.3**	74.8 (SE)
Employment in Services (per cent total employment)	42.2 (RO)	73.1	**73.9**	83.0 (UK)
Employment in Industry (per cent total employment)	13.8 (GR)	21.9	**24.6**	36.8 (CZ)
Employment in Agriculture (per cent total employment)	1.2 (LU)	5.0	**1.5**	29.4 (RO)
Self-employed (per cent total employment)	4.9 (SE)	15.6	**10.3**	33.8 (GR)
Part-time employment (per cent total employment)	2.7 (BG)	20.4	**27.6**	50.4 (NL)
Fixed-term contracts (per cent total employees)	1.5 (RO)	14.0	**13.0**	28.3 (PL)
Unemployment rate (per cent labour force)	5.0 (DE)	10.2	**5.0**	26.5 (GR)
Youth unemployment rate (per cent labour force 15–24)	7.7 (DE)	22.2	**7.7**	53.2 (ES)
Youth unemployment ratio (per cent population aged 15–24)	3.9 (DE)	9.2	**3.9**	19.0 (ES)
Long-term unemployment rate (per cent labour force)	1.5 (AT/SE)	5.1	**2.2**	19.5 (GR)

Note: AT-Austria, BG-Bulgaria, CZ-Czech Republic, DE-Germany, ES-Spain, GR-Greece, LU-Luxembourg, NL-Netherlands, PL-Poland, RO-Romania, SE-Sweden, UK-United Kingdom.
Source: Eurostat, accessed on 15th November 2015.

Table 1 shows that for all categories of employment, the rates for Germany are higher than that of the EU-28 average. This is true for the overall rate, the rates for men and women and for age groups such as youth (15–24) as well as older workers (55–64). The difference between full-time equivalent rates in Germany and the country with the highest level in full-time equivalents, Sweden is larger than the difference between employment rates counted in persons. This is due to the relatively high part-time employment rate in Germany. By contrast, the German self-employment rate is quite low. One reason is the low share of employment in agriculture, which in many countries is associated with self-employment. The rate of fixed-term contracts in Germany is close to the European average. However, one has to bear in mind that in Germany apprenticeships within companies are a dominant element of the training system and are usually counted as fixed-term contracts. Therefore, the German share of temporary employment in Table 1 can be considered as slightly overestimated. The distribution of employment by sectors reveals that employment in manufacturing and construction is overrepresented in Germany. With regard to unemployment, the rates for Germany are low compared to other European countries.

Over time, the German labour market performance has significantly changed and differed from the average of OECD countries (see Figures 1 and 2). The unemployment rate increased until 2005 and reached a record level of 11.3 per cent. Since then we observe a turnaround of the German labour market. In recent years – particularly after the Great Recession – unemployment rates in Germany were much lower than the corresponding OECD average. The comparison of employment rates shows that between 1997 and 2005 employment rates of Germany and the OECD average were almost identical and since then the German rate has increased sharply, whereas the OECD average is far below. This raises the question as to what lies behind the upward trend in the German labour market.

Figure 1: Unemployment rates in Germany compared with the OECD average (excl. Germany), 1997 to 2014, percentages

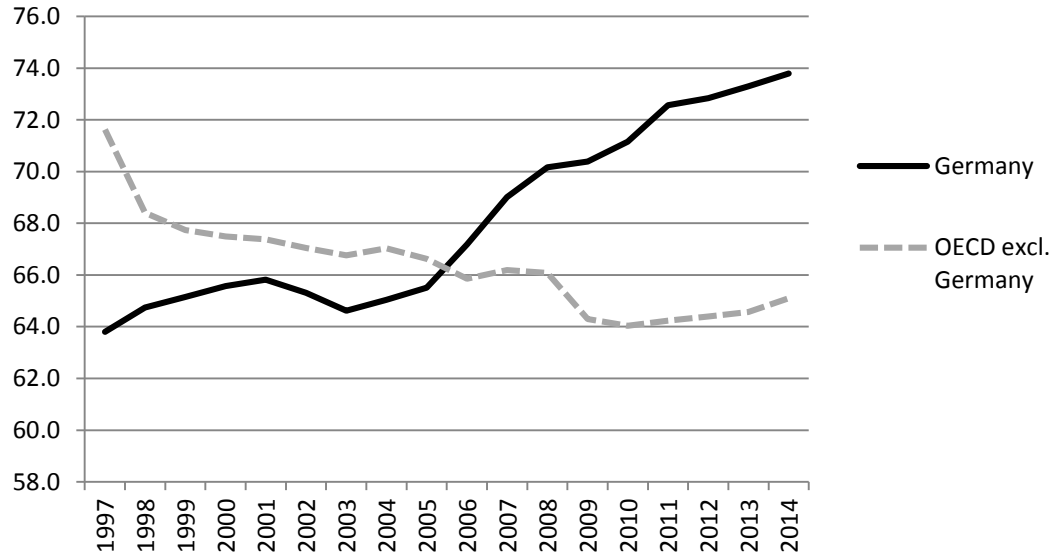


Source: OECD, own calculations.

There are various factors that could be responsible for the turnaround: a higher economic growth, a stagnating labour force, the major labour market reforms or long-lasting wage moderation (Walwei, 2015). First, there are no substantial differences in the level of the economic growth trend before and after 2005 and this is remarkable because in 2009 Germany was heavily hit by the Great Recession. However, the recovery was quick and rather strong. One of the causes for the quick recovery is the high competitiveness of the German manufacturing industry. Nevertheless, since economic growth did not catch up compared to the previous period in recent years it cannot fully explain the turnaround of the labour market. Second, after 2005 the labour force as a whole did not increase at the same pace as before.

Third, it is necessary to turn to the extensive labour market reforms between 2003 and 2005 as one possible explanation for the substantial improvement in the employment situation and there are various indications for this. The more recent development of the unemployment rate points to a decrease in structural unemployment (SBGE, 2013). Since there are less unemployed persons for a given number of vacancies this can be interpreted as an improvement in matching efficiency and as a sign of a tighter labour market. The chances of unemployed individuals entering the labour market rose until 2010 (Klinger and Rothe, 2012). This is because the "Hartz"-reforms facilitated more flexible work arrangements and unemployed were more willing to make concessions (Kettner and Rebien, 2007).

Figure 2: Employment rates in Germany compared with the OECD average (excl. Germany), 1997 to 2014, percentages



Source: OECD, own calculations.

Another factor for the recent positive development of employment is the wage trend, which is not entirely independent of labour market reforms (Dustmann et al., 2014). Although a moderate wage policy has been in place in Germany over the past three decades, it is remarkable that between 2003 and 2007 – including a period of strong economic growth from 2005 onwards – firms continued to exercise wage restraint. The reasons for the generally moderate wage development are the decreasing coverage of collective agreements, the introduction and utilisation of "opening clauses" in collective agreements and growing wage disparities associated with the growth in non-standard work arrangements.

The long-term outlook for the German labour market is provided by the projections of the Institute for Employment Research (IAB). The earlier scenarios had indicated that during the present decade labour supply will decrease (Fuchs et al., 2011) due to the so-called "demographic effect" implying that young cohorts entering the labour market are by far smaller than older cohorts retiring. The scenarios illustrated that neither an increase in labour market participation rates nor previously observed levels of net migration would compensate the demographic effect. However, recent developments have shown something different. At the moment the level of net migration in Germany is remarkably high because of two reasons (Fuchs et al., 2015). One, is the inflow of migrants from other countries of the European Union, which are either affected by the European financial and debt crisis or make use of the new opportunities resulting from free movement. Two, is the recent huge influx of refugees, particularly from countries like Syria and Iraq. This means that the earlier expected decline of labour supply will at least be postponed (Fuchs and Weber, 2015). Almost independent of the size of the expected labour force in the future, low birth rates cause continuous ageing of the German labour force.

The available scenarios display various trends with regard to the future development of employment, (Maier et al., 2015; Vogler-Ludwig et al., 2016). The projections suggest that employment in services will increase further, while employment in manufacturing, construction and agriculture will probably continue to decrease. There are indications that with respect to employment levels particularly

employer-oriented services and the health sector will gain in importance. Correspondingly, the demand for specific occupations (e.g. doctors, nurses, management consultants) in these sectors will also increase. The expected changes may also lead to an additional demand for highly skilled workers (academics), to a slightly lower demand with respect to medium skilled workers (graduates from the dual system of apprenticeships) and to a considerably lower demand for low skilled workers. If, in addition, the changing structure of labour supply by skill level is taken into account, we have to expect an increasing share of academics within the working age population. For this reason, long-term projections reveal probable bottlenecks, particularly concerning occupations requiring medium skill levels.

Although the German labour market has recently improved, there are structural issues that may impede further advances, which are visible in almost all industrialized countries. These structural issues are: increasing recruitment difficulties of companies indicating potential skill shortages; ongoing problems to succeed in tackling the hard core of unemployment; and rising inequality of employment in terms of stability, wages and social security (Dietz et al., 2013a), which will be dealt in more detail in the next section. The recent influx of refugees can be regarded as a new challenge which is, however, interrelated with the mentioned structural issues. It is possible that in the long run the influx will be a valuable source to generate skilled workers because most of the refugees are young and can still be extensively trained. However, if the intended integration fails, e.g. because of underinvestment in education and training, the "hard core" of unemployed may grow further.

4 Potential impacts of digitalization on the German labour market

The section will present first evidence as well as consider implications of digitalization for the German labour market. It will start by looking at jobs that are potentially at risk through digitalization and, in addition, at results based on long-term scenarios addressing the possible impacts of these new technologies. We will then assess the relevance of digitalization for selected structural labour market issues focussing on topics such as recruitment difficulties and skill shortages, the persistence of unemployment, and changes in the forms of employment. The relevant drivers of these structural issues will be identified and then possible implications of the emerging digital technologies will be discussed.

