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Investment in Human Capital: Company expenditures on continuing vocational training in times of technological change in Germany

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Abstract

Context: The scientific and political discourse often acclaims continuing training as the key for adapting to today's changes in the labour market, caused – among others– by technological change. However, changed skill demand and increased continuing training participation does not necessarily translate into increased investment in human capital by employers, especially for already disadvantaged skill groups. Therefore, this analysis focusses on the relation between companies' investment in human capital, technological change indicators and companies' skill structure. Methods: We use quantitative data from the 2020 wave of a representative establishment survey for Germany to estimate ordinary least square regressions. Results: The results show that the investment in technology and the technology level positively relate to investment in human capital. However, the an above average share of low-skilled employees is negatively associated with a companies' human capital investment. Conclusion: Investment in technology and the technology level do lead to an increase in human capital investment. Still, the skill structure in a company is important for determining whether companies invest in the human capital of their employees. Combined with the fact that most training is financed by the employer, increased investment by companies in times of technological change could lead to increased or persistent barriers to continuing training for already disadvantaged groups. Therefore, further research in this area is needed. These findings provide a good starting point for policies aimed at reducing these barriers and increasing human capital investment for disadvantaged groups.

Keywords

human capital investment, continuing vocational training, technological change, company-level data

1 Introduction

Employees must constantly adapt to changing labour market conditions. In recent decades, technological change in particular has had a major impact on the labour market and the skill demand (Kruppe & Baumann, 2019; Schneemann et al., 2021). In the scientific and political discourse, continuing vocational education and training (CVET) is often praised as the key to adapting to these changes (Anbuhl, 2019; Kruppe & Baumann, 2019; Schneemann et al., 2021; Weber, 2017). This demand for higher or new skills also seems to reflect in the increasing participation in CVET. In 2020, 60 per cent of the German workforce participated in CVET and the numbers are increasing (BMBF, 2021), but whether technological change is the driver of this pattern is still unclear. Furthermore, it must be acknowledged that there are large disparities in CVET participation based on qualifications and skills (Anbuhl, 2019; Dobischat et al., 2019; Offerhaus et al., 2016).

Continuing training (CT) is defined as intentional learning after initial training or resumption of education after entering the labour market (Bilger et al., 2017; CEDEFOP, 2019). CT is a heterogeneous term covering different forms of learning. Distinctions are made, according to the content, the duration, the degree of formalisation and the awarding of certificates. CVET is distinguished from general CT. The purpose of CVET is to promote the adaptation, maintenance or upgrading of workers' skills (Janssen & Leber, 2015). If CVET is partly/fully covered by the employer in a direct (e.g., assumption of costs) and/or indirect way (e.g., release from work), it is referred to as company-based CVET (Bilger et al., 2017) and course-based CVET if the company-based CVET takes place in courses.

With regard to technological change, empirical research predominantly shows a positive relation between new technology, technology investment or the technology level of the company and the participation in CVET within a company (e.g. Baum & Lukowski, 2022; Janssen et al. 2018; Lukowski et al., 2021; Mohr et al., 2016; Wotschack, 2020a). An often-used explanation for this connection is that technological change leads to changes in tasks and competence requirements, which require adaptation and thus CVET (Arntz et al., 2016; Ehlert, 2020; Görlitz & Tamm, 2016; Heß et al., 2019; Janssen & Leber, 2020; Kleinert & Wölfel, 2018). However, this link between CVET and technological change indicators often depends on the employee's skills and tasks (e.g. Lukowski et al., 2021; Mohr et al., 2016; Wotschack, 2020a; Wotschack & Solga, 2014; Ehlert, 2020). Especially, routine tasks, which are in higher danger of substitution by technology (e.g. Autor et al., 2003) and are mostly performed by low-skilled employees (e.g. Rohrbach-Schmidt, 2019), are negatively correlated with CVET participation (Ehlert, 2020; Heß et al. 2019; Wölfel & Kleinert, 2018).

In times of technological change companies' expenditures may shift towards investment in technology and away from HCI, as technology may substitute or complement certain tasks (e.g., Autor et al., 2003; Frey & Osborne, 2017) - especially for the low-skilled employees, who more likely perform more routine (Rohrbach-Schmidt, 2019) and substitutable (Autor et al., 2003) tasks. As companies provide the majority of CVET in numerous European countries - like Germany – (Bassanini et al., 2007; Bilger et al., 2017; Dohmen & Cordes, 2019; Hummelsheim, 2009) lower provision and investments in CVET might be problematic. Thus, in addition to participation, employers' human capital investment (HCI) is another important dimension for assessing the development of CVET in times of technological change in a country.

