Universität Trier

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Annika Campaner
John S. Heywood
Uwe Jirjahn

Research Papers in Economics
No. 5/18

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Evidence from German Linked Employer-Employee Data

Annika Campaner

University of Trier

John S. Heywood

University of Wisconsin-Milwaukee

Uwe Jirjahn

University of Trier, GLO and IZA

Abstract: We examine the hypothesis that flexible work organization involves greater skill requirements and, hence, an increased likelihood of receiving employer provided training. Using unique linked employer-employee data from Germany, we confirm that employees are more likely to receive training when their jobs are characterized by greater decision-making autonomy and task variety, two essential elements of flexibility. Critically, the training associated with workplace flexibility does not simply reflect technology. Skill-biased organizational change plays its own role. Moreover, we show that the training associated with workplace flexibility is disproportionately oriented toward employees with a greater formal education. Our results also provide modest evidence of an age bias of workplace flexibility. However, the link between workplace flexibility and training does not appear to differ by gender.

JEL Classification: J24, L00, M53.

Keywords: Delegation, Multitasking, Skill-Biased Organizational Change, Training.

Corresponding Author: Uwe Jirjahn, Universität Trier, Fachbereich IV, Lehrstuhl für Arbeitsmarktökonomik, Universitätsring 15, 54286 Trier, Germany, Email: jirjahn@uni-trier.de.

1. Introduction

The last several decades have witnessed dramatic changes in the organization of work. These changes appear driven by a shift toward more flexible production emphasizing quality and speedy adjustments to changing market conditions. Increased multitasking and the delegation of responsibilities and decision rights to lower layers of hierarchy are key features of flexible production. These two key features of a flexible organization of work imply an increased demand for human capital. If employees perform a broader set of tasks, they need a broader set of skills. If employees make decisions, they need more information-processing and problem-solving skills.

We argue that flexible organization of work not only induces employers to hire employees with greater formal education, but also to spend more resources on continuous training. Flexible production blurs occupational barriers and makes cross-occupational learning critical. It even requires greater social and interactive skills as employees have, for example, more contact with customers. Training also reduces the risk of mistakes made by employees. Mistakes have greater consequences when employees have more responsibilities. Moreover, training keeps employees' skills up to date. Flexible production generates frequent changes in skill requirements as it involves continuous process improvements and speedy adjustments to varying customer needs. Finally, training can have specific incentive effects under flexible production. It provides employees with multiple skills reducing the risk that they are replaced by labor-saving process improvements. This increases their willingness to cooperate with changes.

Using unique linked employer-employee data from Germany, we find that both increased task variety and decision-making responsibility are indeed associated with a higher probability that employees receive employer provided training. Our analysis shows that these associations do not simply reflect technological change. Markers of technological change, information and

communication technologies and recent equipment changes, increase the likelihood of receiving training, but do not change the association between flexible workplace organization and employer provided training. Moreover, when dividing the sample into workplaces that have and do not have the markers of technological change, we confirm a role for a flexible organization of work within each subsample. Thus, the flexible organization of the workplace brings its own skill demand that is not completely determined by technological conditions. Our evidence suggests that employers respond to this demand with the increased provision of training.

However, our empirical analysis also shows that the link between flexible production and employer provided training depends on the employees' formal education. The training associated with flexible production is disproportionately oriented toward those with a greater formal education. The relationship between flexibility and training is larger for the university educated than for skilled employees and larger for skilled than for unskilled employees. Thus, the flexible organization of work widens the training gap between the more and the less educated.

We also examine if the age and the gender of employees play a role in the relationship between flexible production and employer provided training. Our estimates provide no evidence that the relationship differs between male and female employees. However, we find modest evidence of an age bias in the training associated with flexible workplaces. There appears to be no difference in the link between flexible production and training for those above and below 50. Yet, we do find that the link between delegated decision making and training differs between those above and below 55. While the link is positive for those under 55, it is negative for those over 55.

Our study contributes in several ways to the literature. Economists usually stress that skill-biased *technological* change drives the fundamental transformations of the workplace (see Acemoglu 2002 and Acemoglu and Autor 2011 for surveys). The role of skill-biased

organizational change receives far less attention. Yet, some studies show that a flexible organization of work increases the demand for employees with greater formal education (e.g., Caroli and Van Reenen 2001, Piva et al. 2005, 2006). Our examination joins those studies by finding that the flexible organization of work has an independent influence on the demand for skills that cannot be simply reduced to technological factors. However, importantly, our examination shows that a flexible organization of work leads employers also to generate the needed skills and not just buy them in the external labor market. Moreover, our examination demonstrates that flexible production entails a specific skill bias that goes beyond a simple increase in the demand for skills. While flexible workplaces provide more training, this training is oriented to those who already have the greatest skills. Thus, if earlier studies are correct that flexible workplaces hire disproportionately the more skilled, we show that the training decisions of these workplaces compound those hiring decisions.

Some earlier studies have used establishment-level data to demonstrate that indicators of flexible work organization correlate with employer provided training (Bilanakos et al. 2018, Bresnahan et al. 2002, Gerlach and Jirjahn 2001, Lynch and Black 1998, Osterman 1995).[1] Our analysis is based on unique employer-employee data. This has several advantages. First, the linked employer-employee data allow a very rich set of controls for both employee and establishment characteristics. Second, the data measure multitasking and delegated decision making at the individual employee level. Thus, we can examine if those who are in fact engaged in increased multitasking and delegated decision making have a higher likelihood of receiving training. Third, the data are unique in that they enable us to examine if the influences of multitasking and decision-making responsibility on training differ between various types of employees. The OECD (2003) has expressed concerns that in many countries less educated employees, older employees and

women receive less training. Thus, it is important to know how the transformation of the workplace influences the training gaps between the more and the less educated, between the younger and the older and between men and women.

The rest of the paper is organized as follows. The second section provides a background discussion. The third section describes the data and variables. The estimates are presented in the fourth section. The fifth section concludes.

2. Background Discussion

2.1 Multitasking, Delegation and Training

The fundamental transformation of the workplace in the last decades has been a shift from Tayloristic mass production to a more lean and flexible production concept that emphasizes quality and speedy responses to changing market conditions (Milgrom and Roberts 1990, 1995). This development began in the Japanese automobile industry, but quickly spread internationally and to other industries. A key feature of the transformation has been a decentralization of the organization of work involving increased multitasking and the delegation of responsibilities and decision rights to lower-level staff (Caroli et al. 2001, Lindbeck and Snower 2000). Employees are more autonomous and perform a broader set of tasks. This allows the flexible use of local information available at lower layers of hierarchy (Aoki 1986, 1990).

The flexible organization of work should involve an increased demand for human capital. Multitasking means that employees perform a wider set of tasks. This requires a broader set of skills. Delegation means that employees make more and larger decisions. This requires problem-solving skills and higher ability to process information. Empirical research confirms that flexible production is associated with an increased demand for employees with a higher level of formal

education (Caroli and Van Reenen 2001, Piva et al. 2005, 2006). That fits the hypothesis of skill-biased organizational change.

Economists usually emphasize skill-biased technological change (Acemoglu 2002, Acemoglu and Autor 2011). This raises the issue of whether or not skill-biased organizational change simply reflects skill-biased technological change. On the one hand, technological change appears to foster the shift toward flexible production.[2] Computerized information and communication technologies provide the individual employee better access to information about other employees' work within the firm and make it easier to communicate. This is important as employees must coordinate their actions if they have flexibility to tailor their tasks to the local information that can only be observed by them (Dessein and Santos 2006). Moreover, information and communication technologies provide individual employees better information about customer needs, permitting them to respond in a timely manner to changing market conditions.

On the other hand, even if computers and telecommunications have stimulated a flexible organization of work, this flexible organization may have its own influence on the skill demand of firms (Breshnahan et al. 2002, Brynjolfson and Hitt 2000, Hunter et al. 2001). New technologies are likely to require complementary organizational changes to be effective.[3] Thus, the influence of organizational change on the demand for human capital cannot be simply reduced to technological change. This brings us to the influence of flexible production on employer provided training.

For several reasons, a flexible organization of work should not only increase the employers' incentive to hire employees with greater formal education, but also to provide more continuous training to employees. The employees' formal education may not sufficiently match the skill requirements implied by a flexible organization of work. Such organization of work implies a blurring of traditional occupational barriers (Lindbeck and Snower 2000). Workers are

given tasks and responsibilities spanning more than one of the traditional occupational groupings. Thus, cross-occupational training and learning plays an important role in flexible production.