4.1 Employment

To analyse the potential impacts of digitalization on employment, Frey and Osborne (2013) assess the extent to which certain occupations in the United States of America (U.S.) can be automated by computers. The authors used data from the 2010 version of O*Net, which is an online service developed for the U.S. department of labour. It contains more than 900 occupations with detailed job descriptions and these occupations are then allocated to 702 occupations belonging to the Standard Occupational Classification (SOC). This was the prerequisite to link occupational characteristics from O*Net to 2010 Bureau of Labour Statistics (BLS) employment and wage data.

In order to assess the probability of computerisation, Frey and Osborne (2013) make use of expert knowledge, wherein a group of experts examined automation probabilities of different tasks during a workshop held at the Oxford University Engineering Sciences Department. In the first step, the experts selected 70 of the 702 occupations, which were either fully or not at all automatable, and provided subjective assessments. These subjective assessments were then used to generate automation

probabilities for the other 632 occupations. For this purpose three types of tasks were defined reflecting bottlenecks to computerisation: (i) perception and manipulation; (ii) creative intelligence; and (iii) social intelligence. For each occupation their statistical model provides probabilities of automation between 0 and 100 per cent. Based on this exercise the authors distinguished three groups of occupations by their relative probability (risk) of automation: low risk (less than 30 per cent), medium risk (between 30 and 70 per cent), and high risk (more than 70 per cent).

Based on this, Frey and Osborne (2013) expected two waves of automation: the first wave will affect high risk occupations and according to their estimates, about half (47 per cent) of total US employment belongs to this category.[2] Their model predicts that most workers in transportation and logistics occupations, office and administrative support workers, and labour in production occupations are at risk. In addition, the results further indicate that lower the wages and skills for a given occupation, the higher the probability of automation, and vice versa. This implies that the authors do not necessarily expect the previous trend towards polarization of employment in the U.S. to continue in the future. The first wave of transformation will last at least for one or two decades. During the second wave the speed of change will slow down due to engineering bottlenecks and computerisation, and because human labour may still have an advantage in tasks requiring more complex perceptions (Frey and Osborne, 2013).

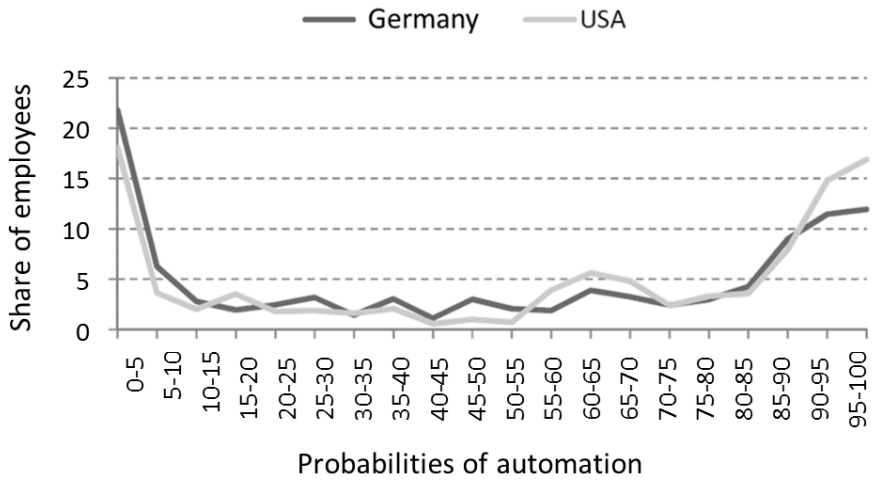
The approach by Frey and Osborne (2013) has been used for the analysis of Germany and Figure 3 shows that differences between the two risk distributions are rather small (Bonin et al., 2015). The findings suggest that in Germany fewer workers are employed in occupations with rather high probabilities of automation. Instead, more workers perform occupations with a comparatively low risk. Using the categorization of risks by Frey and Osborne (2013), the level of high risk occupations (risk of more 70 per cent) in Germany lies at 42 per cent, which is quite significant but slightly lower than in the U.S. (47 per cent). However, other studies not related to Frey and Osborne (2013) found that a larger part of jobs can potentially be substituted by intelligent machines and computers. Brzeski and Burk (2015) estimate that about 59 per cent of German employment could be at risk.

There are certain limitations to the analysis of Frey and Osborne (2013), which is pointed out by the authors themselves. For instance, they did not take into account possible consequences of automation with respect to future wage levels, capital prices, or potential labour shortages. They argue that regulatory concerns and political activism may decelerate the process of automation. Further, they mention major difficulties of making predictions about the speed and spread of technological progress. In addition, other limitations have to be borne in mind (Bonin et al., 2015). This is because the results of Frey and Osborne rely very much on expert knowledge. According to Autor (2014) experts often tend to overestimate the usability and the relevance of new technologies. In particular, comparative advantages of human beings regarding flexibility, discernment and common sense are often neglected or underestimated. The extent to which jobs will disappear due to digitalization does not only depend on the occupation as such but at least as much on the task composition within certain jobs. One has to bear in mind that tasks within certain jobs may shift from those which can be computerised to those which can be less automated by digital technologies (Autor, 2013). This would suggest that one of the

[2] A more recent study by Chui et al. (2015) obtained an almost similar result. The authors investigated a bottom line of 45 per cent of work activities in the United States that could be automated using already available technologies. If artificial intelligence were to reach the median level of human performance, an additional 13 per cent of work activities could be automated.

main impacts of digitalization – like in previous waves of technological change – is that jobs will be reshaped rather than disappear.

Figure 3: Probabilities of automation: Germany compared with the United States of America (USA), percentages



Source: Bonin et al., 2015.

A different approach to assess the relative risk of occupations to be computerised has been chosen by Dengler and Matthes (2015). Instead of incorporating the automation probabilities used by Frey and Osborne (2013), they relied on current job descriptions from an expert database called "BERUFENET", provided by the German Federal Employment Agency. They separated core requirements of certain occupations which can be substituted by computers from those which obviously cannot be replaced through digital technologies. Then, for each occupation under consideration, the number of core requirements substitutable by computers and intelligent machines was divided by the number of total core requirements, and the estimations were undertaken for 2013.

Dengler and Matthes (2015) calculated potential of substitution for different categories: occupations by level of skill requirement, segments of occupations, and employment covered by social security. They distinguish between occupations with low, medium, and high skill requirements. For occupations with low and medium skill requirements they estimated an almost similar substitution potential of roughly 45 per cent. Of particular interest is the finding that some of the occupations requiring medium skills seem to be more easily replaceable by computers than the multitude of occupations requiring rather low skills. This means that not only the level of skills is causing risks of substitution but also how far occupations are dominated by the performance of routine and repetitive tasks as shown by earlier studies (Autor et al., 2003). In general, the substitution potential of occupations with high skill requirements usually performed by academics is significantly lower (19 to 30 per cent) than that of jobs requiring less skills. If certain segments of occupations are compared, the substitution potential in production is highest (70 per cent). In other segments, such as different kinds of services, the potential of substitution is well below 50 per cent. This implies a possible impact of digitalization on the distribution of employment by gender that may favour women. Occupations, particularly in production, in which men are more represented than women, are probably to a higher degree affected by digitalization than occupations that are dominated by women. All in all, in 2013 about 15 per cent of German workers

covered by social security were performing a job in which 70 per cent of the involved tasks may have the potential to be substituted by computers in the future.

Studies that focus on probabilities of computerisation and automation have another shortcoming. They only concentrate on possible job losses and neglect other impacts of technological change such as reshaping of existing jobs or even job creation. Therefore, the results of studies dealing with substitution potentials should not be interpreted as a macro economic impact of digitalization. Arntz et al. (2014) argue that technological change may create new jobs through different channels. First, additional employment may occur in industries producing and introducing digital technologies. Second, new technologies will also reduce costs and prices, which may generate additional demand, production and employment. Third, lower costs of production through digitalization may also make relocation of production from low wage countries (reshoring) to high wage countries more attractive.

In order to assess macroeconomic impacts, Wolter et al. (2015) develop scenarios for future employment in Germany and look at the impacts of digitalization, particularly in the area of manufacturing (so-called "Industry 4.0"). The scenarios are based on the "Q-INFORGE model" which has been established as part of the "QuBe-Project".[3] Its functional core is a matching module allowing for occupational flexibilities and generating feedback effects via wage and price reductions (Weber 2016). The QuBe-Project intends to elaborate projections for skills as well as segments of occupations. The scenarios are based on various assumptions: investments in equipment and construction will significantly rise as a consequence of digitalization; the degree of digitalization in manufacturing will increase from 20 to 40 per cent until 2025; labour productivity as well as corresponding wages will also increase noticeably; the study uses substitution potentials of computers relying on Dengler and Matthes (2015), i.e. that the number of occupations with a high level of routine tasks will decrease in the course of digitalization and that of others will increase; and in relevant areas such as mechanical engineering and sensor technology Germany is supposed to be a forerunner and will have a leading role in the years to come.

The results of the scenarios for the economy and for employment are: consumption of private households as well as companies' investments in equipment will be pushed by "Industry 4.0"; exports as well as imports will be pushed and the trade balance will be strengthened, and profits, productivity, and wages will also grow (Wolter et al., 2015). These results are in line with Graetz and Michaels (2015) who came to almost similar results for other countries. According to the study by Wolter et al. (2015), "Industry 4.0" is neither a "job producer" nor an "employment destroyer". The scenarios estimate an overall loss of 60,000 jobs through digitalization which is not far from zero. However, the results indicate significant additional shifts within different segments of employment. In different occupational and economic sectors 490,000 jobs will be lost, while in other sectors and occupations 430,000 jobs will be newly created until 2025. The already visible structural change favouring employment in services will even be accelerated through "Industry 4.0". Occupations in areas such as information technology or teaching relying on more creative skills are more likely to become more important, whereas jobs in manufacturing (e.g. machine- and facility-controlling and maintenance of machinery) or service administration implying a high level of non-manual routine tasks are more likely to shrink.

