# II Research Papers

# Paper 1 All becoming jacks of all trades? Multitasking as a result of outsourcing and digitalisation

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**Abstract**

In this paper, we study "multitasking" within individual jobs based on the task approach. Utilising German panel data, we show that both digitalisation and outsourcing increase the number of tasks – and surprisingly, these effects are most evident for low-skilled occupations. More multitasking is associated with higher employability, but not with more training for employees in low-skilled occupations. Future research should investigate effects of multitasking on other aspects such as workload, job satisfaction, or wages.

## 1 Introduction

Many employees perform more than one type of activity in their job. This type of "multitasking" has been demonstrated to matter for employees and society as a whole. For example, multitasking appears to be associated with higher job satisfaction (Fahr, 2011; Hackman & Oldham, 1975) and less labour turnover and burnout (Zaniboni et al., 2013). Multitasking also affects income inequality because higher-skilled and better-paid employees are usually able to multitask (Goerlich & Snower, 2013; Wilmers, 2020). For example, entrepreneurs are considered jacks of all trades: generalists who need to perform various tasks and need to hold various skills (Lazear, 2004).

Though multitasking appears to be more common in high-skilled occupations, Lindbeck and Snower (2000) and Boucekkine and Crifo (2008) predict an increase in multitasking for many occupations as a result of digitalisation and outsourcing. Digitalisation may comprise new information and communication technologies (ICT), which enable further communication and

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decision-making tasks, or advanced manufacturing technologies (AMT) that often involve new complex tasks. Growing globalisation and the outsourcing of activities to less affluent countries also appear to be linked to increased multitasking in richer countries. Empirical literature has demonstrated that both factors increase specialisation at company level in the sense that the range of different occupational groups in companies is decreasing (Cortes & Salvatori, 2019; Handwerker & Spletzer, 2016). In other words, digitalisation and outsourcing cost jobs and these job losses coincide with fewer occupations. What is not clear, however, is how the job requirements for workers who stay in firms will change (cf. Ochsenfeld, 2018). When firms outsource activities or introduce new ICT or AMT, will employees take on more or fewer tasks in their job?

We address this question using the German employer-employee panel survey "WeLL" (Further Training as a Part of Lifelong Learning). In addition to following calls for panel data and direct replies from employees (Bayo-Moriones et al., 2017), our paper contributes to the literature in three specific ways. First, we track details on the kind of tasks workers perform in line with the task approach. This task-based operationalisation is expected to provide higher validity than subjective assessments by workers or their supervisors (Bayo-Moriones et al., 2017). Secondly, we test the effects of digitalisation and outsourcing as separate, independent factors influencing multitasking. Usually, economists consider both factors to be highly related as digitalisation facilitates outsourcing (Abramovsky & Griffith, 2006; Bernhardt et al., 2016). But recent research has shown that outsourcing can as well be motivated by firms' rent-seeking behaviour (Goldschmidt & Schmieder, 2017) such that independent effects of outsourcing on multitasking are possible. Lastly, as suggested by Bayo-Moriones et al. (2017), our analysis allows us to determine the type of occupations whose tasks are most affected by an increase in multitasking resulting from digitalisation and outsourcing. This is important because the connection between the tasks of a job, including multitasking, and its quality may differ between occupations and positions in the labour market (e.g. Findlay et al., 2013). So far, many propositions have rested on the assumption that particularly the tasks in high-skilled occupations have been widening due to digitalisation and outsourcing (Bayo-Moriones et al., 2017; Goerlich & Snower, 2013; Lindbeck & Snower, 2000; Wilmers, 2020). However, it is still possible that employees in lower-skilled occupations may also face increases in multitasking with potential positive but also negative consequences. Hence, our analyses enable us to reveal more detailed consequences and recommendations for action.

We find that the average number of tasks performed by employees has increased and that digitalisation and outsourcing strongly drive individual increases. In line with previous statements, we also find that AMT significantly affected multitasking of workers in high-skilled but not low-skilled occupations. However, contrary to earlier suggestions, our main finding is that new ICT and outsourcing only significantly widened the tasks of employees in low-skilled occupations. In addition, we reveal that the increase in multitasking is generally connected to a higher employability of workers. It is also related to training – but only for employees in high-skilled occupations. These findings may explain intensified work stress after digitalisation (e.g. Atanasoff & Venable, 2017) and thus have important practical implications for the provision of targeted training.

## 2 Theoretical effects of new ICT and AMT on multitasking

The empirical analysis of this paper is guided by the theoretical suggestions of Lindbeck and Snower (2000). Although this study has received less attention than other popular contributions on changing task profiles, we believe it is particularly important for understanding how work tasks will change in the future. While frequently considered theories, such as the routine-biased technological change approach by Autor et al. (2003), focus primarily on the substitution of tasks and thus the elimination of jobs through digitalisation, Lindbeck and Snower (2000) seek to explain how the tasks of jobs that remain will change (Eisele & Schneider, 2020). In this study, we also focus on workers who keep their jobs and stay employed in their organisations.

Lindbeck and Snower (2000) predict a shift from Tayloristic to holistic organisations. At the core of these two categories are employees' task profiles. When the workforce heavily specialises in a few tasks, the organisation is described to be Tayloristic. Task profiles of large US firms used to be narrower in previous times (Baron & Bielby, 1984). However, as the organisational structures in large firms eroded (Cappelli, 2001), companies have become more holistic and workers have been given more responsibility over a broader range of tasks (Lindbeck & Snower, 2000).

Lindbeck and Snower (2000) and Boucekkine and Crifo (2008) also discuss the factors that drive the reorganisation process towards holistic organisations and thus the increase in multitasking. At the centre of their studies is digitalisation taking place in two forms. First, they suggest that new ICT can increase multitasking by giving workers easier access to information, which facilitates the decentralisation of decision-making in companies and allows workers to

take on new responsibilities such as communication and decision-making tasks and participate in their colleagues' tasks. Second, AMT have become more capable of performing different tasks thereby leading to decreasing economies of scale, reduced setup and changeover costs and shorter production cycles. Workers who control these technologies may similarly need to cope with a wider spectrum of tasks.

Up to now, only few studies have tested broad-based effects of digitalisation on individual work characteristics (Bayo-Moriones et al., 2017; Winkelhaus et al., 2022), thus also including the suggested effects by Lindbeck and Snower (2000). Some studies draw connections to important work characteristics such as job autonomy and work intensification as reviewed by Wang et al. (2020) or Atanasoff and Venable (2017). Meyer et al. (2019) also summarise studies for the German context (Ahlers, 2018; Holler, 2017; Meyer & Huenefeld, 2018). This review also includes an important study by Arnold et al. (2016), which shows that multitasking may mediate these connections as German employees express their need to perform multiple tasks as a result of new technologies (cf. Davis and Hufnagel (2007) for a survey of employees in UK policy agencies). Two recent studies also find direct connections between digitalisation and task variety by means of regression analyses (Bayo-Moriones et al. (2017) for Spanish manufacturing establishments; Eisele and Schneider (2020) for British establishments). However, both studies only identify insignificant relationships. Though the links put forth by Lindbeck and Snower (2000) are highly plausible, comprehensive robust empirical evidence is still missing. Thus, we will test the following hypothesis:

> *Hypothesis 1a: Digitalisation (new information and communication technologies (ICT) and advanced manufacturing technologies (AMT)) increases multitasking.*

