

EFFECTS OF DIGITALIZATION ON THE LABOR MARKET IN BADEN-WUERTTEMBERG

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Abstract

The technological change is constantly progressing. Digitalization opens up great opportunities for a higher quality of life. It enables more efficient business models and it also has a significant impact on the labor market. More and more tasks, which could be done only by humans so far, will be taken over by computers or robots in the future. It is controversial whether digitalization will lead to a higher unemployment or to a growth in employment because digitalization also creates new kind of jobs. While the impact on labor markets can not be clearly predicted, the fear of digitalization is huge. Many employees in Germany have jobs with a high potential of substitutability. The proportion of employees affected by severe effects of digitalization is estimated to range from 8.1% to 20.4% - depending on the federal-state. In Baden-Wuerttemberg, a very high substitution potential is assumed. Will unemployment significantly rise in the southwest part of Germany?

1. Introduction

With the use of computers and automation by robots since the 1970s and 1980s, Industry 3.0 began. Today, industrial development with the keyword "Industry 4.0" enters its fourth, fundamental transformation in which comprehensive digitalization of production processes and business models play a key role. The term stands for the interactive networking of analog production with the digital world. This transformation includes elements such as big data, autonomous systems, cloud computing, social media, mobile and self-learning systems. Production and logistics processes within companies and between companies can be interlinked intelligently in order to make production even more efficient and flexible. A largely self-organized production cycle becomes possible. The term "Industry 4.0" originates from a project of the high-tech strategy developed by the German government. The meaning of "Industry 4.0" as a revolution is often criticized in view of the fact that technological innovation is a more or less continuous process. However, digitalization not only affects the industry, but almost all sectors of the economy, including the service sector and the public sector. In healthcare for example, innovative digital telemedicine applications could provide new ways to increase the effectiveness and efficiency of service delivery, improve patient care and increase transparency of services and value-added processes. The digitalization of work processes is changing the economy profoundly. Many people perceive digitalization as a threat and not as an opportunity. In the media and in public debates, threat scenarios often attract more attention than scenarios outlining potentialities. The fear of an imminent wave of technologically induced unemployment is one of the dominant political and policy topics of our time. Many employees could be replaced by new and smarter machines and computers; tasks formerly carried out only by humans.

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With a view to the future development of the labor market, central questions are: How will digitalization affect employment? Will jobs be replaced and if so, who will be affected particularly? Formerly, the answer was clear: Jobs with low wages and especially jobs for low-skilled worker will be replaced. In the current discussion, the thesis is present that more and more activities in the mid-level of qualification, especially those with a high degree of routine, could be automated. In Germany, there is some evidence that the importance of routine skills with a medium qualification will decline.

It is controversial whether the progressive digitalization of the economy leads to a reduction in employment or to an employment growth. It is quite possible that digitalization is even leading to employment growth: the computer-controlled machines and devices must be developed and built. Qualified staff is needed to program the associated software. The machines and equipment need to be controlled and maintained. However, qualified employees who can handle the new technology will have to be trained. This in turn requires trainers as well as software specialists who develop tutorials or impart new technologies. The impact of digitalization on labor markets can't clearly be predicted.

2. Studies

Current studies intensely discuss the question of whether and to what extent unemployment is to be feared in consequence of digitalization. The debate about the impact on the labor market and employment evolves around two major perspectives: a pessimistic and an optimistic one. Optimists believe in significant employment growth. They do expect an increase of employment in total. Pessimists however believe that current technological developments will provoke massive job losses. Some studies and popular science articles have even fueled a debate about an "end of work". They focus on the automation potential of digitalization: Intelligent machines and algorithms would replace many employees in the middle and long term. But already the invention of the loom, the steam engine or robots in the 1970s have repeatedly led to similar predictions.

An authoritative input to the effects of robotics and artificial intelligence on the working environment came from Frey and Osborne of the University of Oxford in the year 2013. They examined the potential of digitalization/automatization in the USA. Based on an expert survey, they have estimated the automation potential for 702 occupations. They estimate that 47% of American workers do jobs which could be replaced by computers and algorithms over the next 10 to 20 years. [7] Based on a specific task approach, a job has a high risk of automation if it is composed of more than 70% routine activities. Frey and Osborne point out that low-skilled and low-paid employees are affected mostly by digitalization. In particular, industrial occupations like mechatronics (81%), toolmakers (84%) or assembly worker (97%) have a high probability of automation. On the contrary, jobs requiring creative intelligence (e. g. art, creative problem solving) and tasks requiring social intelligence (e.g. negotiate, convince) tend to have a low probability of automation. According to the authors, workers in the transport and logistics sector are also particularly at risk. In the medium term, self-driving cars or drones could take over a large part of the goods delivery or postal delivery. In the service sector, the fear of substantial rationalization effects is significant too.