[3] "[T]he Q-INFORGE model (...) connects comprehensive macroeconomic modelling with a labour market mapped in detail. The latter [the QuBe project] organises labour supply and demand according to industries, professions and qualifications. The functional core of this model is a matching module allowing for occupational flexibilities and generating feedback effects via wage and price reactions." (Weber, 2016, p. 2)

The demand for workers with high skill requirements will increase at the expense of workers with medium or low skills. In absolute terms the losses of jobs requiring medium skills are highest. This finding has an interesting implication. As already mentioned, due to the demographic development and changing educational attitudes the supply of workers with medium skills will probably decrease. Therefore, this probable impact may soften the above mentioned potential shortages in the field of vocational training.

Wolter et al. (2015) do not cover impacts of digitalization on the service sector in their study. Evidence suggests that substitution potentials of computerisation in the area of services are, in general, lower than in production (Frey and Osborne, 2013; Dengler and Matthes, 2015). Besides the impact of "Industry 4.0" this may additionally shift the structure of employment away from agriculture and manufacturing towards services. However, it would be a mistake to underestimate substitution potentials of digitalization in services. As in the case of manufacturing the probability of automation in services should not be treated equal to macroeconomic job losses. On the one hand, there might be shifts between different segments of service employment or changes with respect to the composition of tasks within certain service occupations. On the other hand, lower prices due to digital technologies will not only put service jobs in risk but may also create new jobs.

Vogler-Ludwig et al. (2016) using a macroeconomic model to estimate potential impacts of accelerating digitalization on employment suggest that an "Economy 4.0" may probably not cause job destruction on a large scale, as observed by others. Their analyses cover the whole economy, including service sectors, and the results indicate a small increase of employment (270,000) until 2030 consisting of 580,000 job gains in certain industries and occupations as well as 310,000 job losses in other areas of the economy. They expect additional jobs particularly in those industries producing digital technologies and digital services (e.g. mechanical and electrical engineering) and corresponding occupations. Other areas in which job creation may take place are research and development, teaching and business consulting. Losses are most likely in sectors such as transport, logistics, and security.

4.2 Skill mismatch

Even if considerable job losses due to digital technologies are rather unlikely, one should not underestimate other impacts on the labour market. They refer to structural issues and the future composition of employment. A crucial structural issue of the labour market is job matching and it deals with the process of allocating individuals to jobs. Matching is causing transaction costs because it takes time for a firm with a vacant job to find the right worker or for a given worker to find a suitable job. Success in matching depends on two factors: firstly, search efforts of both sides of the market, and secondly, correspondence of job characteristics on the one hand and profiles of workers on the other hand. Mismatch can be described as "a situation where industries, occupations, locations or groups with different levels of education/skill diverge over time in the unemployment-to-vacancies ratio" (Cedefop, 2015, p. 27). Skill mismatch is one particular form of labour market mismatch and it is "a situation where there is a (qualitative) discrepancy between the qualifications and skills that individuals possess and those that are needed by the labour market" (Cedefop, 2015, p. 27).

Many instances can lead to skill mismatch. A given vacancy may be hard to fill by employers (recruitment bottleneck or difficulty). Skill gaps can occur if the level of skills of staff members or potential applicants is less than required to perform a job adequately or to match the requirements of a job. Skills previously used in a job can also be no longer required or may have diminished in importance

(skills obsolescence). Furthermore, workers may perform jobs with requirements below their qualification (over qualification) or below their skills (over skilled).

Mismatch is an important reason for structural unemployment (Sahin et al., 2012) and two kinds of difficulties can arise. Firstly, avoidable and unavoidable search costs can cause "frictional unemployment". Profile discrepancies between job characteristics and skills of individuals can even result in a more severe problem. As a consequence there might be jobs that cannot be filled adequately and workers cannot find an appropriate job, and both would lead to so-called “mismatch unemployment”. Empirical evidence for Germany indicates that – depending on the definition – 10 to 45 per cent of German unemployment may be due to mismatch unemployment (Bauer and Gartner, 2014).

Digitalization may have consequences for the course of the matching process as well as for its results. One can expect that digital technologies have the potential to significantly reduce search costs of firms and workers. As a consequence, frictional problems of the labour market can potentially be scaled down. According to the preliminary evidence the spread of digital technologies will alter the composition of labour demand in many ways. A major question is how far possible changes in demand will cause more difficulties for firms to find the right worker and for individuals to find the right job. Two structural issues will be discussed in this section taking the case of Germany. The first is,whether digitalization may have the potential to cause (additional) recruitment difficulties and skill shortages. The second concerns the potential problem of additional persistence with respect to unemployment that may arise as a consequence of the emergence of digital technologies. The question in this context is how far digitalization may reinforce or ease the already visible persistence of unemployment.

4.2.1 Recruitment difficulties and skill shortages

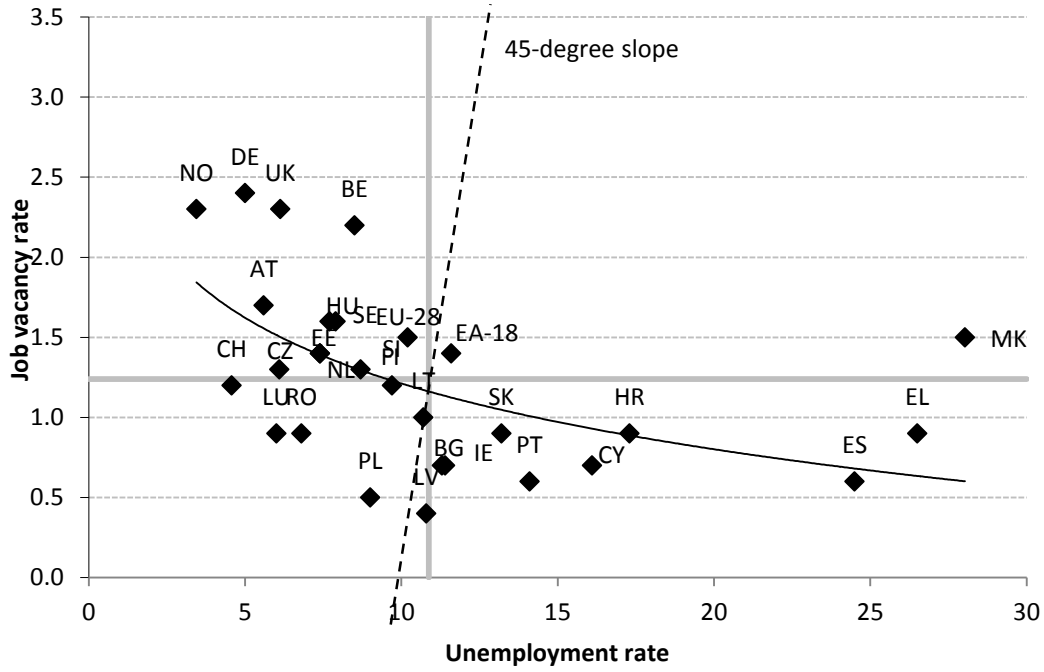
Difficulties in filling vacancies are a potential risk for economic growth because recruitment problems may partly impede production or service delivery. They occur “in a situation where a given vacancy (posted in a recent time period) is hard to fill by employers” (Cedefop, 2015, p. 27). Firms may struggle in two different ways: hiring suitable skilled workers in the external labour market (outside the firm) as well as identifying the right worker within their currently employed workers (inside the firm).

Recruitment difficulties could be due to several reasons. The European Centre for the Development of Vocational Training summarizes evidence addressing potential causes for difficulties in attracting and hiring skilled labour that firms typically face: changes in the organisational processes for the purpose of increasing their economic performance; adoption of high performance work practices; recruitment of labour that is temporary or is supplied in the external market; and job offers with less attractive wages and less pleasant working conditions (Cedefop, 2015).

However, recruitment difficulties may not necessarily be equivalent to skill shortages. Skill shortages can be described as “a situation where the demand for a particular type of skill exceeds the available supply of that skill at the market-clearing rate of pay” (Cedefop, 2015, p. 27). This means one has to distinguish “genuine skill shortages” from “apparent shortages”. Both cases have in common that firms report difficulties of finding workers with the required skills. But the cases are not comparable with respect to the wage offer. In the case of a “genuine” skill shortage the employer offers a market-oriented pay. By contrast, “apparent” skill shortages imply uncompetitive wages. A non-market-oriented pay can have two reasons: firms are either seeking for a (temporary) competitive advantage or they are not able to pay the market-clearing rate in the long run.

One indication of potential recruitment difficulties is the relationship of unemployment and vacancy rates (known as the "Beveridge Curve"). Figure 4 divides the countries into four groups depending on the corresponding level of the rates and also shows the European average. Germany belongs to a group of countries (such as Austria, Belgium, and the United Kingdom) that have an unemployment rate below average and a vacancy rate considerably above average, indicating a rather tight labour market.