However, recent research on technological change and companies' expenditures on CVET or HCI in Germany is scarce (e.g. Baum & Fournier, 2021; Janssen et al. 2018; less recent: Gerlach et al. 2002; Hempell, 2003; Kuckulenz & Meyer, 2006; country comparison: Brunello et al. 2023). To fill this gap, this analysis examines how a company's technology level, technology investment tendency and skill structure are related to its expenditure on CVET. For the analysis we use quantitative company-level data using ordinary least squares (OLS) regression models.

2 Literature overview

2.1 Financing of continuing training in Germany

The majority of CVET in Germany is financed by the private sector (i.e. companies and individuals) (Dohmen & Cordes, 2019; Hummelsheim, 2009; Müller & Wenzelmann, 2018), and mostly takes the form of company-based CVET (Bassanini et al., 2007; Bellmann & Leber, 2010; Bilger et al., 2017; Frei et al., 2020). Financing by the state and employment agencies (i.e. the public sector) is comparatively low, especially if tax compensation is not considered (Dohmen & Cordes, 2019; Hummelsheim, 2009). Since the mid-1990s until 2015, the public sector investment has stagnated, while the private sector investment has increased (Dobischat et al., 2019). In 2015, the state contributed only about a third of total expenditures on CVET (Dobischat et al., 2019; Dohmen & Cordes, 2019). This disproportionate use of private resources to finance CVET is not uncritical, as it has particularly negative consequences for groups that are already disadvantaged in CVET (Dobischat et al., 2019; Hummelsheim, 2009).

Individuals and employees differ in the type of training they finance (Müller & Wenzelmann, 2018). Particularly formal CVET (e.g. upgrading training) is more likely to be financed by employees themselves, while employers are more likely to invest in non-formal CVET, work-related qualifications, conference attendance, lectures, etc. (Müller & Wenzelmann, 2018). CVET participants spend an average of €189 per CVET unit on direct and indirect costs (Müller & Wenzelmann, 2018). The total amount spent by individuals on CVET in 2015 was a sum of €17.8 billion (Müller & Wenzelmann, 2018). The amount spent by the employers per employee is even higher than the individual expenditures (Müller & Wenzelmann, 2018).

Depending on the database, methods, etc. (Schönfeld & Thiele, 2019), different figures on the amount employers in Germany invest in CVET exist. According to the German Economic Institute’s Continuing Training Survey companies spent €41.3 billion (€21 billion direct costs) on CVET in 2019, which corresponds to €1,236 per employee (€629 direct costs) (Seyda & Placke, 2020). Overall, investment has been rising steadily since 2013 (Seyda & Placke, 2020). Projections from the Continuing Vocational Training Survey (CVTS), based on the German microcensus, are more moderate. In 2017, companies spent around €11 billion on CVET and there has been no increase in expenditures in recent years. This places Germany in the middle of the European Union in terms of company expenditure on CVET (Schönfeld & Thiele, 2019).[1]

Due to the high level of financial support, participation in company-based CVET depends not only on self-selection, but also on external selection by the employer (Kaufmann & Widany, 2013; Offerhaus et al., 2016). This leads to inequalities in CVET participations, as employees have different participation chances depending on various factors, even within the same company. Factors that influence the external selection are individual characteristics e.g., the qualification or skills of employees (Hubert & Wolf, 2007; Offerhaus et al., 2016), but also job characteristics and tasks (Ehlert, 2020; Görlitz & Tamm, 2016; Hornberg et al., 2021; Tamm, 2018) as well as company characteristic e.g., qualification demands, HR management, organisational innovations, company size, sector, technology use and investment (e.g., Baum & Lukowski, 2022; Leber, 2009; Lukowski et al., 2021; Mohr et al., 2016; Offerhaus et al., 2016; Wotschack, 2020a).

[1] Recent developments and especially changes due to Covid-19 are not yet considerd here.

2.2 Continuing training, human capital and technological change

A reason why companies invest in CVET can be found in the human capital (HC) theory, which assumes that HCI can be analysed analogously to investment in physical capital (Becker, 1962). All activities for mental and physical well-being that increase productivity are HCI. These activities also include CVET (Becker, 1962). The main assumption of the HC theory is that direct (e.g., participation fees) and indirect costs (e.g., opportunity costs) are weighed against the benefits (e.g., higher productivity) of CVET (Becker, 1962; van Loo & Rocco, 2004). Thus, the decision depends on immediate costs and potential benefits (Becker, 1962; Williamson, 1989). Thus, HCI should only be undertaken if the future benefits outweigh the immediate costs.