Bayo-Moriones et al. (2017) are the first to suggest that the effects of both technologies on multitasking may diverge between different types of workers. As they could not find robust empirical evidence of the effect for lower-skilled production workers, they assume that the effects of ICT and IMT on multitasking should be stronger for high-skilled occupations. ICT especially widens new possibilities of communication for high-skilled occupations such as those in commercial or management. AMT is expected to have a higher impact in high-skilled occupations because they entail significantly more complex tasks that can no longer be performed by purely operational staff but rather by highly qualified employees such as engineers and IT specialists (Bayo-Moriones et al., 2010). Consequently, they underline the need for

empirical findings that distinguish between different occupations, which are not yet available (cf. Absenger et al., 2016; Haertwig & Sapronova, 2021). We hypothesise:

> *Hypothesis 1b: In high-skilled occupations, digitalisation (ICT and AMT) increases the multitasking of workers more than of those in low-skilled occupations.*

Although Bayo-Moriones et al. (2017) do not find statistically significant effects for production workers, they nevertheless assume that effects also exist for low-skilled workers. The strength of the effect is expected to vary depending on whether ICT or AMT has been introduced. Based on Wall et al. (1992), they argue that, for employees in low-skilled occupations, AMT should have a lower effect on multitasking because production technologies will reduce the number of routine tasks, leading to more Tayloristic task profiles. ICT, on the other hand, will have a greater positive impact on multitasking by allowing easier access to information and new communication tasks. Bayo-Moriones et al. (2017) were not able to find support for their suggestions, yet we find the theoretical arguments convincing and therefore hypothesise:

> *Hypothesis 1c: In low-skilled occupations, new information and communication technologies (ICT) increase multitasking more strongly than advanced manufacturing technologies (AMT) do.*

## 3 Theoretical effects of outsourcing on multitasking

The framework suggested by Lindbeck and Snower (2000) has also important implications for decisions to substitute certain jobs. If workers can perform a wide range of tasks that pervades several traditional occupations, companies will likely specialise by reducing the number of different occupations. Hence, the shift to holistic organisations seems to be inherently connected to firms' specialisation measures. In other words, firms seem to specialise in multitaskers. The most common measure to increase specialisation is outsourcing as Peter Drucker states: "Do what you do best and outsource the rest". Consequently, outsourcing increases the homogeneity of tasks within firms (Rawley & Simcoe, 2010). Lindbeck and Snower (2000) also argue that managerial innovations such as lean production foster multitasking and that the expansion of international trade and offshoring are important factors that particularly lead to holistic organisations in richer countries.

Economists widely believe that trends in digitalisation and outsourcing are related: New ICT was a reason for increasing outsourcing because these technologies reduce market transaction and monitoring costs (Bernhardt et al., 2016), which is also empirically supported by Abramovsky and Griffith (2006). If this is true and outsourcing is the result only of technological change, its effect on task profiles should be fully absorbed by the effect of technological change. However, recent research has shown that outsourcing can also be motivated by firms' saving on firm-specific wage premia rather than by lower transaction costs due to digitalisation (Goldschmidt & Schmieder, 2017). Thus, an independent effect of outsourcing on individual tasks is still plausible.

Empirical research on the effects of outsourcing on individual work characteristics other than wages are clearly missing and thus the suggestions by Lindbeck and Snower (2000) have not been tested yet (Cortes & Salvatori, 2019; Ochsenfeld, 2018). We hypothesise:

*Hypothesis 2a: Outsourcing increases the multitasking of remaining workers.*

In line with the skill-biased international trade thesis, Lindbeck and Snower (2000) also expect that firms mainly outsource activities that require less skill. By implication, those who primarily remain in the firm are high-skilled workers (cf. Handwerker & Spletzer, 2016). As a result, the trend towards holistic organisations and multitasking predominantly affects high-skilled workers. Of course, empirical analyses for different occupations are equally missing. We propose:

*Hypothesis 2b: Outsourcing particularly increases the multitasking of workers in high-skilled occupations.*

Figure 1 summarises all five hypotheses.

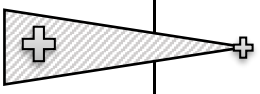
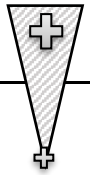
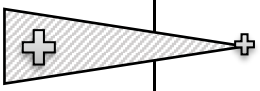
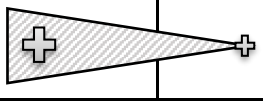
| Specialisation measure | Multitasking | | |
|---|---|---|---|
| | Overall | High-skilled occupations | Low-skilled occupations |
| New ICT | + |  |  |
| New AMT | + |  |  |
| Outsourcing | + |  | |

**Figure 1 Hypotheses on the effects of specialisation measures on multitasking**

*Source*: Own compilation.

*Note*:  = larger effect at the left side of the triangle.
ICT = Information and communication technologies. AMT = Advanced manufacturing technologies.

# 4 Empirical analysis

## 4.1 Data and variables

The German employer-employee survey "WeLL" (Further Training as a Part of Lifelong Learning) by the Institute for Employment Research contains detailed individual-level information on the actual tasks employees perform along with data on the digitalisation of employees' workplaces and information on whether employees are affected by outsourcing activities. The WeLL comprises four survey waves in 2007, 2008, 2009 and 2010. In the original survey, 6,400 employees from 149 establishments were interviewed. To obtain a representative picture of German labour market structures, the establishments for the survey were selected based on establishment size, sector and regional location. For the selected establishments, a random sample of employees was drawn rather than a full survey. We only use balanced data, meaning that only those respondents who were interviewed in all four survey waves are considered. As this implies, we focus solely on respondents who remain in the company over the survey period. After excluding employees in occupations with very few observations (e.g. in agriculture and fisheries), data for 2,076 employees remain.

The dependent variable is the degree to which workers need to perform multiple task types (Number of Task Types). To operationalise multitasking, we use information on the kind of

tasks workers perform. For twelve different task types, workers were asked whether they frequently, rarely or never perform each of them (Table 1). Following Goerlich and Snower (2013), we calculate the sum of tasks workers perform as a measure of the degree of multitasking. A task is considered to be performed if respondents indicated that it occurs (frequently or rarely) in their work. Consequently, this sum ranges from 0 to 12 and reflects low or high levels of multitasking, respectively.

**Table 1 The survey question on task types**

| Question: I will now list some selected activities. Please indicate how often (possible answers: frequently (2), rarely (1), never (0), don't know) these activities occur in your work. |
|---|
| - Fabricating and producing goods |
| - Supervising and controlling machines |
| - Nursing, serving and healing |
| - Repairing, patching |
| - Gathering information and investigating |
| - Developing and researching |
| - Measuring, controlling and quality checks |
| - Buying, providing and selling |
| - Informing and advising |
| - Organising and planning |
| - Negotiating |
| - Training, teaching and educating |

*Source:* WeLL data by Institute for Employment Research.

The two main independent variables are digitalisation and outsourcing. Digitalisation is measured by two variables as it basically occurs in two forms (Lindbeck & Snower, 2000). The first variable asks whether work has been affected by the introduction of new production techniques and accordingly covers AMT (New AMT). The second variable asks whether the equipment of workplaces with ICT changed or whether workers use new software (New ICT). As suggested by Bayo-Moriones et al. (2017), we include both variables simultaneously in the regressions to examine independent effects.

Outsourcing is measured based on the following question: “Was your work affected by outsourcing activities to other companies or by bringing back outsourced activities to your company?“. Thus, we consider task profiles of employees who are indirectly affected by outsourcing measures but remain employed in the company. Whereas earlier research usually concentrates on employees who themselves have been outsourced (Goldschmidt & Schmieder, 2017), a recent study by Ochsenfeld (2018) analyses the effects of firms’ outsourcing activities on workers who stay.