Furthermore, a flexible organization of work is associated with an increased importance of non-cognitive skills (Lindbeck and Snower 2000, Piva et al. 2005). In addition to fulfilling their formal occupational requirements, employees need to exercise greater social and interactive skills. For example, they often have more interactions with customers to provide customer-specific solutions and individualized treatment. Training can provide the required social and interactive skills.

Employers may also provide training to reduce the risk of mistakes made by the employees. Mistakes are more costly under a flexible organization of work. If employees have greater responsibilities, mistakes have more far reaching consequence for firm performance. Relatedly, as employees are involved in each other's tasks, the increased interdependence of worker productivity implies that an employee's mistake negatively affects the productivity of coworkers (Heywood and Jirjahn 2004, 2009). In this context it is important to note that a flexible organization of work appears to entail an intensification of work and an increase in mental health problems (Askenazy and Caroli 2010, Brenner et al. 2004, Cottini and Lucifora 2013, Green 2004). This intensification may itself increase the occurrence of mistakes (Caroli and Van Reenen 2001). Thus, in order to reduce the risk of mistakes, employers may not only provide training that improves employees' problem solving and information processing skills, but also training that is related to stress and health issues.

Moreover, the skill requirements associated with a flexible organization of work have a crucial dynamic dimension. For at least two reasons these skill requirements change frequently. First, firms with flexible organization of work rapidly adjust their production and services to

changing market conditions and varying customer needs. Second, continuous process improvements play a key role in flexible production (Morita 2005). For example, employees may participate in quality circles to conduct continuous process improvements. The basic point is that changes in skill requirements involve a need for continuous training to keep employees' skills up to date.

Employer provided training can also have important incentive effects under flexible production (Carmichael and MacLeod 1993). Training provides employees with multiple skills. Multiple skills reduce the likelihood that employees are replaced when labor-saving process improvements occur or market demand shifts. Instead, organizational change may even involve new career opportunities for multi-skilled employees who can cope with the changes. Thus, multiple skills increase employees' willingness to come up with ideas for process improvements and to cooperate with organizational changes.

More generally put, delegating authority entails a loss of control for the employer (Acemoglu et al. 2007, Aghion and Tirole 1997). If employees act upon a sharply different objective function than that of the employer, they may make choices that are not in the employer's best interest. In this view, delegation is profitable only when there is sufficient congruence between the interests of the employer and the interests of the employees. While this congruity might be achieved through financial incentive schemes (Bloom et al. 2012, De Varo and Kurtulus 2010), part of the calculus is the effort cost at which employees can learn and communicate information. Employer provided training lowers this cost and, hence, increases the probability that employees make decisions that are in the employer's interest (Bilanakos et al. 2018).

Altogether, our theoretical considerations suggest that multitasking and delegation should be positively associated with employer provided training. However, this gives rise to the question

of whether this holds in general or only for particular types of employees. The question is motivated by the fact that training is currently very unequally distributed across employees.

2.2 Initial Education, Age and Gender

In many countries, less educated employees, older employees and women appear to receive less training (OECD 2003). This also holds for Germany (Fitzenberger and Muehler 2015, Grund and Martin 2012). The training gap between educated and less educated employees suggests a complementary relationship between formal education and employer provided training. Employers tend to find it more profitable to train employees who have increased their trainability by learning how to learn through formal education (Heckman 1999, Rosen 1976). The training gap between younger and older employees may be explained by the fact that older workers have a shorter amortization period of human capital investments (Becker 1964, Oi 1962). Finally, the gender training gap may reflect a lower labor force attachment of women (Barron et al. 1993).

At issue is how the various training gaps are influenced by a flexible organization of work. From a theoretical viewpoint, the influence of flexible production on each of the training gaps is ambiguous. Flexible production can involve a series of opposing influences on these gaps. Thus, it depends on the relative strength of these opposing influences whether flexible production widens or narrows the training gaps.

Consider first the training gap between the more and the less educated. On the one hand, the less educated have greater training needs than the educated to cope with the requirements entailed by flexible production. This suggests that flexible production may lead employers to provide more training to the less educated shrinking the training gap.[4] On the other hand, flexible organization of work may strengthen the complementarity between initial education and training

implying a widened training gap. The ability to learn has even greater importance if firm strategy emphasizes quality and speedy adjustments to changing market conditions. In this context, flexible production can imply a change in the division of labor between the more and the less educated even when both types of employees are engaged in multitasking and have more scope for decision making (Jirjahn and Kraft 2010). Under flexible production, educated employees may become team leaders and specialize in problem solving. Thus, greater multitasking and responsibility for decision making means for the educated that the complexity and the skill requirements of their jobs increase. Thus, the employer may disproportionately train the more educated employees.

A flexible organization of work can also have implications for the training gap between younger and older employees. On the one hand, older employees might have more experience to cope with change. Thus, the employer may provide more training to older workers to strengthen their role in a successful implementation of flexible production. On the other hand, flexible production may accelerate the obsolescence of the skills of older employees. Moreover, their age may imply a lower adaptability to change. Empirical research finds that organizational change negatively affects the labor demand for older employees (Aubert et al. 2006). This suggests that flexible production entails an age bias. Remarkably, there is even evidence that training does not reduce this age bias (Behaghel et al. 2014). Against this background, one might hypothesize that flexible production does not increase employers' incentive to provide training for older employees. This would imply a widened training gap between younger and older employees.

Finally, flexible organization can have opposing effects on the gender training gap. On the one hand, longer employment interruptions due to childcare responsibilities imply less work experience so that women need greater training to cope with flexible production. On the other hand, women's lower labor force attachment may negatively influence the return to such training.

Anticipating longer employment interruptions or a higher incidence of part-time work, employers have an incentive to provide less training to women than to men even if both types of employees engage in multitasking and have increased responsibilities. Moreover, even if women work, they remain disproportionately responsible for family. Thus, they sort and are sorted into jobs that allow combining work and family, e.g. jobs allowing to take time off to care for a sick child (Heywood and Jirjahn 2002). Thus, women participating in flexible production may be assigned to more menial multitasking and responsibility for decision making requiring a less strong need for training.

The theoretical viewpoint makes clear that it remains an open question whether flexible work organization widens or narrows the various training gaps. Thus, only empirical research can determine which of the opposing influences dominates.

3. Data and Variables

3.1 The Data Set

Our empirical investigation uses the Linked Personnel Panel (LPP), a unique longitudinal linked-employer-employee data set. The LPP is a biannual additional survey of a subsample of establishments participating in the IAB Establishment Panel. The IAB Establishment Panel is a representative sample of establishments from all sectors in Germany (Fischer et al. 2009). Infratest Sozialforschung, a professional survey and opinion research institute, conducts the interviews on behalf of the Institute for Employment Research (IAB) which belongs to the German Federal Employment Agency. The data are collected on the basis of a questionnaire and follow-up personal interviews with the owner or top manager of the establishment. Each year since 1993 (1996), the IAB Establishment Panel has surveyed several thousand establishments in Western (Eastern)

Germany. The IAB Establishment Panel contains longitudinal information on workplace characteristics (e.g., establishment size, workforce structure and investment activities).

The add-on survey, the LPP, links employer-level with employee-level information (Kampkoetter et al. 2016). The LPP consists of an additional questionnaire for the employers and a questionnaire for the employees. The employer questionnaire, answered by top managers or the owner of the establishment, focusses more than the IAB Establishment Panel on HR management instruments and strategies. The LPP is representative of private sector establishments with at least 50 employees in manufacturing and services industries.

The employee questionnaire asks about job characteristics and the socio-demographic background of the employees. The LPP covers unskilled employees and employees with a completed apprenticeship training or university degree. Apprentices are not surveyed. This makes sense for our analysis as employer provided further training takes place after an apprenticeship training or an initial period of work experience.

Our empirical analysis is based on the waves 2012 and 2014 of the LPP. The survey is complemented by further establishment characteristics of the IAB Establishment Panel. For the analysis, we focus on employees in privately owned commercial establishments. After eliminating observations for which full information is not available, our analysis is based on 8,694 pooled observations from 7,089 employees in 1,231 establishments.

3.2 Employer Provided Training

In Germany, employers can provide two types of training, apprenticeship training and further training. The distinctive feature of the German system of apprenticeship training is its dual structure (Harhoff and Kane 1997, Winkelmann 1996). Apprentices typically attend publicly-

funded vocational part-time schools 1–2 days a week in addition to working and learning at the workplace. Employers bear the cost of within-firm training voluntarily. The apprenticeship training ends after 2–3.5 years. Detailed curricula are developed in cooperation with state institutions, employer organizations and trade unions. Regionally organized chambers of commerce and chambers of crafts coordinate and administer the programs.