The understanding of HC has changed over time. Today it is defined more broadly (Balog & Demidova, 2021), because costs and benefits are no longer only monetary (Becker, 1994). Additionally, the actors are rarely assumed to be purely rational anymore i.e. their goal is not only income/productivity maximisation (Balog & Demidova, 2021). Still, based on the logic of a (partially) rational actor, cost-benefit calculations for HCI are mostly negative for low-skilled employees and positive for medium- and high-skilled employees (e.g., Blossfeld et al., 2020; Wotschack, 2020b; Wotschack & Solga, 2014). Therefore, HCI should be lower in firms with a higher degree of low-skilled employees. Hence, it is assumed that:

> H1) Companies with an above average share of low-skilled employees have lower HCI as those with a below average share of low-skilled.

Next to the skill structure, company-level indicators of technological change also have a strong impact on training participation, such as the company's technology use, technology level or technology investment (e.g., Baum & Lukowski, 2022; Hempell, 2003; Janssen et al., 2018; Kuckulenz & Meyer, 2006; Lukowski et al., 2021; Mohr et al., 2016).

Technological change has a significant influence on HC development, because it creates a constant demand for knowledge, creativity and skill improvement, which increases HC accumulation (Balog & Demidova, 2021). Moreover, the cost-benefit calculation of HC theory is sensitive to changes in the environment, such as technological change (Becker, 1994). An investment that may not have been worthwhile before may become worthwhile (Becker, 1994), because the changes in the environment e.g., technological improvements, may change the cost-benefit analysis of companies (Becker, 1994; van Loo & Rocco, 2004; Wotschack, 2020b). Hence, companies may spend more on HC.

Education and training are key variables in dealing with technological changes (Becker, 1994). Consequently, technological change creates a need for employees and employers to adapt, which can be met through company-based CVET (Acemoglu & Restrepo, 2019; Heß et al., 2019; Schneemann et al., 2021). Moreover, technologies are leading to changes in work tasks, due to substitution or complementarity tendencies between tasks and technologies (e.g., Acemoglu, 2002; Acemoglu & Restrepo, 2019; Autor et al., 2003; Frey & Osborne, 2017). With that work is becoming less physically and more cognitively demanding, which may require adaptation through CVET (Arntz et al., 2016). Technological change therefore plays a major direct role for CVET (Janssen & Leber, 2020). This change is accompanied by increasing demands and skill requirements (Janssen & Leber, 2020; Seyda et al., 2018). Thus, investment in technology, might leads to changes in the company, which can lead to HCI regardless of the skill structure, because the company needs suitably skilled employees who can cope with the changes (Düll & Bellmann, 1999; Hempell, 2003).

Technological change is described as the most important driver of CVET, as companies with a higher technology level invest more in CVET than those with a lower level (Seyda & Placke, 2020). Gerlach et al. (2002) show that capital expenditures increase CVET in firms in

Germany. Janssen et al. (2018) show that investment in digitalisation is associated with more HCI, which is in line with Hempell (2003) that ICT and HCI are positively correlated or Kuckulenz and Meyer (2006) that ICT investment is positively related to CVET spending. Baum and Fournier's (2021) exploratory results support a positive relation between CVET expenditure and technology use. However, a recent cross-country analysis by Brunello et al. (2023) shows a negative relation between the adoption of advanced digital technologies and investment in training. Despite these recent results, it is assumed that:

> H2) Companies with a greater technology level have higher HCI as those with a lower technology level.

> H3) Companies with increased investment in technological infrastructure have higher HCI as those with a decrease in technology investment.

3 Method

3.1 Data

For the analysis we use the quantitative company-level data from the 2020 wave of the Federal Institute for Vocational Education and Training Establishment Panel on Training and Competence Development (BIBB Training Panel), which has been conducted annually since 2011. The disproportionate, stratified random sample is representative of all companies based in Germany that have at least one employee who is subject to social insurance contributions. The main focus of the survey is on vocational training activities (Gerhards et al., 2012). The analysis sample consists of 2.457 companies. For descriptive values of the variables see Appendix 1.

3.2 Operationalization

Human capital investment
HCI is measured by direct expenditure on course-based CVET in euro in the year 2019 (for questionnaire wordings see Appendix 2). The question is broadly based on the CVTS question on CVET costs (Destatis, 2017). This expenditure is divided by the number of employees' subject to social insurance contributions in the company, excluding apprentices. Since the original values are not normally distributed, we logarithmise the expenditure per employee (see Appendix 3).

Technology level
For the technology level we utilise the information on which technologies from 13 categories are currently used in the company (see Appendix 2). For each company the share of used technologies is calculated, along with the average technology use in the sector. Companies are then classified into high (1) and low (0) technology level, depending on whether they are above or below the sector average.

Investment in technology
The question is asked whether investment in technology has changed in 2019 compared to the previous year. The options are categorised as decreased or about the same (0) and increased (1).

