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Digitalisation, hiring and personnel policy: evidence from a representative business survey

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Abstract

In this paper we examine how employment and hiring processes develop in the course of digitalisation in German establishments. To this end we use a large representative business survey – the IAB Job Vacancy Survey – that was extended in 2015 to include special questions about the state of digital development in each establishment surveyed, thereby permitting a direct link between the topics of digitalisation and employment/hiring. We distinguish between different forms of digitalisation and enquire about both the development in the past and that expected for the future. Regression analyses show that digitalisation is already having noticeable effects on both the quantitative developments of hires, separations, vacancies and abandoned search processes and on the structure of labour demand in terms of qualifications, requirements and working conditions of new hires. The duration of the recruitment process, too, is influenced by digitalisation, though the wages agreed at the time of hiring are not.

Zusammenfassung

In unserem Papier untersuchen wir, wie sich Beschäftigung und Einstellungsprozesse im Zuge der Digitalisierung verändern. Dafür nutzen wir die IAB-Stellenerhebung, eine repräsentative Arbeitgeberbefragung, die im Jahr 2015 um Sonderfragen zum Stand der digitalen Entwicklung im jeweils befragten Betrieb erweitert wurde. Dies ermöglicht eine unmittelbare Verknüpfung zwischen den Themen Digitalisierung und Beschäftigung/Einstellungen. Wir unterscheiden zwischen drei Formen von Digitalisierung und erfassen sowohl die digitale Entwicklung in der Vergangenheit als auch die Erwartungen für die Zukunft. Die Regressionsanalysen zeigen, dass die Digitalisierung bereits spürbare Auswirkungen zeigt. Dies betrifft zum einen die quantitative Entwicklung von Einstellungen, Abgängen aus Beschäftigung, offenen Stellen und abgebrochenen Personalsuchprozessen. Zum anderen beobachten wir qualitative Veränderungen bei den Neueinstellungen, konkret bei den nachgefragten Bildungsabschlüssen, den besonderen erforderlichen Qualifikationen und besonderen Arbeitsbedingungen. Die Dauer der Rekrutierung wird ebenfalls durch den Stand der Digitalisierung beeinflusst, während sich die Löhne, die bei Neueinstellung vereinbart wurden, nicht verändern.

JEL-Klassifikation: J23, J63, M5, O3

Keywords: digitalisation, employment, hiring, personnel policy

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1 Motivation

Digitalisation, in other words the increasing use and networking of digital devices and the associated changes in products, services and processes, is a fundamental element of global technological change. A new wave of digitalisation is rapidly moving into all areas of business and life and is characterised above all by the interlinking of the virtual-digital and the physical world, and the use of machine-based learning, meanwhile no longer only in the manufacturing industry but in all sectors of the economy (Weber 2017).

This development can lead to significant changes both on the markets for goods and services and on the labour market. In labour market research, the employment effects of digitalisation in particular are a current topic of discussion. The focus is on estimating the automation potential in occupations or job tasks, which is assessed by some authors as relatively high (Acemoglu/Restrepo 2017, Frey/Osborne 2017), while other authors emphasise the importance of both labour-saving and job-creating effects and assume a balanced or positive employment effect over time (Gregory/Salomons/Zierahn 2016, Wolter/Bellmann/Arnold/Steffes 2016, Mokyr/Vickers/Ziebarth 2015). In connection with this the question arises as to whether digitalisation results in permanent changes in the qualification-related structure of labour demand. Wolter, M.I. et al. 2016, for instance, find that in the medium term the demand for complex jobs and thus for higher qualifications will increase, whereas the demand for skilled and unskilled workers will decline. What the available analyses have in common is that they are assumption-based forecasts, scenario calculations or estimates of potential, which explains why the estimated employment effects differ so strongly in some cases.

In our paper we are able to deliver a picture of the already visible changes in the course of digitalisation, including major quantitative and qualitative aspects regarding employment and hiring. In doing so, we do not contribute to estimating possible future effects of digitalisation, but show concrete, already observable outcomes. To this end, we use the results of a large representative business survey for Germany, the IAB Job Vacancy Survey. This survey observes on a regular basis the development of employment, especially labour demand, as well as the development of hiring processes (Davis/Röttger/Warning/Weber 2014, Kettner et al. 2011). On one occasion the survey was extended to include questions about digital development in the respective establishment/administration, which distinguished between three forms of digitalisation and between past and expected future development. In the context of digitalisation, we can therefore analyse data that are not available from any other source on the development of employment and hiring in firms, as well as on vacancies, recruitment problems and on cases in which the search for staff was abandoned. It is therefore possible, for example, to analyse what balance of hires and separations is associated with digitalisation and whether

there are shortages of suitable personnel. Besides providing comprehensive data, looking at Germany reveals the relationships in a large economy that is highly developed in terms of technology and - according to the Digital Skills Indicator calculated by the European Commission – possesses a good basis for the continuing digitalisation process (European Commission 2017).

In specific, our data on new hires have a considerable advantage: Whereas in the case of the existing workforce, employers are dependent on the willingness of employees to change and are not always able to implement changes with the scope and speed desired, in the case of new hires the employers can formulate the precise requirements and conditions that they consider to be in line with the new challenges and opportunities of digitalisation. The effects on employment, especially on the quality of employment, should be visible first in the new hires. We examine changes in the requirements expected of newly hired employees and that go beyond the typical requirements in the respective occupation. We look at both professional skills and various soft skills, as well as addressing special working conditions. From the employer viewpoint, exploiting the opportunities of (global) digital networking could be restricted among other things by fixed working hours; possible productivity gains could only be achieved to a limited extent. We therefore estimate effects of digitalisation on the temporal flexibility that is expected from the newly hired staff. Also we investigate whether newly hired staff in establishments with digitalisation are expected to be more flexible in terms of the content of their work. The data available from the survey concerning the duration of the recruitment process and the wage agreed at the time of recruitment also provide an insight into how digitalisation is changing hiring processes.

The paper is structured as follows: in section 2 we explain how we define digitalisation in a specific questionnaire as part of the IAB Job Vacancy Survey. In our approach we differentiate between three essential forms of digitalisation and combine the answers provided by the firms on digital development in the past and in the future to distinguish several types of firms for each form of digitalisation. The variables created in this way are used as explanatory variables in our estimations, in addition to a comprehensive set of control variables. Section 3 presents results on the quantitative effects of digitalisation on employment and on the search for new staff, including abandoned search processes. Section 4 discusses effects on the recruitment duration and on the wage agreed at the time of hiring, and section 5 presents changes regarding the qualification level of newly hired staff. Sections 3.4 and 3.5 focus on qualitative changes: first, we look at specific requirements expected of newly hired employees in terms of qualifications and soft skills. Second, we estimate effects on working conditions, focussing in particular on requirements regarding working-time flexibility. The paper finishes with a summary of the estimation results and a conclusion.

2 Data and research approach

Our statistical analyses are based on data from the IAB Job Vacancy Survey conducted in the fourth quarter of 2015. The IAB Job Vacancy Survey is a unique representative survey conducted regularly among employers in Germany. Its aim is to determine the current demand for labour and to observe staff-search and hiring processes in detail (Davis/Röttger/Warning/Weber 2014, Kettner et al. 2011). Every year some 12,000 establishments and administrations¹ of all sizes and from all sectors of the economy complete the written questionnaire in the fourth quarter of the year. The information they report on vacancies, employment and the development of search and hiring processes are extrapolated to all establishments and all new hires in Germany, thereby providing a unique, representative picture of the current labour market development in Germany (Brenzel et al. 2016).

In order to be able to examine employment and hiring in the context of digitalisation, in the fourth quarter 2015 the standard questions in the survey were supplemented by two separate questions on the level of digitalisation in each establishment surveyed. One challenge in this respect was operationalising the term ‘digitalisation’ adequately since there is no clear, generally recognised definition of it. As the IAB Job Vacancy Survey is conducted in written form, the operationalisation had to be done in such a way that the responsible human resources staff or – in smaller establishments – the managing directors would understand the questions easily and would be able to answer them for their own individual establishment. The questions had to be short and precise because space is limited in a written questionnaire.

To operationalise the term ‘digitalisation’, the three forms of digitalisation that we consider to be the most important were briefly described in the questionnaire, thereby differentiating them from one another:

- digital networking in the internal production or service chain (“internal digitalisation”)
- digital networking with suppliers or customers (“external digitalisation”) and
- the use of learning systems, also in human-machine interaction.

The surveyed establishments were asked to report whether they saw a strong trend, a slight trend or no change with regard to each of these three forms of digitalisation or whether they considered the respective form of digitalisation not to be relevant for their establishment. In order to be able to take previous experience into account and to better differentiate the establishments with regard to their activities over time, they were asked

¹ In the following the term ‘establishments’ includes establishments and (public) administrations.

to answer separately for the last five years and the coming five years (see questions in the appendix in figure A).

The responses from about 12,000 establishments and administrations show that all three digitalisation forms are of importance in Germany's economy, although there are differences in terms of how well advanced the developments are. With regard to internal and external digitalisation, the vast majority of the establishments reported a slight or strong trend, in both the past and the future. For instance, the extrapolation shows that 35 percent of all establishments saw a strong trend regarding internal digitalisation in the previous five years and 39 percent expected a strong trend in the future, too (see table 1). In contrast, learning systems were used by only a minority of the establishments – though it was by no means an insignificant minority – and this form of digitalisation is on the increase especially when comparing the past and the future.²

Table 1

Share of establishments with the respective form of digitalisation as a percentage of all establishments, in the past five years (past) and the coming five years (future), extrapolated shares as percentages

	Internal digitalisation		External digitalisation		Use of learning systems	
	Past	Future	Past	Future	Past	Future
strong trend	35.3	38.8	34.1	41.4	9.3	16.0
slight trend	20.9	21.6	26.1	25.6	14.1	17.2
no change	12.2	10.6	12.4	9.2	18.8	15.3
no relevance	31.6	29.0	27.4	23.8	57.8	51.6
total	100.0	100.0	100.0	100.0	100.0	100.0

Source: IAB Job Vacancy Survey IV.2015, own calculations

Our results on the state of the establishments' digital developments are in line with the results of other business surveys, in which digitalisation was defined on the basis of an extensive catalogue of variables (Arntz et al 2016), using data from the IAB/ZEW business survey "Working World 4.0". In our questions the differentiation using the three forms of digitalisation is rather rough – as a result of it being embedded in an existing written survey. However, this has the advantage that the phenomenon of digitalisation is described in such a way that establishments can easily classify themselves with regard to their own developments. At the same time this provides the unique opportunity to link

² The change in the response behaviour with regard to the last and the coming five years was found to be statistically significant at the 1% level in each of the three digitalisation forms and for all the response options.

the answers on digitalisation directly with data from the other parts of a large quality-assured survey, in this case with data on employment and hiring.

For decisions regarding employment and hiring it is likely to be of importance whether an establishment that expects a strong development towards internal digitalisation in the future, for example, has already gained experience of this form of digitalisation in the past or whether this topic is new on its agenda. In the next step we therefore combined the answers given on the individual establishments' past and expected future development for each form of digitalisation and the three digitalisation variables that we were to use in our estimations. We defined five categories for each digitalisation variable, relating past and expected future development to each other, see table 2. These types reflect the possible ways that an establishment can develop with regard to each digitalisation form over time.

Table 2
Combined digitalisation types, for internal digitalisation, external digitalisation and the use of learning systems respectively

no digitalisation	not relevant in the past or the future
starting digitalisation	not relevant in the past, but slight or strong trend in the future
slight further digitalisation	trend in the past and slight trend in the future
strong further digitalisation	trend in the past and strong trend in the future
digitalisation no longer relevant	trend in the past but not relevant in the future

According to the information provided by the establishments and then extrapolated, 37 percent of the establishments were undergoing a strong further internal digitalisation process, i.e. were continuing a strong trend of networking in their internal production or service chain. They had already started the process in the past and were planning to continue it with a strong trend in the future (see table 3). A further 15 percent of all establishments reported slight further internal digitalisation; 8 percent were planning to begin internal digitalisation and in a good third of all the establishments there was no development.

Table 3

Share of establishments in the respective digitalisation type with the respective form of digitalisation as a percentage of all establishments, extrapolated values

	Internal digitalisation	External digitalisation	Use of learning systems
no digitalisation	34.9	29.2	63.8
starting digitalisation	7.6	9.5	11.0
slight further digitalisation	15.5	17.5	8.0
strong further digitalisation	37.2	39.8	14.2
digitalisation no longer relevant	4.8	4.0	3.0
total	100.0	100.0	100.0

Source: IAB Job Vacancy Survey IV.2015, own calculations

In the case of external digitalisation, the extrapolated share of establishments with a strong further development stood at 40 percent and the share of establishments with no digital networking was just under a third. A strong further digitalisation in terms of the use of learning systems was of importance in only a comparatively small number of establishments (14 %), whereas almost two thirds of all establishments reported no development in this area for either the past or the future³.

To examine what statistically measurable effects digitalisation is having on the development of employment in firms and on employers' hiring behaviour, we apply several estimations and use the three forms of digitalisation as explanatory variables with the combined digitalisation types as categories. In addition we use a comprehensive set of control variables to describe the nature of the establishment and of the job vacancy that was filled, in order to isolate the digitalisation effect that is of interest here.

In the following we first present quantitative results on the development of employment in firms, in other words effects on hires, separations, vacancies and abandoned searches. We then examine what (qualitative) effects digitalisation is having on new hires. This seems to us to be particularly worthwhile, as with new hires the employers are able – within the scope of the valid framework agreements or collectively agreed regulations – to define those requirements and conditions that they consider necessary to make full use of the potential of digitalisation for the success of their business. In the

³ Only few establishments (under five percent in each form of digitalisation) reported activities of digitalisation for the past but did not consider the topic to be relevant for the future. The results for these establishments are not included in the estimation results presented below.

case of existing employment relationships, on the other hand, the employers are dependent on the cooperation and adaptability of their staff and in some cases also on the employee representatives' consent, which can hamper or delay processes of change. Furthermore, current adjustments to job tasks or working conditions are very difficult to observe from outside via research⁴.