Figure 4: Unemployment and job vacancy rates in European countries, 2014, percentages

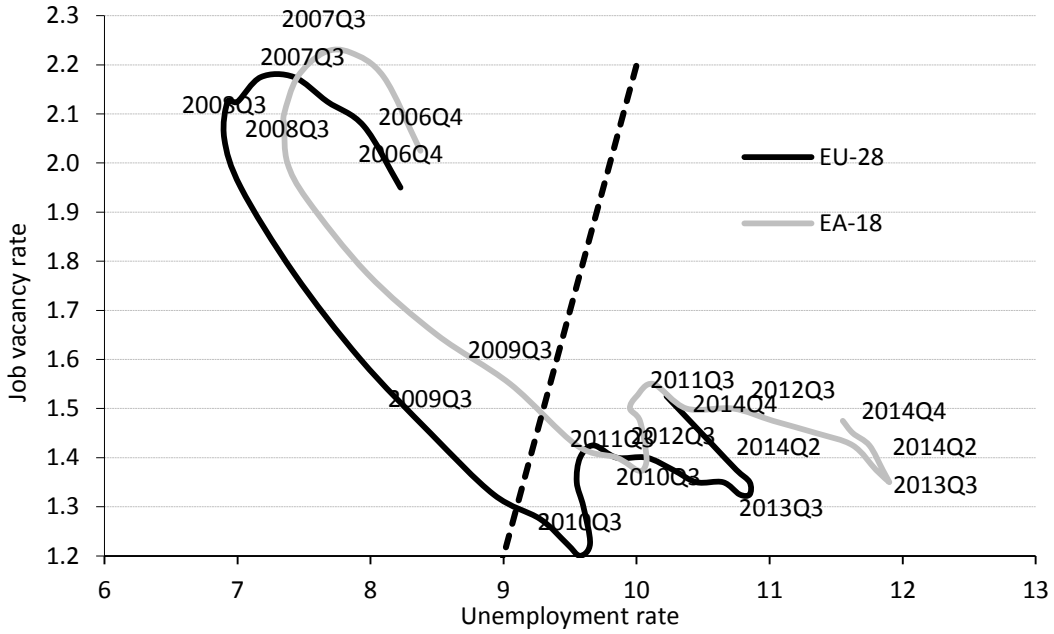


Note: EU-28: European Union (28 countries), EA-18: Euro area (18 countries);
AT-Austria, BE-Belgium, BG-Bulgaria, CH-Switzerland, CY-Cyprus, CZ-Czech Republic, DE-Germany, DK-Denmark, EE-Estonia, ES-Spain, FI-Finland, FR-France, GR-Greece, HR-Croatia, HU-Hungary, IE-Ireland, IT-Italy, LT-Lithuania, LU-Luxembourg, LV-Latvia, MK-Macedonia, MT-Malta, NL-Netherlands, NO-Norway, PL-Poland, PT-Portugal, RO-Romania, SE-Sweden, SI-Slovenia, SK-Slovakia, UK-United Kingdom.

Source: Eurostat, accessed on 16th July 2016.

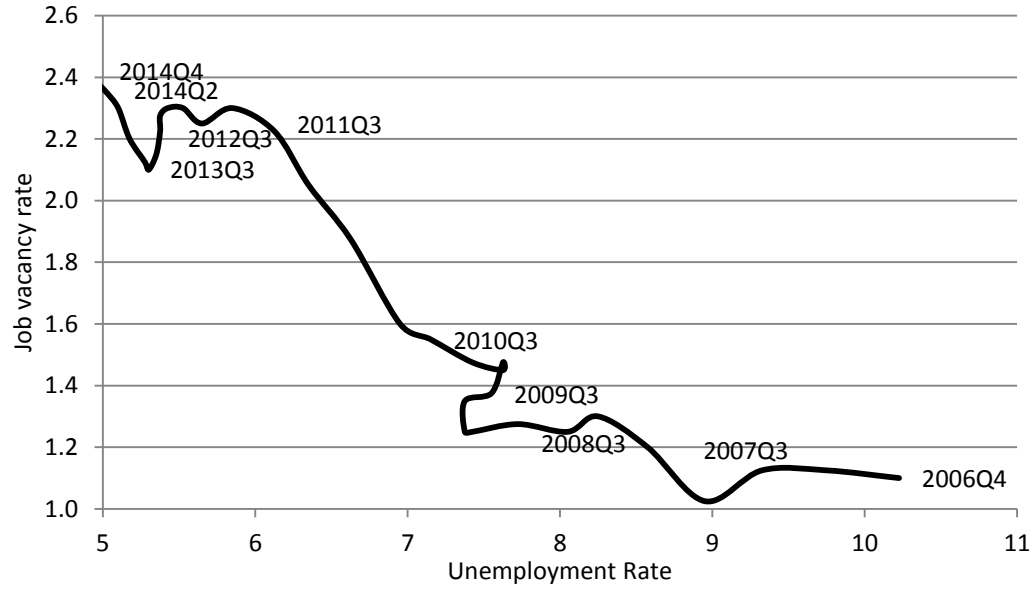
Figures 5 and 6 illustrate the "Beveridge Curve", i.e. the development of unemployment and vacancy rates over time, for the average of European countries and Germany. For the average of European countries the curve indicates an outward shift for the period between 2006 and 2014, and the opposite is the case for Germany. This means that there are more unemployed for a given number of vacancies over time in most of the European countries and fewer unemployed for a given number of vacancies in Germany. This suggests significant differences in matching efficiency and in labour market tightness over time between the European countries and Germany.

Figure 5: Beveridge Curve Europe, 2006 Q4 – 2014 Q4, percentages



Source: Eurostat, accessed on 16th July 2016.

Figure 6: Beveridge Curve Germany, 2006 Q4 - 2014 Q4, percentages

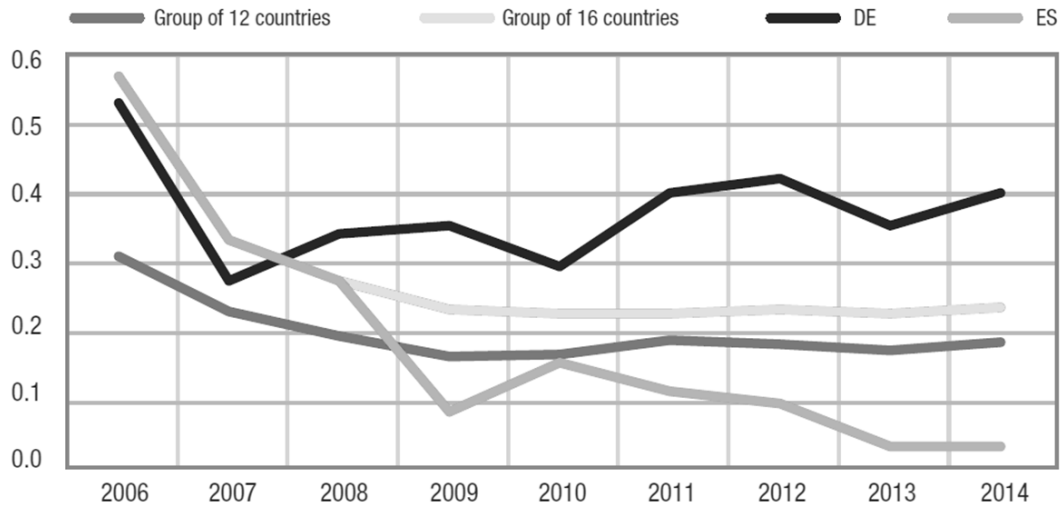


Source: Eurostat, accessed on 16th July 2016.

Besides the relationship of unemployed and vacancies there are also other indications for (a greater) tightness in the German labour market. In recent years the vacancy duration increased and the number of applicants per vacancy decreased (Czepek et al., 2015). In some labour segments recruitment bottlenecks appear more often than in other, and it differs between regions. In southern parts of Western Germany (particularly in Baden-Württemberg or Bavaria) full employment has almost been reached, while there are regions in Eastern Germany where the labour market cannot at all be regarded as tight. The most difficult-to-fill jobs are in the following occupations: engineers, technicians, software analysts, nurses and personal care workers. In addition, the share of employers with difficult-to-fill jobs has increased in recent years and is much higher than in most other European countries (Figure 7). Interestingly, this does not only apply to jobs with high skill requirements but also to jobs with low skill requirements.

The "Eurobarometer" survey indicates a comparatively high share of German firms that see skill shortages as the greatest challenge in filling vacancies (European Commission 2010). In 2010, 63 per cent of German firms reported skill shortage as constituting a major barrier to filling their vacancies (European average: 47 per cent). At that time, only Austria, Luxembourg and Norway had reached similarly high levels. However, there is no evidence for a general labour shortage in Germany (Brenzel et al., 2014). This is confirmed by looking at probabilities of firms facing "genuine" skill shortages. The analysis based on Eurobarometer survey suggests that in Germany the (adjusted) probability of firms facing "genuine" skill shortages was somewhere in the midrange compared to other European countries (Cedefop, 2015).

Figure 7: Share of European employers with difficulty filling jobs, 2006 -2014, percentages



Note: The average EU difficulty per year is based on the means of either 12 (2006–14) or 16 (2008–14) European countries for which valid information is available. The group of 12 countries includes: Austria, Belgium, France, Germany, Ireland, Italy, the Netherlands, Norway, Spain, Sweden, Switzerland, and the UK. The group of 16 further includes: the Czech Republic, Greece, Poland, and Romania. EU average weighted according to the share of each country in total employment.

Source: Cedefop 2015 (based on ManpowerGroup, talent shortage survey, 2006–2014).

The future development of "apparent" as well as "genuine" skill shortages depends on various factors. Labour market performance is an important issue, as a better performance of the labour market over time, would more likely lead to skill shortages. In addition, the demographic development may cause skill imbalances. One can observe that cohorts leaving the labour market through retirement are much larger than young cohorts entering the labour market. As the qualifications and skills of the "baby boomer generation" are already high and this group will leave the labour market in due course, additional shortages may simply arise as a consequence of potentially necessary replacement (Neumark et al., 2011).