Skill structure
Companies are asked as follows, how many employees they had with certain skill levels in 2019: 1) employees in low-skilled jobs, i.e. employees performing tasks that do not require vocational qualification; 2) employees in medium-skilled jobs, i.e. employees performing tasks that require vocational education and training (VET) degree or equivalent; 3) employees in high-skilled jobs, i.e. employees performing tasks that require university degree or equivalent.

For each company, the share of low-skilled employees is calculated, as well as the average share of low-skilled employees in the sector. Companies are then categorised into having an above average (1) or below average (0) share of low-skilled employees compared to their sector.

Control Variables

CVET, technology level or investment and skill structure in a company depend on various company characteristic that are controlled for (Leber, 2009; Offerhaus et al., 2016; Schönfeld & Thiele, 2019; Seyda & Placke, 2017). Sector type is considered with an allocation to eight industries, based on a summary of the 2-digit NACE Rev. 2 classification. Company size is controlled for by the standardised number of employees' subject to social insurance. High-skilled employees are considered analogous to the share of low-skilled, with above average (1) or below average (0) share of high-skilled employees. It is also controlled for whether the companies are located in Eastern- (0) or Western-Germany (1), whether the company provides VET (1) (i.e. at least one apprentice) or not (0), and whether a works council exists (1) or not (0).

3.3 Analysis Strategy

The aim is to identify the relation between a company's technology level, it's skill structure and HCI using several regression models. The dependent variable is a continuous variable, so linear OLS-regression is used. The dependent variable is logarithmised. Therefore, the regression coefficients cannot be interpreted as an increase in euros per unit increase in the independent variable, but rather as an increase in per cent (Best & Wolf, 2015).