Especially the new hires should therefore reveal whether digitalisation – depending on its form and type – influences the hiring process and whether it leads to higher wages. Every year the IAB Job Vacancy Survey provides a representative picture of the structure of all new hires in employment covered by social security in German establishments and public administrations. Extensive information is available about the vacancy filled, the person recruited and the hiring process, which we link with the digitalisation variables created. We examine changes in the wage level at the time of recruitment and in the duration of the hiring process. Regarding qualitative effects, we look specifically at the formal qualification level and special skills and qualifications that the newly hired employees are expected to have. We also take a look at the working conditions in the job for which the person was hired.

3 Results

3.1 Employment and hiring in the course of digitalisation

The impact of digitalisation on employment stems above all from the effects on new hires and separations (outflows). Table A1 in the appendix shows the coefficients from linear regressions used to examine the influence of digitalisation on hiring and separation rates at establishment level for the year 2015, as well as the effect on the share of vacancies in the establishment. Furthermore, the IAB Job Vacancy Survey makes it possible to analyse the ratio of abandoned attempts to fill vacancies (abandoned search processes as a proportion of all successful and abandoned attempts to fill vacancies).

All in all the results do not indicate that workforce reductions are occurring due to digitalisation: there are no significantly negative effects on the number of new hires, and the number of outflows is significantly higher in only one case, and that is the case of the strong further use of learning systems. Here 3.18 more outflows per 100 employees are found than in the establishments not using learning systems. At the same time, however, there are significantly more new hires with this form of digitalisation (4.39 more new hires

⁴ For this it would be necessary to have differentiated longitudinal surveys that make it possible to categorise firms in the process of digitalisation and ask the employees about their jobs and working conditions in a differentiated manner over time.

per 100 employees), in other words a higher level of staff turnover on the whole. This trend can also be ascertained in the case of external digitalisation.

Our finding is in line with those obtained in the scenario simulation conducted by Wolter, M.I. et al. (2016), who find no decline in employment as a result of digitalisation but do find an increase in employment dynamics. Instead, the analysis shows that additional employment potential would arise if firms managed to reduce the number of abandoned attempts to find suitable candidates for vacancies and to fill more vacancies. The share of vacancies in the establishments with internal digitalisation is considerably – 1.5 to 1.8 percent – higher than in those without internal digitalisation. Establishments with internal digitalisation also abandon attempts to fill vacancies significantly more frequently (1.4 to 2.8 percent more often) because they were unable to find suitable candidates. On the whole, no noticeable effect therefore emerges for new hires. If it were possible to fill these vacancies, there would be further employment potential due to internal digitalisation, which is of relevance for many establishments in Germany.

This interpretation is underpinned by the results of a logistic regression that examines the occurrence of economic constraints caused by not having enough suitable staff in the last 12 months. The underlying question is whether establishments with a digitalisation trend are affected more strongly by labour shortages than other establishments, which could indicate inadequate adjustment of the labour supply to new demand profiles. Table A2 shows that the establishments with starting, slight further and strong further internal digitalisation reported significantly more often (2.7 to 5.0 percent more often) that they were affected by labour shortages than was the case in establishments without internal digitalisation.

Internal changes in the course of digitalisation, i.e. in adjustments to the production of goods or the provision of services and the associated technological and organisational reorientation, lead proportionately to more vacancies, more abandoned searches for new staff and more frequent labour shortages. Higher labour demand is therefore harder to meet in establishments with internal digitalisation, though there are no unequivocally interpretable differences between the establishments that are only just starting internal digitalisation and those that already have experience with it.

In principle, the result could also be partly driven by a reverse effect, i.e. establishments with hiring problems could intensify digitalisation. However, this would imply digitalisation being accompanied by a reduction in employment, which cannot be observed. By the same token, one could presume that successful firms self-select into digitalisation, and that the digitalisation-employment link is biased by the fact that successful firms usually tend to grow. In this regard, we use a comprehensive set of variables to control for firm

characteristics. If this mechanism were nonetheless important in quantitative terms, firms without digitalisation trends (i.e. the unsuccessful ones) should suffer employment losses. Again, this cannot be confirmed. Furthermore, we find no clear wage effects below, which would be implausible if the results were driven by selection.

Even if the total number of employees does not decrease as a result of digitalisation, workforces undergo restructuring processes due to changes in jobs and tasks. It is therefore worth taking a look at the new hires in order to investigate recent changes in the context of digitalisation.

3.2 Recruitment duration and starting wage

The data on new hires make it possible to divide the entire hiring process into several phases, from the start of the search for new staff, through the decision in favour of one particular candidate, to the time when the newly hired person takes up work (Davis/Röttger/Warning/Weber 2014). In order to examine whether digitalisation has an impact on hiring processes, we analyse effects on the duration of recruitment, measured as the period of time between the start of the search and the decision in favour of an applicant and his or her acceptance of the job offer. This time span expresses the duration of searching and screening from the employer's perspective. In 2015 the weighted average of this span across all establishments was 55 days.

We apply a parametric survival model analysis with a Weibull specification. The recruitment duration in days is the dependent variable, while the three digitalisation forms as well as firm-specific and job-specific characteristics are the explanatory variables.

The results in table A3 show that significant effects are only found in the case of new hires in the establishments with strong further internal digitalisation and in those with strong further use of learning systems. The hazard ratios of 0.90 and 0.91 prove that for both digitalisation forms the ratio of successful recruitments is just under 10 percent lower than is the case for new hires in establishments without the respective form of digitalisation; the search for staff therefore tends to last longer. Numerous other variables were controlled for, with their coefficients exhibiting the expected magnitude and sign.

Evidently the recruitment duration only increases noticeably when the establishments already have experience of internal digitalisation or the use of learning systems and plan strong further developments. No significant hazard ratios are found for new hires in establishments that are only just starting digitalisation or report that they are only planning slight further development.

It cannot be deduced from this result alone that strong further internal digitalisation and the strong further use of learning systems lead to increased difficulties in filling

vacancies. It is possible that the recruitment processes last longer because establishments with these two forms of digitalisation look for new staff in different ways and, for example, the applicants have to take part in more demanding and longer-lasting selection processes. In the next step we examined possible effects on wages, as increasing relative labour supply shortages are likely to be reflected in wage increases (albeit with a delay in some cases).

A linear regression using the level of the gross hourly wage agreed at the time of hiring as the dependent variable yielded no noteworthy effects of digitalisation (see table A4). Only in establishments with slight further development in the use of learning systems do we measure a significant small increase by 46 cents per hour, compared to the new hires in establishments not using learning systems.

Both the results regarding the recruitment duration and those regarding the starting wage are in line with our rather neutral findings on the development of employment presented above. However, as shown there, abandoned searches for staff and difficulties in finding suitable staff are considerably more common in establishments with internal digitalisation. This could also explain the weaker effects on the recruitment duration because no recruitment duration is measured at all if the search is abandoned. At any rate, no reaction can be observed in the wage level agreed at the time of hiring.

3.3 Qualification requirements of hires

Scenario calculations by Wolter, M.I. et al. (2016) for Germany infer that the qualifications demanded by employers will change during the course of digitalisation. Consequently the demand for complex and highly complex activities will increase in the medium term, whereas the demand for both skilled and unskilled work will decrease. We examine what effects can already be observed in the new hires, using the information about the qualification level required at the time of recruitment as the dependent variable. This has five possible attributes: unskilled, vocational training, technician/master craftsman, bachelor, master/PhD.

Table A5 shows the average marginal effects of a multinomial logistic regression. They reveal first that there tends to be a decline in the demand for people without formal qualification in connection with digitalisation. A statistically significant result can only be observed in the establishments with a strong further use of learning systems. Presumably low-skilled workers are being substituted here by technology or by more qualified employees, probably because the production or the service provision has already been digitalised to a degree that increasingly demands staff with formal qualifications even for comparatively simple activities. Notwithstanding, negative coefficients – even if less precisely measured – are also found in several further cases.

The probability of people with vocational training being hired is reduced significantly by digitalisation when establishments are in the process of slight or strong further internal digitalisation, compared to those without internal digitalisation. Further negative, less precise, estimates appear for the use of learning systems. Positive demand effects are found with regard to the hiring of master craftsmen and technicians when establishments already have experience of external digitalisation or with the use of learning systems and plan to make strong further progress with this in the future.

Effects in the opposite direction are found for the probability of hiring people with a bachelor's degree. Establishments with slight further and strong further internal digitalisation have positive coefficients, while establishments with external digitalisation of any type exhibit negative coefficients. A lower demand for employees with a bachelor's degree may be explained by the fact that in this degree the educational system is concentrating more strongly on the transfer of pre-structured, content-based knowledge, which has been a result of the Bologna Process in the German higher education system (Winter 2015). This is not always what is desired when a firm is looking for creativity and the ability to try out new concepts and processes in the context of digitalisation.

In contrast, in establishments with slight further and strong further internal digitalisation and in establishments that are starting external digitalisation we measure significantly positive effects on the likelihood of graduates with a master's degree or a higher qualification being recruited. The probability is two to four percentage points higher than in the respective reference groups.

To sum up, negative effects – measured in terms of the formal qualification level required at the time of recruitment – tend to emerge in the case of jobs for low-skilled workers and for applicants who have completed vocational training. Positive effects tend to be found for master craftsmen/technicians and graduates with at least a master's degree. In the case of demand for bachelor's degrees the effects vary. While the broad picture is in line with the scenario calculations mentioned above, our results make it clear that it is very important to differentiate between several forms of digitalisation and to take into account the stage of digitalisation an establishment has reached. All in all the significant average marginal effects are somewhat larger in the establishments with strong further development than in those just starting digitalisation or with slight further development. This suggests that the effects intensify over time – as digitalisation progresses, the establishments gain experience in this subject and adapt their staffing policy on it.

In the next step we examine effects on the specific requirements asked of employees at the time of hiring.

3.4 Changes in the requirements expected of the employees

In the IAB Job Vacancy Survey several variables are available that can be used to gather information about special requirements that go beyond what is usual for new hires in the respective position. In this way it is taken into account that, for example, weekend work is a matter of course in some occupations and jobs, whereas elsewhere it is regarded as a special requirement. The requirement variables are coded as 0-1 variables. They take the value 1 when the requirement is frequently, and the value 0 when the requirement is never or only rarely called for. We again use logistic regressions with further variables depicting the structure of the establishment and the vacancy.

What stands out in the results shown in table A6 is that above all knowledge and skills acquired in training courses, in other words in further training measures, as well as social and communication skills and team competence are required more frequently by those establishments that regard digitalisation as important. In the case of new hires in establishments with slight further and strong further internal digitalisation and in those with slight further and strong further use of learning systems, the likelihood of knowledge and skills gained in further training measures being required is 2.5 to 4 percentage points higher than for new hires in establishments without the respective form of digitalisation.

Especially large marginal effects are found for social and communication skills and team competence. They are relevant in all three forms of digitalisation for individual types of establishments. New hires in establishments that are just starting external digitalisation exhibit the largest effect with 7.3 percentage points. The findings underline the great importance of good communication both within the establishments and with external partners and customers. In today's working life, in which other members of the same team are more likely than in the past to work at different times of the day or in different places, more employees have to plan their work processes independently on the one hand, and coordinate them with the other team members on the other hand. The digital integration of different processes in the establishment increasingly requires communication and coordination also across different functions and hierarchy levels (Weber 2017).

Longer experience in the respective occupational field is of importance in only one type of establishment – those with further strong external digitalisation. Establishments thus do not rely more strongly on tried and trusted methods when implementing this global and comparatively new trend, but break new ground. For this they need employees with up to date digital and non-digital skills. Results concerning leadership qualities are rather weak. This can probably be put down to the fact that, under the conditions of digitally integrated processes, some of the competences that are traditionally attributed to leadership are more likely to be seen in the area of “social competence, communication and the ability to work in a team”.

It is plausible that intercultural competence is required less in the case of internal digitalisation but above all in the case of external digitalisation, in other words when it is a matter of exchanging information with different customers and suppliers using digital technologies, often on a global scale. Special foreign language skills are not required significantly more frequently by establishments with digitalisation.

At first sight the estimated effects appear to be smaller than one would expect when following the intensive discussion surrounding the changes in the working world associated with digitalisation. It must be taken into account that we measure the effects on the newly filled vacancies in a single year. A growing number of employment relationships that are affected by these changes would cumulate if new hires over a period of several years are observed. This applies both for the effects on qualification levels and for the special requirements and working conditions stipulated by the employers when hiring new employees.

3.5 Changes in working conditions

A demand that is often made by employers' associations in debates surrounding the future of work is a loosening of the valid regulations on working time with regard to maximum daily working hours and rest periods between consecutive working days. This should enable firms to make better use of the technological and organisational opportunities provided by global digitalisation and to adapt the work input flexibly. So far, the valid working time legislation in Germany has remained unchanged. However, employers are likely to attempt to put their flexibility ideas into practice within the valid legal framework. Once again, this should be observable first in the new hires.

The IAB Job Vacancy Survey includes several variables that can be used to gather information about working conditions for new hires. They are coded as 0-1 variables and take the value 1 when the condition is frequently stipulated, and the value 0 when it is never or only rarely stipulated.

Temporal flexibility in work input is expressed in the following variables: frequent time pressure, frequent overtime and frequent changes in working time at short notice. The marginal effects of the individual logistic regressions indicate that the employers' demands develop differently in this respect depending on the form and type of digitalisation, see table A7. In establishments with internal digitalisation, for instance, only frequent overtime is significant, whereas both newly beginning and strong further external digitalisation are characterised by frequent time pressure and frequent changes in working time at short notice. New hires in establishments with strong further external digitalisation have a seven percentage-points higher likelihood of experiencing frequent pressure of

time compared to new hires in establishments without external digitalisation. In establishments that are beginning to use learning systems the probability of newly filled positions being associated with frequent time pressure is four percentage points higher.

Frequent weekend work is only relevant in the case of starting internal digitalisation. However, it can be plausibly assumed that establishments in the survey only report regular weekend work and do not take into account for example employees replying to emails at home. Frequent changes in the place of work are not related to digitalisation, which was also to be expected. In many fields of work, digitalisation makes it possible to work from any location, with the result that the need for business trips is more likely to decrease rather than increase.

What is most striking are the strong and significant effects regarding frequently changing work content, both for internal and external digitalisation. The probability of the new employee being hired for a position that is characterised by frequently changing work content is between 2.5 and 6 percentage points higher, depending on the type of digitalisation, than it is in establishments without internal or external digitalisation.