The variable is formulated to include both the outsourcing and the bringing back of activities. But given the trends toward lean management (Lindbeck & Snower, 2000) and away from internal- towards market-based employment relationships (Cobb, 2016), it is more likely that firms outsource activities rather than re-establishing traditional organisational structures (Vosko, 2010). Though the variable does not precisely measure what we are interested in, it is of high value because data on outsourcing are scarce at the firm level (Cortes & Salvatori, 2019) and not directly available at the individual level (Bernhardt et al., 2016). Complex approaches to identifying individual workers who are outsourced (Goldschmidt & Schmieder, 2017) cannot be applied to workers who stay. To probe into the validity of the measure, we combined this variable with another variable that captures employees' perceived probability that outsourcing will take place within the next 12 months.

Some control variables were included. First, the number of official working hours (contractually agreed number of working hours excluding overtime) were included. If workers are employed for more hours, they likely perform a wider range of tasks. Given this information, we are not obliged to limit our sample to a homogenous group of employees (i.e. full-time employees) as done in other studies (Baumgarten et al., 2020; Ochsenfeld, 2018). Second, workers who are permanently employed may be particularly capable of handling multiple tasks and switching between them. Therefore, we control whether workers have a temporary contract (reference category: Permanent Contract). Following the same conception, we control for employees in marginal employment, i.e. those with gross earnings of 400€. These workers may only accomplish a very narrow range of tasks but their task profiles may still change. By contrast, employees who have managerial responsibilities likely have to perform more tasks, which is why we control whether the employees' tasks include managing employees or leading a team, a division or parts of an operation. In general, by estimating the effects of these variables, we also further probe into the plausibility of our constructs and the regression model. Plausible coefficients of main and control variables can then be compared to assess effect sizes. Descriptive statistics are summarised in Table 2.

**Table 2 Descriptive statistics**

| Variable | Observations | Mean | Std. dev. | Min | Max |
|---|---|---|---|---|---|
| Number of Task Types | 114,180 | 7.113 | 2.721 | 1 | 12 |
| New AMT | 112,082 | 0.191 | 0.393 | 0 | 1 |
| New ICT | 97,766 | 0.429 | 0.495 | 0 | 1 |
| Outsourcing | 111,636 | 0.215 | 0.411 | 0 | 1 |
| Working Hours | 111,048 | 35.767 | 7.934 | 0 | 78.5 |
| Temporarily Employed | 112,077 | 0.0351 | 0.184 | 0 | 1 |
| Marginally Employed | 112,060 | 0.0146 | 0.120 | 0 | 1 |
| Leadership | 112,100 | 0.815 | 0.870 | 0 | 2 |

*Source*: Own calculations based on WeLL data by Institute for Employment Research.
*Notes:* ICT = Information and communication technologies. AMT = Advanced manufacturing technologies.

## 4.2 Descriptive results

We first demonstrate that some stylised patterns that had been identified in previous literature and on which we have built our analysis are also visible in our data. When firms specialise, this will reduce the variety of occupations (Cortes & Salvatori, 2019; Handwerker & Spletzer, 2016) and increase the homogeneity of tasks within firms (Rawley & Simcoe, 2010). In line with this trend, the task profiles within companies in our data have become more aligned over time. More precisely, the average distance of task profiles, i.e. the averaged Mahalanobis distance of the task profile of individual employees to other employees in the company, has decreased significantly over time (from 3.45 to 3.34). The Mahalanobis distance (Mahalanobis, 1936) is used because it is suitable for calculating distances between points in a multidimensional vector space, here consisting of different task types (Procedure in line with Hellweg, 2020). Unlike common measures such as Euclidean distance, it takes into account not only the mean distance but also the distribution of observations, allowing more accurate results to be obtained. Importantly, we find that this increasing alignment of tasks is not the result of a convergence towards a narrower set of tasks. Instead, in line with the theoretical literature, the average number of task types performed by all employees increased over time (from 6.9 to 7.3).

In the next step, we report some descriptive support that the two fundamental explanations, digitalisation and outsourcing, seem to have increased multitasking. Figure 2 and 3 provides cross-sectional results (2007—2010) showing that, on average, workers who are affected by

digitalisation perform a higher number of task types. This is in line with *Hypothesis 1a*. Moreover, Figures 2 and 3 split findings for different occupational groups providing first evidence on *Hypotheses 1b* and *1c*. *Hypothesis 1b* says that new ICT and AMT increase multitasking more among workers in high-skilled occupations than among those in low-skilled occupations. This hypothesis receives less support. The potential effects of digitalisation are not substantially higher for high-skilled occupations on the left side of the figures (high ISCO skill level). For new ICT, they are substantially lower. *Hypothesis 1c* states that in low-skilled occupations, new ICT will increase multitasking more than new AMT do. In the descriptive findings, substantial differences between the potential effects of new ICT and AMT cannot be identified for low-skilled occupations, located on the right side of the two figures (those requiring a low level of education and task complexity, i.e. a low ISCO skill level).