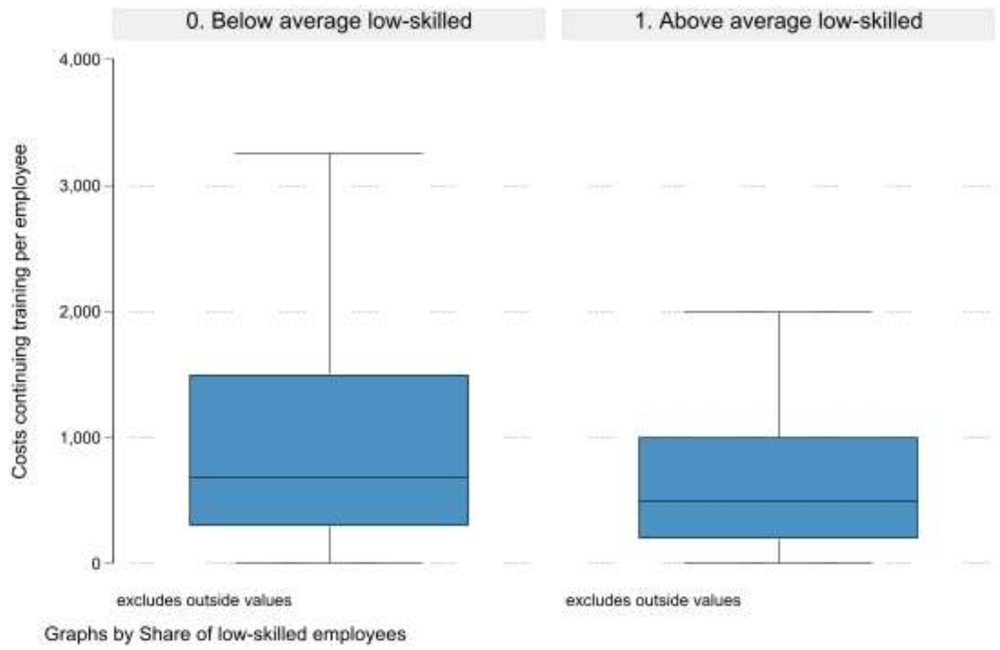
4 Results

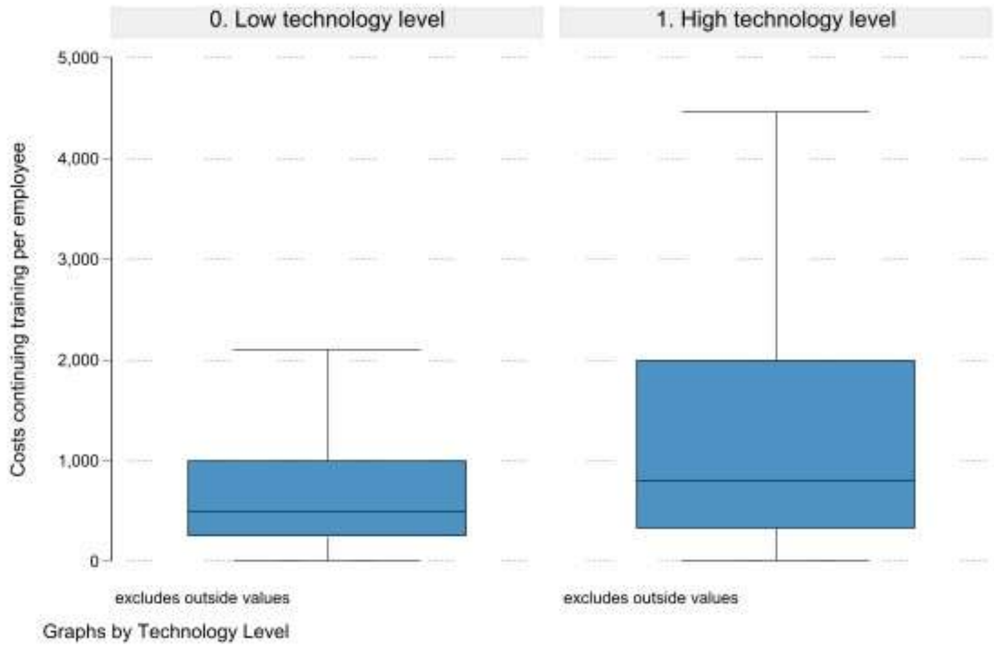
4.1 Descriptives

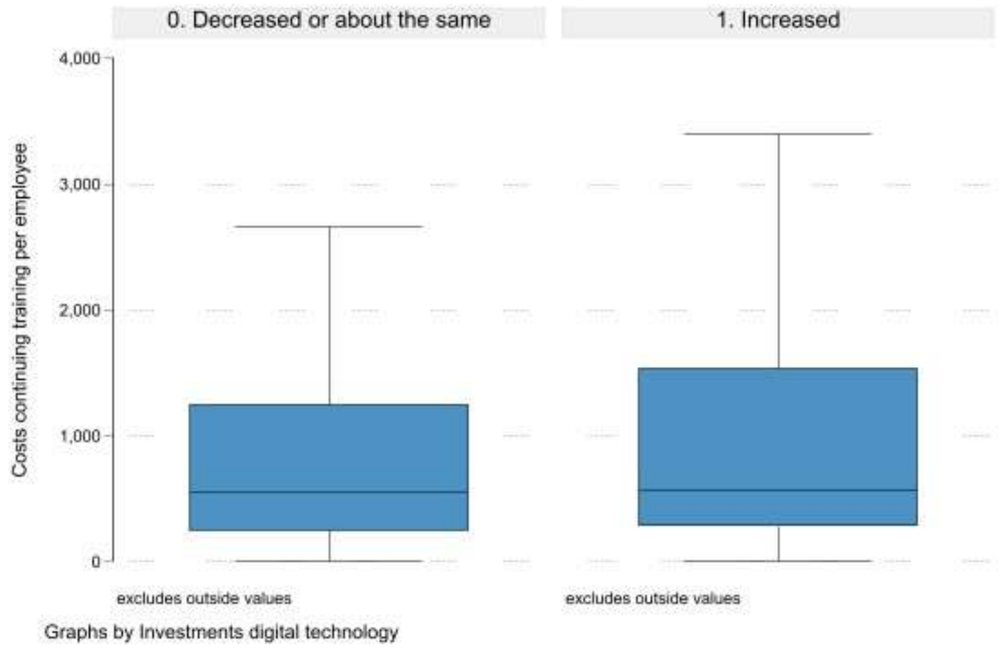
Figure 1 displays boxplots for the CVET expenditures per employees separated by the independent variables.

Figure 1

Boxplots of costs of continuing training per employee (weighted; outside values excluded)







These boxplots show that there are differences in the expenditures on CVET when there is an above average share of low-skilled employees or not in the company (first row). The median expenditure (black line in the box) seems to be higher when there is a below average share of low-skilled employees – in accordance with H1. In line with H2 and H3, the median values of CVET expenditure per employee are (slightly) higher in companies with a high technology level and increased investment in digital technology (second and third row). Tests to see whether the mean values are significantly different from each other i.e. tests for independent samples (e.g., t-test and Mann-Whitney-U-test (Appendix 4)) confirm these assumptions.

4.2 Regression

Table 1 shows the results of the OLS-regression analysis (for graphical representation see Appendix 5). The first column tests for H1 that the influence of the average share of low-skilled employees is negative. HCI decreases by about 34% when a company has an above average share of low-skilled employees, which is in line with H1. Columns 2 and 3 support H2 & H3. Both a high technology level (24%) and increased investment in digital technology (17%) increase a company's HCI, regardless of the share of high-skilled employees, company size, sector, VET provision and a works council existence.