All in all the regressions reveal a trend towards increasing demands concerning various forms of temporal flexibility and the willingness to deal with changing work contents. According to representative employee surveys commissioned by the German Trade Union Confederation (Deutscher Gewerkschaftsbund), only some of the employees see these digitalisation-related changes in a positive light: almost half of all employees (46 percent) associate digitalisation with an increasing workload, only nine percent observe a workload reduction (Institut DGB-Index Gute Arbeit 2016, Institut DGB-Index Gute Arbeit 2017). In particular employees who work to a considerable extent with digital media report an increase in their work intensity, feel rushed and are increasingly under time pressure. Furthermore, in the context of digitalisation, employees complain about frequent disruptions and interruptions in their work and about constantly having to be reachable for issues concerning their employer.

Health insurance providers in turn report a growing number of illnesses that are linked to increasing workloads, time pressure and deadlines, as well as to changing working time, and warn of the negative effects of digitalisation on health (Marschall/Hildebrandt/Sydow/Nolting 2017). They point out that the increase in stress-related illnesses is not only associated with a loss of working hours and a burden on health insurance and social security funds, but that employers also have to assume considerable reductions in performance in those who continue to work although they are sick.

As the scientific literature has shown, an increase in working-time flexibility has both advantages and disadvantages for the workforce (Dettmers/Kaiser/Fietze 2013,

Zijlstra/Sonnentag 2006). Some employees can use more flexible working time to improve their work-life balance. Others are faced by the challenge of reconciling new working-time conditions with other areas of their lives. This can be difficult to manage and may involve work-family-conflicts and extra costs (Allen/Herst/Bruck/Sutton 2000, Ford/Heinen/Langkamer 2007). In establishments that use working-time accounts it is mainly the employer who decides when “credits” may be accumulated in the accounts and stipulates the time frame during which the employees may use up the excess hours they have accumulated (Groß/Seifert 2017, Zapf/Weber 2017).

An increase in employees’ time- or content-related flexibility is likely to be accompanied by positive productivity effects. Our analyses do not indicate any wage rises and there has not yet been a reduction in weekly working hours in Germany, either. In the course of advancing digitalisation, conflicts of interest between employers and employees with regard to working hours and flexibility are likely to multiply. Solving this problem and developing company health management systems to maintain employees’ performance despite increasing workloads are factors that will determine whether or not digitalisation will be successful in the long term.

4 Summary

In this paper we examine the labour market effects of digitalisation that are already emerging in German establishments and administrations on the basis of a representative business survey. For this, we added special questions about digital development to the IAB Job Vacancy Survey conducted in the fourth quarter of 2015, which enabled us to link the topics of digitalisation and employment/hiring directly. In the survey we split the concept of digitalisation into three essential forms: internal digitalisation (digital networking in the internal production or service chain), external digitalisation (digital networking with suppliers or customers) and the use of learning systems, also in human-machine interactions. Furthermore, we asked each establishment in the survey questions about its digital development in the past (for the past five years) and the future (expectations for the coming five years). By combining the answers for the past and the future for each form of digitalisation we obtained three digitalisation variables with five categories depicting the establishment’s stage of digital development. In various estimates, these three variables serve to examine the effects of digitalisation on personnel policy, in other words on the development of employment, new hires and hiring processes, job requirements and working conditions. Table A8 summarises the results with regard to our digitalisation variables.

Our analyses regarding the quantitative effects of digitalisation reveal significantly positive effects on hiring rates in those establishments that have already gained experience of external digitalisation or the use of learning systems in the past and intend to continue

developing these forms of digitalisation considerably. In establishments with internal digitalisation, no effects are found on new hires, but unused employment potential is visible. Here, both the share of vacancies and the share of staff-search processes that were abandoned without success are significantly higher than in the establishments without internal digitalisation. The likelihood of labour shortages occurring is also significantly higher in establishments with internal digitalisation than in those without. Stronger employment dynamics, in the sense of labour outflows and inflows, are found in establishments continuing a strong use of learning systems, and a trend in the same direction is found for external digitalisation.

The decline in demand for unskilled labour that is expected in some of the literature is found in establishments with a strong further use of learning systems, which account for only a small proportion of all establishments and new hires overall, and also in establishments with internal digitalisation, though there the effect is statistically insignificant. With regard to demand for employees with vocational training, we observe negative effects in the establishments with internal digitalisation; however, on the other hand these establishments exhibit a significantly higher likelihood of hiring university graduates. These two effects are also found in establishments using learning systems, though they are measured less precisely.

The internal digitalisation of the production and service chain is therefore associated with a shift towards higher qualification requirements. This is of particular importance in that internal digitalisation is likely to take place at the start of the digitalisation process in most firms, while external digitalisation and the use of learning systems are likely to occur at a later point in time. On the whole, the polarisation hypothesis that is often discussed in the context of changes in the qualification-related demand for labour (Autor 2015, Goos/Manning/Salomons 2014) cannot be confirmed for the German labour market in connection with digitalisation.

A significantly longer recruitment duration is only found when establishments are undergoing a strong further internal digitalisation process or are continuing a strong further use of learning systems, in other words in those establishments that have made the most progress in these two forms of digitalisation. No notable wage effects – with regard to the wages agreed at the time of hiring – are found for any of the three digitalisation forms.

The analyses of the qualitative changes in employment – measured in terms of special requirements and working conditions for new hires – point to the growing importance of further training measures undertaken by employees in order to keep their required digital and non-digital skills up-to-date, in cases of both internal digitalisation and the use of learning systems. In establishments with these two forms of digitalisation it is becoming

more important for employees to possess social skills and communication skills and to be able to work in a team, reflecting changes in management structures and work organisation in the course of digitalisation.

Structural changes are also visible in the working conditions stipulated by the employers at the time of hiring. For instance, the probability of the employee having to deal with frequently changing work contents increases significantly in cases of internal and external digitalisation. Furthermore, the regressions show a trend towards increasing demands regarding temporal flexibility, albeit in different forms and intensities.

This study has harnessed the potential of an extensive business survey on staffing requirements and personnel policy in order to analyse digitalisation processes. A further important step would be to obtain more information regarding the changes in individual occupations. Most of the analyses conducted so far on employment effects at the level of individual occupations focus on the automation potential as a result of the increasing use of digital technology and estimate quantitative effects on labour demand. However, the qualitative changes in the occupations and the employment relationships are very relevant too. These changes could be examined in a subsequent step on the basis of another special survey that has been conducted within the framework of the IAB Job Vacancy Survey.

5 Annex

Figure A

Questions on the stage of digitalisation in the establishment

38. If you look circa five years – about the year 2010 – back,
what developments do you hold true for your establishment/your administration?

	strong trend	small trend	no change	for us not relevant
digital interconnection of the internal production- or service-chain	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
digital interconnection with suppliers or customers	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
use of learning systems (counts also for human-machine-interactions)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

39. If you look circa five years – about the year 2020 – into the future,
what developments do you expect for your establishment/ your administration?

	strong trend	small trend	no change	for us not relevant
digital interconnection of the internal production- or service-chain	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
digital interconnection with suppliers or customers	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
use of learning systems (counts also for human-machine-interactions)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Source: IAB-Job Vacancy Survey in the fourth quarter 2015, own translation of special questions on digitalisation

Table A1
Digitalisation and employment - results of linear regressions

	Hirings per 100 employees 2015		Separations per 100 employees 2015		Job vacancies per 100 employees IV/2015		Proportion of abandoned search processes 2015 #	
	Coeff.	SE	Coeff.	SE	Coeff.	SE	Coeff.	SE
Internal digitalisation (ref. no digitalisation)								
Starting	-1.4600	(2.3699)	-0.9741	(1.9032)	1.7704 ***	(0.5718)	2.7994 ***	(0.9667)
slight further	0.4420	(1.9730)	0.7774	(1.5848)	1.7417 ***	(0.4780)	1.3568 *	(0.8065)
strong further	-1.3117	(1.9046)	-1.1778	(1.5300)	1.5397 ***	(0.4610)	2.2675 ***	(0.7781)
External digitalisation (ref. no digitalisation)								
Starting	1.4504	(2.3060)	1.7669	(1.8493)	-0.1492	(0.5551)	-0.0492	(0.9416)
slight further	1.5459	(1.9966)	0.9586	(1.6027)	-1.4354 ***	(0.4832)	-0.4033	(0.8164)
strong further	3.2072	(1.9899)	1.1950	(1.5975)	0.1405	(0.4811)	0.5389	(0.8123)
Use of learning systems (ref. no use)								
starting	2.4264	(1.6974)	0.8728	(1.3660)	-0.2018	(0.4106)	-0.5905	(0.6933)
slight further	-0.8549	(1.8111)	-0.3670	(1.4502)	0.5056	(0.4341)	-1.7173 **	(0.7395)
strong further	4.3924 ***	(1.6946)	3.1804 **	(1.3586)	-0.3363	(0.4085)	-0.7545	(0.6918)
Economic sector (ref. Information and communication)								
Agriculture, forestry and fishing	-2.9281	(3.8122)	0.7643	(3.0667)	-2.9154 ***	(0.9283)	-1.6037	(1.5649)
Mining and quarrying	-6.8955	(4.5615)	-4.1700	(3.6808)	-4.7108 ***	(1.1036)	-1.4851	(1.8491)
Manufacture of food, textiles, wearing apparel, furniture, others	-3.8947	(3.6248)	-0.7357	(2.9140)	-2.4498 ***	(0.8754)	2.9428 **	(1.4797)
Manufacture of wood and paper; printing	-7.4354 **	(3.6312)	-2.9635	(2.9148)	-3.8854 ***	(0.8793)	-0.2120	(1.4852)
Manufacture of chemicals, plastic, glass, building materials	-3.8353	(3.5201)	-3.3371	(2.8241)	-3.2954 ***	(0.8506)	1.2356	(1.4390)
Manufacture of metal and metal products	-5.7022	(3.5683)	-3.1061	(2.8659)	-3.4215 ***	(0.8641)	0.9260	(1.4572)
Manufacture of machines and equipment, electronics, vehicles	-4.3061	(3.4825)	-3.6686	(2.7983)	-2.0821 **	(0.8435)	4.8017 ***	(1.4203)
Electricity, gas, steam and air conditioning supply	-5.6887	(3.8140)	-3.8656	(3.0690)	-3.9658 ***	(0.9233)	-2.1271	(1.5573)
Water supply; sewerage, waste management and remediation activities	-2.0898	(3.6750)	-1.7315	(2.9452)	-3.1938 ***	(0.8882)	0.1435	(1.5020)
Construction	-4.7130	(3.7262)	2.5765	(2.9873)	-2.3347 ***	(0.9000)	6.0905 ***	(1.5237)
Wholesale and retail trade; repair of motor vehicles and motorcycles	-4.9668	(3.5450)	-1.6465	(2.8450)	-2.3028 ***	(0.8575)	1.1000	(1.4489)
Transportation and storage	2.4501	(3.6981)	3.8259	(2.9647)	-0.0532	(0.8910)	5.3184 ***	(1.5084)
Accommodation and food service activities	9.2925 **	(3.9411)	9.7154 ***	(3.1732)	-0.5445	(0.9524)	3.6104 **	(1.6177)
Financial and insurance activities	-6.5508 *	(3.6651)	-3.9454	(2.9430)	-2.0100 **	(0.8852)	-0.8732	(1.5022)
Real estate activities	-3.6370	(3.6600)	-2.3877	(2.9256)	-3.4933 ***	(0.8790)	-2.7358 *	(1.4916)
Professional, scientific and technical activities	0.6206	(3.5331)	2.3579	(2.8322)	-1.5188 *	(0.8508)	3.3200 **	(1.4368)
Administrative and support service activities	42.5350 ***	(3.1331)	31.0761 ***	(2.5169)	9.6313 ***	(0.7571)	6.5626 ***	(1.2818)
Public administration and defence; compulsory social security	-6.5685 *	(3.6338)	-3.4431	(2.9105)	-3.0185 ***	(0.8727)	-1.8157	(1.4744)
Education	-0.4574	(3.7186)	3.2848	(2.9824)	-0.6671	(0.8954)	1.4187	(1.5294)

	Hirings per 100 employees 2015		Separations per 100 employees 2015		Job vacancies per 100 employees IV/2015		Proportion of abandoned search processes 2015 #	
	Coeff.	SE	Coeff.	SE	Coeff.	SE	Coeff.	SE
Human health and social work activities	-0.3887	(3.6572)	0.8618	(2.9270)	0.4513	(0.8789)	2.1619	(1.4908)
Arts, entertainment and recreation	1.5531	(3.9135)	4.0962	(3.1488)	-2.9079 ***	(0.9443)	-1.9591	(1.5937)
Other service activities	-2.4828	(3.6671)	-0.7848	(2.9266)	-2.5929 ***	(0.8826)	-0.8865	(1.5014)
Number of employees (ref. 1-9)								
10 - 19	-2.6433 *	(1.5897)	-2.8738 **	(1.2752)	-0.2565	(0.3846)	0.7864	(0.6501)
20 - 49	-1.4833	(1.5261)	-2.0251 *	(1.2235)	-0.6036	(0.3682)	-1.5894 **	(0.6242)
50 - 249	0.8482	(1.6433)	-2.2613 *	(1.3157)	-1.8457 ***	(0.3953)	-4.0115 ***	(0.6711)
250 - 499	0.7375	(2.7569)	-4.5261 **	(2.2069)	-2.7347 ***	(0.6601)	-7.2148 ***	(1.1215)
500+	-6.3375 **	(2.9954)	-5.8089 **	(2.4078)	-3.1061 ***	(0.7204)	-7.5467 ***	(1.2272)
Federal State (ref. Bavaria)								
Schleswig-Holstein/Hamburg	-0.9034	(2.9744)	0.9937	(2.3819)	0.0319	(0.7151)	-3.0785 **	(1.2156)
Lower Saxony/Bremen	-3.3518	(2.4330)	-1.5652	(1.9538)	-0.6681	(0.5851)	-2.4986 **	(0.9894)
North Rhine-Westphalia	-1.4711	(2.0821)	-0.0770	(1.6729)	-0.7619	(0.5030)	-2.3038 ***	(0.8509)
Hessen	-8.2717 ***	(2.6853)	-5.0946 **	(2.1555)	-1.2522 *	(0.6481)	-3.4846 ***	(1.0947)
Rhineland-Palatinate/Saarland	-4.7059	(2.8884)	-2.7215	(2.3196)	-1.0055	(0.6984)	-3.9154 ***	(1.1831)
Baden-Wuerttemberg	-5.4701 **	(2.2646)	-3.5239 *	(1.8172)	-0.4139	(0.5450)	-1.3952	(0.9240)
Berlin/Brandenburg	-3.6490 *	(2.0660)	-2.4463	(1.6581)	0.2800	(0.4974)	-1.3936 *	(0.8417)
Mecklenburg-Western Pomerania	-3.6770	(2.8116)	-4.2302 *	(2.2617)	-0.9439	(0.6817)	-2.4776 **	(1.1498)
Saxony	-4.9620 **	(2.1179)	-2.3261	(1.7000)	0.2680	(0.5118)	0.1853	(0.8650)
Saxony-Anhalt	-6.3210 **	(2.5759)	-3.3208	(2.0613)	-0.8825	(0.6207)	-0.1593	(1.0580)
Thuringia	-4.9291 **	(2.3416)	-3.5197 *	(1.8793)	-0.2217	(0.5655)	-1.9053 **	(0.9606)
Proportion of academics*	-0.0406	(0.0282)	-0.0554 **	(0.0227)	-0.0113 *	(0.0068)	-0.0317 ***	(0.0115)
Proportion of women*	0.0126	(0.0252)	0.0088	(0.0202)	-0.0202 ***	(0.0061)	-0.0038	(0.0103)
Proportion of part-time work*	-0.0097	(0.0259)	-0.0483 **	(0.0207)	-0.0278 ***	(0.0062)	-0.0284 ***	(0.0106)
Constant	16.7778 ***	(3.4573)	15.9590 ***	(2.7764)	6.6538 ***	(0.8350)	8.1929 ***	(1.4129)
N	7,478		7,607		7,782		7,488	

* Ratio among employees

Number of abandoned search processes/(number of hires + number of abandoned search processes)

Coeff.= coefficient, SE=standard errors

Source: IAB-Job Vacancy Survey IV/2015, own calculations.