In contrast to apprenticeship training, employer provided further training is characterized by a very low degree of regulation by the state (Allaart et al. 2009). There is no legal framework regulating the content, financing or structure of such training. Employer provided further training is an investment in workers' human capital that aims at a better understanding of, or coping with, current job tasks (Brussig and Leber 2006). Usually further training takes place after an apprenticeship training and/or an initial period of work experience (Gerlach and Jirjahn 2001). It can be organized as courses and seminars or it can be integrated in the process of work itself. Further training can take place internally or externally. Employer provided further training plays an important role in Germany. In 2013 employers in Germany invested about 33.5 billion Euro in further training (Seyda and Werner 2014).

Our dependent variable builds from a two-part question in the employee questionnaire of the LPP. The first part asks if the employee participated in courses of further training during the respective year. The second part identifies if the costs were borne by the firm in release time and/or paying explicit training costs. These two questions allow us to distinguish three outcomes: employer provided further training, employee paid further training, and no further training. Table 1 provides the descriptive statistics on these constellations. There are 33 percent of observations with employer provided further training, 1 percent with employee paid further training and 64 percent with no further training.

For the major part of our empirical analysis, we use a dummy dependent variable equal to 1 if the employee received employer provided further training in the respective year. The reference group consists of employees who received no further training or paid the further training for themselves. However, we also provide a robustness check by distinguishing between employer provided and employee paid further training. In that case, the reference group consists of employee who received no further training.

3.3 Flexible Organization of Work

The data provide a rich set of explanatory variables capturing a variety of employee and establishment characteristics. Tables 2 and 3 show the definitions and descriptive statistics of the explanatory variables. Our two key explanatory variables identify to which extent each employee's job has conditions associated with a flexible organization of work. Thus, we match the information on work organization and the information on training at the employee level. Delegated decision making is measured with a Likert scale variable ranking the employee's job on a five-point scale according to the extent to which the employee can make many decisions autonomously (5 is the greatest extent). Multitasking is measured with a Likert scale variable ranking the employee's job on a five-point scale according to the degree of task variety (5 is the greatest extent).[5] We hypothesize that when jobs have greater delegated decision making and multitasking, the likelihood of employer provided training is greater.

We recognize that testing our hypothesis empirically requires variation across employees in the degree of multitasking and delegated decision making. It might be thought that in equilibrium all employees would share the same degree. Yet, variation will exist if the employees' jobs differ in the cost of implementing a flexible work organization. Moreover, variation in

multitasking and delegated decision making can result if employers have imperfect information on the potential advantages and disadvantages of flexible work organization (Bresnahan et al. 2002, Caroli and van Reenen 2001). Imperfect information on the advantages and disadvantages of flexible work organization implies that employers may experiment with the organization of work for their employees' jobs.

3.4 Technology

As stressed in the background discussion, there exists concern that the organization of work simply reflects underlying technological factors. Skill-biased technological change could drive the decision of employers to train employees. Empirical evidence, indeed, suggests that technological change has a positive influence on employer provided training (Gashi et al. 2008, 2010). Thus, we test whether or not the organization of work has its own influence on training. In order to disentangle the influences of technological change and work organization, we include a series of control variables capturing technology. Technology at the establishment level is captured by the amount of investment in physical capital per employee and a dummy equal to 1 if production technology is of a more recent vintage than the industry median.

Moreover, as our focus is on the training of individual employees and the dimensions of their job, we also ultimately measure technological change at the employee level using two indicators. The first identifies whether the employee uses information or communication technologies at work. The second identifies if the technological equipment of the employee's workplace has changed recently. These two variables exist only in the 2014 wave of the LPP. Thus, we use these variables for robustness checks. First, we examine how the influence of delegation and task variety are changed by including these markers of technological change. Second, we

examine separate regimes, those with and without the markers of technological change. We can then measure whether or not the influence of flexible work organization is confined to, or substantially larger in, the regime where the markers of technological change are present. This sheds light on the relationship between flexibility, technological change and training.

3.5 Initial Education, Age and Gender

In the regressions, we also include variables for the employee's initial education, age and gender. Initial education, age and gender may have both a direct influence on receiving employer provided further training and an indirect influence. As emphasized in our background discussion, they may moderate the link between work organization and employer provided training. Thus, in order to examine whether flexible work organization widens or narrows training gaps, we also run separate estimations by education, age and gender.

3.6 Control Variables

We include a series of individual level variables capturing additional employment related and demographic characteristics. Variables for spousal relationship and German citizenship account for further demographic characteristics of the employees. Variables for flexible working hours, part-time status, having a fixed-term contract, being a blue-collar worker, and being a supervisor take into account employment related characteristics.

The data provide also a series of control variables for further characteristics of the interviewee's job. We identify the extent to which the jobs of other workers depend on the interviewee's performance and the extent to which the interviewee's performance depends on other workers. We include measures of the physical effort required on the job, the time pressure on the

job and the extent of unpleasant working conditions. These five variables help proxy for other critical aspects of an employee's job that may stand as determinants of training and be correlated with delegation and flexibility.

An employee's probability of receiving training may depend not only on his or her job and individual characteristics, but also on the characteristics of the establishment. Thus, we control for the share of university graduates and the share of skilled employees. Such establishment-level variables may capture skill or education spillovers associated with high human capital workplaces. We also include the share of apprentices. This variable indicates the general propensity of an employer to train workers. Furthermore, we control for the use of temporary agency workers and for the shares of women and part-timers. The influence of these variables is ambiguous. On the one hand, they may be seen as indicating a low expected tenure of the workforce resulting in less training. On the other hand, they may reflect a high share of peripheral workers protecting a core group of workers who receive more training.

Variables for the presence of a works council and the coverage by a collective bargaining agreement control for the dual system of worker representation in Germany. Collective agreements are usually negotiated on a broad industrial level between unions and employers' associations. Establishments are covered if they are members of an employers' association. Works councils provide a highly developed mechanism for establishment-level codetermination. The Works Constitution Act expressly provides for them, but their creation depends on the initiative of the establishment's employees. Thus, works councils are not present in all eligible establishments (Jirjahn and Smith 2006). Works councils can be seen as a collective voice institution ensuring that managers take employees' interest into account. They promote the internal labor market and

reduce personnel turnover. Reduced mobility of the employees, in turn, increases employers' incentives to invest in the human capital of their employees (Gerlach and Jirjahn 2001).

We recognize the debate over the role that product market competition may play as a spur to training. Indeed, Heywood et al. (2017) review a dozen studies across several countries that show no consistent pattern. Using German data, they present evidence that competition threatening survival of the establishment reduces training incentives by shortening the expected payback period for training investments. In this work we also include variables indicating high competitive pressure with a threat of liquidation and high competitive pressure without such a threat. These serve largely as needed controls that might be correlated with the measures of flexibility. Industry, region and time dummies are also included from the establishment data.

Furthermore, we control for multi-establishment status. If training involves fixed costs, these can be spread over a number of establishments suggesting a positive association with training. Similar reasoning may also apply to establishment size. In order to account for possible nonlinearity, we include variables for both establishment size and establishment size squared.

Dummy variables for job vacancies for unskilled and for skilled and highly skilled employees are also included. If employers face difficulties in filling vacancies, they may train current employees who temporarily take on tasks of the unfilled positions. This may apply particularly to vacancies for skilled and highly skilled employees. Finally, we control for establishment age, foreign ownership, industry, region and year of observation.

4. Results

4.1 Initial Estimates

Table 4 provides the initial estimations. A random effects probit model estimates the determinants of employer provided training. The random effects probit accounts for cross-period correlation of error terms. We also cluster standard errors at the establishment level using the Huber-White sandwich estimator of variance to recognize that error terms may be correlated within establishments.[6] The estimations start with our two key explanatory variables and add ever more extensive controls. This serves to demonstrate the durability of the relationship between the two key indicators of flexible work organization and training.

The first column of Table 4 presents the very parsimonious probit estimate of the training dummy against the two key explanatory variables. This indicates that a unit change in either decision-making autonomy or task variety is associated with about a five percentage point increase in the probability of receiving employer provided training. The second column adds the variables for other characteristics of the employee's job. Physical effort and unpleasant working conditions are associated with a smaller probability of training whereas time pressure and depending upon others' performance are associated with a larger probability of training. The important point is that while controlling for other job characteristics reduces the marginal effects of decision-making autonomy and task variety, they remain large and statistically significant.

The third column adds the remainder of the basic individual-level controls. Skilled employees and those with a university degree are more likely to receive training whereas older employees and women are less likely to receive training. These findings confirm training gaps between the more and the less educated, between the younger and the older, and between men and women. Furthermore, those with a spouse and those who are supervisors are more likely to receive

training. Blue-collar workers are less likely to receive training. Most importantly, including the additional individual-level controls leaves largely in place the role of flexible work organization. The magnitudes are again somewhat smaller, but the coefficients still remain large and highly significant supporting the hypothesis that flexible work organization is associated with a greater likelihood of training.