Table 1

OLS-Regression Results for logarithmised CVET expenditures per employee

	Model H1	Model H2	Model H3	Model All
Above average low-skilled	-0.339***			-0.342***
	(0.054)			(0.054)
High technology level		0.239***		0.213***
		(0.051)		(0.051)
Increased Invest. technology			0.174***	0.143**
			(0.049)	(0.050)
Primary Sector	0.0443	0.0514	0.0591	0.0330
	(0.113)	(0.114)	(0.114)	(0.113)
Manufacturing	Ref.	Ref.	Ref.	Ref.
Construction	0.103	0.0831	0.129	0.0767
	(0.116)	(0.117)	(0.117)	(0.116)
Trade and Repair	0.0834	0.0919	0.101	0.0580
	(0.087)	(0.088)	(0.088)	(0.087)
Business-related Services	0.321***	0.317***	0.343***	0.279***
	(0.079)	(0.080)	(0.079)	(0.079)
Personal Services	-0.0687	-0.0994	-0.0536	-0.130
	(0.089)	(0.090)	(0.089)	(0.089)
Health Services	-0.182	-0.173	-0.173	-0.198*
	(0.095)	(0.096)	(0.096)	(0.095)
Public Sector	-0.192*	-0.185*	-0.205*	-0.188*
	(0.082)	(0.082)	(0.082)	(0.081)
Above average high-skilled	0.349***	0.426***	0.433***	0.331***
	(0.052)	(0.050)	(0.051)	(0.052)
Stand. No. of employees	-0.0944**	-0.109***	-0.104***	-0.114***
	(0.031)	(0.031)	(0.031)	(0.031)
West-Germany	0.268***	0.221***	0.217***	0.259***
	(0.057)	(0.057)	(0.057)	(0.057)
VET provision	-0.195***	-0.212***	-0.202***	-0.235***
	(0.055)	(0.056)	(0.056)	(0.056)
Works Council	-0.117*	-0.165**	-0.128*	-0.169**
	(0.054)	(0.055)	(0.055)	(0.055)
Constant	5.674***	5.474***	5.477***	5.564***
	(0.084)	(0.083)	(0.084)	(0.087)
R^2	0.093	0.086	0.083	0.104
Observations	2,457	2,457	2,457	2,457

Note: Standard errors in parentheses; *** p<0.001, ** p<0.01, * p<0.05; Ref. =Reference Category

Columns 4 includes all explanatory variables. The results show that when the above average share of low-skilled is considered, a high technology level (21%) and increased investment in technology (14%) still are positively associated with HCI. With that the results suggests that while the skill structure still impacts the HCI of companies, technology level and investment in technology increases HCI. Investment in technology and HC go hand in hand, as previous findings as well suggest (Gerlach et al., 2002; Janssen et al., 2018; Hempell, 2003; Kuckulenz and Meyer, 2006). Nevertheless, skills are important for HCI even in times of technological change.

5 Conclusion

The aim of this analysis is to explore the lesser explored relation between technological change and HCI, while considering a major determinant of CVET - a companies' skill structure. For this indicator of technological change i.e. companies' technology level and changes in technology investment are used, as well as the share of low-skilled employees in a company and companies' expenditures on CVET. It is thus one of the few recent studies focussing on the relation between technological change and HCI (in terms of so CVET expenditures) using representative quantitative data.

The results of the regressions are largely consistent with the hypotheses. An above average share of low-skilled employees in a company is associated with lower HCI – supporting H1. The results suggest that investment in technology and the level of technology - and hence technological change – do lead to more HCI, which is in line with H2 and H3 as well as most previous findings on investment in technology and CVET. This result is the good news because it suggests that technological change may lead not only to increased participation in CVET for (some) employees - as found in the literature - but also to increased company expenditures.

The bad news, however, is that the skill structure, and in particular the presence of low-skilled employees, is still very important for determining companies HCI. This finding may not be surprising, as it is one of the core assumptions of HC theory. Though, it is problematic, because it perpetuates inequalities. Therefore, further research should focus more on the differences in expenditure for employees with different skill levels as well as the interrelation of skills and technology indicators.

Moreover, while it might be positive that technology investment and technology level go hand in hand with increased HCI of companies and do not reduce HCI, one aspect might be suboptimal: In Germany and many other European countries, companies are the main sponsors of CVET (Bassanini et al., 2007). The heavy sponsoring by companies might be problematic, because companies do not primarily focus on reducing unequal access to CVET (Anbuhl, 2019; Bassanini et al., 2007). An increase in HCI, due to technological change, could further increase the reliance on companies for access to CVET, which could increase the barriers for people who are already disadvantaged (Anbuhl, 2019) – as the negative impact of an above average share of low-skilled shows. This problem is not only an issue in Germany, but also should concern other countries, even those with lower levels of company sponsored CVET, as the role of companies in CVET might increase everywhere, and with that potential barriers.