Table A2
Digitalisation and labour shortages – results of a logistic regression

	Labour shortages	
	AME	SE
Internal digitalisation (ref. no digitalisation)		
starting	0.0455***	(0.0168)
slight further	0.0271**	(0.0135)
strong further	0.0500***	(0.0133)
External digitalisation (ref. no digitalisation)		
starting	-0.0183	(0.0160)
slight further	-0.0032	(0.0147)
strong further	0.0160	(0.0149)
Use of learning systems (ref. no use)		
starting	-0.0066	(0.0118)
slight further	-0.0119	(0.0125)
strong further	-0.0064	(0.0115)
Economic sector (ref. Information and communication)		
Agriculture, forestry and fishing	-0.0954***	(0.0247)
Mining and quarrying	-0.1100***	(0.0259)
Manufacture of food, textiles, wearing apparel, furniture, others	-0.0219	(0.0273)
Manufacture of wood and paper; printing	-0.0982***	(0.0233)
Manufacture of chemicals, plastic, glass, building materials	-0.0691***	(0.0244)
Manufacture of metal and metal products	-0.0262	(0.0257)
Manufacture of machines and equipment, electronics, vehicles	-0.0177	(0.0259)
Electricity, gas, steam and air conditioning supply	-0.1231***	(0.0227)
Water supply; sewerage, waste management and remediation activities	-0.0845***	(0.0243)
Construction	0.0464	(0.0297)
Wholesale and retail trade; repair of motor vehicles and motorcycles	-0.0224	(0.0269)
Transportation and storage	0.0401	(0.0294)
Accommodation and food service activities	0.0352	(0.0327)
Financial and insurance activities	-0.1028***	(0.0241)
Real estate activities	-0.0978***	(0.0241)
Professional, scientific and technical activities	0.0030	(0.0291)
Administrative and support service activities	0.2051***	(0.0273)
Public administration and defence; compulsory social security	-0.1137***	(0.0235)
Education	0.0198	(0.0331)
Human health and social work activities	0.0967***	(0.0346)
Arts, entertainment and recreation	-0.0811***	(0.0273)
Other service activities	-0.0817***	(0.0262)
Number of employees (ref. 1-9)		
10 - 19	0.0479***	(0.0116)
20 - 49	0.0406***	(0.0107)
50 - 249	0.0359***	(0.0115)
250 - 499	-0.0008	(0.0173)
500+	-0.0185	(0.0182)
Federal State (ref. Bavaria)		
Schleswig-Holstein/Hamburg	-0.0285	(0.0211)
Lower Saxony/Bremen	-0.0527***	(0.0165)
North Rhine-Westphalia	-0.0225	(0.0150)

	Labour shortages	
	AME	SE
Hessen	-0.0432**	(0.0185)
Rhineland-Palatinate/Saarland	-0.0198	(0.0213)
Baden-Wuerttemberg	-0.0177	(0.0164)
Berlin/Brandenburg	0.0056	(0.0155)
Mecklenburg-Western Pomerania	-0.0277	(0.0200)
Saxony	0.0058	(0.0160)
Saxony-Anhalt	-0.0136	(0.0188)
Thuringia	-0.0042	(0.0176)
Proportion of academics	-0.0011***	(0.0002)
Proportion of women	-0.0005***	(0.0002)
Proportion part-time work	-0.0008***	(0.0002)
N	7,681	

AME= average marginal effects, SE=standard errors

Source: IAB-Job Vacancy Survey IV/2015, own calculations.

Table A3
Digitalisation and recruitment duration – results of a survival analysis

	Hazard ratios	SE
Internal digitalisation (ref. no digitalisation)		
starting	0.9672	(0.0638)
slight further	0.9407	(0.0487)
strong further	0.9025**	(0.0467)
External digitalisation (ref. no digitalisation)		
starting	0.9372	(0.0589)
slight further	0.9959	(0.0522)
strong further	0.9799	(0.0521)
Use of learning systems (ref. no use)		
starting	1.0387	(0.0455)
slight further	1.0006	(0.0460)
strong further	0.9141**	(0.0398)
Region (ref. western Germany)		
Eastern Germany/Berlin	0.8728	(0.0264)
Number of employees (ref. 500+)		
< 10	0.7847***	(0.0597)
10 - 19	0.8344***	(0.0579)
20 - 49	0.8726**	(0.0577)
50 - 249	0.9345	(0.0614)
250 - 499	1.0683	(0.0859)
Economic sector (ref. Information and communication)		
Agriculture, forestry and fishing	0.9902	(0.1245)
Mining and quarrying	1.1628	(0.1576)
Manufacture of food, textiles, wearing apparel, furniture, others	1.0288	(0.1027)
Manufacture of wood and paper; printing	1.0763	(0.1131)
Manufacture of chemicals, plastic, glass, building materials	1.0968	(0.1064)
Manufacture of metal and metal products	0.9175	(0.0934)
Manufacture of machines and equipment, electronics, vehicles	1.0349	(0.0978)
Electricity, gas, steam and air conditioning supply	1.0848	(0.1181)
Water supply; sewerage, waste management and remediation activities	0.9864	(0.0992)
Construction	0.8692	(0.0931)
Wholesale and retail trade; repair of motor vehicles and motorcycles	0.9171	(0.0896)
Transportation and storage	0.9188	(0.0968)
Accommodation and food service activities	0.8794	(0.1025)
Financial and insurance activities	1.0416	(0.1123)
Real estate activities	1.0445	(0.1047)
Professional, scientific and technical activities	1.0582	(0.1027)
Administrative and support service activities	1.2070**	(0.1021)
Public administration and defence; compulsory social security	1.0877	(0.1079)
Education	0.9951	(0.1088)
Human health and social work activities	0.9414	(0.0998)
Arts, entertainment and recreation	0.9489	(0.1034)
Other service activities	1.1565	(0.1177)
Qualification level (ref. vocational training)		
unskilled	1.2832***	(0.0609)
master craftsman/technician	0.8424***	(0.0545)
bachelor	0.8536***	(0.0510)

	Hazard ratios	SE
master/diploma/PhD	0.7953***	(0.0362)
Occupational segments (ref. Occ. concerned with production technology)		
Occupations in agriculture, forestry and horticulture	1.1323	(0.1227)
Manufacturing occupations	1.1141	(0.0756)
Occupations in building and interior construction	1.1299*	(0.0791)
Occupations in the food industry, in gastronomy and in tourism	1.1683	(0.1249)
Medical and non-medical health care occupations	1.0516	(0.0968)
Service occupations in social sector and cultural work	1.2290**	(0.1168)
Occupations in commerce and trade	1.1814**	(0.0839)
Occupations in business management and organisation	1.3364***	(0.0821)
Business-related service occupations	1.2107***	(0.0785)
Service occupations in the IT sector and the natural sciences	0.9680	(0.0891)
Safety and security occupations	0.7582	(0.1399)
Occupations in transport and logistics	1.1504*	(0.0915)
Occupations in cleaning services	1.3463**	(0.1673)
Contract (ref. permanent)		
Fixed-term	1.1037***	(0.0330)
Working hours (ref. > 36)		
< 20	1.2336**	(0.1043)
20 - 36	1.1343***	(0.0421)
Unemployed per job vacancy	1.0204	(0.0146)
Hiring rate by occupation	1.0364**	(0.0148)
Separation rate by occupation	0.9650**	(0.0139)
Search channel (ref. Internal and external search)		
only external	1.2527***	(0.0391)
only internal	1.9649***	(0.0826)
cons	0.0074***	(0.0010)
/ln_p	0.0977	(0.0104)
p	1.1026	(0.0115)
1/p	0.9070	(0.0095)

SE=standard errors

Source: IAB-Job Vacancy Survey IV/2015, own calculations.

Table A4
Digitalisation and hiring wage - results of a linear regression

	Hourly wage	
	AME	SE
Internal digitalisation (ref. no digitalisation)		
starting	0.2114	(0.3803)
slight further	0.2605	(0.3062)
strong further	0.0688	(0.3002)
External digitalisation (ref. no digitalisation)		
starting	0.0623	(0.3685)
slight further	-0.3934	(0.3127)
strong further	-0.3275	(0.3134)
Use of learning systems (ref. no use)		
starting	-0.1680	(0.2591)
slight further	0.4609*	(0.2674)
strong further	0.0010	(0.2519)
Economic sector (ref. Information and communication)		
Agriculture, forestry and fishing	-3.8379***	(0.7499)
Mining and quarrying	0.3238	(0.8029)
Manufacture of food, textiles, wearing apparel, furniture, others	-1.7275***	(0.5996)
Manufacture of wood and paper; printing	-1.9188***	(0.6335)
Manufacture of chemicals, plastic, glass, building materials	-1.1351*	(0.5864)
Manufacture of metal and metal products	-1.5042**	(0.6060)
Manufacture of machines and equipment, electronics, vehicles	-0.9696*	(0.5737)
Electricity, gas, steam and air conditioning supply	-0.3378	(0.6575)
Water supply; sewerage, waste management and remediation activities	-1.5145**	(0.6001)
Construction	-1.4741**	(0.6426)
Wholesale and retail trade; repair of motor vehicles and motorcycles	-1.8290***	(0.5965)
Transportation and storage	-2.2793***	(0.6387)
Accommodation and food service activities	-2.2909***	(0.7131)
Financial and insurance activities	-1.0070	(0.6430)
Real estate activities	-0.5679	(0.6080)
Professional, scientific and technical activities	-2.1102***	(0.5778)
Administrative and support service activities	-2.5465***	(0.5138)
Public administration and defence; compulsory social security	-1.6731***	(0.6221)
Education	-1.0775	(0.6648)
Human health and social work activities	-1.9439***	(0.6431)
Arts, entertainment and recreation	-3.0998***	(0.6451)
Other service activities	-2.3173***	(0.6128)
Number of employees (ref. 1-9)		
10 - 19	0.3067	(0.3042)
20 - 49	0.8892***	(0.2881)
50 - 249	1.0645***	(0.3037)
250 - 499	2.2064***	(0.4342)
500+	2.5791***	(0.4489)
Federal State (ref. Bavaria)		
Schleswig-Holstein/Hamburg	-0.7443*	(0.4492)
Lower Saxony/Bremen	0.1464	(0.3663)
North Rhine-Westphalia	-0.1304	(0.3184)
Hessen	-0.5713	(0.4206)
Rhineland-Palatinate/Saarland	-1.0899**	(0.4602)

	Hourly wage	
	AME	SE
Baden-Wuerttemberg	0.3910	(0.3428)
Berlin/Brandenburg	-1.6409***	(0.3164)
Mecklenburg-Western Pomerania	-2.4608***	(0.4305)
Saxony	-3.2437***	(0.3312)
Saxony-Anhalt	-3.1014***	(0.4029)
Thuringia	-3.0753***	(0.3628)
Qualification level (ref. vocational training)		
unskilled	-1.8785***	(0.2619)
master craftsman/technician	3.1377***	(0.3724)
bachelor	5.0951***	(0.3659)
master/diploma/PhD	8.5847***	(0.2937)
Classification of occupations 2010 (ref. Computer science, information and communication technology)		
Agriculture, forestry, and farming	-1.6944*	(0.9749)
Gardening and floristry	-2.1910***	(0.8417)
Production and processing of raw materials, glass- and ceramic-making and -processing	-3.3865***	(1.3118)
Plastic-making and -processing, and wood-working and -processing	-3.0239***	(0.8352)
Paper-making and -processing, printing, and in technical media design	-1.3283	(0.9633)
Metal-making and -working, and in metal construction	-2.6154***	(0.7330)
Technical occupations in machine-building and automotive industry	-2.4517***	(0.6797)
Mechatronics, energy electronics and electrical engineering	-2.4274***	(0.7194)
Technical research and development, construction, and production planning and scheduling	-0.6034	(0.7720)
Textile- and leather-making and -processing	-2.6513**	(1.2738)
Food production and processing	-2.9714***	(0.8322)
Construction scheduling, architecture and surveying	-1.6525*	(0.8656)
Building construction above and below ground	-2.0589**	(0.8692)
Interior construction	-2.7140***	(0.9535)
Building services engineering and technical building services	-3.1101***	(0.7287)
Mathematics, biology, chemistry and physics	-1.5836	(1.1566)
Geology, geography and environmental protection	-1.8820	(1.7758)
Transport and logistics (without vehicle driving)	-3.0410***	(0.7396)
Drivers and operators of vehicles and transport equipment	-3.6693***	(0.7119)
Safety and health protection, security and surveillance	-3.0747***	(1.0046)
Cleaning services	-2.6908***	(0.8544)
Purchasing, sales and trading	1.4167**	(0.7002)
Sales in retail trade	-2.3406***	(0.8350)
Tourism, hotels and restaurants	-2.5841***	(0.8232)
Business management and organization	0.2416	(0.6196)
Financial services, accounting and tax consultancy	1.6755**	(0.6883)
Law and public administration	-0.8032	(0.7820)
Medical and health care	-0.3990	(0.8001)
Non-medical healthcare, body care, wellness and medical technicians	-1.8061**	(0.8627)
Education and social work, housekeeping, and theology	-0.7677	(0.7459)
Teaching and training	2.0633**	(0.9105)
Philology, literature, humanities, social sciences, and economics	-2.7733*	(1.5035)
Advertising and marketing, in commercial and editorial media design	-0.4231	(0.7454)
Product design, artisan craftwork, fine arts and the making of musical instruments	-2.3173	(2.1769)
Performing arts and entertainment	4.3924***	(1.2496)
Other occupations	-1.8734***	(0.6639)
Working hours (ref. > 36)		
< 20	0.7959	(0.4916)

	Hourly wage	
	AME	SE
20 - 36	-0.0424	(0.2233)
Age	0.0591***	(0.0082)
Gender (ref. male)		
female	-1.7435***	(0.2105)
Previous status of applicant (ref. employed)		
unemployed	-1.0271***	(0.2096)
self-employed	-1.4829***	(0.5073)
not gainfully employed	-1.1074**	(0.5308)
she/he was a temporary worker in our firm	-0.6583	(0.4924)
she/he was a trainee in our firm	-1.4801**	(0.5939)
she/he was a trainee in a different firm	-1.7032***	(0.3025)
Contract (ref. permanent)		
fixed-term	-0.9117***	(0.1775)
Special bonus (ref. yes)		
no	-1.0586***	(0.1793)
Wage subsidies (ref. yes)		
no	0.6637*	(0.3755)
Constant	18.4957***	(0.7667)
N	6,147	

AME= average marginal effects, SE=standard errors

Source: IAB-Job Vacancy Survey IV/2015, own calculations.