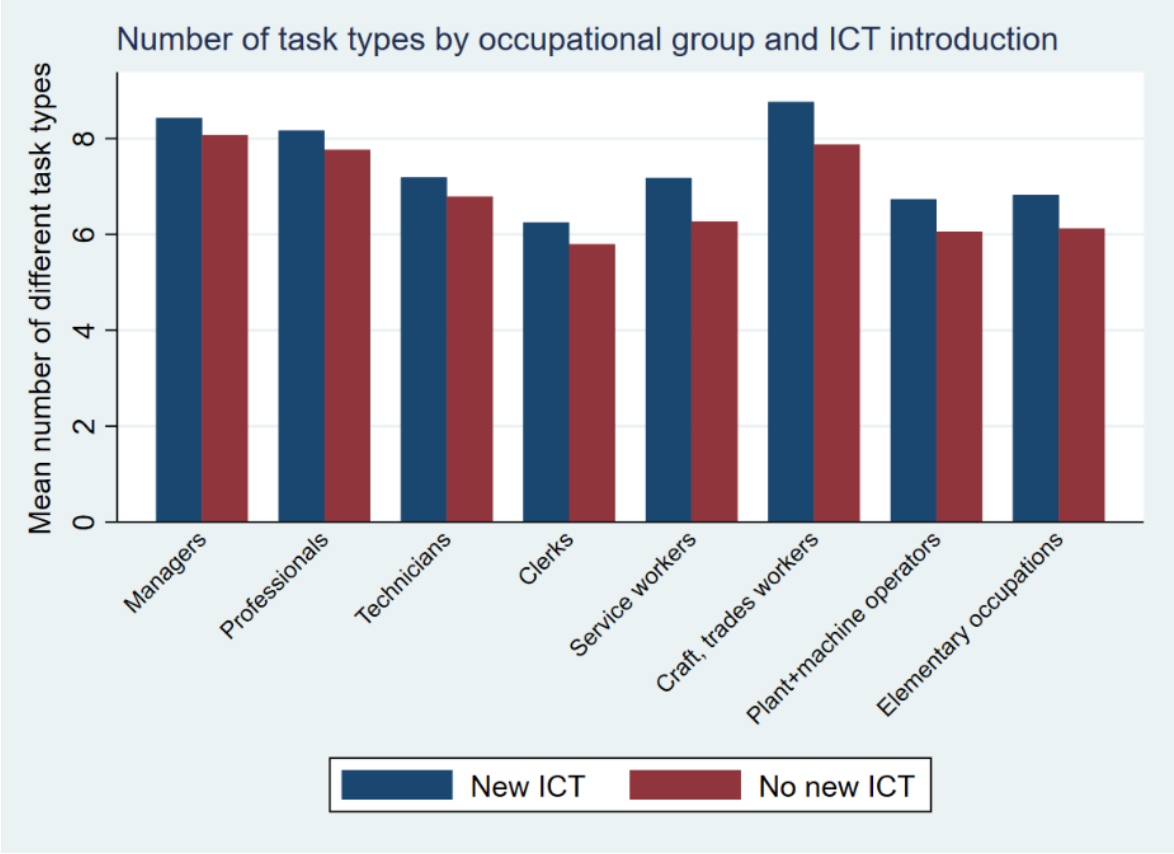



**Figure 2 Workers affected by ICT implementation perform more task types**

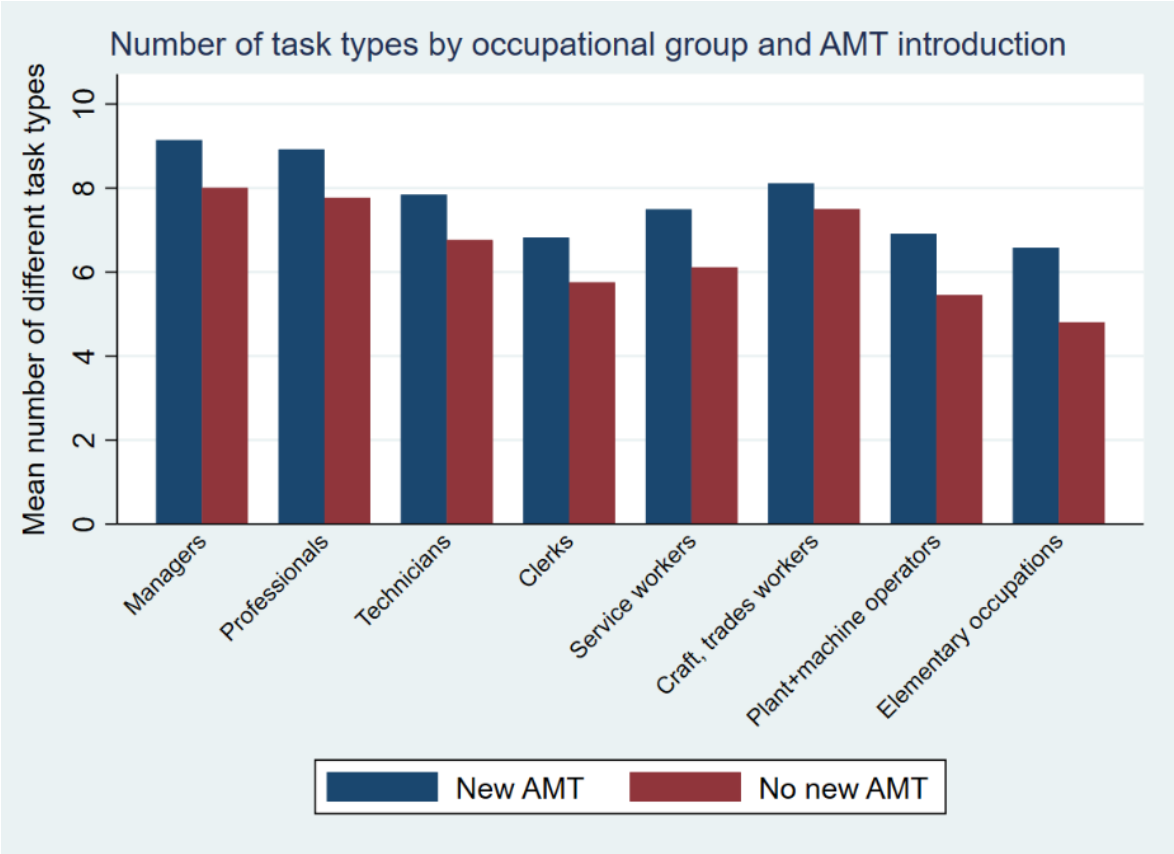



**Figure 3 Workers affected by AMT implementation perform more task types**

*Source*: Own calculations based on WeLL data by Institute for Employment Research.

*Note:* ICT = Information and communication technologies. AMT = Advanced manufacturing technologies. Cross-sectional comparison across survey periods. Occupational groups based on one-digit ISCO-88. Descending order of occupations in terms of their ISCO skill levels in the right direction.

Figure 4 replicates the results for outsourcing. In line with *Hypothesis 2a*, workers who are affected by outsourcing perform a higher average number of task types. Contrary to *Hypothesis 2b*, which states that outsourcing particularly increases multitasking in high-skilled occupations, it seems that the effects of multitasking are stronger in low-skilled occupations.

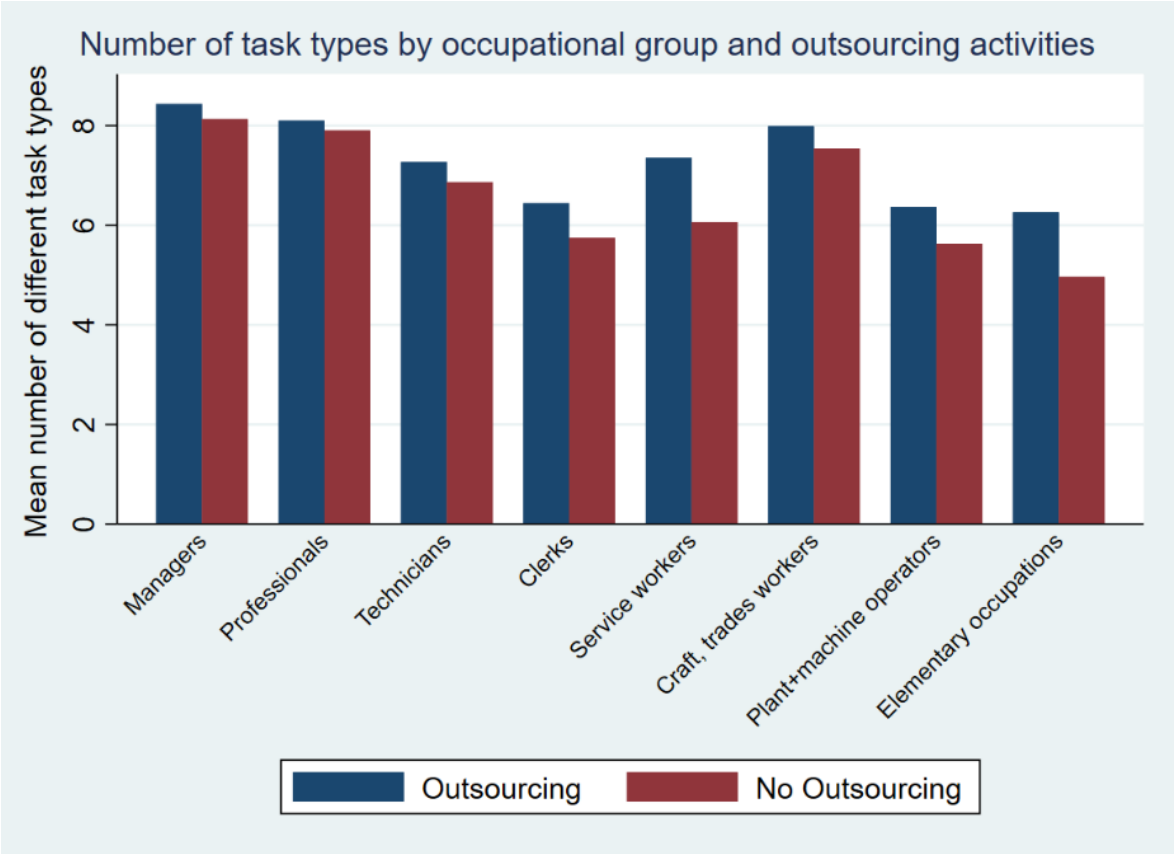



**Figure 4 Workers affected by outsourcing perform more task types**

*Source*: Own calculations based on WeLL data by Institute for Employment Research.