Therefore, more research is needed on the impact of technological change on governmental funded CVET. Moreover, policies are needed to address the barriers to CVET for low-skilled employees and other disadvantaged groups, i.e. increased governmental support, easier access to training, and information on benefits and opportunities. Though, increasing CVET and HCI for the disadvantaged groups has always been difficult (Bellmann & Leber, 2019).

It must be recognised that the analysis cannot make causal claims and that not all results can be fully generalised to other countries, which requires, among other things, longitudinal or comparative data across countries. Moreover, the analysis cannot distinguish between general (i.e. skills that can be used anywhere) and specific (i.e. skills that can only be used in the current company) HC, which is one of the assumptions of the HC theory (Becker, 1962). Companies should invest only in specific skills because these skills are not useful for other companies (e.g. Acemoglu & Pischke, 1999; Becker, 1962). However, this lack of distinction should not affect the analysis, as CVET expenditure is collected after the decision to finance CVET has been made. Companies should therefore only incur costs for CVET that they consider to be useful.

Furthermore, general and specific skills are not always (empirically) distinguishable or are accumulated simultaneously (e.g. Acemoglu & Pischke, 1999; Kuckulenz & Meyer, 2006).

It must also be acknowledged that the HC theory has been the subject of much criticism and modification since it was first published (cf. new training literature) (Bellmann & Leber, 2019, pp. 13–20). The main points of criticism are the rational actor, the assumed freedom of choice of the actors, the fact that not all investment is associated with increased productivity (or wages) and the phenomenon of the financing of general training by employers (Bellmann & Leber, 2019, pp. 13–20). Therefore, when interpreting the results, it is important to keep these caveats of HC theory in mind.

Overall, the technological change is associated with an increase of HCI. However, the skill structure is still important in determining whether or not companies make HCI. Together with the fact that most CVET is financed by the employer, it could lead to increased barriers to CVET for already disadvantaged groups. These findings provide a good starting point for further research to assess the impact of technological change on HCI in the public and private sectors. The results also offer impulses for policies aimed at reducing barriers for disadvantaged groups and increasing their participation in CVET, as well as for strengthening state support.

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Biographical note

Myriam Baum has been a research assistant at the BIBB since 2019. Among others she was part in the Polarisation 4.0 project, which focused on the impact of the technological change on the labour market and the vocational education system. Her research interests lie in the area of technological change in the world of work with a special focus on continuing vocational training. Currently she is pursuing her PhD degree in Sociology.

Appendix

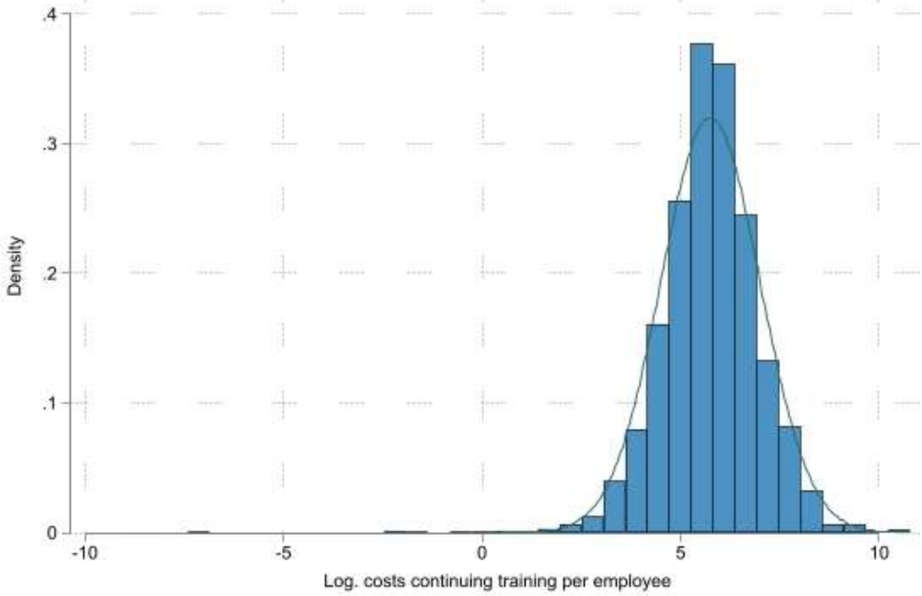
Appendix 1: Descriptive values of the variables (unweighted)