Finally, the fourth column adds all the establishment level controls. The establishment variables suggest that the size of the establishment is positively associated with training as are the shares of apprentices, skilled employees and university graduates. The fact that these shares have an influence that persists beyond whether the individual employee is skilled or a university graduate indicates the complementarities between more educated employees that raise the value of training. Product market competition that threatens liquidation is associated with a smaller likelihood of training. Finally, production technology of a more recent vintage and greater investment are associated with a greater likelihood of training. This suggests that skill-biased technological change also plays a role in employer provided training.

Despite the many significant influences of the establishment level variables, the inclusion of these variables does not change the role of the indicators of flexible work organization. The coefficients on our two key explanatory variables remain highly significant. A one unit increase in decision-making autonomy is associated with a two percentage point increase in the likelihood of being trained while a one unit increase in task variety is associated with a four percentage point increase in the likelihood of being trained. A one unit change represents approximately a standard deviation for each measure and the combined increase of six percentage points is substantial given that the training mean is thirty-three percent.[7]

4.2 Skill-Biased Organizational vs. Skill-Biased Technological Change

Our estimates show a significant influence of decision-making autonomy and task variety on training even controlling for technology. This suggests that skill-biased organizational factors play their own role beyond reflecting technological factors. However, the technology variables for the vintage of production technology and investment per capita are only measured at the establishment level. At issue is whether or not our key results persist when controlling for individual-level technology variables. The 2014 wave of the LPP provides such variables. Thus, we now move to that wave.

Our first marker of skill-biased technology is whether or not the employee uses information or communication technologies (ICT) at work. Table 5 provides the key results. The first column reproduces the basic result for only 2014 confirming that decision-making autonomy and task variety play their usual role. The second column adds the measure of ICT use. This variable takes a very large coefficient implying a very large marginal effect of 16 percentage points on the probability of training. This large and highly significant result confirms the role of technology in driving employer provided training. Yet, that role does little or nothing to diminish the importance of workplace flexibility. The coefficients on decision-making autonomy and task variety show virtually no change. This suggests that excluding ICT use, as important as it is, does not change the key pattern of results. Decision-making autonomy and task variety play their own role in receiving employer provided training.

We recognize that ICT may play a moderating role. The link between flexible work organization and training might depend on ICT. Thus, in a further step, we divide the sample into those that use ICT and those that do not. Despite the relatively small size of the latter group, the general pattern conforms to what we have seen earlier. Even when there is no use of ICT, the

indicators of flexible organization of work are associated with increased employer provided training. While the marginal effects are somewhat larger for those using ICT, the coefficients across the split remain within each other's confidence intervals. This again supports the view that flexible work organization plays a role that is not (entirely) driven by technology.

The 2014 wave provides a second technology marker, whether or not the technological equipment of the employee's workplace has changed in the last five years. We use this second marker to mirror the exercise we just described with ICT use. The first column of Table 6 reproduces the key findings on the 2014 sample. As there are relatively few missing observations it essentially reproduces the first column of Table 5. The second column includes the variable for technological change in the estimation showing another very large marginal effect of 13.5 percentage points and a highly significant coefficient. This indicator of equipment change is a very important determinant of employer provided training. Yet, as before it does little to change the role of workplace flexibility. Both indicators of flexible work organization retain their size and significance.

In a further step, we again split the sample by whether or not this marker of technological change is present. The third column shows the influence of flexible work organization when equipment change has happened and the fourth column shows that influence when there has been no equipment change. Decision-making autonomy takes a positive and roughly similar sized effect in each column, but it is statistically significant only in the larger sample of the third column. Task variety takes essentially identical size and significance in the two columns. While the lack of significance and a modestly smaller marginal effect suggest that decision-making autonomy plays less of a role without technological change, the smaller sample size might generate the lack of significance and, thus, a roughly similar appearance remains.

When taken with the identical role of task variety and the earlier results on ICT use, we feel reasonably confident suggesting that technology does not eliminate the role of flexible work organization in driving greater training. This might hint that the training associated with organizational change differs in type from that associated with technological change. The former presumably has more emphasis on communication skills, decision-making skills and making efficient use of time across many tasks.

4.3 Self-Paid and Employer Provided Training

So far, we used a dummy dependent variable for employer provided training. The reference group consisted of both employees without further training and employees who received training they completely paid for themselves. As a check of robustness, we now return to the pooled sample of the 2012 and the 2014 wave of the LPP and provide a more differentiated analysis. We distinguish between self-paid training and employer provided training. The reference group now consists only of employees who received no further training in the respective year. This more differentiated analysis helps address the question if employees find it in their interest to undertake their own training so as to retain a position and thrive in the flexible work environment.

Table 7 provides the key results of a multinomial probit estimation. Neither the variable for task variety nor the variable for decision-making autonomy plays a significant role in completely self-paid training. This may reflect the relatively small number of observations with completely self-paid training, but it gives no indication that a flexible organization of work generates additional training paid for by the employee. Most importantly, the multinomial probit estimation does little to change the roles of task variety and decision-making autonomy in employer provided training. These key indicators of a flexible organization of work retain highly

significant coefficients implying marginal effects of roughly the same magnitude as in random effects probit estimation (4) of Table 4.

4.4 The Training Gap between the Less and the More Educated

To this point, we have shown that two key features of flexible work organization, task variety and decision-making autonomy, are associated with a higher probability of receiving training. This supports the notion of skill-biased organizational change. We now consider how the increase in training associated with task variety and decision-making autonomy is distributed across initial education levels. To do this we return to our dummy dependent variable and divide the sample into three subsamples: employees with a university degree, skilled employees with a completed apprenticeship training as the highest degree, and unskilled employees without completed apprenticeship training. The estimations from Table 3 confirmed a training gap between the less and the more educated. We now examine how the link between workplace flexibility and training varies across these three subsamples. This reveals whether workplace flexibility reinforces or reduces the training gap between the less and the more educated.

Table 8 provides the key results and shows a clear pattern. The greater the initial education, the larger is the influence of workplace flexibility on the likelihood of receiving employer provided training. Among the university educated, decision-making autonomy is associated with a six percentage point increase in the likelihood of training. Among skilled workers this falls to two percentage points but remains still statistically different from zero. Among the unskilled the associated effect drops to essentially zero. This pattern is largely replicated with task variety: the largest influence with 6 percentage points for those with a university degree, a smaller one with four percentage points for the skilled and none for the unskilled.

Our results show that flexible workplaces are associated with additional training but only for the more educated. Thus, the skill bias of workplace flexibility goes beyond simply generating more training. Instead, the resulting training associated with flexible work organization is concentrated among the already more educated. This widens the training gap between less and more educated employees.

Table 9 provides separate estimations for blue-collar and white-collar workers. While this largely reflect the distinction between clerical and production workers, it is often viewed as an alternative differentiation between the less and the more educated (e.g., Berman et al. 1998). Our results confirm that it is white-collar workers who receive a disproportionate share of training associated with workplace flexibility. The coefficient on decision-making autonomy for blue-collar workers is not significantly different from zero while that for white-collar workers is significant and implies a large marginal effect. While the coefficient on task variety is significant for both groups of workers the marginal effect for white-collar workers is 70 percent larger than that for blue-collar workers. Thus, the results for blue-collar and white-collar workers largely reflect the skill bias we have already isolated.

4.5 The Training Gap between the Older and the Younger

Our initial results also confirmed a training gap between older and younger employees. Recalling the argument that flexible work organization can be age biased (Aubert et al. 2006, Behaghel et al. 2014), we now examine if the link between workplace flexibility and training differs between older and younger employees.

Table 10 first provides separate estimations for employees less than 50 years of age and employees that are 50 years of age or older. The evidence is simply too weak to draw much in the

way of a concluding pattern. The marginal effects are slightly larger for the younger workers but it is clear that the coefficients are within each other's confidence interval. All coefficients on both flexibility variables remain positive and of similar magnitude by age.

In our second split we compare employees less than 55 to those that are 55 or older. This reveals a more differentiated pattern. Decision-making autonomy plays an opposite role among the younger and the older cohort. It has a negative influence on training among those older than 55 and a positive one among those younger than 55. This can be seen as evidence of an age bias. Delegation of decision rights brings with it the need to train, but those over 55 are excluded from that needed training. However, the finding on the other indicator of workplace flexibility shows no difference. Task variety continues to exhibit essentially the same influence on training for those above and below age 55.