*Note:* Cross-sectional comparison across survey periods. Occupational groups based on one-digit ISCO-88. Descending order of occupations in terms of their ISCO skill levels in the right direction.

In sum, the descriptive findings provide first initial evidence that digitalisation and outsourcing may increase multitasking. However, they also suggest that, contrary to expectations, potential effects apply more strongly to workers in low-skilled occupations.

## 4.3 Regression analysis

We conduct a fixed-effects panel analysis of the following model:

$$Number\ Of\ Task\ Types_{ti} = \beta_{0i} + \beta_{1i} * New\ AMT_{ti} + \beta_{2i} * New\ ICT_{ti} + \beta_{3i} * Outsourcing_{ti}$$

$$+ \beta_{mi} * control\ variables_{ti} + d_t + e_{ti}\ where\ d_t = wave\ dummy, e_{ti} = error\ term$$

In Table 3, the regression results show that workers who were affected by new ICT (0.136***) and those who were affected by new AMT (0.192***) perform, on average, a significantly higher number of different work tasks (Model 1). Employees who were affected by outsourcing (0.111**) also perform significantly more tasks on average. Hence, the two explanations appear to be important such that *Hypotheses 1a* and *2a* are empirically supported.

**Table 3 Effects of digitalisation and outsourcing on multitasking**

| Number of Task Types | (1) | (2) | (3) | (4) | (5) | (6) Low-skilled occupation | (7) High-skilled occupation |
|---|---|---|---|---|---|---|---|
| New AMT | 0.204*** | 0.198*** | 0.195*** | 0.197*** | **0.192*** ** | **0.087** | **0.257*** ** |
| | (0.07) | (0.069) | (0.069) | (0.069) | (0.069) | (0.120) | (0.082) |
| New ICT | 0.162*** | 0.147*** | 0.143*** | 0.141*** | **0.136*** ** | **0.301*** ** | **0.058** |
| | (0.049) | (0.049) | (0.049) | (0.049) | (0.049) | (0.104) | (0.054) |
| Outsourcing | 0.120** | 0.120** | 0.120** | 0.114* | **0.111*** | **0.171** | **0.076** |
| | (0.060) | (0.06) | (0.06) | (0.060) | (0.06) | (0.105) | (0.073) |
| Working Hours | | 0.037*** | 0.037*** | 0.033*** | 0.031*** | 0.029* | 0.032*** |
| | | (0.008) | (0.008) | (0.008) | (0.008) | (0.015) | (0.008) |
| Temporarily Employed | | | -0.298 | -0.298 | -0.253 | -0.444 | -0.173 |
| | | | (0.187) | (0.187) | (0.182) | (0.284) | (0.236) |
| Marginally Employed | | | | -0.729** | -0.655** | -0.687* | -0.709 |
| | | | | (0.293) | (0.286) | (0.389) | (0.470) |
| Leadership Occasionally | | | | | 0.320*** | 0.242* | 0.363*** |
| | | | | | (0.073) | (0.133) | (0.086) |
| Leadership Regularly | | | | | 0.626*** | 0.630*** | 0.646*** |
| | | | | | (0.100) | (0.180) | (0.122) |
| Waves | ✓ | ✓ | ✓ | ✓ | ✓ | - | - |
| Constant | 7.309*** | 5.996*** | 6.011*** | 6.137*** | 5.934*** | 5.884*** | 5.959*** |
| | (0.0398) | (0.288) | (0.286) | (0.285) | (0.281) | (0.571) | (0.311) |
| Number of observations | 96,019 | 96,019 | 96,019 | 96,019 | 96,019 | 32,548 | 61,922 |
| Number of groups | 1,936 | 1,936 | 1,936 | 1,936 | 1,936 | 714 | 1,190 |
| $R^2$ (within) | 0.0262 | 0.0352 | 0.0360 | 0.0381 | 0.0478 | 0.056 | 0.0467 |
| $R^2$ (between) | 0.0390 | 0.0478 | 0.0488 | 0.0498 | 0.1816 | 0.1679 | 0.1754 |
| $R^2$ (overall) | 0.0276 | 0.0450 | 0.0454 | 0.0471 | 0.1454 | 0.1358 | 0.1378 |

*Source*: Own calculations based on WeLL data by Institute for Employment Research.
*Note*: Levels of significance: * p<0.1; ** p<0.05; *** p<0.01; standard errors in parentheses.
ICT = Information and communication technologies. AMT = Advanced manufacturing technologies.
Skill level is based on the ISCO classification of occupational groups (Elias, 1997).

Control variables are gradually added in models 2 to 5. As expected, adding one hour of official working time significantly increases the number of performed tasks (0.031***). Changing into a permanent contract increases the number of task types, which is in line with our expectations though insignificant (-0.253 for temporary employment). As assumed, working under marginal employment significantly reduces the number of task types (-0.655***). With increased leadership responsibility, the number of work tasks increases (0.320*** for leadership

occasionally and 0.626*** for leadership regularly). Consequently, the applied variables and the regression model seem plausible.

Importantly, the coefficients for digitalisation and outsourcing do not change substantially when adding these control variables (Model 5). Moreover, they indicate more substantial effect sizes in comparison to the coefficients of the control variables. For example, the effect of new AMT roughly equals the effect of adding six working hours per week (0.192/0.0311). For new ICT and outsourcing, this relative effect amounts to four working hours.

To test the remaining three hypotheses (1b, 1c, 2b), Model 6 and Model 7 each use a subsample of occupations with high and low skill levels, respectively. The classification of respondents into the two groups is based on their ISCO-88 one-digit occupational group, which can be assigned to ISCO skill levels. This classification rests on the complexity and scope of the tasks and duties to be performed in the occupation. There are four different skill levels, where skill level 1 is considered low, 2 is medium and 3 and 4 are regarded as high. In Model 6, only occupations with an ISCO skill level of 1 or 2 (low and medium skill level) and in Model 7, those with ISCO skill levels of 3, 4 or 5 (high skill level) are examined.

A comparison of the two models yields the following results. The effect of new AMT on the number of task types is large and highly significant for high skilled employees in Model 7 (0.257***) and smaller and insignificant in Model 6 (0.087). This is in line with *Hypothesis 1b*, which says that digitalisation increases multitasking more in high-skilled than in low-skilled occupations. But if we look at the introduction of ICT, different results emerge. The coefficient of new ICT is small and insignificant (0.058) for high-skilled occupations but high and significant for low-skilled occupations (0.301***), which is not in line with *Hypothesis 1b*. In addition, the coefficient of outsourcing is also even smaller (0.076) than in Model 6 (0.171) such that *Hypothesis 2b* also cannot be supported. Sample sizes do not explain these differences, as they are larger for high-skilled occupations.