Table A5

Digitalisation and new hires by qualification level – results of a multinomial logistic regression

	Unskilled		Vocational Training		Technicians, Master Craftsman		Bachelor		Master, PhD	
	AME	SE robust	AME	SE robust	AME	SE robust	AME	SE robust	AME	SE robust
Internal Digitalization (ref. no digitalization)										
starting	-0.0123	(0.0170)	0.0058	(0.0269)	0.0024	(0.0144)	-0.0077	(0.0114)	0.0118	(0.0174)
slight further	-0.0009	(0.0149)	-0.0463 **	(0.0215)	0.0022	(0.0110)	0.0226 **	(0.0096)	0.0223 *	(0.0135)
strong further	-0.0186	(0.0144)	-0.0493 **	(0.0209)	-0.0015	(0.0107)	0.0301 ***	(0.0094)	0.0393 ***	(0.0133)
External Digitalization (ref. no digitalization)										
starting	0.0054	(0.0165)	-0.0029	(0.0261)	-0.0046	(0.0113)	-0.0291 *	(0.0151)	0.0313 *	(0.0183)
slight further	-0.0101	(0.0143)	0.0227	(0.0221)	0.0056	(0.0099)	-0.0221 *	(0.0133)	0.0039	(0.0148)
strong further	0.0003	(0.0152)	0.0148	(0.0222)	0.0174 *	(0.0103)	-0.0265 **	(0.0131)	-0.0060	(0.0142)
Use of Learning Systems (ref. no use)										
starting	-0.0070	(0.0125)	-0.0264	(0.0184)	0.0101	(0.0084)	0.0094	(0.0093)	0.0139	(0.0124)
slight further	-0.0155	(0.0128)	-0.0110	(0.0190)	0.0087	(0.0088)	0.0140	(0.0094)	0.0037	(0.0123)
strong further	-0.0229 *	(0.0119)	-0.0106	(0.0178)	0.0186 **	(0.0088)	0.0083	(0.0083)	0.0066	(0.0114)
Economic sector – aggregated (ref. Manufacturing)										
Agriculture, forestry and fishing	-0.0096	(0.0252)	0.0295	(0.0408)	0.0209	(0.0230)	0.0032	(0.0179)	-0.0440	(0.0271)
Construction	-0.0332 *	(0.0192)	0.1388 ***	(0.0280)	0.0049	(0.0138)	-0.0213	(0.0135)	-0.0891 ***	(0.0125)
Wholesale and retail trade, transportation, accommodation	-0.0009	(0.0130)	0.0434 *	(0.0223)	0.0037	(0.0129)	-0.0099	(0.0099)	-0.0364 **	(0.0159)
Information and communication	-0.0625 **	(0.0250)	-0.0663 *	(0.0345)	-0.0087	(0.0125)	0.0749 ***	(0.0186)	0.0626 ***	(0.0224)
Financial and insurance activities	-0.0223	(0.0403)	0.0494	(0.0433)	-0.0034	(0.0186)	0.0041	(0.0122)	-0.0278	(0.0190)
Real estate activities	-0.0890 ***	(0.0161)	0.0585 *	(0.0306)	0.0147	(0.0189)	-0.0118	(0.0122)	0.0276	(0.0215)
Professional, scientific and technical activities, administrative and service activities	0.0122	(0.0136)	-0.0666 ***	(0.0198)	-0.0149 *	(0.0081)	0.0126	(0.0098)	0.0568 ***	(0.0145)
Public administration, education, human health, social work	-0.0259	(0.0164)	0.0550 **	(0.0240)	-0.0077	(0.0134)	0.0173	(0.0109)	-0.0387 ***	(0.0132)
Arts, entertainment, recreation, other service activities	-0.0247	(0.0168)	-0.0584 **	(0.0267)	-0.0044	(0.0137)	0.0406 ***	(0.0139)	0.0469 **	(0.0187)
Number of Employees (ref. 1-9)										
10 - 19	-0.0363 **	(0.0145)	0.0270	(0.0207)	0.0097	(0.0102)	0.0224 ***	(0.0085)	-0.0227 *	(0.0128)
20 - 49	-0.0211	(0.0137)	-0.0072	(0.0195)	0.0049	(0.0092)	0.0189 **	(0.0076)	0.0045	(0.0126)
50 - 249	-0.0389 ***	(0.0141)	-0.0199	(0.0204)	0.0062	(0.0098)	0.0390 ***	(0.0084)	0.0135	(0.0132)
250 - 499	-0.0594 ***	(0.0197)	-0.0451	(0.0300)	-0.0089	(0.0124)	0.0898 ***	(0.0162)	0.0236	(0.0196)
500+	-0.0641 ***	(0.0222)	-0.1221 ***	(0.0319)	-0.0135	(0.0124)	0.1121 ***	(0.0167)	0.0877 ***	(0.0227)
Federal State (ref. Bavaria)										
Schleswig-Holstein/Hamburg	-0.0406 *	(0.0214)	0.0266	(0.0319)	-0.0188	(0.0159)	0.0155	(0.0152)	0.0174	(0.0201)
Lower Saxony/Bremen	-0.0117	(0.0178)	0.0323	(0.0253)	-0.0207 *	(0.0124)	-0.0071	(0.0113)	0.0071	(0.0159)
North Rhine-Westphalia	-0.0140	(0.0160)	-0.0045	(0.0225)	-0.0173	(0.0112)	0.0279 **	(0.0113)	0.0079	(0.0133)
Hessen	0.0054	(0.0219)	-0.0696 **	(0.0310)	0.0030	(0.0165)	0.0116	(0.0137)	0.0497 **	(0.0195)
Rhineland-Palatinate/Saarland	-0.0490 **	(0.0201)	0.0158	(0.0323)	0.0037	(0.0173)	0.0018	(0.0158)	0.0276	(0.0211)
Baden-Wuerttemberg	0.0172	(0.0181)	-0.0381	(0.0245)	-0.0123	(0.0122)	0.0284 **	(0.0124)	0.0048	(0.0144)

	Unskilled		Vocational Training		Technicians, Master Craftsman		Bachelor		Master, PhD	
	AME	SE robust	AME	SE robust	AME	SE robust	AME	SE robust	AME	SE robust
Berlin/Brandenburg	-0.0555 ***	(0.0146)	0.0184	(0.0218)	-0.0231 **	(0.0107)	0.0089	(0.0104)	0.0513 ***	(0.0143)
Mecklenburg-Western Pomerania	-0.0606 ***	(0.0185)	0.0533 *	(0.0292)	-0.0248 *	(0.0139)	0.0079	(0.0154)	0.0241	(0.0196)
Saxony	-0.0623 ***	(0.0150)	0.0355	(0.0226)	-0.0250 **	(0.0109)	-0.0064	(0.0106)	0.0582 ***	(0.0155)
Saxony-Anhalt	-0.0376 **	(0.0191)	0.0342	(0.0285)	-0.0287 **	(0.0124)	0.0076	(0.0141)	0.0244	(0.0187)
Thuringia	-0.0433 **	(0.0173)	0.0590 **	(0.0252)	-0.0326 ***	(0.0114)	-0.0102	(0.0116)	0.0271	(0.0166)
Occupational segments (ref. Occ. concerned with production technology)										
Agriculture, forestry and horticulture	0.0874 ***	(0.0295)	0.1220 ***	(0.0393)	-0.1015 ***	(0.0234)	-0.0095	(0.0164)	-0.0984 ***	(0.0179)
Manufacturing occupations	0.0364 **	(0.0163)	0.2142 ***	(0.0245)	-0.0910 ***	(0.0165)	-0.0364 ***	(0.0101)	-0.1232 ***	(0.0128)
Building and interior construction	0.0599 ***	(0.0181)	-0.0129	(0.0290)	-0.0832 ***	(0.0188)	-0.0092	(0.0132)	0.0454 **	(0.0210)
Occupations in the food industry, in gastronomy and in tourism	0.1698 ***	(0.0256)	0.0887 ***	(0.0323)	-0.1182 ***	(0.0194)	-0.0249 *	(0.0131)	-0.1154 ***	(0.0145)
Medical and non-medical health care occupations	0.0365 *	(0.0217)	0.0998 ***	(0.0356)	-0.1084 ***	(0.0229)	-0.0413 ***	(0.0101)	0.0133	(0.0263)
Service occupations in social sector and cultural work	-0.0293 *	(0.0161)	-0.0579 *	(0.0350)	-0.1236 ***	(0.0200)	0.0335 **	(0.0168)	0.1773 ***	(0.0317)
Occupations in commerce and trade	0.0022	(0.0170)	0.1588 ***	(0.0291)	-0.1261 ***	(0.0178)	0.0269 *	(0.0160)	-0.0619 ***	(0.0176)
Occupations in business management and organization	-0.0573 ***	(0.0113)	0.1561 ***	(0.0246)	-0.1312 ***	(0.0165)	0.0300 **	(0.0127)	0.0023	(0.0169)
Business related service occupations	-0.0585 ***	(0.0118)	0.1026 ***	(0.0265)	-0.1264 ***	(0.0169)	0.0611 ***	(0.0144)	0.0212	(0.0189)
Service occupations in the IT-sector and the natural sciences	-0.0515 ***	(0.0163)	-0.0922 **	(0.0405)	-0.0557 **	(0.0264)	0.0677 ***	(0.0216)	0.1317 ***	(0.0321)
Safety and security occupations	0.3526 ***	(0.0593)	-0.1178 *	(0.0633)	-0.0579	(0.0430)	-0.0522 ***	(0.0086)	-0.1246 ***	(0.0155)
Occupations in transport and logistics	0.2430 ***	(0.0217)	0.0638 **	(0.0277)	-0.1477 ***	(0.0159)	-0.0367 ***	(0.0102)	-0.1224 ***	(0.0130)
Occupations in cleaning services	0.6113 ***	(0.0437)	-0.2808 ***	(0.0462)	-0.1446 ***	(0.0183)	-0.0522 ***	(0.0086)	-0.1336 ***	(0.0123)
N	6,685		6,685		6,685		6,685		6,685	

AME= average marginal effects, SE=standard errors

Source: IAB-Job Vacancy Survey IV/2015, own calculations.