In summary, the overall pattern of our age splits is mixed. The split between those younger and older than 50 reveals nothing and the split between those younger and older than 55 shows an age bias only for decision-making autonomy. The training associated with decision-making autonomy is not provided to those 55 and over. Thus, if one was to conclude, it might be fair to suggest we find weak or mixed evidence that workplace flexibility is age biased.

4.6 The Training Gap between Women and Men

Finally, our initial results also confirmed a training gap between women and men. Thus, in a further step, we split the sample by gender. As shown in Table 11, the pattern by gender suggests few important differences. The marginal effect of delegation is larger for females but the marginal effect of task variety is larger for males. All remain of the rough magnitude we started with in the overall sample.

5. Conclusion

Modern workplaces are increasingly characterized by flatter hierarchies, greater delegation of decision making and a wider variety of tasks. These flexible workplaces have evolved together with technological change but have brought their own skill bias. Those more skilled will be in increasing demand by firms with flexible work organization. While previous studies on skill-biased organizational change have largely focused on the formal education of employees, our examination focuses on employer provided training. We argue that the firm may benefit by generating the needed skills rather than simply trying to buy them in the labor market. Thus, using unique employer-employee data from Germany, we test whether two major indicators of flexible workplaces, decision-making autonomy and task variety, are associated with an increased likelihood of receiving employer provided training. Our results strongly confirm this association and, hence, support the notion that flexible work organization is indeed skill-biased.

In an attempt to disentangle the unique role of workplace flexibility, we show that several markers of technological change, use of ICT and recent equipment change strongly increase the likelihood of training but do not change the incremental training associated with flexible workplace organization. Indeed, when dividing the sample into employees whose jobs have and do not have the markers of technological change, we confirm a role for flexible workplaces within each subsample. Decision-making autonomy and task variety bring their own skill demands. Our evidence suggests that firms respond to these demands with employer provided training.

Moreover, we demonstrate a number of important patterns. Among the most interesting results is that the skill bias goes beyond a uniform increase in the demand for skills. The training associated with decision-making autonomy and task variety is disproportionately oriented toward

those employees with greater formal education. While flexible workplaces provide greater training, it is oriented to those employees already with the greatest initial skills. Thus, if earlier researchers are correct that flexible workplaces hire disproportionately more skilled employees, we show that the training decisions of these workplaces compound that hiring decision.

We also find modest evidence of an age bias in the training associated with flexible workplaces. While there is a positive link between decision-making autonomy and training for employees below 55, there appears to be a negative link for employees over 55. Decision-making autonomy brings with it the need to train but those over 55 are excluded from that training. However, the results on task variety do not reveal an age bias. The link between task variety and training is positive for both employees below and employees over 55.

Finally, we find no evidence that the workplace flexibility widens the training gap between women and men. There are similar associations between workplace flexibility and employer provided training for both female and male employees.

We think our focus on training in response to workplace organization is important and recognize additional aspects that could be explored by future research. Our data set does not allow us to identify the actual content of training. It would be instructive to know if the training associated with a flexible workplace differs and if so, how. One might anticipate that the training associated with workplace flexibility is more nearly focused on social skills, decision-making skills, making efficient use of time across many tasks and providing an improved understanding of production and markets.

References

Acemoglu, Daron 2002. "Technical Change, Inequality and the Labor Market," *Journal of Economic Literature* 40: 7-72.

Acemoglu, Daron, Philippe Aghion, Claire Lelarge, John Van Reenen and Fabrizio Zilibotti. 2007. "Technology, Information, and the Decentralization of the Firm," *Quarterly Journal of Economics* 122: 1759-1799.

Acemoglu, Daron and David Autor. 2011. "Skills, Tasks and Technololgies: Implications for Employment and Earnings," in Orley Ashenfelter and David Card, eds., *Handbook of Labor Economics*, Vol. 4, Part B, Amsterdam, Elsevier: 1043 – 1171.

Aghion Philippe and Jean Tirole. 1997. "Formal and Real Authority in Organizations," *Journal of Political Economy* 105: 1 – 29.

Allaart, P., Bellmann, L. and Leber, U. 2009. "Company-Provided Further Training in Germany and the Netherlands," *Empirical Research in Vocational Education and Training* 1: 103-121.

Aoki, Masahiko. 1986. "Horizontal vs. Vertical Information Structure of the Firm," *American Economic Review* 76: 971-983.

Aoki, Masahiko. 1990. "The Participatory Generation of Information Rents and the Theory of the Firm," in M. Aoki, B. Gustafsson and O.E. Williamson, eds., *The Firm as Nexus of Treatises*, Thousand Oaks, CA: Sage: 26-55.

Askenazy, Philippe and Eve Caroli. 2010. "Innovative Work Practices, Information Technologies, and Working Conditions: Evidence for France," *Industrial Relations* 49: 544-565.

Aubert, P., Caroli, E. and M. Roger. 2006. "New Technologies, Organisation and Age: Firm Level Evidence," *Economic Journal* 116: F73-F93.

Barron, John M., Dan A. Black and Mark A. Loewenstein. 1993. "Gender Differences in Training, Capital and Wages," *Journal of Human Resources* 28: 343-364.

Bartel, Ann P. and Nachum Sicherman. 1998. "Technological Change and the Skill Acquisition of Young Workers," *Journal of Labor Economics* 16: 718-755.

Becker, Gary. 1964. *Human Capital*, University of Chicago Press, Chicago.

Behaghel, Luc, Eve Caroli and Muriel Roger. 2014. "Age Biased Technical and Organizational Change, Training and Employment Prospects of Older Workers," *Economica* 81: 268-389.

Berman, E., J. Bound and S. Machin. 1998. "Implications of Skill-Biased Technological Change: International Evidence," *Quarterly Journal of Economics* 113: 1245-1279.

Bilanakos, C., J.S. Heywood, J.G. Sessions and N. Theodorpoulos. 2018. "Does Delegation Increase Worker Training?" *Economic Inquiry* 56: 1089-1115.

Bloom, Nicholas, Raffaella Sadun and John Van Reenen. 2013. "Americans Do IT Better: US Multinationals and the Productivity Miracle," *American Economic Review* 102: 167-201.

Brenner, Mark D., David Fairris and John Ruser. 2004. “Flexible Work Practices and Occupational Safety and Health: Exploring the Relationship Between Cumulative Trauma Disorders and Workplace Transformation,” *Industrial Relations* 43: 242-266.

Bresnahan, Timothy F., Erik Brynjolfsson and Lorn M. Hitt. 2002. “Information Technology, Workplace Organization, and the Demand for Skilled Labor: Firm-Level Evidence,” *Quarterly Journal of Economics* 117: 339-376.

Brussig, M. and Leber, U. 2006. “Formal and Informal Ways of Learning in Employer-Provided Further Training in East and West German Enterprises: Results from a Large-Scale Establishment Survey,” *Journal of East European Management Studies* 11: 305-325.

Brynjolfson, Erik and Lorin M. Hitt. 2000. “Beyond Computation: Information Technology, Organizational Transformation and Business Performance,” *Journal of Economic Perspectives*14: 23-48.

Carmichael, H. Lorne and W. Bentley MacLeod. 1993. “Multiskilling, Technical Change and the Japanese Firm,” *Economic Journal* 103: 142-160.

Caroli, Eve, Nathalie Greenan and Dominique Guellec. 2001. "Organization Change and Skill Accumulation," *Industrial and Corporate Change* 10: 481 – 506.

Caroli, Eve and John Van Reenen. 2001. "Skill-Biased Organizational Change? Evidence from a Panel of British and French Establishments," *Quarterly Journal of Economics* 116: 1449 – 1492.

Cottini, Elena and Claudio Lucifora. 2013. “Mental Health and Working Conditions in Europe,” *Industrial and Labor Relations Review* 66: 958-988.

De Varo, J., and F.A. Kurtulus. 2010. "An Empirical Analysis of Risk, Incentives and the Delegation of Work Authority," *Industrial and Labor Relations Review* 64: 641 – 661.

Doms, M., T. Dunne and K.R. Troske. 1997. “Workers, Wages and Technology,” *Quarterly Journal of Economics* 112: 253-290.

Dessein, Wouter and Tano Santos. 2006. “Adaptive Organizations,” *Journal of Political Economy* 114: 956-995.

Fischer, G., Janik, F., Mueller, D., and Schmucker, A. 2009. “The IAB Establishment Panel – Things Users Should Know,” *Journal of Applied Social Science Studies* 129: 133-148.

Fitzenberger, Bernd and Grit Muehler. 2015. “Dips and Floors in Workplace Training: Using Personnel Records to Estimate Gender Differences,” *Scottish Journal of Political Economy* 62: 325-429.

Gashi, A.N., G. Pugh and N. Adnett. 2008. “Technological Change and Employer Provided Training: Evidence from German Establishments,” Leading House Working Paper No. 26, Zurich.