Globalization may be another driving force, as it increases the division of labour between countries. In order to be competitive high wage countries, such as Germany, need to create "intelligent" products as well as professional services. This does not only require an ever-increasing level of skills but also the availability of new skills within the economy. Therefore, globalization may be a potential and permanent source for newly emerging bottlenecks. Furthermore, changes in the structure of the economy may also have an impact on skill shortages. Due to ageing almost all European countries are already facing the challenge of skill shortages in the growing sector of health and social care.

In the past, technological change had pushed labour demand towards high skill requirements, known as skill-biased technological change (Spitz, 2004). The impacts of digitalization on skill shortages in the future are uncertain as there are many other possible implications of new technologies. This is due to the expectation that digitalization probably accelerates productivity in all sectors of the economy and will most likely foster structural change. In the case of Germany, severe job losses seem to be rather unrealistic as scenarios suggest that the overall labour market performance will probably not be weakened through the emergence of digital technologies. By contrast, increasing dislocation is a more realistic scenario implying considerable changes in the composition of tasks and jobs. Therefore, scarcity of skills is more probable than scarcity of jobs.

Due to routine-biased technological change, scarcities are most likely to be associated with the requirement of high skills (see Section 4.1). On the one hand, evidence indicates that high skilled workers are less likely to be substituted by digital technologies. This might also be due to the fact that high skills and high qualification are often associated with higher flexibility and adaptability of the corresponding workers. On the other hand, new jobs that will be generated through the spread of digital technologies will also have a higher probability of requiring high skills and less routine tasks.

For Germany, baseline long-term scenarios that neglect impacts of digitalization indicate that future bottlenecks may occur particularly in the area of medium skill levels, i.e. jobs requiring vocational training (Wolter et al., 2015; Vogler-Ludwig et al., 2016). However, such bottlenecks are not so much driven by increasing labour demand but more by a shrinking labour supply. The latter is due to diminishing cohorts of youth as well as their increasing preference for universities. Additional labour demand can be expected in employer-oriented services as well as health and social services. Digitalization has at least some potential to compensate the imbalances emerging in the baseline scenario. Probable shortages in the field of vocational training may partly be softened by digital technologies. As employer-oriented services as well as health and social services require comprehensive interactive competencies, their potential of automation is comparatively low. All in all, Vogler-Ludwig et al. (2016) expect a positive digitalization effect for employer-oriented services and a small negative digitalization effect for health and social services. The latter mainly concerns occupations requiring rather low skills in these two sectors.

With regard to future qualification needs, the development of ICT skills as well as of creative and social skills will be of high relevance at the same time. ICT skills are of strategic importance in order to make full use of new technologies. They will increasingly be needed in almost any profession. Key ICT skills consist in being able to deal professionally with computer languages, programming and social media. In addition, tasks and skills requiring creative and social intelligence will be decisive for employment in the twenty-first century because these competences are less susceptible to substitution by digital technologies (Frey and Osborne 2013). Therefore, actual abilities and competences of individuals could be more important in the sense that specialised knowledge can be provided in a flexible as well as tailor-made manner ("talent on demand"). Among others, social skills include adaptability, universal problem-solving competences, sensing emotions, critical thinking, and communication skills.

Dynamics in skill requirements may cause more problems in the future to provide skills on time. The pace of vocational education and subsequent further training is, therefore, crucial in order to avoid unnecessary shortages. All in all, the future labour force will need a particular mix of skills, knowledge and competences for the emerging digital technologies which enables a wide and rapid adoption as well as diffusion in the economy. One requisite is that firms need to ensure that available skills and competences are utilized as far and as possible. This implies that in the future it may not only be important to optimize skills for evolving jobs but also to optimize jobs for available skills.

4.2.2 Persistence of unemployment

In Germany, unemployment significantly decreased since 2005 (see Section 3) and compared to the European average, the German unemployment rate and long-term unemployment rate are low. Figure 8 shows the development of unemployment and long-term unemployment rates over time for Germany and the EU 15 average. However, almost at any point of time half of all unemployed have been out of work for more than one year. This means that in Germany, individuals becoming unemployed face a relatively high risk of staying out of work for a rather long time (Konle-Seidl, 2016). Empirical evidence shows that the monthly outflow rate of short-term unemployed into regular employment is almost seven times higher than the corresponding rate of long-term unemployed (Bruckmeier et al., 2015a), which indicates a certain persistence of unemployment.

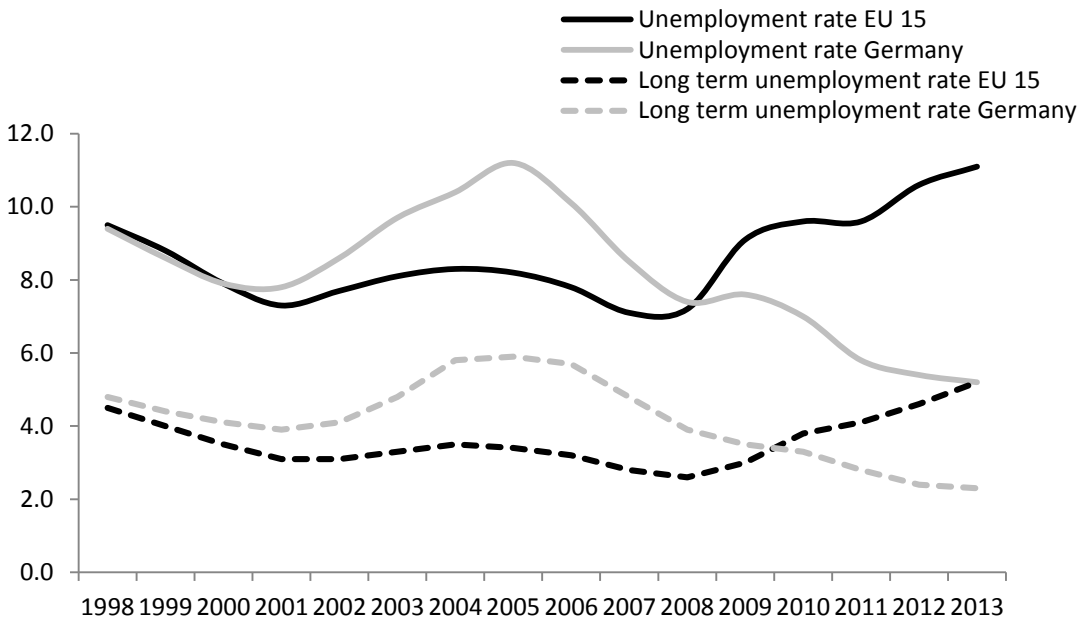
There are two partly interrelated reasons for the persistence of unemployment. On the one hand, there might simply be not enough jobs. Compared to other jobseekers, unemployed may suffer from an overall lack of jobs as well as from a specific lack of suitable entry-level jobs. On the other hand, although jobs might be available, the competitiveness of unemployed workers might not be sufficient.

A recent analysis for Germany has identified eight individual characteristics of welfare recipients[4] that can be seen as obstacle for them to (re-)enter regular employment: (i) low level of education; (ii) low level of qualification; (iii) old age; (iv) health problems; (v) weak knowledge of the language; (vi) obligations to take care of relatives; (vii) lone parent; and (viii) previous benefit receipt (Achatz and Trappmann, 2011). Each of these characteristics significantly reduces the probability of (re-)entering regular employment, and cumulative impacts of such characteristics are a matter of concern. If one

[4] As many other countries, Germany also provides welfare benefits to workers who are long-term unemployed. Apart from registered unemployed, welfare recipients also consist of additional groups like the working poor, people who do not have the obligation to look for work due to child or elder care and people who temporarily take part in labour market programmes.

person cumulates four or five of these characteristics at the same time, the probability of (re-)entering regular employment is almost zero.

Figure 8: Unemployment and long-term unemployment rates in Germany and in EU-15, 1998-2013, percentages



Source: Eurostat, accessed on 15th November 2015.

The question is now how far the emergence of digital technologies may have the potential to either improve or worsen the situation for "hard-to-place" workers. At first glance, there seems to be at least some positive news. The likelihood that the absorbability of the labour market as a whole will substantially suffer as a consequence of continuous digitalization is rather low. However, this does not necessarily mean that the "hard core" of unemployed or other welfare recipients will have more options to (re-)enter the labour market.

If one takes the employment obstacles of welfare recipients as a starting point they may either become an even greater hurdle or be partly removed. At least four obstacles (1, 2, 5, and 8) will most likely be reinforced by digitalization. These are already workers within the labour force for whom the acquisition of the potentially required skills is difficult. The difficult labour market situation of less skilled workers may even deteriorate (see Section 4.1). Due to increasing skill requirements low levels of education, qualification, and communication, as well as language skills will in the future be probably an increasing risk for persistent unemployment (obstacles 1, 2, and 5). Being out of work, their skills and qualifications may be devalued more quickly (obstacle 8). However, it is often argued that a more frequent use of electronically controlled systems of assistance such as head-mounted displays may have the potential to integrate problem groups of the labour market to a larger extent. However, it remains to be seen how realistic this is in the foreseeable future. "Smart" automation requires an excellent understanding of complex work routines because machines and production facilities will be able to permanently reconfigure themselves in the future (BAA, 2012).

For two groups of "hard-to-place" workers, it is conceivable that there could be slight improvements. One group consists of workers with problems to perform heavy work (obstacles 3, 4). This comprises workers with intellectual or mental disabilities who will probably face even more difficulties to (re-)enter the labour market, whereas the opportunities for physically disabled workers may be improved through the emergence of digital technologies. For them the acquisition of creative and social skills and performing an intellectually demanding task are not a serious hurdle. Digitalization may enable at least parts of the physically disabled workers to be even more productive than they would have been otherwise. Particularly the emergence of more evolved mobile robots may have such a potential because intelligent machines may strengthen the ability to carry out the more physically demanding tasks. The second group consists of people who must take care of relatives and often have to stay at home (obstacles 6, 7). In order to arrange gainful employment and managing family life in a better way, the use of digital technologies offers opportunities for mobile work and home work. The limitation here is that mobile work is not an option for all kinds of jobs. But at least for those jobs in which physical presence at the workplace is not (or less) important, digitalization may offer more possibilities to increase labour market participation.