	Mean/Share	Standard Division	Median	Min	Max	Observations
Costs of continuing training per employee	673.78	1,744.96	327.87	0	47,753	2,457
Above average low-skilled	0.32	0.47	0.00	0	1	2,457
High technology level	0.54	0.50	1.00	0	1	2,457
Increased investment in technology	0.54	0.50	1.00	0	1	2,457
Primary Sector	0.06	0.23	0.00	0	1	2,457
Manufacturing	0.25	0.43	0.00	0	1	2,457
Construction	0.05	0.22	0.00	0	1	2,457
Trade and Repair	0.11	0.32	0.00	0	1	2,457
Business-related Services	0.17	0.38	0.00	0	1	2,457
Personal Services	0.11	0.31	0.00	0	1	2,457
Health Services	0.10	0.30	0.00	0	1	2,457
Public Sector	0.15	0.36	0.00	0	1	2,457
Above average high-skilled	0.38	0.49	0.00	0	1	2,457
Standardized No. of employees	-0.01	0.83	-0.22	-0.30	17	2,457
West-Germany	0.76	0.43	1.00	0	1	2,457
VET provision	0.59	0.49	1.00	0	1	2,457
Works Council	0.47	0.50	0.00	0	1	2,457

Appendix 2: Survey Questions Variables

Variable	Question	Answers
Expenditures on continuing training	You have indicated that part of your workforce has participated in continuing training measures in the past year. How high were the approximate total costs for internal and external courses, seminars or training courses? For example, consider the following costs for course fees, training staff, teaching materials, rooms, travel and accommodation costs, learning software, etc. accommodation costs, learning software, etc.	Openly surveyed from 0 till infinite
Technology use	A: Digital technologies specifically related to services for customers, e.g., online ordering and booking systems or online trade (so-called B2C e-commerce), customer loyalty and customer care systems (Customer Relationship Management (CRM)) and comparable applications. B: Digital technologies specifically related to networking with suppliers and between companies, e.g., supply chain management (SCM) and B2B e-commerce. C: Technologies related to human resource management, e.g., for personnel selection, competence management, human resource development. D: Technologies that enable new forms of communication and cooperation between employees, e.g., team collaboration systems, gamification, evaluation systems. E: Technologies that support project-based and cross-company collaboration, e.g., collaboration platforms, crowd working or crowdsourcing, web-based project management for distributed teams. F: Digital technologies that enable the collection, compilation, storage and processing of large amounts of data, e.g., big data, cloud computing, in-house database systems. G: Special software and hardware for IT security, e.g., encryption technologies, protection against hacking and DDOS attacks, server security and stability. H: Digital technologies that enable a new type of networking of previously individual digital and/or automated processes, e.g., smart factory, Internet of Things, cyber-physical systems. I: Use of artificial intelligence and machine learning for physical work processes, e.g., deep learning and pattern recognition in production and maintenance, building management or care. J: Application of artificial intelligence and machine learning for non-physical work processes, e.g., deep learning and pattern recognition in marketing, procurement or human resources. K: New technologies that enable more individual products in small quantities, e.g., additive manufacturing (3D printing), collaborative lightweight robotics. L: Digital devices on the body of employees, so-called wearables, e.g., smartwatches, AR/VR glasses, smart workwear. M: Technology for autonomous transport, e.g., transport drones, self-driving transport robots or vehicles.	1 Yes, the technology is currently used in operation 2 No, the technology is not currently in use. However, an acquisition is planned. 3 No, the technology is not currently in use. An acquisition is also not planned. (Both “No” Answers are combined)
Number of employees with certain skill levels	How were the employees, i.e. excluding trainees, distributed among the following employee groups on 31.12.2019? A) Employees with low-skilled task that do not usually require vocational training (open) B) Employees with medium-skilled task that usually require completed vocational training or corresponding work experience C) Employees with high-skilled task that usually require a university or technical college degree or a master craftsman's, technician's or comparable degree	Openly surveyed
Change in technology investment	When you think about the development of investment in digital technology, how have they changed?	1 Decreased 2 Remained more or less the same 3 Increased

Appendix 3: Histogram of the logarithmised expenditures on CVET per employee



Appendix 4: Tests for independent sample

Test	Variable	Degrees of freedom (df)/ Observations	t-value/z-value with significant value
t-test for logarithmised expenditures on continuing training per employee	Technology level	2,455 (df)	-3.7133***
	Above average low-skilled	2,455 (df)	8.3051***
	Investment in technology	2,455 (df)	-2.7852**
Mann Whitney U test for expenditures on continuing training per employee	Technology level	2,457 (Observations)	-3.542***
	Above average low-skilled	2,457 (Observations)	8.895***
	Investment in technology	2,457 (Observations)	-2.435*

*** p<0.001, ** p<0.01, * p<0.05

Appendix 5: Coefficient plot of the OLS-Regression