Gashi, A.N., G. Pugh and N. Adnett. 2010. “Technological Change and Employer-Provided Training: Evidence from UK Workplaces,” *International Journal of Manpower* 31: 426-448.

Gerlach, Knut and Uwe Jirjahn. 2001. “Employer Provided Further Training: Evidence from German Establishment Data,” *Schmollers Jahrbuch – Journal of Applied Social Science Studies* 121: 1-26.

Green, Francis. 2004. “Why Has Work Become More Intense?” *Industrial Relations* 43: 709-741.

Grund, Christian and Johannes Martin. 2012. “Determinants of Further Training – Evidence for Germany,” *International Journal of Human Resource Management* 23: 3536-3558.

Harhoff, D. and Kane, T.J. 1997. “Is the German Apprenticeship System a Panacea for the U.S. Labor Market?” *Journal of Population Economics* 10: 171-196.

Heckman, J.J. 1999. “Policies to Foster Human Capital,” NBER Working Paper No. 7288.

Heywood, John S. and Uwe Jirjahn. 2002. “Payment Schemes and Gender in Germany,” *Industrial and Labor Relations Review* 56: 44-64.

Heywood, John S. and Uwe Jirjahn. 2004. “Teams, Teamwork and Absence,” *Scandinavian Journal of Economics* 106: 765-782.

Heywood, John S. and Uwe Jirjahn. 2009. “Profit Sharing and Firm Size: The Role of Team Production,” *Journal of Economic Behavior and Organization* 71: 246-258.

Heywood, John S., Uwe Jirjahn and Annika Pfister. 2017. “Product Market Competition and Employer Provided Training in Germany,” Research Papers in Economics 2017-07, University of Trier, Department of Economics.

Hunter, Larry W., Annette Bernhardt, Katherine L. Hughes and Eva Skuratowicz. 2001. “It’s Not Just the ATMs: Technology, Firm Strategies, Jobs, and Earnings in Retail Banking,” *Industrial and Labor Relations Review* 54: 402-424.

Jirjahn, Uwe and Kornelius Kraft. 2010. “Teamwork and Intra-Firm Wage Dispersion among Blue-Collar Workers,” *Scottish Journal of Political Economy* 57: 404-429.

Jirjahn, U. and S.C. Smith. 2006. “What Factors Lead Management to Support or Oppose Employee Participation – With and Without Works Councils? Hypotheses and Evidence from Germany,” *Industrial Relations* 45: 650-680.

Kampkoetter, Patrick, Jens Mohrenweiser, Dirk Sliwka, Susanne Steffes and Stefanie Wolter. 2016. “Measuring the Use of Human Resources Practices and Employee Attitudes: The Linked Personnel Panel,” *Evidence-Based Human Resource Management* 4: 94-115.

Lindbeck, A. and D.J. Snower. 2000. "Multitask Learning and the Reorganization of Work: From Tayloristic to Holistic Organization," *Journal of Labor Economics* 19: 353-376.

Lynch, L.M. and Black, S.E. 1998. “Beyond the Incidence of Employer-Provided Training,” *Industrial and Labor Relations Review* 52: 64-81

Milgrom, Paul and John Roberts. 1990. “The Economics of Modern Manufacturing: Technology, Strategy, and Organization,” *American Economic Review* 89: 511-528.

Milgrom, Paul and John Roberts. 1995. “Complementarities and Fit: Strategy, Structure, and Organizational Change in Manufacturing,” *Journal of Accounting and Economics* 19: 179-208.

Morita, H. 2005. "Multi-skilling, Delegation and Continuous Process Improvement: A Comparative Analysis of US- Japanese Work Organizations," *Economica* 72: 69 – 93.

Moulton, B. 1990. “An illustration of a Pitfall in Estimating the Effects of Aggregate Variables on Micro Units,” *Review of Economics and Statistics* 72: 334 – 338.

OECD. 2003. *Employment Outlook*, Paris, OECD Publishing.

Oi, W. 1962. “Labor as a Quasi-Fixed Factor,” *Journal of Political Economy* 70: 538-555.

Osterman, Paul. 1995. “Skill, Training, and Work Organization in American Establishments,” *Industrial Relations* 34: 125-147.

Piva, Mariacristina, Enrico Santarelli and Marco Vivarelli. 2005. "The Skill Bias Effect of Technological and Organisational Change: Evidence and Policy Implications," *Research Policy* 34: 141 - 157.

Piva, Mariacristina, Enrico Santarelli and Marco Vivarelli. 2006. "Technological and Organizational Changes as Determinants of the Skill Bias: Evidence from the Italian Machinery Industry," *Managerial and Decision Economics* 27: .63 – 73

Rosen, S 1976. "A Theory of Life Earnings," *Journal of Political Economy* 84: S45-S67.

Seyda, S. and Werner, D. 2014. “IW-Weiterbildungserhebung 2014 – Höheres Engagement und mehr Investitionen in betriebliche Weiterbildung,” IW-Trends 4/2014, Köln.

Winkelmann, R. 1996. “Employment Prospects and Skill Acquisition of Apprenticeship-Trained Workers in Germany.” *Industrial and Labor Relations Review* 49: 658-672.

Xu, Kuan and Zhengxi Lin. 2011. "Participation in Workplace Employer-Sponsored Training in Canada: Role of Firm Characteristics and Worker Attributes," *Contemporary Economic Policy* 29: 416-430.

Table 1: Further Training

Category	*Definition*	*Share of observations*
Employer provided further training	The employee participated in courses of further training in the respective year and the costs were partially or completely borne by the employer in release time and/or paying explicit training costs.	0.33
Employee paid further training	The employee participated in courses of further training in the respective year and he or she completely paid the further training for themselves (i.e., there was no release time and the explicit costs were not partially or completely borne by the employer).	0.01
No further training	The employee did not participate in courses of further training in the respective year.	0.65

Number of pooled observations of employees = 8,694.

Table 2: Explanatory Variables: Employee Characteristics

Variable	*Definition (Mean, Standard Deviation)*
Decision-making autonomy	The employee's job is ranked on a five-point Likert scale according to the extent to which the employee can make many decisions autonomously where 1 = does not apply at all, . . ., 5 = fully applies (3.98, 1.02).
Task variety	The employee's job is ranked on a five point Likert scale according to the degree of task variety where 1 = does not apply at all, . . ., 5 = fully applies (4.23, 0.95).
Others' performance depends on employee	The employee's job is ranked on a five-point Likert scale according to the degree to which the performance of others depends on the employee's performance where 1 = does not apply at all, . . ., 5 = fully applies (3.83, 1.23).
Employee's performance depends on others	The employee's job is ranked on a five-point Likert scale according to the degree to which his or her performance depends on the performance of others where 1 = does not apply at all, . . ., 5 = fully applies (3.36, 1.32).
Physical effort required	The employee's job is ranked on a five-point Likert scale according to the degree of required physical effort where 1 = does not apply at all, . . ., 5 = fully applies (2.47, 1.50).
Unpleasant working conditions	The employee's job is ranked on a five-point scale according to the degree the employee is exposed to unpleasant working conditions where 1 = does not apply at all, . . ., 5 = fully applies (2.88, 1.56).
Time pressure and work overload	The employee's job is ranked on a five-point Likert scale according to the degree of time pressure and work overload where 1 = does not apply at all, . . ., 5 = fully applies (3.55, 1.24).
Older employee	Dummy equals 1 if the employee is older than 50 years (0.41, 0.49).
Blue-collar worker	Dummy equals 1 if the employee is a blue-collar worker (0.43, 0.49).
Skilled employee	Dummy equals 1 if the employee's highest educational attainment is a completed apprenticeship training (0.80, 0.40).
University degree	Dummy equals 1 if the employee has a university degree (0.17, 0.38).
Woman	Dummy equals 1 if the employee is a woman (0.26, 0.44).
German citizenship	Dummy equals 1 if the employee has a German citizenship (0.95, 0.21).
Employee has a partner	Dummy equals 1 if the employee is a stable partner or spouse (0.84, 0.36).
Supervisor	Dummy equals 1 if the employee is supervisor (0.31, 0.46).
Flexible working hours	Dummy equals 1 if the employee has flexible working hours (0.44, 0.50).
Fixed-term contract	Dummy equals 1 if the employee has a fixed-term contract (0.06, 0.23).
Part-time employee	Dummy equals 1 if the employee has a part-time employee (0.11, 0.32).
Information and communication technology	Dummy equals 1 if the employee uses information or communication technologies during working time (0.76, 0.43).*
Technological change	Dummy equals 1 if the technological equipment of the employee's workplace changed during the past five years (0.71, 0.45). **

Number of pooled observations of employees = 8,694. The variables for information and communication technology and for technological change are only available from the 2014 wave of the LPP. For these two variables, the number of observations are 3,989 and 3,968, respectively.