4.3 Forms of employment

Work arrangements are changing in many ways, both in terms of overall composition and types of employment. In many countries there is a tendency towards greater diversity in the structure of employment. This development concerns the growth of so-called "nonstandard work arrangements" with partly low levels of protection and increasing wage disparities. Eurofound (2015) has documented different types of employment categories that have been emerging in Europe over the past decade, which include new types of mobile work, crowd employment, etc.

In Germany, the share of nonstandard work arrangements to total employment is quite high compared to other countries and the European average (Schulze-Buschoff, 2015; Table 2). In 2014, a comparison of EU countries shows that the Netherlands (62.0 per cent) and Spain (41.5 per cent) are the only countries, which have a higher share of nonstandard work other than Germany (40.3 per cent). However, one has to bear in mind that in Germany, apprentices, who are generally employed on a temporary basis, are counted as fixed-term contracts who are part of non-standard work arrangements. Like the Netherlands, Germany belongs to a group of countries which is often classified as "continental conservative" (Hipp et. al, 2015), and one of the characteristics of these countries is the so-called "modernised breadwinner model", which depicts a role model of a man usually working full-time and a woman often working part-time.

Besides the current level of nonstandard work, the development of work arrangements over time needs attention. It is important to point out that at least in Germany the increase in the proportion of atypical forms of employment such as part-time work, "mini-jobs" (marginal part-time employment), temporary agency work and fixed-term employment did not emerge recently, and this development is evident since mid-1990s until 2005 (see Dietz et al. 2013b). Figure 9 illustrates that nonstandard jobs[5] strongly increased between 1998 and 2006, and since then the increase was much lower. If one disregards regular part-time work – as being part of standard type of employment – then the level of nonstandard jobs has

[5] Nonstandard jobs include all dependent employed with less than 32 hours a week, non-permanent workers (more than 31 hours a week) and one-person-businesses.

almost remained constant between 2006 and 2014, and in addition, standard employment relationships[6] have begun to grow. However, a closer look at certain forms of employment and their share of total employment displays a more differentiated picture. The share of one-person-businesses and fixed-term contracts has declined in recent years and the share of agency workers grew slightly (see Figure 10). It should also be emphasized that the number of multiple job holders related to the total number of dependent employed increased from 3.8 per cent in 1998 to 5.4 per cent in 2006 to 7.2 per cent in 2014 (Fuchs et al., 2015). In this context, it needs to be mentioned that mini-jobs can also be performed as a second job and are in general tax-free.

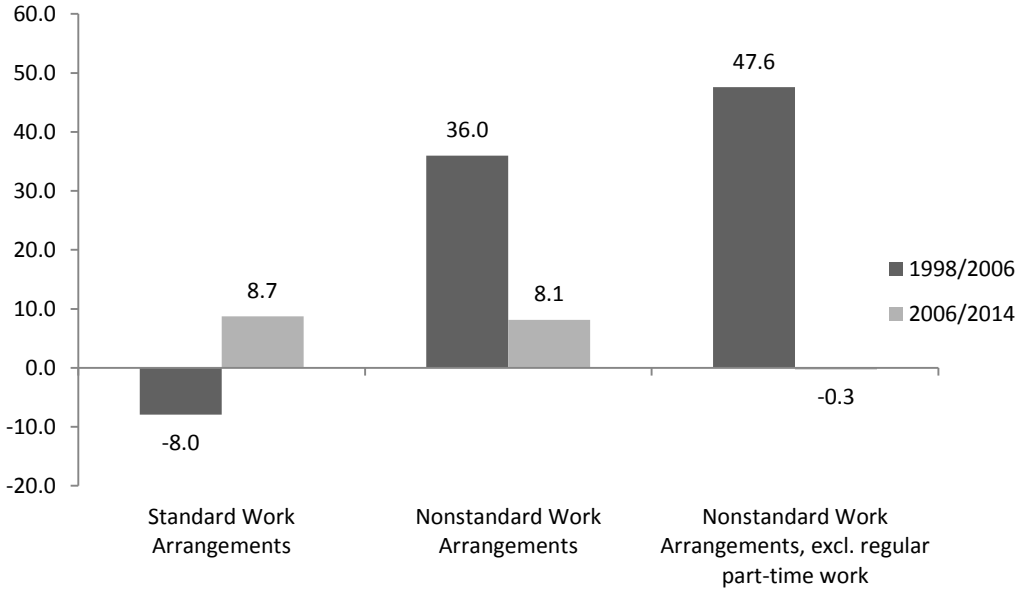
Table 2: Share of nonstandard workers in total employment, 2006 to2014, percentages

	2006	2010	2014
AT	34.6	37.4	39.1
BE	34.5	35.7	36.5
BG	11.6	12.3	13.3
CY	26.4	27.0	34.5
CZ	21.1	23.3	24.4
DE	39.9	40.9	40.3
DK	32.1	35.4	34.3
EE	13.2	15.7	14.7
ES	44.9	39.3	41.5
EU-28	35.1	35.7	36.4
FI	32.1	30.5	31.1
FR	31.8	32.6	33.4
GR	30.8	33.1	37.9
HR	25.7	25.7	25.0
HU	15.7	19.2	19.8
IE	28.2	34.3	35.5
IT	35.4	36.3	38.8
LT	21.6	15.3	17.7
LU	25.5	25.5	28.3
LV	16.1	19.8	14.8
MT	22.8	22.7	27.0
NL	54.3	59.0	62.0
PL	40.4	39.1	39.3
PT	32.6	34.1	32.5
RO	22.4	24.2	22.6
SE	39.0	37.9	36.9
SI	26.0	28.0	28.5
SK	16.3	19.0	21.7
UK	33.7	35.0	35.6

Note: The results are based on a summarizing indicator that excludes multiple counting of persons that apply to more than one characteristic of nonstandard work arrangements. Nonstandard work arrangements are defined as: agency workers; employees with fixed-term contracts (excl. agency workers); one-person-businesses in full-time employment; part-time workers in permanent employment (excl. agency workers) and one-person-businesses working part-time (> 15 h/W) who define themselves as part-time workers; and "Marginal" part-time workers in permanent employment (excl. agency workers) or "marginal" part-time one-person-businesses (<15 h/W). Abbreviations: AT-Austria, BE-Belgium, BG-Bulgaria, CY-Cyprus, CZ-Czech Republic, DE-Germany, DK-Denmark, EE-Estonia, ES-Spain, EU-28-European Union (28 countries), FI-Finland, FR-France, GR-Greece, HR-Croatia, HU-Hungary, IE-Ireland, IT-Italy, LT-Lithuania, LU-Luxembourg, LV-Latvia, MT-Malta, NL-Netherlands, PL-Poland, PT-Portugal, RO-Romania, SE-Sweden, SI-Slovenia, SK-Slovakia, UK-United Kingdom. Source: Schulze-Buschoff, 2015.

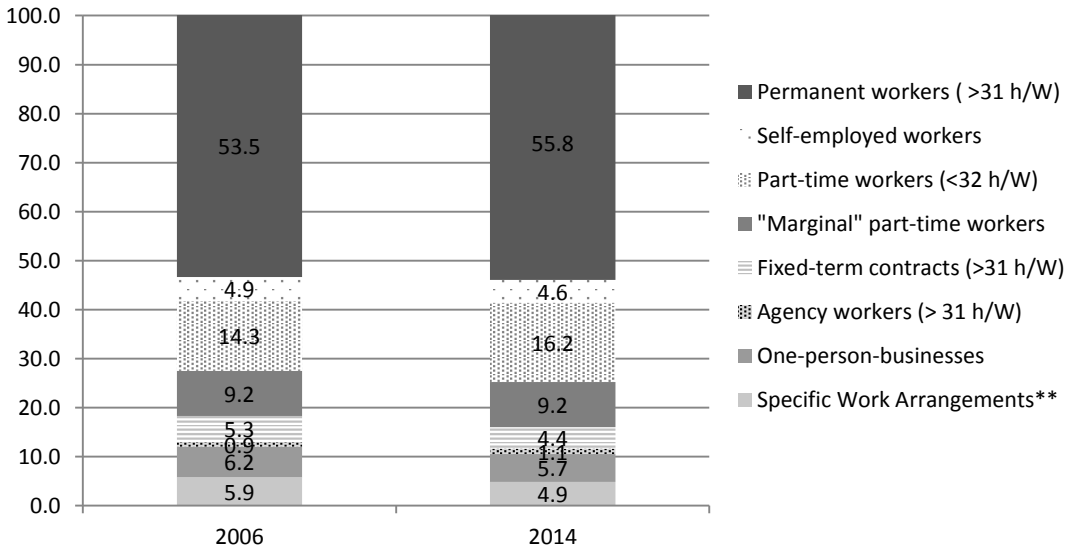
[6] Standard work arrangements include here self-employed (without one-person-businesses and related family workers) as well as workers with a permanent contract, with weekly working hours close to full-time (more than 31 hours a week) and who are not involved in agency work.

Figure 9: Development of standard and nonstandard jobs in Germany 1998/2006/2014, growth rates in percentages



Source: Destatis, 2014 (special analysis based on microcensus).