Table A6

Digitalisation and special requirements asked of newly hired employees - results of logistic regressions

	Knowledge from further training		Longer experience in occupational field		Intercultural competence		Knowledge of foreign languages		Social, team and communicative competence		Leadership competence	
	AME	SE	AME	SE	AME	SE	AME	SE	AME	SE	AME	SE
Internal digitalisation (ref. no digitalisation)												
starting	-0.0094	(0.0212)	0.0371	(0.0249)	-0.0317***	(0.0112)	0.0003	(0.0172)	0.0127	(0.0241)	-0.0245	(0.0154)
slight further	0.0399**	(0.0178)	0.0215	(0.0201)	-0.0034	(0.0105)	0.0003	(0.0128)	0.0315	(0.0194)	-0.0028	(0.0135)
strong further	0.0356**	(0.0169)	0.0129	(0.0195)	0.0065	(0.0107)	0.0091	(0.0129)	0.0329*	(0.0188)	-0.0201	(0.0128)
External digitalisation (ref. no digitalisation)												
starting	0.0200	(0.0225)	0.0227	(0.0239)	0.0294**	(0.0144)	-0.0281*	(0.0166)	0.0731***	(0.0240)	0.0192	(0.0147)
slight further	-0.0087	(0.0180)	-0.0027	(0.0199)	0.0105	(0.0107)	-0.0211	(0.0145)	0.0005	(0.0193)	-0.0115	(0.0116)
strong further	0.0093	(0.0186)	0.0327	(0.0205)	0.0059	(0.0104)	-0.0144	(0.0147)	0.0275	(0.0197)	0.0158	(0.0127)
Use of learning systems (ref. no use)												
starting	0.0126	(0.0148)	0.0029	(0.0166)	0.0107	(0.0094)	0.0119	(0.0111)	0.0174	(0.0166)	0.0132	(0.0103)
slight further	0.0248	(0.0155)	0.0084	(0.0173)	0.0046	(0.0093)	-0.0002	(0.0108)	0.0275	(0.0172)	0.0301***	(0.0115)
strong further	0.0303**	(0.0143)	0.0042	(0.0159)	0.0155*	(0.0089)	0.0122	(0.0101)	0.0418***	(0.0159)	0.0184*	(0.0102)
Economic sector (ref. Information and communication)												
Agriculture, forestry and fishing	-0.0028	(0.0484)	0.0210	(0.0473)	0.0000	(.)	-0.0324	(0.0348)	-0.0641	(0.0494)	-0.0061	(0.0249)
Mining and quarrying	-0.0847**	(0.0432)	0.0175	(0.0512)	-0.0098	(0.0322)	0.0149	(0.0413)	-0.0634	(0.0528)	0.0731**	(0.0360)
Manufacture of food, textiles, wearing apparel, furniture, others	-0.0591*	(0.0338)	0.0390	(0.0371)	-0.0070	(0.0211)	0.0062	(0.0279)	-0.0779**	(0.0376)	0.0507**	(0.0241)
Manufacture of wood and paper; printing	-0.0256	(0.0372)	0.0061	(0.0386)	0.0081	(0.0236)	-0.0307	(0.0257)	-0.0777*	(0.0398)	0.0386	(0.0248)
Manufacture of chemicals, plastic, glass, building materials	-0.0349	(0.0346)	0.0239	(0.0361)	-0.0138	(0.0194)	0.0265	(0.0265)	-0.0533	(0.0366)	0.0357*	(0.0203)
Manufacture of metal and metal products	-0.0417	(0.0337)	0.0289	(0.0365)	-0.0449***	(0.0153)	-0.0226	(0.0258)	-0.0511	(0.0380)	0.0199	(0.0204)
Manufacture of machines and equipment, electronics, vehicles	-0.0392	(0.0311)	0.0355	(0.0339)	0.0319	(0.0199)	0.0835***	(0.0263)	-0.0509	(0.0353)	0.0246	(0.0186)
Electricity, gas, steam and air conditioning supply	0.0068	(0.0375)	0.0803**	(0.0409)	-0.0615***	(0.0128)	-0.0961***	(0.0192)	-0.0741*	(0.0390)	-0.0098	(0.0186)
Water supply; sewerage, waste management and remediation activities	-0.0020	(0.0356)	0.0101	(0.0374)	-0.0493***	(0.0153)	-0.0892***	(0.0210)	-0.0409	(0.0392)	0.0524**	(0.0227)
Construction	0.0407	(0.0411)	0.0640	(0.0409)	-0.0339*	(0.0203)	-0.0607**	(0.0280)	-0.0594	(0.0409)	0.0575**	(0.0255)
Wholesale and retail trade; repair of motor vehicles and motorcycles	-0.0108	(0.0347)	0.0104	(0.0354)	-0.0055	(0.0182)	0.0108	(0.0261)	-0.0177	(0.0372)	0.0370*	(0.0212)
Transportation and storage	-0.0382	(0.0374)	-0.0129	(0.0389)	0.0024	(0.0264)	0.0266	(0.0333)	-0.0201	(0.0427)	0.0248	(0.0255)
Accommodation and food service activities	0.0747	(0.0523)	0.0346	(0.0458)	0.0391	(0.0327)	0.0403	(0.0404)	0.0040	(0.0467)	0.0890**	(0.0379)
Financial and insurance activities	0.0061	(0.0356)	0.0124	(0.0376)	-0.0484***	(0.0145)	-0.0724***	(0.0200)	-0.0601	(0.0378)	0.0083	(0.0198)
Real estate activities	-0.0972***	(0.0321)	0.0058	(0.0357)	-0.0336**	(0.0161)	-0.0923***	(0.0188)	-0.1082***	(0.0355)	0.0060	(0.0183)
Professional, scientific and technical activities	-0.0566*	(0.0310)	-0.0240	(0.0332)	-0.0150	(0.0154)	-0.0279	(0.0208)	-0.0747**	(0.0346)	-0.0214	(0.0151)
Administrative and support service activities	-0.0045	(0.0303)	0.0700**	(0.0313)	0.0279	(0.0176)	-0.0179	(0.0212)	0.0090	(0.0334)	0.0171	(0.0174)
Public administration and defence; compulsory social security	-0.0556*	(0.0332)	-0.0305	(0.0360)	-0.0264	(0.0161)	-0.0827***	(0.0202)	-0.0769**	(0.0365)	0.0043	(0.0186)
Education	-0.0463	(0.0357)	0.0016	(0.0404)	0.0449*	(0.0243)	-0.0247	(0.0272)	0.0421	(0.0419)	0.0638**	(0.0261)
Human health and social work activities	-0.0182	(0.0365)	0.0653	(0.0426)	0.0156	(0.0205)	-0.0618***	(0.0236)	0.0715*	(0.0426)	0.0643**	(0.0289)
Arts, entertainment and recreation	-0.0726**	(0.0363)	-0.0143	(0.0400)	-0.0107	(0.0192)	-0.0285	(0.0254)	-0.0090	(0.0414)	0.0640**	(0.0259)
Other service activities	-0.0279	(0.0347)	-0.0025	(0.0365)	0.0096	(0.0187)	-0.0557***	(0.0214)	-0.0394	(0.0376)	0.0377*	(0.0200)

	Knowledge from further training		Longer experience in occupational field		Intercultural competence		Knowledge of foreign languages		Social, team and communicative competence		Leadership competence	
	AME	SE	AME	SE	AME	SE	AME	SE	AME	SE	AME	SE
Number of employees (ref. 1-9)												
10 - 19	-0.0217	(0.0182)	-0.0389*	(0.0202)	0.0007	(0.0109)	-0.0221	(0.0145)	0.0047	(0.0200)	0.0084	(0.0140)
20 - 49	-0.0381**	(0.0171)	-0.0363*	(0.0191)	-0.0027	(0.0102)	-0.0281**	(0.0137)	-0.0288	(0.0187)	-0.0170	(0.0130)
50 - 249	-0.0233	(0.0178)	-0.0303	(0.0197)	0.0040	(0.0106)	-0.0200	(0.0140)	-0.0146	(0.0191)	-0.0088	(0.0133)
250 - 499	-0.0018	(0.0249)	0.0291	(0.0282)	0.0233	(0.0153)	-0.0021	(0.0187)	0.0324	(0.0271)	-0.0120	(0.0175)
500+	0.0277	(0.0260)	0.0438	(0.0292)	0.0227	(0.0163)	-0.0050	(0.0190)	0.0075	(0.0278)	-0.0296*	(0.0162)
Federal State (ref. Bavaria)												
Schleswig-Holstein/Hamburg	-0.0105	(0.0255)	0.0090	(0.0295)	0.0213	(0.0180)	0.0375*	(0.0205)	0.0541*	(0.0302)	-0.0129	(0.0184)
Lower Saxony/Bremen	-0.0002	(0.0206)	-0.0454*	(0.0232)	-0.0076	(0.0132)	0.0127	(0.0162)	0.0140	(0.0233)	-0.0030	(0.0153)
North Rhine-Westphalia	0.0071	(0.0180)	0.0267	(0.0211)	0.0035	(0.0118)	0.0246*	(0.0137)	0.0406**	(0.0207)	0.0028	(0.0136)
Hessen	-0.0092	(0.0236)	0.0050	(0.0276)	-0.0046	(0.0147)	0.0466**	(0.0189)	0.0183	(0.0279)	-0.0077	(0.0167)
Rhineland-Palatinate/Saarland	-0.0240	(0.0249)	-0.0345	(0.0293)	-0.0186	(0.0156)	-0.0149	(0.0187)	-0.0276	(0.0283)	-0.0398**	(0.0163)
Baden-Wuerttemberg	0.0017	(0.0195)	0.0052	(0.0227)	-0.0048	(0.0124)	0.0076	(0.0141)	0.0300	(0.0224)	0.0024	(0.0144)
Berlin/Brandenburg	0.0305*	(0.0181)	-0.0032	(0.0204)	0.0180	(0.0119)	0.0090	(0.0131)	0.0048	(0.0203)	-0.0138	(0.0127)
Mecklenburg-Western Pomerania	-0.0015	(0.0247)	0.0075	(0.0276)	-0.0329**	(0.0128)	-0.0153	(0.0173)	-0.0600**	(0.0262)	-0.0130	(0.0175)
Saxony	0.0316*	(0.0191)	0.0060	(0.0214)	-0.0011	(0.0121)	0.0027	(0.0136)	-0.0016	(0.0210)	-0.0014	(0.0140)
Saxony-Anhalt	-0.0181	(0.0220)	-0.0210	(0.0257)	-0.0244*	(0.0133)	-0.0360**	(0.0146)	-0.0352	(0.0246)	-0.0280*	(0.0159)
Thuringia	0.0179	(0.0213)	-0.0158	(0.0234)	-0.0337***	(0.0113)	-0.0237*	(0.0144)	-0.0146	(0.0231)	-0.0399***	(0.0136)
Qualification level (ref. vocational training)												
unskilled	-0.1455***	(0.0096)	-0.1885***	(0.0121)	-0.0343***	(0.0049)	-0.0520***	(0.0060)	-0.1698***	(0.0133)	-0.0421***	(0.0051)
master craftsman/technician	0.1768***	(0.0265)	0.2177***	(0.0277)	0.0861***	(0.0200)	0.0346**	(0.0164)	0.2197***	(0.0268)	0.2343***	(0.0241)
bachelor	0.0791***	(0.0241)	0.0958***	(0.0264)	0.0687***	(0.0151)	0.1052***	(0.0174)	0.1606***	(0.0265)	0.1067***	(0.0194)
master/diploma/PhD	0.0633***	(0.0187)	0.1212***	(0.0209)	0.0992***	(0.0136)	0.1749***	(0.0166)	0.2036***	(0.0208)	0.1846***	(0.0176)
Classification of occupations 2010 (ref. Mechatronics, energy electronics and electrical engineering)												
Agriculture, forestry, and farming	-0.0797	(0.0530)	-0.0246	(0.0608)	0.0000	(.)	0.0000	(.)	-0.0155	(0.0601)	0.0772	(0.0496)
Gardening and floristry	-0.0603	(0.0460)	-0.0731	(0.0509)	-0.0032	(0.0162)	-0.0306	(0.0212)	-0.0643	(0.0477)	0.0448	(0.0322)
Production and processing of raw materials, glass- and ceramic-making and -processing	-0.1679***	(0.0574)	-0.0529	(0.0831)	0.0000	(.)	0.0000	(.)	-0.1671**	(0.0720)	0.0000	(.)
Plastic-making and -processing, and wood-working and -processing	-0.1196***	(0.0409)	-0.1347***	(0.0468)	0.0044	(0.0179)	-0.0062	(0.0237)	-0.1382***	(0.0431)	0.0013	(0.0236)
Paper-making and -processing, printing, and in technical media design	-0.0120	(0.0574)	0.0166	(0.0639)	-0.0056	(0.0186)	0.0013	(0.0329)	-0.0014	(0.0606)	-0.0001	(0.0325)
Metal-making and -working, and in metal construction	-0.0239	(0.0376)	-0.0214	(0.0415)	0.0011	(0.0149)	-0.0234	(0.0177)	-0.1175***	(0.0364)	-0.0095	(0.0192)
Technical occupations in machine-building and automotive industry	-0.0332	(0.0333)	-0.0521	(0.0366)	0.0186	(0.0131)	0.0134	(0.0171)	-0.0882***	(0.0332)	-0.0018	(0.0165)
Technical research and development, construction, and production planning and scheduling	-0.0154	(0.0400)	-0.0448	(0.0439)	0.0247	(0.0155)	0.0450**	(0.0213)	0.0166	(0.0417)	0.0585**	(0.0229)
Textile- and leather-making and -processing	0.0067	(0.0778)	-0.0023	(0.0857)	0.0000	(.)	-0.0308	(0.0264)	-0.0754	(0.0773)	0.0000	(.)
Food production and processing	-0.1454***	(0.0386)	-0.0317	(0.0525)	0.0044	(0.0165)	-0.0263	(0.0203)	-0.0157	(0.0480)	0.0212	(0.0275)
Construction scheduling, architecture and surveying	-0.0938**	(0.0419)	-0.0661	(0.0501)	-0.0167	(0.0106)	-0.0303*	(0.0181)	-0.0550	(0.0458)	0.0284	(0.0227)
Building construction above and below ground	-0.0550	(0.0445)	-0.0404	(0.0515)	0.0099	(0.0222)	0.0000	(.)	-0.1019**	(0.0460)	0.0224	(0.0253)
Interior construction	-0.1409***	(0.0411)	-0.0703	(0.0545)	0.0212	(0.0289)	0.0000	(.)	-0.0236	(0.0547)	0.0225	(0.0312)