For low-skilled occupations (Model 6), the results show a strong and highly significant effect of the new ICT on the number of task types (0.301***). In contrast to that, the coefficient of new AMT is substantially smaller and insignificant (0.087). This pattern is in line with *Hypothesis 1c*, which states that in low-skilled occupations, new ICT increase multitasking more than new AMT do. Figure 5 summarises the findings of the main analysis.

| Specialisation measure | Multitasking | | |
|---|---|---|---|
| | Overall | High-skilled | Low-skilled |
| New ICT | + | | |
| New AMT | + | | |
| Outsourcing | + | | |

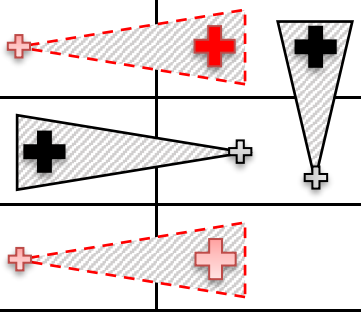
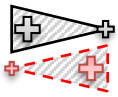


**Figure 5 Identified effects of specialisation measures on multitasking**

*Source*: Own compilation.

*Note*:  = identified effect larger at the left side of the triangle (as expected).

= identified effect larger at the right side of the triangle (different than expected).

ICT = Information and communication technologies. AMT = Advanced manufacturing technologies.

Levels of significance: Unfilled cross = p>=0.1; filled cross = p<0.1.

## 4.4 Robustness tests

We test the robustness of our findings calculating different interaction effects. Specifically, interaction effects were estimated for new AMT, new ICT and Outsourcing for 5 different skill levels (again according to the ISCO classification). The results do not show significant results for AMT and outsourcing, which could be due to the number of observations. However, significant results are found for the interaction between new ICT and skill levels. These results indicate that especially low-skilled employees, in particular elementary occupations, experience an increase in work tasks due to new ICT (for details see appendix, Table A 1). This result is in line with the descriptive comparison between low and high skilled occupational groups.

Moreover, we tested our findings using a recalculated outsourcing variable and workers' earnings as additional control variables (Table 4). First, as mentioned above, the outsourcing variable used includes both the outsourcing of activities and the reintegration of activities. To corroborate that the results refer to outsourcing, we combine the initial variable with information from a second outsourcing variable. The second item asks how employees assess the likelihood that their work will be affected by outsourcing within the next 12 months. The new variable that combines both items takes the value of 1 if respondents also indicated a medium to high probability (Outsourcing Probability). Thereby, it is likely that they refer to the outsourcing and not the reintegration of activities in the initial item.

**Table 4 Robustness tests with a recalculated outsourcing variable and with earnings as control variables**

| | *Robustness tests with Outsourcing Probability* | | | *Robustness tests with Earnings* | | |
|---|---|---|---|---|---|---|
| Number of Task Types | (1) Whole sample | (2) Low-skilled occupation | (3) High-skilled occupation | (4) Whole sample | (5) Low-skilled occupation | (6) High-skilled occupation |
| New AMT | 0.198*** | 0.0492 | 0.296*** | 0.198*** | 0.108 | 0.258*** |
| | (0.0750) | (0.128) | (0.0928) | (0.0694) | (0.120) | (0.0845) |
| New ICT | 0.137*** | 0.307*** | 0.0615 | 0.140*** | 0.293*** | 0.0673 |
| | (0.0504) | (0.109) | (0.0560) | (0.0489) | (0.106) | (0.0537) |
| Outsourcing | | | | 0.0994 | 0.151 | 0.0693 |
| | | | | (0.0615) | (0.111) | (0.0731) |
| Outsourcing Probability | **0.114** | **0.223** | **0.0473** | | | |
| | (0.0851) | (0.172) | (0.0943) | | | |
| Earnings | | | | **0.0156** | **-0.0261** | **0.0373** |
| | | | | (0.0493) | (0.0953) | (0.0596) |
| Working Hours | 0.0316*** | 0.0317** | 0.0312*** | 0.0322*** | 0.0332** | 0.0313*** |
| | (0.00774) | (0.0159) | (0.00852) | (0.00762) | (0.0154) | (0.00840) |
| Temporarily Employed | -0.265 | -0.487 | -0.164 | -0.256 | -0.379 | -0.186 |
| | (0.189) | (0.299) | (0.244) | (0.183) | (0.289) | (0.239) |
| Marginally Employed | -0.905*** | -1.105** | -0.764 | -0.739** | -0.766* | -0.706 |
| | (0.315) | (0.463) | (0.479) | (0.296) | (0.418) | (0.487) |
| Leadership Occasionally | 0.331*** | 0.234 | 0.376*** | 0.334*** | 0.244* | 0.382*** |
| | (0.0787) | (0.147) | (0.0909) | (0.0746) | (0.138) | (0.0868) |
| Leadership Regularly | 0.649*** | 0.616*** | 0.673*** | 0.640*** | 0.628*** | 0.670*** |
| | (0.106) | (0.185) | (0.130) | (0.103) | (0.185) | (0.125) |
| Waves | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Constant | 5.864*** | 5.733*** | 5.942*** | 5.755*** | 5.840*** | 5.695*** |
| | (0.289) | (0.599) | (0.318) | (0.414) | (0.804) | (0.494) |
| Number of observations | 89,279 | 29,697 | 58,077 | 94,663 | 32,215 | 60,915 |
| Number of groups | 1,930 | 711 | 1,188 | 1,934 | 713 | 1,189 |
| $R^2$ (within) | 0.0494 | 0.0615 | 0.0484 | 0.0497 | 0.0578 | 0.0495 |
| $R^2$ (between) | 0.1781 | 0.1316 | 0.1865 | 0.1829 | 0.1531 | 0.1687 |
| $R^2$ (overall) | 0.1458 | 0.1187 | 0.1501 | 0.1469 | 0.1262 | 0.1400 |

*Source*: Own calculations based on WeLL data by Institute for Employment Research.
*Note*: Levels of significance: * p<0.1; ** p<0.05; *** p<0.01; standard errors in parentheses.
ICT = Information and communication technologies. AMT = Advanced manufacturing technologies.
Skill level is based on the ISCO classification of occupational groups (Elias, 1997).

Models 1 to 3 in Table 4 show results for the whole sample and the two subsamples based on ISCO skill levels. For the whole sample, the coefficient of the new variable is similar in terms of sign and size though now insignificant (0.114). This is even more the case for the coefficients in the two subsamples but here, an interesting pattern emerges. The coefficient for low-skilled

occupations is now substantial (0.223) and the one for high-skilled occupations is marginal (0.0473). Thus, they correspond even less to *Hypothesis 2b*.

Secondly, increasing earnings may compensate for additional tasks after outsourcing or digitalisation. Therefore, we also seek to control for changes in respondents' monthly earnings (Models 4 to 6 in Table 4). The variable is only included in robustness tests because it is measured in broad categories of 500€ intervals (e.g. 500-1,000€). Hence, particularly in fixed-effects regressions, increasing earnings are unlikely to change the earnings category. In models 4 to 6, the item is included as a continuous variable in the regressions based on the whole sample and the two subsamples. As expected, due to the measurement, the coefficients are small and insignificant. Most importantly, the inclusion of this variable does not affect the coefficients for our variables of interest.

## 4.5 Analysis of further implications of multitasking

Our analysis showed that digitalisation and outsourcing contribute to an increase in multitasking. In this section, we analyse two important implications of this finding. As a first important implication, we analyse how multitasking affected the employability of workers. Secondly, we study whether increasing multitasking is accompanied by employer-financed training. Because previous research has rather concentrated on high-skilled workers and given our new finding that particularly task profiles of employees in low-skilled occupations are widening due to digitalisation and outsourcing, we analyse occupational-specific effects of multitasking on the provision of training. Surprisingly, we find that, on average, employees in high-skilled occupations receive training when they perform more task types whereas employees in low-skilled occupations do not.