Figure 10: Employment by different work arrangements, 2006 and 2014, percentages of total employed

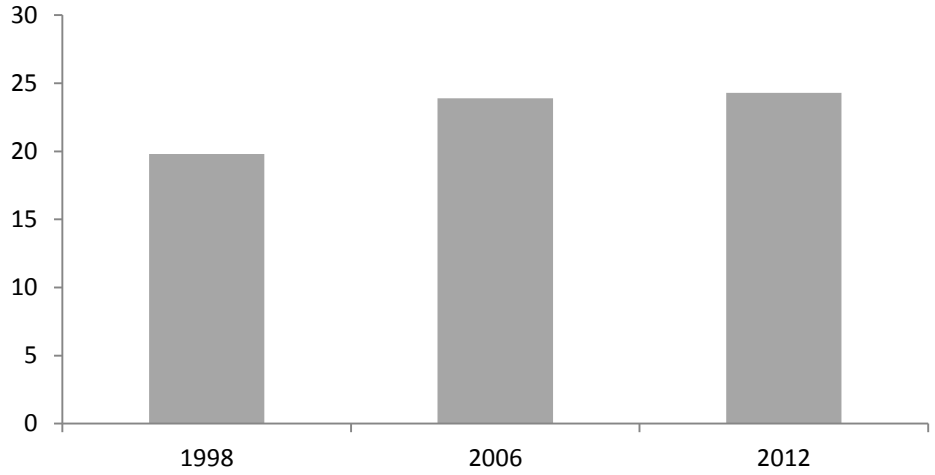


Note: ** Specific Work Arrangements include: Apprentices, soldiers, persons working in alternatives to military services, related family workers and workers who do not indicate whether their contract is on a permanent or temporary basis.
Source: Destatis, 2014 (special analysis based on microcensus).

Developments in the past decade also indicate that the proportion of workers with low hourly pay in Germany grew only marginally. Kalina and Weinkopf (2013) using a threshold value of two-thirds of the median hourly wage, show that the proportion of low-wage earners increased marginally from 23.9 per cent in 2006 to 24.3 per cent in 2012. Much of the growth in low-pay workers seems to have thus occurred before 2005, i.e. before the turnaround of the German labour market. The share of low-wage

earners grew by four percentage points between 1998 and 2006 (Figure 11). Several studies have found a strong correlation of low pay workers with nonstandard jobs, as low hourly pay is found more frequently in part-time jobs covered by social security and in particular in mini-jobs. Furthermore, analyses of fixed-term jobs and temporary agency work also show considerable gross wage differentials compared to regular employment (Jahn and Pozzoli 2011; Keller and Seifert 2013).

Figure 11: Share of workers with low hourly wages, 1998/2006/2012, percentages of dependent employees



Source: Kalina and Weinkopf (2013) based on German Socio-Economic Panel (SOEP) 2012

The past developments raise the question of what lies behind the changes and the potential drivers for changes in the forms of employment and wage inequality. Whether the changes are due to the structural changes in employment, changes in labour market institutions, changing preferences and behaviour of employers and workers, or market power of the parties involved. The main findings for Germany in this respect can be found in Box 1.

The possible implications of digitalization on forms of employment and wage inequality are manifold, and as already mentioned digitalization will most likely accelerate structural change in employment (see Section 4.1). There are indications that the increase in service employment and its relative importance may be pushed further. One can also expect an impact of digitalization on employment by gender. Men are more often performing occupations (e.g. in the field of manufacturing) which may be endangered by automation, while women are to a greater extent in occupations requiring social tasks being less susceptible to automation. In addition, women probably get an easier access to jobs in manufacturing or construction because due to "smart" automation such jobs will be physically less demanding than in the past. As shift-share-analyses show, both, more employment in services and more female employment tend to increase regular part-time employment (excluding mini jobs).

As already mentioned, because of digitalization neither large job losses nor technological unemployment are very likely. However, this does not mean that within certain segments of the labour market such impacts may not occur at all. As mentioned in the earlier section, jobs with low skill requirements are endangered by digitalization, which may have an impact on the quality of attainable jobs for unskilled workers, e.g. regarding their employment security. In recent years, we have already observed that low-skill workers bear a higher risk of being employed in a less stable job than more qualified workers (Himsel et al., 2013).

Box 1: Employment forms and wage inequality in Germany: Drivers of change

One driver of growth in nonstandard work arrangements is the structural change in total employment, as nonstandard work can be found in the employment increases. According to shift-share analyses, long-term changes in the structure of employment, such as the growth of female employment, the increasing importance of service jobs, the on-going trend of a higher qualification, or the constant ageing of the workforce have made at most a small contribution to the change in the composition of work arrangements (Walwei, 2014b). With respect to regular part-time employment (i.e. excluding "mini-jobs") up to 40 per cent of the increase can be associated to changes in the composition of employment by industries and gender. This is due to the fact that employment in services and women engaged in employment have a higher part-time rate than their counterparts.

The composition of work arrangements and changes in labour market institutions can also make a difference. In general, institutions define the relative attractiveness of work arrangements, and either open up or limit options for those concerned. The "Hartz"-reforms in Germany between 2003 and 2005 generated push- and pull-effects in this respect. In particular, the fourth stage of the "Hartz"-reforms, which emphasised activation and relaxed the criteria of what constitutes a suitable job, is of importance. Since the reforms recipients of basic social benefits have to accept any employment, which not only affects the labour market entry of people who are in need of assistance but also affects the job-search behaviour of people who want to avoid having to claim basic social benefits, in the sense of a deterrent effect (Erlinghagen, 2010). In this respect, the labour market reforms could have resulted in push-effects towards employment that is less stable and not always sufficient to secure the worker's livelihood. These effects were accompanied by the pull-effects, wherein there was increased scope for action for firms as a result of deregulating non-standard work arrangements as part of the "Hartz"-reforms (Dietz et al. 2013b).

Himsel et al. (2013) show that there was an increase in atypical employment after the implementation of the "Hartz"-reforms between 2004 and 2012. Deregulation and early effects of the reforms led to an increase in temporary agency work and marginal part-time employment in 2004. However, this appears to be a one-off effect, as the initial increase did not continue after 2004. The number of people engaged as marginally part-time showed minimal annual growth after 2004. Temporary agency work went up but was influenced by the economic situation (Antoni and Jahn, 2009). The possible reasons why temporary agency work did not accelerate further after the labour market reforms may have to do with re-regulation in the temporary work in recent years such as the introduction of a minimum wage.

A third driver of change is the behaviour of the main players on the labour market, i.e. employers and workers. While using work arrangements, employers are confronted with a trade-off because they have to take into account costs and benefits of certain forms of employment. There might be several reasons for companies to use nonstandard jobs (Walwei, 2014b). They can be used to lower total labour costs, and it may also be an option to reduce extra payments to regular workers for overtime. In addition, temporary employment can be utilized as a recruiting device and may therefore increase the efficiency of matching labour supply and demand. Non-standard work arrangements also offer a high degree of flexibility to adapt available personal resources to variations in product demand and can also be seen as a kind of buffer to protect core workers.

Changes in preferences of workers could also be partly responsible for the change in the composition of work arrangements. In principle, most workers are expected to prefer a regular employment relationship. Nonetheless, some individuals may desire certain forms of employment like part-time work because they can facilitate the compatibility of employment with other activities such as childcare or education and further training during certain periods of their lives (Stops and Walwei, 2014). The risk preferences may also change over time and sometimes a fixed-term contract with a well-reputed employer might be recognized as a stepping stone for a successful career.

Of further importance is that following a period of unemployment, atypical employment can facilitate labour market entry (Hohendanner and Walwei, 2013). However, there is little evidence of flexible employment

functioning substantially as a bridge to regular employment (Gensicke at al., 2010; Lehmer, 2012; Brülle, 2013). Yet it must be taken into consideration that temporary forms of employment need not be less stable in the long-run than a permanent job (Boockmann and Hagen, 2005), as fixed-term employment contracts can be converted into permanent ones, and permanent employees can also be dismissed. Likewise, even full-time and permanent employment does not necessarily guarantee an income that is sufficient to secure one's livelihood if the job is in the low-wage sector (Bruckmeier et al., 2013; Bruckmeier et al., 2015b).

A peculiarity of the labour market is that preferences of employers and workers may not always correspond to one another. An important issue in this respect is the relative market power of the parties involved (Houseman and Osawa, 2003). During periods of economic slack and high unemployment, nonstandard work can be pushed at the expense of standard work. During such periods of excess supply at the labour market, employers can more easily enforce nonstandard work arrangements. As a consequence of the recent labour market recovery in Germany we can assume declining push-effects into these types of employment.

As regards the causes of the wage inequality, the "Hartz"-reforms cannot be seen as the sole cause of the increase in wage inequality since the mid-1990s, since they only became effective from 2003 onwards. The relevant literature cites a whole range of factors that may have fostered this development (Card et al., 2013). The heavy job losses in eastern Germany after reunification put the collective bargaining system to test and contributed to a decline in union density and collective agreement coverage. Recent studies indicate that the reduction in the coverage of collective agreements between the mid-1990s and mid-2005 can explain a considerable part of the growing wage inequality (Antonczyk et al., 2010a; Antonczyk et al., 2010b). Other possible explanatory factors for the stronger wage disparity are growing international trade, outsourcing trends in some sectors of the economy (Autor and Dorn, 2013), the increasing immigration of workers with low skill levels, specific effects of technological progress on various skill groups, and an increased heterogeneity of firms.