This study, especially its prognosis, was criticized. The statement that 47% of the jobs in the USA are at risk of automation implies that everything that could be automated theoretically will be automated in practice. The results are based on a great extent on subjective assessments of robotic and digitalization experts. These experts tend to overestimate the potential impact and practical relevance of new technologies. Furthermore, technical automation potentials are not necessarily

implemented in a timely manner. Another major aspect is that the focus of the discussion is on the threat potential of existing employment relationships. The authors explicitly ignore the emergence of new fields and new jobs - and thus possible positive employment effects. In addition, in determining the technical potential, social, legal and ethical hurdles in the introduction of new technologies aren't taken into account. Consequently it could be argued, that the real automation potential is probably (much) lower. At the same time it needs to be positively noticed, that the authors vividly illustrate how automation technologies continue to advance into areas of activity previously reserved only for humans. In doing so, the authors address an under-researched topic whose significance is likely to increase in importance in the future due to rapid technological development. [1]

Other studies have transferred the findings to Germany. Based on a detailed breakdown of jobs in Germany, Brezki and Burk transferred Frey's and Osborne's results to the German labor market and calculated how many jobs in Germany are endangered. In this study, 30.9 million socially insured and marginally employed persons are considered. 18.3 million among them (59%) are threatened by progressive technologization/digitalization in Germany. (See table 1) [1]

	Employees subject to social security contributions and marginally employed	Endangered jobs due to digitalization	likelihood
Investigated occupations	30,870,000	18,300,000	59%
Office employees	3,500,000	3,000,000	86%
Elementary occupations	3,800,000	3,260,000	85%
Machine operators, assemblers	4,640,000	3,210,000	69%
Service and sales professions	4,570,000	3,120,000	68%
Craftsmen	4,100,000	2,580,000	63%
Academic professions	3,990,000	471,000	12%
Executive persons	1,380,000	157,000	11%

Table 1: Endangered jobs due to digitalization [1]

Administrative employees such as secretaries or clerks are subject to the highest risk (86%), followed by ancillary workers (85%). Mechanics, drivers and operators of machines are also particularly affected (69%). Looking at the individual occupations, the following jobs could be regarded as having a high potential of rationalization via digitalization: Office and secretarial staff (1.9 million), employees in postal and delivery auxiliaries and warehousing (1.5 million), salesmen (1.2 million), cleaning assistants (1.1 million) and catering service workers (661,570). The use of drones, automated processes in warehouses and transport could replace up to 1.5 million jobs. Altogether, the named professions alone make up 6.3 million jobs at risk. Digitalization will also affect particularly public administration, the manufacturing sector and machine controlling professions. Executives, as well as academics in scientific and creative professions are seen as having a minor likelihood of being replaced. [3]. Overall, there will be a shift towards IT activities in almost all professions.

Bonin et al. initially draw the conclusion that 42% of jobs in Germany are endangered - following Frey's and Osborne's approach. [1] But they change the approach to estimate the impact of digitalization on the labor market. They argue in a narrow sense, that only concrete activities will be automated not however entire jobs. For this purpose, the automation probabilities are transferred on the basis of the job structure at the workplace. Taking this method into account only 12% of employees in Germany and 9% of employees in the US are endangered by digitalization in the next 10 to 20 years.

The IAB (Institut für Arbeitsmarkt und Berufsforschung) estimates that in 2015 about 15%, approximately 4.5 million, of the employees (subject to social insurance contributions) in Germany have a job with a high potential of substitution. [5] These two studies (Bonin et al. and IAB) thus predict moderate rationalization effects.