Table 3: Explanatory Variables: Establishment Characteristics

Variable	*Definition (Mean, Standard Deviation)*
Investment per capita	Amount of investment in physical capital (in Euro) divided by the number of employees (7062.5,14133.45)
Vintage of technology	Dummy equals 1 if production technology is of a more recent vintage than the industry median (0.73, 0.44). The dummy builds from an underlying five-point Likert scale for the vintage of production technology where 1 = very old, …, 5 = state of the art.
Multi-establishment firm	Dummy equals 1 if the establishment is part of a multi-establishment firm (0.43, 0.50).
Foreign ownership	Dummy equals 1 if the establishment has a dominant foreign owner (0.18, 0.38).
Founded after 1990	Dummy equals 1 if the establishment was founded after the year 1990 (0.45, 0.50).
Establishment size	Number of employees at the establishment (436.53, 2313.50).
Establishment size squared	Number of employees squared.
High competitive pressure with threat of liquidation	Dummy equals 1 if the establishment reports high competitive pressure entailing a threat of liquidation (0.11, 0.32).
High competitive pressure without threat of liquidation	Dummy equals 1 if the establishment reports high competitive pressure, but faces no threat of liquidation (0.42, 0.49).
Collective bargaining	Dummy equals 1 if the establishment is covered by a collective bargaining agreement (0.58, 0.49).
Works council	Dummy equals 1 if a works council is present in the establishment (0.66, 0.48).
Temporary agency employees	Dummy equals 1 if the establishment uses temporary agency workers (0.16, 0.37).
Share of part-time employees	Part-time employees as a share of the establishment's workforce (0.12, 0.18).
Share of women	Female employees as a share of the establishment's workforce (0.30, 0.23).
Share of apprentices	Apprentices as a share of the establishment's workforce (0.04, 0.04).
Share of skilled employees	Employees with completed apprenticeship training as a share of the establishment's workforce (0.65, 0.24).
Share of university graduates	University graduates as a share of the establishment's workforce (0.11, 0.14).
Vacancies for unskilled employees	Dummy equals 1 if the establishment has job vacancies for unskilled workers (0.11, 0.31).
Vacancies for skilled and high-skilled employees	Dummy equals 1 if the establishment has job vacancies for skilled workers and university graduates (0.48, 0.50).
Industry dummies	3 broad industry dummies are included.
Region dummy	Dummy equals 1 if the establishment is located in West Germany.
Time dummy	Dummy for the year 2014.

Number of pooled observations of establishments = 1,231.

Table 4: Initial Estimates

Variable	*(1)*	*(2)*	*(3)*	*(4)*
Decision-making autonomy	0.165 [0.054] (7.01)***	0.104 [0.034] (4.60)***	0.062 [0.021] (2.81)**	0.069 [0.022] (3.08)**
Task variety	0.148 [0.049] (5.89)***	0.131 [0.043] (5.31)***	0.115 [0.038] (4.69)***	0.119 [0.039] (4.64)***
Others' performance depends on employee	---	-0.022 [-0.007] (1.26)	-0.030 [-0.010] (1.70) *	-0.002 [-0.001] (0.13)
Employee's performance depends on others	---	0.035 [0.012] (2.28)**	0.035 [0.012] (2.28)**	0.030 [0.010] (1.92)*
Physical effort required	---	-0.160 [-0.053] (8.14)***	-0.076 [-0.025] (3.87)***	-0.080 [-0.026] (4.27)***
Unpleasant working conditions	---	-0.090 [-0.030] (5.57)***	-0.055 [-0.018] (3.32)***	-0.062 [-0.020] (3.76)***
Time pressure and work overload	---	0.125 [0.041] (7.53)***	0.063 [0.021] (3.71)***	0.059 [0.019] (3.51)***
Older employee	---	---	-0.182 [-0.039] (4.46)***	-0.212 [-0.046] (5.16)***
Blue-collar worker	---	---	-0.415 [-0.077] (6.97)***	-0.339 [-0.068] (5.90)***
Skilled employee	---	---	0.444 [0.127] (2.78)**	0.383 [0.109] (2.39)**
University degree	---	---	0.606 [0.184] (3.56)***	0.494 [0.147] (2.91)**
Woman	---	---	-0.118 [-0.026] (1.90)*	-0.111 [-0.025] (1.90)*
German citizenship	---	---	0.146 [0.046] (1.58)	0.099 [0.028] (1.07)
Employee has partner	---	---	0.110 [0.027] (2.02)**	0.117 [0.030] (2.01)**
Supervisor	---	---	0.279 [0.075] (5.75)***	0.300 [0.083] (6.00)***
Flexible working hours	---	---	0.115 [0.029] (2.18)**	0.087 [0.022] (1.62)
Fixed-term contract	---	---	-0.170 [-0.048] (1.82)*	-0.082 [-0.021] (0.87)
Part-time employee	---	---	-0.083 [-0.024] (0.97)	-0.150 [-0.038] (1.66)*
Investment per capita	---	---	---	$3x10^{-6}$ [$1x10^{-6}$] (2.39)**
Vintage of technology	---	---	---	0.124 [0.035] (1.88)*
Multi-establishment firm	---	---	---	0.139 [0.039] (2.07)**
Foreign ownership	---	---	---	0.097 [0.027] (1.33)
Founded after 1990	---	---	---	-0.008 [-0.002] (0.10)

Establishment size	---	---	---	$5x10^{-5}$ [$2x10^{-5}$] (3.20)***
Establishment size squared	---	---	---	$-8x10^{-10}$ [$3x10^{-10}$] (2.90)**
High competitive pressure with threat of liquidation	---	---	---	-0.178 [-0.050] (1.88)*
High competitive pressure without threat of liquidation	---	---	---	-0.050 [-0.015] (0.80)
Collective bargaining	---	---	---	-0.011 [-0.003] (0.15)
Works council	---	---	---	0.220 [0.072] (2.76)**
Temporary agency employees	---	---	---	-0.035 [-0.010] (0.98)
Share of part-time employees	---	---	---	0.309 [0.100] (1.21)
Share of women	---	---	---	0.035 [0.011] (0.18)
Share of apprentices	---	---	---	3.086 [1.001] (3.95)***
Share of skilled employees	---	---	---	0.492 [0.160] (3.18)***
Share of university graduates	---	---	---	0.675 [0.219] (2.70)**
Vacancies for unskilled employees	---	---	---	0.134 [0.038] (1.45)
Vacancies for skilled and high-skilled employees	---	---	---	-0.049 [-0.013] (0.83)
Constant	-1.913 (13.65)***	-1.406 (9.36)***	-1.769 (7.41)***	-2.605 (7.87)***
Industries dummies	Not included	Not included	Not included	Included
Region dummy	Not included	Not included	Not included	Included
Time dummy	Not included	Not included	Not included	Included
Pseudo-R^2	0.013	0.045	0.065	0.088
Number of observations	8,694	8,694	8,694	8,694
Number of employees	7,089	7,089	7,089	7,089

Estimations are based on the 2012 and the 2014 wave of the LPP. The dummy dependent variable equals 1 if the employee received employer provided training in the respective year. Method: Random effects probit. The table shows the estimated coefficients. Z-statistics in parentheses are based on standard errors clustered at the establishment level. Average marginal effects are in square brackets. Marginal effects of dummy variables are evaluated for a discrete change from 0 to 1. *Statistically significant at the 10% level; ** at the 5% level; *** at the 1% level.

Table 5: The Role of Information and Communication Technologies (ICT)

Variable	*(1) All employees*	*(2) All employees*	*(3) Only employees using ICT*	*(4) Only employees not using ICT*
Information or communication technologies	---	0.452 [0.160] (6.76)***	---	---
Decision-making autonomy	0.066 [0.025] (2.87)**	0.064 [0.024] (2.77)**	0.060 [0.024] (2.28)**	0.091 [0.020] (1.76)*
Task variety	0.097 [0.036] (3.66)***	0.091 [0.034] (3.39)***	0.091 [0.036] (2.93)**	0.084 [0.019] (1.68)*
Pseudo-R^2	0.099	0.109	0.070	0.083
Number of observations	3,989	3,989	3,040	949

Estimations are only based on the 2014 wave of the LPP. The dummy dependent variable equals 1 if the employee received employer provided training in the respective year. Method: Probit. The table shows the estimated coefficients. Z-statistics in parentheses are based on standard errors clustered at the establishment level. Average marginal effects are in square brackets. *Statistically significant at the 10% level; ** at the 5% level; *** at the 1% level. Results on the other explanatory variables are suppressed to save space.