To identify employability, we again calculate the (Mahalanobis) distance of the task profiles. However, this time we do not calculate distances and their averages within establishments. Instead, we calculate individual distances of task profiles to those of the whole sample or the workers' own occupational group. A lower distance means that task profiles better match task demands in the labour market such that workers can change jobs more easily (Bechichii et al., 2018; Eggenberger et al., 2018). Table 5 shows regression results of fixed-effects panel regressions of individual distances of task profiles on the number of task types.

**Table 5 Effects of multitasking on workers' employability**

| Low Employability | Workers' own occupational group | | Whole sample | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Number of Task Types | **-0.186*** ** | **-0.188*** ** | **-0.199*** ** | **-0.200*** ** |
| | (0.00958) | (0.00957) | (0.00926) | (0.00926) |
| New AMT | | 0.0295 | | 0.0219 |
| | | (0.0348) | | (0.0341) |
| New ICT | | 0.0364 | | 0.0333 |
| | | (0.0266) | | (0.0260) |
| Outsourcing | | **0.0785** ** | | **0.0722** ** |
| | | (0.0309) | | (0.0300) |
| Working Hours | 0.00464 | 0.00450 | 0.00562* | 0.00550* |
| | (0.00318) | (0.00318) | (0.00300) | (0.00300) |
| Temporarily Employed | -0.166* | -0.158 | -0.166* | -0.159 |
| | (0.0990) | (0.0984) | (0.0977) | (0.0972) |
| Marginally Employed | 0.247 | 0.260 | 0.272 | 0.285* |
| | (0.169) | (0.171) | (0.166) | (0.167) |
| Leadership Occasionally | 0.0270 | 0.0228 | 0.0260 | 0.0222 |
| | (0.0399) | (0.0399) | (0.0390) | (0.0390) |
| Leadership Regularly | 0.168*** | 0.167*** | 0.172*** | 0.171*** |
| | (0.0560) | (0.0558) | (0.0556) | (0.0554) |
| Waves | ✓ | ✓ | ✓ | ✓ |
| Constant | 1.030*** | 1.016*** | 1.136*** | 1.123*** |
| | (0.129) | (0.128) | (0.122) | (0.121) |
| Number of observations | 94,546 | 94,546 | 94,546 | 94,546 |
| Number of groups | 1,906 | 1,906 | 1,906 | 1,906 |
| $R^2$ (within) | 0.1213 | 0.1231 | 0.1269 | 0.1284 |
| $R^2$ (between) | 0.0263 | 0.0278 | 0.0462 | 0.0481 |
| $R^2$ (overall) | 0.0498 | 0.0521 | 0.0617 | 0.0639 |

*Source*: Own calculations based on WeLL data by Institute for Employment Research.
*Note*: Levels of significance: * p<0.1; ** p<0.05; *** p<0.01; standard errors in parentheses.
ICT = Information and communication technologies. AMT = Advanced manufacturing technologies.
Employability is measured using the Mahalanobis distance. Here, it measures the distance of the employee's task profile from the task profiles of other employees in the same occupation or the whole labour market. The higher the distance, the lower the employability. For details on the distance measure see Mahalanobis (1936).

In Model 1 and Model 2, the distances are calculated to workers' own occupational group based on one-digit ISCO-88. A highly significant negative coefficient of the number of task types is identified. Thus, multitasking decreases the distance and correspondingly increases employability. The effect of multitasking also seems to be substantial, as performing one further task decreases the distance by roughly 18 percent compared to the intercept (e.g. 0.188/1.016).

In Model 2, the variables for digitalisation and outsourcing are added. The size of the coefficient of the number of task types remains virtually identical. The small and insignificant coefficients of digitalisation suggest that working with new technologies does not per se increase employability. With a positive and significant coefficient, outsourcing decreases the employability of remaining workers. However, when these workers handle more task types after the outsourcing event, they can seemingly attenuate this decreasing effect of outsourcing (though a more detailed empirical analysis of these connections is pending). In Model 3 and Model 4, the distance is calculated to the whole sample and coefficients of the number of task types remain similar.

In Table 6, we test the impact of multitasking, new AMT, new ICT and outsourcing on the probability of receiving employer-financed training using panel regressions. To examine the impact of the educational level of the occupation on these relationships, we also estimate various interaction effects. For the analysis, respondents were excluded from the sample who stated that they had not undertaken any further training because they were constantly learning everything they needed to in the course of their work and their qualifications were sufficient. A clear difference is identified: Workers in high-skilled occupations are, on average, more likely to receive training after increases in multitasking, which is not the case in low-skilled occupations. A similar pattern is also found for digitalisation. Notably, new AMTs have a statistically significant negative effect on training in low-skilled occupations since it may replace tasks. Outsourcing has no significant effect on the receipt of employer-financed training.

**Table 6 Effects of multitasking on training measures**

| Employer-financed Training (0/1) | (1) Interaction Skill Level and Number of Task Types | (2) Interaction Skill Level and New AMT | (3) Interaction Skill Level and New ICT | (4) Interaction Skill Level and Outsourcing |
|---|---|---|---|---|
| Holistic (Number of Task Types) | **-0.00809*** ** | 0.00165 | 0.00202 | 0.00191 |
| | (0.00306) | (0.00270) | (0.00272) | (0.00272) |
| Holistic*High-skilled occupation | **0.0156*** ** | | | |
| | (0.00465) | | | |
| New AMT | 0.00884 | **-0.0304** ** | 0.0104 | 0.00979 |
| | (0.0119) | (0.0139) | (0.0119) | (0.0119) |
| New AMT*High-skilled occupation | | **0.0631*** ** | | |
| | | (0.0215) | | |
| New ICT | 0.0194** | 0.0190** | **-0.00298** | 0.0188** |
| | (0.00880) | (0.00878) | (0.0140) | (0.00879) |
| New ICT*High-skilled occupation | | | **0.0295*** | |
| | | | (0.0173) | |
| Outsourcing | -0.00688 | -0.00677 | -0.00637 | **-0.0147** |
| | (0.0109) | (0.0109) | (0.0109) | (0.0163) |
| High-skilled occupation*Outsourcing | | | | **0.0119** |
| | | | | (0.0216) |
| Working Hours | -0.000839 | -0.000762 | -0.000792 | -0.000844 |
| | (0.000963) | (0.000972) | (0.000971) | (0.000975) |
| Temporarily Employed | -0.0190 | -0.0181 | -0.0162 | -0.0172 |
| | (0.0167) | (0.0168) | (0.0169) | (0.0170) |
| Marginally Employed | -0.00311 | 0.00299 | -0.000983 | -0.00119 |
| | (0.0406) | (0.0405) | (0.0398) | (0.0410) |
| Leadership Occasionally | 0.0159 | 0.0168 | 0.0170 | 0.0166 |
| | (0.0124) | (0.0125) | (0.0125) | (0.0125) |
| Leadership Regularly | 0.0311* | 0.0334** | 0.0331** | 0.0331** |
| | (0.0159) | (0.0159) | (0.0159) | (0.0159) |
| Waves | ✓ | ✓ | ✓ | ✓ |
| Constant | 0.111*** | 0.116*** | 0.113*** | 0.116*** |
| | (0.0392) | (0.0394) | (0.0395) | (0.0395) |
| Number of observations | 78,784 | 78,784 | 78,784 | 78,784 |
| Number of groups | 1,839 | 1,839 | 1,839 | 1,839 |
| R2 (within) | 0.0034 | 0.0034 | 0.0029 | 0.0027 |
| R2 (between) | 0.0503 | 0.0469 | 0.0395 | 0.0323 |
| R2 (overall) | 0.0120 | 0.0123 | 0.0103 | 0.0091 |

*Source*: Own calculations based on WeLL data by Institute for Employment Research.
*Note*: Levels of significance: * p<0.1; ** p<0.05; *** p<0.01; standard errors in parentheses.
Employer-financed training = 1 if employees reported training and 0 otherwise.
ICT = Information and communication technologies. AMT = Advanced manufacturing technologies.
Skill level is based on the ISCO classification of occupational groups (Elias, 1997).