It also must be taken into account that growth effects might be caused by digitalization. Technical progress can create new tasks and jobs. Several long-term forecasts on the development of the labor market have already been prepared on behalf of the BMAS (Bundesministerium für Arbeit und Soziales; Federal Ministry of Labor and Social Affairs). The study by Vogler-Ludwig / Düll / Kriechel on behalf of the Federal Ministry of Labor and Social Affairs comes up with a positive result. Its key finding is that in a baseline scenario, the workforce in 2030 will be at about the same level as in 2014, while the scenario of accelerated digitalization, due to productivity effects, may even have a significant positive impact on growth and employment. This would result in an additional loss of total 750,000 jobs in 27 sectors (e.g. retail, paper and printing, public administration), but also generate one million additional jobs in 13 other sectors (e.g. IT services, research and development). On balance, employment could rise by approximately a quarter of a million people by 2030. [13]

The long-term effects on the labor market were also estimated in the context of the BIBB-IAB qualification and occupational projections. According to this study, the expected net labor market effects are to be neglected. By the year 2025, a decline of only around 60,000 workers is expected. [14]

Further studies draw similar results. They do not predict significant employment losses but a significant change in labor structure. The „Sachverständigenrat zur Begutachtung der gesamtwirtschaftlichen Entwicklung“ in Germany draws the same conclusion. Although digitalization will change the world of work in the middle and long term, there are no negative macroeconomic effects to date. [10] All studies assume that machines/computer are likely to take over primarily more routine work.

Furthermore it is assumed that automation/digitalization will replace not only low-skilled activities but in particular medium-skilled activities with a high degree of routine work. This could lead to an employment polarization, a relative increase of low-skilled and high-skilled employment. The studies also indicate that activities requiring a high level of emotional and social skills, as well as those requiring a willingness to innovate and the ability to think analytically, will be the least affected by digitalization. Cognitive activities will only partially replaceable. These include, for example, managerial occupations, social, medical and health professions. Among the experts there is slightly potential for substitutable tasks too. On the other hand, digitalization affect particularly the public administration, the manufacturing sector and machine controlling professions. [6]

3. Regional impacts

The IAB, estimating a rationalization potential of 15 % (approximately 4.5 million jobs) in Germany due to digitalization (see chapter 2), has also examined its regional impact. Accordingly, the proportion of activities that could be done by computers and computer-controlled machines varies considerably between occupations. Therefore, the occupational and thus the economical structure largely determines the possible labor market effects of digitalization in each federal state.

The potential of substitution varies between 8.1% and 20.4% among federal states. The higher the importance of the manufacturing sector in a federal state, the higher the proportion of employees with a high potential of substitution tends to be and vice versa. This is in particular discernible in Berlin and Hamburg, where the proportion of employees in the manufacturing sector is only about 11% and 15% (see table 2). In these cities, many employees work in occupations of corporate management and organization or in business-related services, which have a significantly lower potential of substitution. In Berlin, there is an above-average number of employees working in the social and cultural sector - occupations with a low potential of substitution. In federal city-states, the service sector is generally much more pronounced. As a result, Berlin is least affected. It has the lowest share of employees in the manufacturing sector (11.5%) and so it has the lowest potential of substitution (8.1%). [4]

Significantly above average is the proportion of the manufacturing sector in Baden-Wuerttemberg and in Saarland. The share of the manufacturing sector (measured by the gross value added) is more than 30% respectively; in Saarland 31.3% and in Baden-Wuerttemberg 35.4% (see table 2). A hint: The manufacturing industry in Germany plays a much more important role than in other developed countries: Compared with other economies such as France (19.5 %), the United Kingdom (20.2 %) or the United States (20.7 %), the share of the German manufacturing sector is significantly higher in terms of gross domestic product (and also measured in gross value added). Baden-Wuerttemberg has the highest proportion of employees subject to social insurance contributions in the manufacturing sector in Germany. A particularly large number of employees are working in mechanical engineering and in the automotive industry. Therefore, the potential of substitution in Baden-Wuerttemberg is relatively high. In Baden-Wuerttemberg, this applies to around 753,400 employment relationships that corresponds to a potential substitution of around 17.4% of total employees. [4] However, the correlation between the proportion of the manufacturing sector (measured by gross value added) and the substitution potential is not perfect but the correlation coefficient is very high: 0.89.

Federal states	Unemployment rate (2017)	Proportion of manufacturing sector (measured by gross value added)	Potential of substitution
Baden-Wuerttemberg	3.5	35.4	17.4
Bavaria	3.2	29.3	15.4
Berlin	9.0	11.5	8.1
Brandenburg	7.0	20.3	12.1
Bremen	10.2	25.1	13.3
Hamburg	6.8	15.0	9.3
Hesse	5.0	20.3	13.1
Mecklenburg-Hither Pomerania	8.6	15.3	10.8
Lower Saxony	5.8	25.0	15.2
North Rhine-Westphalia	7.4	23.6	15.6
Rhineland-Palatinate	4.8	29.3	15.3
Saarland	6.7	31.3	20.4
Saxony	6.7	24.7	15.9
Saxony-Anhalt	8.4	25.7	14.6
Schleswig-Holstein	6.0	18.5	12.0
Thuringia	6.1	27.0	18.8
Germany	5.7	25.7	15.0