	Knowledge from further training		Longer experience in occupational field		Intercultural competence		Knowledge of foreign languages		Social, team and communicative competence		Leadership competence	
	AME	SE	AME	SE	AME	SE	AME	SE	AME	SE	AME	SE
Building services engineering and technical building services	-0.0685*	(0.0357)	-0.0963**	(0.0395)	0.0082	(0.0171)	-0.0373**	(0.0184)	-0.0584	(0.0385)	0.0032	(0.0195)
Mathematics, biology, chemistry and physics	-0.0204	(0.0631)	-0.1921***	(0.0561)	-0.0020	(0.0215)	-0.0121	(0.0255)	-0.1677***	(0.0540)	-0.0031	(0.0350)
Geology, geography and environmental protection	0.0329	(0.1028)	-0.0298	(0.1045)	0.0000	(.)	-0.0199	(0.0330)	0.0871	(0.1125)	0.0422	(0.0572)
Computer science, information and communication technology	-0.0432	(0.0403)	-0.0076	(0.0462)	0.0318*	(0.0165)	0.0312	(0.0223)	0.0018	(0.0437)	0.0053	(0.0205)
Transport and logistics (without vehicle driving)	-0.0978**	(0.0386)	-0.0325	(0.0432)	0.0182	(0.0178)	0.0518**	(0.0239)	-0.0602	(0.0403)	0.0277	(0.0250)
Drivers and operators of vehicles and transport equipment	0.0143	(0.0392)	-0.0088	(0.0419)	-0.0070	(0.0128)	-0.0299*	(0.0173)	-0.0642*	(0.0376)	-0.0277	(0.0182)
Safety and health protection, security and surveillance	0.1047	(0.0685)	-0.1735***	(0.0582)	0.0955**	(0.0445)	0.0845	(0.0549)	0.0903	(0.0678)	0.0053	(0.0351)
Cleaning services	-0.0824	(0.0550)	-0.0987*	(0.0591)	-0.0006	(0.0214)	0.0000	(.)	-0.0882	(0.0565)	0.0512	(0.0504)
Purchasing, sales and trading	-0.0851**	(0.0345)	0.0196	(0.0409)	0.0440**	(0.0173)	0.1206***	(0.0257)	0.1749***	(0.0408)	0.0400*	(0.0219)
Sales in retail trade	-0.1065***	(0.0410)	-0.0828*	(0.0474)	0.0444	(0.0272)	-0.0122	(0.0226)	-0.0105	(0.0470)	0.0414	(0.0317)
Tourism, hotels and restaurants	-0.1363***	(0.0377)	-0.0899*	(0.0471)	0.1230***	(0.0357)	0.2115***	(0.0475)	0.1372***	(0.0503)	0.0544*	(0.0321)
Business management and organization	-0.0804***	(0.0295)	-0.0695**	(0.0332)	0.0661***	(0.0134)	0.0991***	(0.0180)	0.1031***	(0.0320)	0.0993***	(0.0176)
Financial services, accounting and tax consultancy	0.0368	(0.0365)	0.0389	(0.0401)	0.0404**	(0.0178)	0.0751***	(0.0235)	0.0943**	(0.0384)	0.0466**	(0.0220)
Law and public administration	-0.0058	(0.0422)	-0.0635	(0.0450)	0.0451**	(0.0210)	0.0346	(0.0269)	0.0803*	(0.0450)	0.0735***	(0.0264)
Medical and health care	0.0183	(0.0451)	-0.0798*	(0.0474)	0.0386**	(0.0184)	0.0192	(0.0255)	0.0234	(0.0461)	0.0036	(0.0227)
Non-medical healthcare, body care, wellness and medical technicians	0.0277	(0.0511)	-0.0585	(0.0522)	0.0208	(0.0207)	-0.0411**	(0.0198)	0.0704	(0.0525)	0.0183	(0.0287)
Education and social work, housekeeping, and theology	-0.0777**	(0.0373)	-0.1276***	(0.0410)	0.1162***	(0.0240)	0.0190	(0.0234)	0.1025**	(0.0430)	0.0247	(0.0227)
Teaching and training	-0.0125	(0.0522)	-0.0570	(0.0568)	0.0510**	(0.0227)	0.0383	(0.0290)	0.0011	(0.0531)	0.0483*	(0.0293)
Philology, literature, humanities, social sciences, and economics	-0.1131	(0.0749)	-0.0849	(0.0916)	0.0385	(0.0358)	0.0175	(0.0422)	0.0800	(0.0937)	0.0589	(0.0520)
Advertising and marketing, in commercial and editorial media design	-0.1071***	(0.0367)	-0.0423	(0.0439)	0.0698***	(0.0197)	0.0824***	(0.0262)	0.0680	(0.0440)	0.0236	(0.0219)
Product design, artisan craftwork, fine arts and the making of musical instruments	-0.0193	(0.1433)	0.1036	(0.1638)	0.0000	(.)	0.0000	(.)	-0.1583	(0.1302)	0.1030	(0.1124)
Performing arts and entertainment	-0.0812	(0.0694)	-0.0907	(0.0818)	0.0559	(0.0426)	0.0457	(0.0460)	-0.0237	(0.0772)	0.0370	(0.0461)
Other occupations	-0.0963***	(0.0326)	-0.0827**	(0.0366)	0.0326**	(0.0156)	0.0314	(0.0198)	-0.0067	(0.0352)	0.0344*	(0.0199)
Reason for hiring (ref. Long-term additional demand)												
Temporary additional demand/seasonal demand	-0.0440**	(0.0194)	-0.0872***	(0.0215)	-0.0046	(0.0114)	0.0088	(0.0156)	-0.0225	(0.0217)	-0.0369***	(0.0132)
Temporary replacement	-0.0620***	(0.0219)	-0.1082***	(0.0239)	0.0035	(0.0161)	0.0102	(0.0206)	-0.1046***	(0.0246)	-0.0765***	(0.0110)
Long-term replacement	-0.0025	(0.0103)	-0.0045	(0.0116)	0.0053	(0.0063)	-0.0040	(0.0073)	-0.0073	(0.0114)	-0.0076	(0.0073)
Working hours (ref. > 36)												
< 20	-0.0725***	(0.0251)	-0.0936***	(0.0299)	-0.0268**	(0.0128)	-0.0529***	(0.0151)	-0.1282***	(0.0260)	-0.0837***	(0.0098)
20 - 36	-0.0115	(0.0130)	-0.0451***	(0.0142)	-0.0117	(0.0072)	-0.0271***	(0.0089)	-0.0415***	(0.0138)	-0.0580***	(0.0077)
N	6,968		6,968		6,602		6,424		6,968		6,897	

AME= average marginal effects, SE=standard errors

Source: IAB-Job Vacancy Survey IV/2015, own calculations.

Table A7

Digitalisation and special working conditions of newly hired employees - results of logistic regressions

	Deadline pressure		Working overtime		Changes in working time at short notice		Working at weekends		Changes in work content at short notice		Changes in place of work	
	AME	SE	AME	SE	AME	SE	AME	SE	AME	SE	AME	SE
Internal digitalisation (ref. no digitalisation)												
starting	0.0108	(0.0269)	0.0198	(0.0201)	-0.0040	(0.0199)	0.0360**	(0.0177)	0.0532**	(0.0234)	0.0182	(0.0209)
slight further	0.0073	(0.0217)	0.0275*	(0.0167)	-0.0089	(0.0166)	0.0111	(0.0132)	0.0392**	(0.0182)	-0.0067	(0.0162)
strong further	0.0279	(0.0213)	0.0334**	(0.0160)	-0.0056	(0.0156)	0.0110	(0.0128)	0.0360**	(0.0173)	0.0093	(0.0160)
External digitalisation (ref. no digitalisation)												
starting	0.0487*	(0.0264)	0.0175	(0.0221)	0.0292	(0.0188)	-0.0101	(0.0163)	0.0254	(0.0215)	-0.0093	(0.0196)
slight further	0.0262	(0.0222)	-0.0188	(0.0177)	0.0134	(0.0154)	-0.0079	(0.0135)	0.0374**	(0.0180)	-0.0098	(0.0170)
strong further	0.0684***	(0.0222)	-0.0084	(0.0179)	0.0405***	(0.0153)	0.0037	(0.0136)	0.0571***	(0.0181)	0.0044	(0.0174)
Use of learning systems (ref. no use)												
starting	0.0393**	(0.0182)	0.0070	(0.0144)	0.0195	(0.0137)	0.0074	(0.0119)	0.0094	(0.0153)	-0.0082	(0.0137)
slight further	0.0147	(0.0192)	-0.0223	(0.0141)	-0.0105	(0.0135)	-0.0182	(0.0124)	-0.0249*	(0.0151)	-0.0035	(0.0144)
strong further	0.0217	(0.0179)	-0.0001	(0.0139)	0.0080	(0.0128)	0.0052	(0.0121)	-0.0082	(0.0146)	-0.0209	(0.0130)
Economic sector (ref. Information and communication)												
Agriculture, forestry and fishing	0.0493	(0.0545)	-0.0175	(0.0431)	0.0407	(0.0405)	0.1312***	(0.0433)	0.1122**	(0.0468)	-0.1327***	(0.0377)
Mining and quarrying	-0.2242***	(0.0492)	-0.0313	(0.0426)	0.0056	(0.0400)	-0.0179	(0.0391)	0.0191	(0.0454)	-0.1083***	(0.0393)
Manufacture of food, textiles, wearing apparel, furniture, others	0.1015**	(0.0426)	-0.0383	(0.0346)	0.0081	(0.0302)	0.0172	(0.0279)	0.0344	(0.0342)	-0.1075***	(0.0347)
Manufacture of wood and paper; printing	0.1019**	(0.0449)	-0.0012	(0.0370)	0.0604*	(0.0353)	-0.0389	(0.0272)	0.0640*	(0.0359)	-0.1114***	(0.0352)
Manufacture of chemicals, plastic, glass, building materials	0.0182	(0.0410)	-0.0441	(0.0335)	-0.0115	(0.0287)	-0.0032	(0.0282)	0.0525	(0.0334)	-0.1198***	(0.0319)
Manufacture of metal and metal products	0.0746*	(0.0423)	-0.0579*	(0.0329)	-0.0102	(0.0308)	-0.0370	(0.0271)	0.0432	(0.0336)	-0.1128***	(0.0332)
Manufacture of machines and equipment, electronics, vehicles	0.0955**	(0.0407)	-0.0082	(0.0332)	0.0339	(0.0300)	-0.0333	(0.0268)	0.0658**	(0.0314)	-0.0650*	(0.0333)
Electricity, gas, steam and air conditioning supply	-0.0330	(0.0451)	-0.0787**	(0.0355)	0.0093	(0.0346)	0.0986**	(0.0415)	-0.058*	(0.0316)	-0.0521	(0.0383)
Water supply; sewerage, waste management and remediation activities	-0.0779*	(0.0417)	-0.0651**	(0.0330)	-0.0134	(0.0297)	0.0266	(0.0309)	0.0077	(0.0325)	-0.0852**	(0.0338)
Construction	0.1742***	(0.0452)	0.0965**	(0.0407)	0.0492	(0.0352)	-0.0112	(0.0321)	0.0925**	(0.0373)	0.1421***	(0.0416)
Wholesale and retail trade; repair of motor vehicles and motorcycles	0.0809*	(0.0423)	-0.0258	(0.0346)	0.0033	(0.0292)	0.0235	(0.0288)	0.0011	(0.0319)	-0.1069***	(0.0336)
Transportation and storage	0.0605	(0.0453)	-0.0236	(0.0343)	0.0667**	(0.0331)	0.0867***	(0.0332)	0.0181	(0.0356)	-0.0246	(0.0366)
Accommodation and food service activities	0.2143***	(0.0478)	0.0448	(0.0479)	0.1369***	(0.0433)	0.4163***	(0.0474)	0.0739	(0.0486)	-0.1742***	(0.0399)
Financial and insurance activities	-0.0408	(0.0445)	-0.0526	(0.0375)	0.0285	(0.0349)	0.0106	(0.0443)	0.0229	(0.0357)	-0.0035	(0.0418)
Real estate activities	-0.0346	(0.0419)	-0.0625*	(0.0348)	-0.0684***	(0.0263)	-0.0201	(0.0332)	-0.0329	(0.0313)	-0.1451***	(0.0319)
Professional, scientific and technical activities	0.1483***	(0.0408)	-0.0394	(0.0342)	-0.0389	(0.0276)	-0.0305	(0.0309)	0.0143	(0.0308)	-0.0614*	(0.0355)
Administrative and support service activities	0.1077***	(0.0360)	0.0455	(0.0310)	0.0766***	(0.0270)	0.0598**	(0.0261)	0.0456*	(0.0277)	0.0342	(0.0316)
Public administration and defence; compulsory social security	-0.0180	(0.0443)	-0.0982***	(0.0332)	-0.0157	(0.0303)	-0.0140	(0.0298)	0.0496	(0.0365)	0.0109	(0.0421)
Education	-0.0075	(0.0469)	-0.0960***	(0.0347)	-0.0361	(0.0279)	-0.0279	(0.0301)	-0.0210	(0.0336)	-0.1616***	(0.0331)
Human health and social work activities	0.1175**	(0.0463)	-0.0128	(0.0377)	0.0422	(0.0328)	0.1245***	(0.0338)	0.1096***	(0.0408)	-0.1065***	(0.0378)