# 5 Discussion

Our analysis based on the task approach shows that digitalisation and outsourcing are both distinctive factors contributing to more multitasking in German establishments. In addition, it offers new insights into differences between occupational groups. In line with suggestions of previous literature, we find that the introduction of advanced manufacturing technologies (AMT) increases the multitasking of workers in high-skilled occupations much more than of those in low-skilled occupations, in which the effect of new information and communication technologies (ICT) dominates.

Contrary to earlier suggestions, our main finding is that the effect of new ICT and outsourcing is only present for workers in low-skilled occupations. Hence, it seems to be the case that developments in ICT and outsourcing, which have arguably impacted multitasking in high-skilled occupations in earlier years (Lindbeck & Snower, 2000), appear to have passed through to low-skilled occupations. Thus, firms may have been only able to focus on fewer occupations (Cortes & Salvatori, 2019) because especially employees in low-skilled occupations can perform a wider range of tasks.

The fact that workers in low-skilled occupations particularly face increased multitasking as a result of outsourcing and digitalisation has important implications. In our study, we have shown that being able to handle multiple tasks generally increases employability in the labour market, which holds across all analysed occupations. However, we identified an important discrepancy between high- and low-skilled occupations in terms of training measures. Increases in multitasking place a high need for training given that changes in task profiles rather seem to be long-lasting. Despite that, we found that workers in low-skilled occupations do not receive training when they need to perform more task types. These findings are in line with research by the OECD (2019, 2021), which also highlights that low-skilled workers are most in need of training but receive less training on average. Consequently, this calls for support for employees in all areas (Haertwig & Sapronova, 2021).

When multitasking is not necessarily followed by training measures, this may have further important implications, and we invite future research to address them. A first implication concerns the effects on workload. When training measures do not occur, it becomes more likely that the workload of employees increase. In line with that, it has been shown that new ICT can be followed by increased time pressure and work speed (Atanasoff & Venable, 2017). Thus, in accordance with our findings on training measures, it has been suggested that the digital load

can differ between occupational groups (Haertwig & Sapronova, 2021). Therefore, future research should identify occupation-specific linkages between multitasking and workload.

Increasing workload is also likely to affect a second factor, namely job satisfaction. While handling multiple tasks can be a valuable enrichment and preferred by workers in high-skilled occupations (Lindbeck & Snower, 2000), more recent research shows that this assumption cannot be generalised (Wegman et al., 2018) and thus does not necessarily apply to low-skilled occupations. Consequently, further empirical analyses are required.

Finally, multitasking should be considered in the wage-setting process. If workers take over tasks that were initially performed within other occupations that have been outsourced (Cortes & Salvatori, 2019), this should be compensated. However, it has been found in Germany that workers without a college degree do not necessarily earn more when their employer outsources activities (Ochsenfeld, 2018). Testing wage premia for each occupational group is vital to decide whether the increase in multitasking ends up increasing or decreasing income inequality (Goerlich & Snower, 2013; Wilmers, 2020).

# 6 Conclusion

Outsourcing and digitalisation, though often entailing that firms will employ fewer occupational groups, lead to more multitasking within individual jobs. This effect is particularly evident for employees in occupations requiring a lower formal skill level. Hence, not only entrepreneurs or workers in high-skilled occupations but also those in low-skilled occupations increasingly become jacks-of-all-trades. Given this new insight, possible consequences for this employee group should receive special attention. Multitasking seems to increase employability, with potential benefits for workers, but workers in low-skilled occupations do not receive employer-financed training. This missing support may cause skill gaps, unemployment and a decline in work satisfaction and productivity. Consequently, testing the occupational-specific effects of multitasking on other important job characteristics and based on newer and more encompassing data is a fruitful avenue for future research.

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# Appendix

**Table A 1 Robustness Tests with Interaction Effects**

| Number of Task Types | (1) | (2) | (3) |
|---|---|---|---|
| New AMT | 0.463 | **0.184*** ** | **0.189*** ** |
| | (0.369) | (0.0691) | (0.0696) |
| New AMT*2. Skill level | -0.442 | | |
| | (0.391) | | |
| New AMT*3. Skill level | -0.207 | | |
| | (0.384) | | |
| New AMT*4. Skill level | -0.172 | | |
| | (0.424) | | |
| New AMT*5. Skill level (Manager) | -0.209 | | |
| | (0.403) | | |
| New ICT | **0.133*** ** | **0.989*** ** | **0.135*** ** |
| | (0.0491) | (0.301) | (0.0492) |
| New ICT*2. Skill level | | **-0.870*** ** | |
| | | (0.321) | |
| New ICT*3. Skill level | | **-0.860*** ** | |
| | | (0.310) | |
| New ICT*4. Skill level | | **-0.937*** ** | |
| | | (0.323) | |
| New ICT*5. Skill level (Manager) | | **-0.992*** ** | |
| | | (0.320) | |
| Outsourcing | **0.115*** | **0.120**** | 0.102 |
| | (0.0604) | (0.0601) | (0.278) |
| Outsourcing*2. Skill level | | | 0.0609 |
| | | | (0.299) |
| Outsourcing*3. Skill level | | | -0.0732 |
| | | | (0.294) |
| Outsourcing*4. Skill level | | | 0.227 |
| | | | (0.335) |
| Outsourcing*5. Skill level (Manager) | | | -0.0578 |
| | | | (0.311) |
| Working Hours | 0.0312*** | 0.0308*** | 0.0316*** |
| | (0.00762) | (0.00759) | (0.00767) |
| Temporarily Employed | -0.301 | -0.282 | -0.295 |
| | (0.183) | (0.183) | (0.184) |
| Marginally Employed | -0.710** | -0.722** | -0.700** |
| | (0.292) | (0.286) | (0.293) |
| Leadership Occasionally | 0.319*** | 0.317*** | 0.317*** |
| | (0.0732) | (0.0730) | (0.0736) |
| Leadership Regularly | 0.628*** | 0.626*** | 0.634*** |
| | (0.101) | (0.102) | (0.101) |
| Waves | ✓ | ✓ | ✓ |
| Constant | 5.931*** | 5.949*** | 5.912*** |
| | (0.284) | (0.282) | (0.286) |
| Number of observations | 94,470 | 94,470 | 94,470 |
| Number of groups | 1,904 | 1,904 | 1,904 |
| $R^2$ (within) | 0.049 | 0.051 | 0.048 |
| $R^2$ (between) | 0.172 | 0.153 | 0.176 |
| $R^2$ (overall) | 0.136 | 0.123 | 0.138 |

*Source*: Own calculations based on WeLL data by Institute for Employment Research.
*Note*: Levels of significance: * p<0.1; ** p<0.05; *** p<0.01; standard errors in parentheses.
ICT = Information and communication technologies. AMT = Advanced manufacturing technologies.
Skill level is based on the ISCO classification of occupational groups (Elias, 1997); Skill Level 5=Legislators, senior officials and managers.