The emergence of digitalization may also have an influence on the behaviour of the parties involved, as markets may be confronted with new requirements for flexibility. For workers digital technologies may offer additional options to arrange work and family life. In this respect, ICT-based mobile work seems to have a great potential and it is getting ever less important when and where people work. The availability of this opportunity depends, of course, on the particular job. In jobs dominated by manual tasks and where there is a need for face-to-face contacts, mobile work will not be feasible. However, in other jobs that do not require a permanent presence at the workplace, mobile work could be prevalent. Recent evidence for Germany shows that new types of "home office" occur more often in the case of white-collar workers than blue-collar workers (BAS, 2015). Therefore, more options to use mobile work provide the opportunity for workers to realize a level of working hours which meets their expectations. This is especially so among women working part-time with low hours who indicate that they would on average be interested to work longer hours (Wanger, 2015). However, the realization of more ICT-based mobile work depends not only on technological opportunities but also on a suitable reconcilement of interests of the parties involved.

The issue of working hours gets more attention from employers, too. The main reason is that the Internet and its various applications remove spatial and systematic barriers of work. Due to the obvious "blurring of boundaries" it will be more difficult to measure working hours and to regulate them. If workers are less present at the workplace this implies less control of input and it causes rather a greater focus on output-orientation, questioning the traditional concept of measuring working hours. This can create a conflict of interests between both sides of the market, particularly with respect to suitable distinctions between working time and leisure time. In addition, there are limits of mobile work because the advantages of direct interaction between human beings cannot be fully utilized. Valuable face-to-face

contacts can lose in importance and the building of trust within a team will probably be made more difficult. There is no indication up to now that ICT-based home office has rapidly increased in the recent past (BAS, 2015). However, other evidence suggests that the potential of "home office" is currently not fully utilized (Brenke, 2016).

For employers, digital technologies offer even more opportunities. This is mainly due to the assumption that the emergence of these new technologies tends to lower transaction costs of market coordination and enables firms to find proper counterparts more easily. In addition, the almost perfect connectivity increases the speed of interaction between potential contract partners. This has at least two implications. First, the opportunity costs of market coordination will be substantially reduced. This will increase the incentive for companies to out-source activities which can be performed more efficiently by external suppliers (subcontractors). The hiring of a subcontracting company offers an opportunity to partly circumvent collective bargaining and may contribute to rising wage inequality (Goldschmidt and Schmieder, 2015). The tendency towards more outsourcing may, in addition, generate additional solo entrepreneurs, and may push self-employment at the expense of dependent employment. Both, subcontracting to companies and individuals, may enable firms to concentrate even more on their core activities. Second, the emergence of digitalization may also reduce the opportunity costs of external flexibility and influence its attractiveness in relation to possible alternatives such as internal flexibility. Due to a substantial increase of relevant information, e.g. concerning the magnitude and quality of future orders as well as the degree of utilization, firms know much more about their current and future demand for labour. If they are able to adapt personal resources to variations in product demand as far as possible, they generate cost advantages. In the digital world, freelancers might become at least partly a functional equivalent for other types of external flexibility such as fixed-term contracts. Online platforms offering various services by workers to customers may also partly substitute intermediaries, particularly temporary work agencies, as long as workers do not necessarily have to be present at the workplace.

Most of the change regarding forms of employment probably refers to self-employment. This does not only – as already mentioned – concern its relative weight compared to dependent employment but also its formation. Results-only work environments may become more important and may fundamentally change the value chain. Particularly new forms of virtual work (crowd employment) can be seen as a forerunner in this respect. Crowd employment can be considered as a type of gainful employment that utilizes "smart" platforms in order to enable firms or single individuals to provide specific services or particular products (Green and Barnes, 2013; Saxton et al., 2013). Crowd workers are usually self-employed and their activities are based on individual tasks or projects rather than on a regular work arrangement. Activities of this kind are mostly carried out separately, implying a kind of global division of tasks. Crowd employment often occurs in the context of specific activities and it may also be used for more complex projects.

The use of crowdsourcing can have many advantages for firms (Linnhoff-Popien et al., 2015). The speed of finding potential contractors via intelligent platforms is comparatively high, it enables a selection of contractors in terms of quality, it contributes to lower fix costs of employment and it purifies organizational processes within companies. Crowdsourcing requires organizational changes within firms, though, because they rely on new types of networking. Nevertheless, it is still a quite new phenomenon. Up to now the spread of crowd employment seems to be marginal, and there are hardly any reliable data available. A recent survey carried out in Germany indicates that most of crowd

employment is not done by individuals as their sole source of income but mainly as a side job. In addition, the survey suggests that almost half of the interviewed crowd workers would – if available – prefer standard employment, whereas the other half prefer the autonomy which is associated with this type of employment (Leimeister et al., 2015). This autonomy of crowd workers can be characterized as follows: free to decide at any time when, where, and to what extent they want to work; new type of homework and a new way of organising work and family life. However, autonomy also implies the risk of fluctuations in demand. The future potential of this type of employment will very much depend on how this work will be regulated, e.g. with respect to product market regulations or minimum standards concerning remuneration and social security, and the extent to which it paves the way to a successful career and ensures a continuous employability.

5 Conclusions and policy implications

Previous research indicates that new technologies are always associated with complex labour market impacts, which are difficult to assess ex-ante and isolate from other relevant impulses ex-post. In general, impacts of technological change on the level of employment must not necessarily be negative. Additionally, with the emergence of digitalization massive job losses for the economy as a whole seems to be rather unrealistic. However, digitalization will most likely cause considerable shifts in the structure of the economy and employment. One can expect more digital products, a stronger digitalized production and a larger degree of digital knowledge. The shifts would take place in the composition of employment by industries, occupations, skill levels and tasks. The study explores whether the emergence of digital technologies would facilitate or aggravate coping with structural labour market problems. The analysis in the paper did not find substantial indications that in the future it will be much easier to tackle current issues such as skill shortages, persistence of unemployment or inequality in the forms of employment. Instead, potential risks may arise in a digital world, which can could lead to certain problems and would be difficult to tackle. However, due to lack of solid evidence in many respects, concrete policy conclusions or recommendations cannot be derived at this point of time.

The findings indicate, in general, that societies and their economies seem to be in need for a new and suitable “operating system” (Möller, 2015b). The question is how far the important components of the present institutional setting in Germany may or may not help in addressing challenges arising from digitalization. In this context, the institutions of particular interest are the strong role of vocational training, strong focus of social security on dependent employment, advanced labour market programmes, and the comprehensive social partnership between employer organizations and trade unions. More concretely, one can identify at least four main areas of concern which are associated with the mentioned institutions: skill adjustment and development, (labour market) regulations, labour market programmes, and social dialogue.

In order to tackle skill shortages and unemployment persistence at the same time, *skill adjustment and development* will be the major topic. Since new technologies will arise and will be used at the workplace, work-based training seems to be one of the ways to acquire relevant skills. In this context, apprenticeship systems, like in Germany, are a valuable asset and an appropriate starting point for large parts of the workforce. Recent research on technological change suggests that in the German case adaptations of vocational training would not be fully sufficient (Hanushek et al., 2016). This is because obvious gains of vocational training related to youth employment can under certain circumstances be

offset by less adaptability and diminished employment later in life. Therefore, fast growing digital technologies require an ever more concomitant investment in "life-long learning" process. In the case of Germany this would require combining up-to-date formal qualifications with a more flexible and coordinated acquisition of required competences (Weber, 2016). Concerning the contents of future qualification needs, the development of ICT skills on the one hand and of creative and social skills on the other hand will be crucial at the same time.

The policy implications of the emerging digitalization also concern the *regulatory framework*. Of great importance in this context is how far self-employed are insured against various risks. The German legislation already offers an option for self-employed to insure themselves against unemployment. However, due to increasing contributions in 2011 the number of insured self-employed recently decreased (Jahn and Springer, 2013). This increases the risk of self-employment who must get out of business to be immediately dependent on basic social income. The present focus of German social security on dependent employment is not only a problem for the unemployment insurance but also with regard to old-age insurance. Additional incentives or even obligations to enter the old-age insurance system need to be examined in the years to come.

Similarly, with regard to new forms of work, like crowd-work, standards for remunerations are another important issue. Instead of far-reaching and detailed regulations, platforms that enable to continuously assess clients would be one option to establish "fair" crowd employment. The other alternative or complementary issue – depending on regular market observations and the incidence of possible distortion – would be regulations similar to minimum wages or binding "collective" agreements between crowd workers and their clients which may define reasonable standards of payment (Cherry, 2015; BAS, 2016).

Labour market programmes meet the challenge of adjusting to new developments caused by increased dynamics and reallocation of jobs and labour. In this respect labour market policy will have to play a more preventive role than in the past by facilitating lifelong employability. Such policies would consist of a more continuous professional counselling (e.g. regarding options of further and new qualifications) as well as of fostering transitions from less stable forms of employment to more secure forms. The strong tendency towards self-employment induced by digitalization also needs to be addressed by different means such as professional infrastructure to support self-employed right from the beginning. An additional issue refers to the long-term skill development of self-employed, particularly regarding freelancers, who are the most vulnerable group in this respect (Kittur et al., 2013). Human resource practices within companies might be affected because the swift availability of outside labour may reduce incentives for firms to train their staff. More incentives for freelancers towards further on-the-job training might even increase their employability and their career path.

Finally, *social dialogue* is a well-established means to accompany ongoing technological changes as previous experience in Germany shows. Social partners have several opportunities to establish supporting measures, e.g. within their collective agreements. Possible areas of interest in this context are to establish a new culture of life-long learning, to initiate new ways of financing further training, to deal with conflicting interests regarding working time regulation and management, to take care of significant progress concerning the humanization of work (e.g. with respect to occupational health and safety) and to ensure an appropriate data protection for workers.

All in all, there are no hints that digitalization must be regarded as a major threat for the labour market as a whole. However, the extent to which the labour force will be able and willing to cope with these new and fascinating technologies is crucial. The discussion of policy implications has shown that significant challenges have to be addressed and, therefore, the achievement of the desired advantages of digitalization will not be a sure-fire success.

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