	Deadline pressure		Working overtime		Changes in working time at short notice		Working at weekends		Changes in work content at short notice		Changes in place of work	
	AME	SE	AME	SE	AME	SE	AME	SE	AME	SE	AME	SE
Arts, entertainment and recreation	0.0212	(0.0456)	-0.0015	(0.0396)	0.0571	(0.0363)	0.2625***	(0.0414)	0.0593	(0.0393)	-0.0942**	(0.0385)
Other service activities	0.0158	(0.0431)	-0.0675**	(0.0337)	-0.0381	(0.0281)	0.0272	(0.0317)	-0.0213	(0.0318)	-0.0756**	(0.0370)
Number of employees (ref. 1-9)												
10 - 19	-0.0131	(0.0215)	0.0215	(0.0163)	-0.0473***	(0.0162)	0.0139	(0.0123)	-0.0447**	(0.0197)	-0.0242	(0.0166)
20 - 49	-0.0041	(0.0203)	0.0240	(0.0152)	-0.0353**	(0.0155)	0.0446***	(0.0117)	-0.0593***	(0.0184)	-0.0295*	(0.0155)
50 - 249	-0.0166	(0.0211)	0.0182	(0.0160)	-0.0338**	(0.0161)	0.0738***	(0.0127)	-0.095***	(0.0188)	-0.0237	(0.0163)
250 - 499	-0.0036	(0.0302)	0.0287	(0.0233)	-0.0308	(0.0222)	0.1174***	(0.0212)	-0.1273***	(0.0242)	-0.0276	(0.0227)
500+	0.0820***	(0.0317)	0.0406*	(0.0244)	-0.0272	(0.0233)	0.1508***	(0.0236)	-0.1172***	(0.0247)	-0.0434*	(0.0231)
Federal State (ref. Bavaria)												
Schleswig-Holstein/Hamburg	0.0156	(0.0323)	-0.0111	(0.0262)	0.0055	(0.0226)	0.0336*	(0.0194)	-0.0364	(0.0272)	-0.0073	(0.0241)
Lower Saxony/Bremen	-0.0431*	(0.0258)	-0.0207	(0.0209)	0.0188	(0.0188)	0.0213	(0.0158)	0.0132	(0.0227)	0.0377*	(0.0206)
North Rhine-Westphalia	-0.0050	(0.0226)	-0.0149	(0.0185)	0.0173	(0.0166)	0.0159	(0.0145)	0.0311	(0.0200)	0.0086	(0.0167)
Hessen	0.0016	(0.0296)	-0.0161	(0.0244)	0.0253	(0.0233)	0.0077	(0.0199)	-0.0137	(0.0262)	0.0215	(0.0238)
Rhineland-Palatinate/Saarland	-0.0498	(0.0323)	-0.0495*	(0.0256)	0.0053	(0.0240)	0.0029	(0.0199)	0.0022	(0.0283)	0.0391	(0.0260)
Baden-Wuerttemberg	-0.0294	(0.0244)	0.0077	(0.0207)	-0.0070	(0.0176)	0.0107	(0.0158)	-0.0266	(0.0205)	-0.0095	(0.0178)
Berlin/Brandenburg	-0.0316	(0.0222)	-0.0826***	(0.0169)	0.0056	(0.0161)	0.0464***	(0.0147)	-0.0331*	(0.0187)	0.0094	(0.0168)
Mecklenburg-Western Pomerania	-0.0592*	(0.0311)	-0.0481**	(0.0232)	0.0092	(0.0219)	0.0371*	(0.0194)	-0.0147	(0.0259)	-0.0149	(0.0224)
Saxony	-0.0181	(0.0231)	-0.0296	(0.0189)	0.0037	(0.0167)	0.0415***	(0.0153)	-0.0352*	(0.0194)	-0.0198	(0.0169)
Saxony-Anhalt	-0.0225	(0.0279)	-0.0596***	(0.0216)	0.0026	(0.0201)	0.0429**	(0.0191)	-0.0278	(0.0237)	-0.0038	(0.0195)
Thuringia	-0.0365	(0.0256)	-0.0528***	(0.0201)	0.0120	(0.0190)	0.0542***	(0.0175)	-0.0462**	(0.0212)	-0.0028	(0.0194)
Qualification level (ref. vocational training)												
unskilled	-0.0258	(0.0185)	0.0077	(0.0140)	0.0016	(0.0124)	0.0414***	(0.0121)	-0.0350**	(0.0145)	0.0075	(0.0135)
master craftsman/technician	0.0538**	(0.0271)	0.0267	(0.0214)	0.0036	(0.0198)	-0.0862***	(0.0170)	0.0349	(0.0224)	0.0399*	(0.0206)
bachelor	0.071***	(0.0257)	0.0204	(0.0218)	0.0112	(0.0197)	-0.1122***	(0.0155)	0.0698***	(0.0245)	0.0312	(0.0211)
master/diploma/PhD	0.1149***	(0.0218)	0.0385**	(0.0182)	0.0357**	(0.0174)	-0.0704***	(0.0127)	0.0780***	(0.0201)	0.0799***	(0.0184)
Classification of occupations 2010 (ref. Mechatronics, energy electronics and electrical engineering)												
Agriculture, forestry, and farming	-0.1897***	(0.0619)	0.2130***	(0.0654)	0.1881***	(0.0617)	0.4166***	(0.0646)	0.0480	(0.0598)	-0.0190	(0.0606)
Gardening and floristry	-0.0586	(0.0546)	0.0372	(0.0443)	0.0360	(0.0386)	-0.0408	(0.0278)	0.0483	(0.0503)	0.1003**	(0.0472)
Production and processing of raw materials, glass- and ceramic-making and -processing	0.0496	(0.1002)	-0.0269	(0.0684)	-0.0235	(0.0642)	0.0199	(0.0694)	-0.0483	(0.0820)	0.0626	(0.0857)
Plastic-making and -processing, and wood-working and -processing	-0.0191	(0.0534)	0.0356	(0.0435)	0.0262	(0.0364)	0.0398	(0.0394)	-0.0651	(0.0431)	-0.0306	(0.0451)
Paper-making and -processing, printing, and in technical media design	0.0680	(0.0666)	-0.0690	(0.0437)	-0.0882***	(0.0276)	0.0753	(0.0548)	-0.0438	(0.0565)	0.0000	(.)
Metal-making and -working, and in metal construction	-0.0197	(0.0448)	0.0793**	(0.0383)	-0.0093	(0.0287)	0.0673**	(0.0322)	0.0225	(0.0408)	-0.0286	(0.0370)
Technical occupations in machine-building and automotive industry	-0.0786*	(0.0408)	0.0168	(0.0317)	0.0167	(0.0271)	0.1035***	(0.0305)	-0.0223	(0.0356)	-0.0526	(0.0327)
Technical research and development, construction, and production planning and scheduling	-0.022	(0.0521)	-0.038	(0.0341)	-0.0479*	(0.0269)	-0.0375	(0.0299)	-0.0353	(0.0416)	-0.1567***	(0.0327)
Textile- and leather-making and -processing	0.0456	(0.0898)	-0.0307	(0.0693)	-0.0217	(0.0623)	-0.0423	(0.0533)	-0.0156	(0.0803)	-0.1543**	(0.0607)

	Deadline pressure		Working overtime		Changes in working time at short notice		Working at weekends		Changes in work content at short notice		Changes in place of work	
	AME	SE	AME	SE	AME	SE	AME	SE	AME	SE	AME	SE
Food-production and -processing	0.0175	(0.0543)	-0.0039	(0.0439)	0.0533	(0.0384)	0.208***	(0.0457)	-0.0909**	(0.0461)	-0.2027***	(0.0364)
Construction scheduling, architecture and surveying	0.0312	(0.0592)	0.0133	(0.0427)	0.0157	(0.0422)	-0.0005	(0.0476)	-0.0756*	(0.0453)	-0.0549	(0.0446)
Building construction above and below ground	0.0812	(0.0533)	0.1068**	(0.0464)	0.0955**	(0.0466)	-0.0358	(0.0322)	0.0514	(0.0530)	0.1599***	(0.0510)
Interior construction	0.0412	(0.0609)	-0.0012	(0.0453)	0.0396	(0.0439)	0.0048	(0.0426)	-0.0769	(0.0485)	0.1569**	(0.0613)
Building services engineering and technical building services	-0.1357***	(0.0453)	0.0299	(0.0362)	0.0438	(0.0332)	0.0520*	(0.0303)	0.0004	(0.0402)	0.0569	(0.0386)
Mathematics, biology, chemistry and physics	-0.1203	(0.0809)	-0.0665	(0.0535)	-0.0542	(0.0458)	0.1095*	(0.0610)	-0.1434**	(0.0562)	-0.1530***	(0.0530)
Geology, geography and environmental protection	-0.0329	(0.1263)	-0.0289	(0.0765)	0.0079	(0.0661)	0.0012	(0.0768)	0.0971	(0.1020)	-0.1856***	(0.0483)
Computer science, information and communication technology	0.0051	(0.0531)	-0.0605*	(0.0344)	-0.0382	(0.0287)	-0.0421	(0.0304)	0.0337	(0.0472)	-0.1403***	(0.0331)
Transport and logistics (without vehicle driving)	0.0117	(0.0454)	0.0317	(0.0364)	0.0055	(0.0291)	0.0171	(0.0281)	-0.1185***	(0.0378)	-0.1461***	(0.0330)
Drivers and operators of vehicles and transport equipment	0.1376***	(0.0425)	0.2038***	(0.0381)	0.1513***	(0.0336)	0.0623**	(0.0288)	-0.0345	(0.0388)	0.1036***	(0.0383)
Safety and health protection, security and surveillance	-0.3625***	(0.0581)	-0.0596	(0.0472)	0.0887	(0.0558)	0.4951***	(0.0687)	-0.0690	(0.0632)	-0.0917*	(0.0472)
Cleaning services	-0.0449	(0.0552)	-0.0884**	(0.0367)	-0.0336	(0.0331)	0.0407	(0.0320)	-0.0693	(0.0520)	-0.0416	(0.0469)
Purchasing, sales and trading	0.0152	(0.0447)	-0.0512	(0.0314)	0.0424	(0.0306)	-0.0433*	(0.0263)	-0.0786**	(0.0367)	0.0721*	(0.0399)
Sales in retail trade	-0.1765***	(0.0530)	-0.0089	(0.0415)	0.0649*	(0.0388)	0.2802***	(0.0463)	-0.1101***	(0.0425)	-0.1017**	(0.0444)
Tourism, hotels and restaurants	-0.0241	(0.0545)	-0.0513	(0.0354)	0.0622*	(0.0359)	0.2838***	(0.0486)	-0.1094**	(0.0432)	-0.2148***	(0.0313)
Business management and organisation	0.0043	(0.0373)	-0.0716***	(0.0266)	-0.0180	(0.0229)	-0.0556**	(0.0220)	-0.0626**	(0.0317)	-0.1704***	(0.0281)
Financial services, accounting and tax consultancy	-0.0502	(0.0435)	-0.0465	(0.0309)	-0.0151	(0.0260)	-0.0753***	(0.0228)	-0.0860**	(0.0352)	-0.1613***	(0.0299)
Law and public administration	0.0166	(0.0504)	-0.0359	(0.0382)	-0.0559**	(0.0283)	-0.0035	(0.0317)	-0.0693*	(0.0420)	-0.1932***	(0.0310)
Medical and health care	0.0202	(0.0534)	0.0294	(0.0407)	0.0628*	(0.0361)	0.1574***	(0.0383)	-0.1067***	(0.0403)	-0.0844**	(0.0430)
Non-medical healthcare, body care, wellness and medical technicians	0.1371**	(0.0552)	0.0049	(0.0454)	0.0981**	(0.0443)	0.3827***	(0.0487)	-0.0727	(0.0460)	-0.0636	(0.0482)
Education and social work, housekeeping, and theology	-0.1628***	(0.0468)	-0.0485	(0.0350)	0.1031***	(0.0370)	0.0882**	(0.0347)	-0.0778**	(0.0387)	-0.0784**	(0.0386)
Teaching and training	-0.1086*	(0.0619)	-0.0771*	(0.0397)	0.0574	(0.0476)	0.1151**	(0.0496)	-0.1028**	(0.0470)	-0.0971**	(0.0467)
Philology, literature, humanities, social sciences, and economics	-0.1934*	(0.1039)	0.0317	(0.0952)	-0.0238	(0.0661)	0.0407	(0.0913)	-0.0434	(0.1007)	-0.0200	(0.0872)
Advertising and marketing, in commercial and editorial media design	0.0094	(0.0492)	-0.0350	(0.0344)	0.0008	(0.0306)	0.0386	(0.0326)	-0.0789**	(0.0401)	-0.1226***	(0.0354)
Product design, artisan craftwork, fine arts and the making of musical instruments	0.1438	(0.1371)	-0.0469	(0.1056)	0.0000	(.)	0.0000	(.)	0.0613	(0.1790)	0.0000	(.)
Performing arts and entertainment	0.0283	(0.0880)	0.0595	(0.0746)	0.1406*	(0.0808)	0.3808***	(0.0869)	-0.0677	(0.0701)	0.1530	(0.0967)
Other occupations	-0.0643	(0.0403)	-0.0258	(0.0299)	0.0179	(0.0266)	0.0598**	(0.0271)	-0.0109	(0.0359)	-0.1275***	(0.0309)
Reason for hiring (ref. Long-term additional demand)												
Temporary additional demand/seasonal demand	-0.0258	(0.0253)	-0.0731***	(0.0197)	-0.0305*	(0.0180)	-0.0479***	(0.0146)	-0.0094	(0.0225)	-0.0609***	(0.0171)
Temporary replacement	-0.0311	(0.0268)	-0.0082	(0.0219)	0.0128	(0.0197)	-0.0322**	(0.0152)	-0.0274	(0.0228)	0.0641***	(0.0225)
Long-term replacement	-0.0174	(0.0127)	-0.0113	(0.0101)	0.0096	(0.0092)	-0.0086	(0.0083)	0.0037	(0.0107)	0.0326***	(0.0095)
Working hours (ref. > 36)												
< 20	-0.1368***	(0.0336)	-0.0434	(0.0282)	-0.0140	(0.0245)	-0.0498**	(0.0201)	-0.0775***	(0.0259)	-0.0793***	(0.0231)
20 - 36	-0.0765***	(0.0155)	-0.0090	(0.0125)	0.0087	(0.0113)	0.0014	(0.0094)	-0.0155	(0.0133)	-0.0615***	(0.0109)

	Deadline pressure		Working overtime		Changes in working time at short notice		Working at weekends		Changes in work content at short notice		Changes in place of work	
	AME	SE	AME	SE	AME	SE	AME	SE	AME	SE	AME	SE
Required competences (ref. no)												
Leadership competence	0.1340***	(0.0236)	0.0970***	(0.0201)	0.0814***	(0.0187)	0.0399**	(0.0192)	0.0798***	(0.0201)	0.0281	(0.0172)
Social, team and communicative competence	0.0487***	(0.0165)	0.0140	(0.0130)	0.0385***	(0.0127)	-0.0005	(0.0113)	0.0271*	(0.0141)	0.0335***	(0.0127)
Knowledge of foreign languages	0.0175	(0.0243)	0.0708***	(0.0204)	0.0057	(0.0164)	0.0205	(0.0182)	-0.0289*	(0.0174)	0.0241	(0.0185)
Intercultural competence	0.0301	(0.0290)	0.0437**	(0.0222)	0.0766***	(0.0221)	0.0484**	(0.0207)	0.1304***	(0.0269)	0.0680***	(0.0226)
Knowledge from further training	0.0295*	(0.0166)	0.0101	(0.0124)	0.0175	(0.0119)	0.0127	(0.0114)	0.0251*	(0.0135)	0.0004	(0.0115)
Longer experience in this occupational field	0.0546***	(0.0151)	0.0314***	(0.0118)	0.0035	(0.0106)	-0.0031	(0.0098)	0.0311**	(0.0126)	0.0187*	(0.0111)
N	6,818		6,787		6,766		6,789		6,747		6,681	

AME= average marginal effects, SE=standard errors

Source: IAB-Job Vacancy Survey IV/2015, own calculations.

Table A8
Significant effects of digitalisation – an overview

	Internal digitalisation			External digitalisation			Use of learning systems		
	starting	slight further	strong further	starting	slight further	strong further	starting	slight further	strong further
Employment									
hirings						+			+
separations									+
job vacancies	+	+	+						
abandoned search	+	+	+						
labour shortages	+	+	+						
Recruitment duration			+						+
Hiring wage								+	
Qualification level									
unskilled									
vocational training									
master craftsman/technician						+			+
bachelor		+	+						
Master/diploma/PhD		+	+	+					
Special requirements									
experience						+			
further training		+	+					+	+
intercultural competence				+					+
foreign languages									
social competence		+	+	+				+	+
leadership								+	+
Special working conditions									
deadline pressure				+		+	+		
working overtime			+	+					
changes in working time						+			
changes in place of work									
changes in work content	+	+	+		+	+			
working at weekends	+								

+ statistically significant positive effects, - statistically significant negative effects
(statistically significant at the 0.1 level at least)

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