Table 2: Unemployment rates, proportion of manufacturing sector, potential of substitution

Within Baden-Wuerttemberg too, there are considerable regional differences. The differences at county level can be explained to a large extent - as well as the level of the federal-states - on the

basis of the varying importance of the manufacturing sector. In cities like Heidelberg and Freiburg, low levels can be explained by an above-average proportion of employees in the social and cultural service sector and in the medical health sector, for whom the potential of substitutability is particularly low. In rural areas like Tuttlingen, Rottweil and the Enzkreis, however, service occupations with low substitutability potential play a subordinate role, while manufacturing and manufacturing occupations with a high proportion of manual routine activities are considerably overrepresented. (see table 3) The correlation between substitution potential and number of persons working in the manufacturing sector is not perfect, but similar to the federal-states, also significant. In addition, some regional characteristics must be considered. [10]

	Potential of substitution
Baden-Wuerttemberg	17.1
Heidelberg	9.1
Stuttgart	9.6
Freiburg	9.7
Karlsruhe	10.1
Heilbronn	14.3
Ludwigsburg	15.1
Rottweil	28.6
Enzkreis	28.8
Tuttlingen	32.1

Table 3: Proportion of substitutional potential in selected districts in Baden-Württemberg [10]

4. Current labor market situation in Germany

The German economy continues its moderate upswing in 2017 and 2018. Important reasons of economic growth are the domestic consumption and the export, which support a positive development on the labor market. The number of employed persons is growing furthermore. In 2017, it has reached the highest level since reunification in 1991. (see table 4) [11]

Year	Working population (in 1,000)	Volume of work (millions hours)
1991	38,790	60,261
1995	37,958	57,999
1999	39,031	57,716
2005	39,326	55,500
2009	40,892	56,133
2013	42,328	57,657
2016	43,486	59,281

Table 4: Working population, volume of work [11]

The number of the working population increased from 38.8 million in the year 1991 to 43.5 million in 2016. This corresponds to an increase of more than 12%. However, the increase in the labor force did not go hand in hand with an increase in the volume of work. The annual number of hours worked by the employed fell from 60 billion in 1991 to 55.5 billion in 2005. That corresponds to a minus of almost 8%. One major reason for this reduction was the reunification. In the 1990s, it led to a significant job loss in Germany, especially in the eastern part, but since 2005, annual working hours increased, reaching an hourly volume of over 59 billion hours in 2016. Although digitalization has progressed for years, the "work did not go out" - on the contrary: more workers and a higher workload are recorded in Germany.

The rate of unemployment – in comparison to other European states - is very low in Germany, especially in Baden-Wuerttemberg (3.5%) and Bavaria (3.2%). In some regions of these federal-states, especially in the south, it is less than 2.5%. The overall job vacancy in the third quarter of 2017 was 1.1 million jobs in Germany. [9] The rising number of job vacancies in the last years indicates that it is becoming more and more difficult for companies to find suitable employees. Although it can not be said there is a widespread shortage of skilled workers, bottlenecks in some technical jobs, such as the information and communication sector, construction professions as well as some social, health and care professions are evident.

In Baden-Wuerttemberg, the bottleneck of skilled workers is more noticeable than in most other federal states. Here in addition to the nationwide bottlenecks as mentioned above, there are bottlenecks in numerous industrial and craft trades, but also in manufacturing. There is also a bottleneck in the vehicle, aerospace and logistic sector, in civil engineering and building construction. In the next years, the shortage of skilled workers will increase significantly due to the demographic change. (see chapter 5). Furthermore the labor market experts expects a significant growing labor demand in business-related services, in the building sector, information and communication sector, social services especially health care and elderly care, scientific and in the field of polymer processing and electrical engineering due to the moderate economic growth. [2] The shortage of skilled workers is getting bigger.

5. Demographic change and digitalization

Demographic change will aggravate this trend in the next years. The working-age population will be severely affected by shrinkage and aging despite the influx of many (young) migrants. The main reason for this is a very low birth rate. The fertility rate is only 1.4 - 1.5, making it one of the lowest in Europe. In recent years, significantly more people retired than young people moved up from the school system (or from universities) to the labor market. This demographic effect amounted to approximately 300,000 persons only in 2016 - tendency to rise.