Table 6: The Role of Technological Change

Variable	*(1) All employees*	*(2) All employees*	*(3) Only employees with technological change*	*(4) Only employees without technological change*
Technological change	---	0.377 [0.135] (6.79)***	---	---
Decision-making autonomy	0.066 [0.025] (2.85)**	0.058 [0.022] (2.46)**	0.061 [0.024] (2.07)**	0.065 [0.017] (1.45)
Task variety	0.097 [0.036] (3.65)***	0.093 [0.035] (3.48)***	0.082 [0.032] (2.70)**	0.120 [0.032] (2.38)**
Pseudo-R^2	0.099	0.109	0.068	0.149
Number of observations	3,968	3,968	2,835	1,133

Estimations are only based on the 2014 wave of the LPP. The dummy dependent variable equals 1 if the employee received employer provided training in the respective year. Method: Probit. The table shows the estimated coefficients. Z-statistics in parentheses are based on standard errors clustered at the establishment level. Average marginal effects are in square brackets. **Statistically significant at the 5% level; *** at the 1% level. Results on the other explanatory variables are suppressed to save space.

Table 7: Self-Paid Training and Employer Provided Training

Variable	*Self-paid training*	*Employer provided training*
Decision-making autonomy	0.034 [$4x10^{-5}$] (0.67)	0.081 [0.020] (3.42)***
Task variety	-0.026 [-0.002] (0.45)	0.128 [0.033] (4.72)***
Pseudo-R^2	0.093	
Number of employees	7,089	
Number of observations	8,694	

Estimations are based on the 2012 and the 2014 wave of the LPP. The reference group consists of employees who received no training in the respective year. Method: Multinomial probit. The table shows the estimated coefficients. Z-statistics in parentheses are based on standard errors clustered at the establishment level. Average marginal effects are in square brackets. ***Statistically significant at the 1% level. Results on the other explanatory variables are suppressed to save space.

Table 8: Separate Estimations by the Employees' Initial Education

Variable	*(1) Employees with a university degree*	*(2) Skilled employees (with apprenticeship training)*	*(3) Unskilled employees (without apprenticeship training)*
Decision-making autonomy	0.143 [0.057] (2.41)**	0.063 [0.019] (2.53)**	0.019 [$1x10^{-7}$] (0.03)
Task variety	0.156 [0.062] (2.54)**	0.119 [0.036] (4.09)***	-0.122 [$-7x10^{-7}$] (0.09)
Pseudo-R^2	0.067	0.081	0.177
Number of observations	1,516	6,978	155
Number of employees	1,231	5,678	141

Estimations are based on the 2012 and the 2014 wave of the LPP. The dummy dependent variable equals 1 if the employee received employer provided training in the respective year. Method: Random effects probit. The table shows the estimated coefficients. Z-statistics in parentheses are based on standard errors clustered at the establishment level. Average marginal effects are in square brackets. **Statistically significant at the 5% level; *** at the 1% level. Results on the other explanatory variables are suppressed to save space.

Table 9: Separate Estimations for Blue-Collar and White-Collar Workers

Variable	*(1)* *Blue-collar workers*	*(2)* *White-collar workers*
Decision-making autonomy	0.050 [0.009] (1.48)	0.081 [0.031] (2.63)**
Task variety	0.139 [0.026] (3.40)***	0.115 [0.044] (3.50)***
Pseudo-R^2	0.079	0.056
Number of observations	3,703	4,991
Number of employees	3,091	4,131

Estimations are based on the 2012 and the 2014 wave of the LPP. The dummy dependent variable equals 1 if the employee received employer provided training in the respective year. Method: Random effects probit. The table shows the estimated coefficients. Z-statistics in parentheses are based on standard errors clustered at the establishment level. Average marginal effects are in square brackets. **Statistically significant at the 5% level; *** at the 1% level. Results on the other explanatory variables are suppressed to save space.

Table 10: Separate Estimations by the Employees' Age

Variable	*(1) Employees younger than 50*	*(2) Employees older than 50*	*(3) Employees younger than 55*	*(4) Employees older than 55*
Decision-making autonomy	0.075 [0.026] (2.79)**	0.067 [0.020] (1.90)*	0.100 [0.034] (4.07)***	-0.025 [-0.007] (0.53)*
Task variety	0.122 [0.042] (3.96)***	0.121 [0.035] (2.87)**	0.109 [0.037] (3.95)***	0.160 [0.040] (2.87)**
Pseudo-R^2	0.089	0.098	0.089	0.111
Number of observations	5,121	3,573	6,581	2,113
Number of employees	4,311	2,925	5,484	1,778

Estimations are based on the 2012 and the 2014 wave of the LPP. The dummy dependent variable equals 1 if the employee received employer provided training in the respective year. Method: Random effects probit. The table shows the estimated coefficients. Z-statistics in parentheses are based on standard errors clustered at the establishment level. Average marginal effects are in square brackets. *Statistically significant at the 10% level; ** at the 5% level; *** at the 1% level. Results on the other explanatory variables are suppressed to save space.

Table 11: Separate Estimations by the Employees' Gender

Variable	*(1)* *Men*	*(2)* *Women*
Decision-making autonomy	0.058 [0.020] (2.36)**	0.099 [0.026] (1.86)*
Task variety	0.120 [0.041] (4.21)***	0.117 [0.031] (2.09)**
Pseudo-R^2	0.080	0.142
Number of observations	6,414	2,280
Number of employees	5,224	1,865

Estimations are based on the 2012 and the 2014 wave of the LPP. The dummy dependent variable equals 1 if the employee received employer provided training in the respective year. Method: Random effects probit. The table shows the estimated coefficients. Z-statistics in parentheses are based on standard errors clustered at the establishment level. Average marginal effects are in square brackets. *Statistically significant at the 10% level; ** at the 5% level; *** at the 1% level. Results on the other explanatory variables are suppressed to save space.

Appendix

Table A1: Separate Estimations for 2012 and 2014

Variable	*(1)* *2012*	*(2)* *2014*
Decision-making autonomy	0.051 [0.017] (2.09)**	0.066 [0.025] (2.87)**
Task variety	0.095 [0.032] (3.64)***	0.097 [0.036] (3.66)***
Pseudo-R^2	0.091	0.099
Number of observations	4,705	3,989

Estimations are based on the 2012 and the 2014 wave of the LPP. The dummy dependent variable equals 1 if the employee received employer provided training in the respective year. Method: Random effects probit. The table shows the estimated coefficients. Z-statistics in parentheses are based on standard errors clustered at the establishment level. Average marginal effects are in square brackets. **Statistically significant at the 5% level; *** at the 1% level. Results on the other explanatory variables are suppressed to save space.

Endnotes

[1] A study by Xu and Lin (2011) uses linked employer-employee data. However, their indicators of flexible production are measured at the firm level. That study provides very mixed results on the influence of flexible production on training.

[2] Further factors are an increased volatility of markets, a shortening in the length of batches, a better formal education of employees, and changes in employees' tastes (Caroli et al. 2001, Lindbeck and Snower 2000).

[3] In the extreme, the introduction of new technologies may increase firm performance only if firms undergo complementary organizational changes. Technological change alone may be not enough. Doms et al. (1997) show that new production technologies have little influence on the skill requirements for production workers. Jirjahn and Kraft (2010) provide evidence that the influence of a modern production technology on the intra-firm wage differential between skilled and unskilled blue-collar workers crucially depends on the organization of work. A modern production technology has a positive influence on the wage differential when the firm uses self-autonomous production teams, but it has a negative influence if the firm has no such teams. This suggests that new technologies have a deskilling effect on blue-collar workers when there is no reorganization of work and workers have little scope for decision-making. By contrast, new technologies coupled with increased responsibilities and expanded involvement in decision making increase the skill requirements for blue-collar workers.

[4] Bartel and Sicherman (1998) provide evidence from the U.S. that technological change narrows the training gap between the more and less educated.

[5] The statements underlying our key explanatory variables are 'In my job, I can make many decisions autonomously' and 'In my job, I perform a variety of tasks'. Interviewees respond to

each of the statements on a five-point Likert scale ranging from 1 ‘agree completely’ to 5 ‘disagree completely’. For the empirical analysis, the items are recoded in inverse order.

[6] Ignoring clustering is likely to produce downward biased standard errors (Moulton 1990) as establishment characteristics and the training provided to the individual employee differ in the level of aggregation.

[7] As a robustness exercise we split the two years of the sample to make sure that our results were not driven by a single anomalous year. We summarize the results in Appendix Table A1 which makes clear that the key results on the two workplace flexibility variables remain essentially identical across the two years.