This trend affects the number of working population, aged from 20 to 64 years. In 2013, 49.2 million people belonged to this age group. Their number will decrease significantly after 2020. The decline in potential labor force – if the baby-boomers (born in the 1960s) retire – will accelerate in the next decade. In 2030, the number will be approximately 44 - 45 million. In 2060, approximately 38 million people will be in the working age (- 23%) if the migration balance gradually falls from around 500,000 in 2014 to 200,000 by 2021 and then remains constant (Option 2 "Continuity of increased immigration"). If immigration decline to 100,000 people every year by 2021 and then remains constant (option 1 "Continuity of weaker immigration"), there will be an even more decreased potential labor force in 2060: 34 million or - 30% compared to 2013. [6]

Population in Germany	year	mio.
population overall	2013	80.8 mio.
20-64 years (age)	2013	49.2 mio.
Development with weaker immigration:		
Population overall	2060	67.6 mio.
20-64 (age)	2060	34.3 mio.
Development with stronger immigration:		
Population overall	2060	73.1 mio.
20-64 (age)	2060	37.9 mio.

Table 5: Demographic change [6]

Assumption:

Birth rate 1.5 children per woman, life expectancy at birth 2060 for boys 84.7 / girl 88.6 years, external migration balance decreases from 750 000 in 2016 to 200 000 in 2021, then constant (G1-L1-W2015)

Birth rate 1.4 children per woman, life expectancy at birth 2060 for boys 84.8 / girl 88.8 years, external migration balance decreases from 500 000 in 2014 to 200 000 in 2021, then constant (G1-L1-W2)

Accordingly, the demographic change has a dominant effect. The number of working people in Germany is falling faster than the total population. The bottleneck of skilled worker is getting bigger in coming years. The potential labor shortage will cover a wide range of jobs, specialists and occupations. The biggest bottlenecks occur in the service sector (especially health and care) also in research and development. Overall, there is a potential labor shortage of 3.9 million workers by 2040. For the service sector, there is predicted a potential gap of 2.8 million workers nationwide by 2040. With a potential staff shortage of around 1.5 million in 2040, most workers in the public and other service providers, education and health will be missing, thereof one million people in the health and social services. [2] From the year 2025 onwards, when the baby boomers are going to retire, the situation will be worsening in more and more occupations. Digitalization can therefore be an opportunity to counteract the bottleneck of skilled workers in Germany. But the lack of skilled workers will be significant in business-related services, social and health professions. In these sectors, productivity progress is relatively low and the potential for substitution due to digitalization is relatively low too, the shortage of skilled workers is unlikely to be remedied. Digitalization can solve this problem only partially. Due to the demographic change, the bottleneck of many jobs will get worse. This is especially true in the federal states, having already low unemployment rates, as in the case for example in Baden-Wuerttemberg.

6. Conclusion

In the discussion on the consequences of digitalization, fears of a massive loss of jobs conflict with the hope for innovation and employment gains. Most studies point up that the fear of a massive job loss in the course of further digitalization is currently unfounded, but there are also studies that predict significant rationalization potential in many occupations. Whether the effects of technological change on the production process and society will have a revolutionary character will eventually only be answered in retrospective.

Even if these studies have different approaches and time horizons, the studies indicate a certain order of magnitude. The potential of substitution about one-seventh to one-eighth of the workforce, is quite significant, though far away from the 47% of Frey/Osborne's original study and it does not mean the "end of work". In recent years, both the number of employed persons and the number of working hours have increased considerably in Germany, despite ongoing digitalization. However, the progressive digitalization can at least counteract partially the shortage of skilled workers caused - in particular - by demographic change.

The progressive digitalization of the work environment poses somewhat bigger challenges for Baden-Wuerttemberg than most other federal states: the share of employees subject to social security contributions who work in a profession with high substitutability potential is clearly above average, compared to other federal-states. The higher number can be explained largely by the specific economic structure in Baden-Wuerttemberg. The manufacturing sector and thus also the production occupations are of great importance here, but these occupations have at the same time a high potential of substitutability.

In Baden-Wuerttemberg unemployment is currently very low and will decline in the next years furthermore. The bottleneck of skilled worker that currently exists in some sectors will intensify - despite ongoing digitalization. Digitalization will only partly eliminate skills shortages, but rather exacerbate in some areas. New employment opportunities will arise in many sectors where bottlenecks exist, for example in the IT professions. In the social and health professions, where there is currently an acute bottleneck of skilled workers too, the substitution potential of digitalization is low. The author does not see “an end of work” (at least until the year 2030), especially in Baden-Wuerttemberg - on the contrary - in many professions there will be a wider shortage of skilled workers.

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