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// SUSANNE STEFFES AND
ARNE J. WARNKE

Determinants of Work-Related Training: An Investigation of Observed and Unobserved Firm-, Job- and Worker-Heterogeneity

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Determinants of Work-Related Training: An Investigation of Observed and Unobserved Firm-, Job- and Worker-Heterogeneity*

Susanne Steffes† and Arne Jonas Warnke‡

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Abstract

One of the most important policy goals in industrialized countries is to increase the skill level of the labor force by life-long-learning strategies. In this paper our aim is to explain to what extent the variation in training investments is determined either by (observed and unobserved) heterogeneity of firms or of workers, hence we put a new perspective on the determinants of training. Rather than analyzing single determinants or groups of variables, we decompose the variation into a worker-specific and a firm-specific part and show how much of the unexplained variation is independent of both. Our results show that both firm-, job- and worker-level heterogeneity explains training participation and that firm heterogeneity is far less important compared to the others. Also interesting, is the finding that a large part of the overall variance is not driven by firm- or worker heterogeneity, hence training participation seems to be to some extent an unexplained event which happens by chance.

JEL Classification: I24, J24, M53

Keywords: Human Capital, Training, Linked-Employer-Employee Data (LEE), Decomposition, Unobserved Heterogeneity

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†Corresponding author; ZEW – Leibniz-Centre for European Economic Research and University of Cologne, Germany. E-mail: susanne.steffes@zew.de

‡BASF SE, Germany. E-mail: arne.warnke@gmail.com

1 Introduction

One of the most important policy goals in industrialized countries is to increase the skill level of the labor force by life-long-learning strategies. Studies on the determinants of training give important insights about firm and worker investments in work-related training because they reveal which groups in the labor market potentially underinvest in skills (Bassanini et al., 2007). Such insights are used by policy makers who aim to provide equal opportunities to every worker.[1] However, most of these studies use either firm- or worker-level data only, which is a limiting factor as investments in work-related training are – in contrast to schooling decisions – determined jointly by firms and workers.

Beyond the importance for policy makers, studies on the determinants of training are a prerequisite for the empirical work on returns to training because they uncover possible selection mechanisms which are relevant for training investments. In a comment on Bassanini et al. (2007), Pischke (2007) highlights the necessity to consider the selection into training in order to estimate returns to training appropriately. In this paper, our aim is to explain to what extent the variation in training investments is determined either by heterogeneity of firms or of workers, hence we put a new perspective on the determinants of training.

In this study, we do not investigate the importance of single models. We focus rather on both the explained and the unexplained part of training variation. We decompose the variation into a worker-specific and a firm-specific part, split both into an observed and unobserved part, and finally show how much of the variation is independent of both. Thereby, we address especially the role of job heterogeneity. Moreover, we test whether firm's and worker's investments are substitutes or complements.

In line with former studies we do not only look at overall work-related training participation but also distinguish between purely firm-sponsored and worker co-sponsored training. Bassanini et al. (2007) finds evidence for differences in the determinants regarding overall or purely employer-sponsored training. And also Pischke (2001) discusses differences in the determinants (and also on self-assessed benefits) of training that is initiated by workers or firms and financed by firms or workers in terms of money or time respectively.[2] The motivation for this differentiation goes again back to Pischke (2007) who called for a closer link between the theoretical and empirical literature on training.

[1] One example is a German program called WeGebAU which subsidizes training participation of unskilled workers and employees of small- and medium-sized firms. Recent literature reveals that less skilled workers and employees in smaller firms are trained less than others (Asplund, 2005).

[2] He shows with the German Socio-Economic Panel that there is a correlation between worker-sponsored training (in terms of money and time) and the generalizability of training courses (measured in terms of certificates). But also the participation in a lot of firm-sponsored training courses is rewarded with a certificate.

Our results reveal, with regard to firm's investments, that although the firm-level heterogeneity seems to be more important in theoretical literature, the worker-level heterogeneity is more pronounced in the real world. The same is true regarding worker co-sponsored investments. Moreover, tasks and occupations are the most important determinants at both levels which highlights the requirement regarding theoretical considerations to move from the firm-specific perspective to a more job-specific perspective. Additionally interesting is the finding that a large part of the overall variance is not driven by firm-, or worker heterogeneity, hence training participation seems to be to some extent an unexplained event which happens by chance.

Many empirical studies have investigated determinants of work-related training and show that individual, job-specific, and firm characteristics are important (this literature is summarized by among others Arulampalam et al., 2004; Bassanini et al., 2007; Asplund, 2005). In her review on the determinants of and returns to training, Asplund (2005) documents that formal education, gender, age, job status, firm size, labor market imperfections like wage compressions and search frictions, and finally unions are common characteristics that are generally found to be correlated with firm-provided training. In recent years, several studies confirmed former results and showed other job characteristics like tasks (Görlitz and Tamm, 2016) or high-performing workplaces (O'Connell and Byrne, 2012) to be further important aspects of observed heterogeneity. In addition, training persistence indicates that undetected worker heterogeneity is an important driver of training investments. Sousounis and Bladen Hovell (2010) and Bassanini et al. (2007), for instance, find evidence that previously unexplained training heterogeneity can be substantially reduced if lagged values of training participation are considered.

Very few studies address the relationship between worker-level determinants and selection into firms. One reason is that such an approach requires data which cover several firms and several workers per firm, hence linked employer-employee data is necessary.[3] We are aware of only two studies which use linked-employer-employee data with information about individual participation in training in order to show the impact of worker's selection into firms. Frazis et al. (2000) is an early example which uses a US matched dataset to analyze firm and worker characteristics correlated with provision of, and participation in training. The authors can mostly validate results of previous studies using unmatched data and conclude that studies with only firm characteristics or only worker characteristics do not provide biased results due to omitted variables. Görlitz and Tamm (2016) use German linked employer-employee data to compare estimates of the determinants of training with and without task information and with and without firm-fixed effects.[4] Their results show ambiguous effects of including the firm-fixed effects but a clear impact of the inclusion of task information on the marginal effects of other worker-level characteristics.

[3]Most studies look either at individuals only using household data, at firms using establishment data (sometimes aggregating individual information) or at the workforce of single firms.

[4]Görlitz and Tamm (2016) use the German WeLL-Data which is also used here.

Thus, on the one hand our knowledge about the determinants of training has increased in the last two decades thanks to improved data with regard to the measurement of training incidence and intensity, the usage of panel methods, and the quality of observable characteristics. On the other hand, we still do not know a lot about the drivers of training participation; a huge share of the variation remains unexplained. Görlitz and Tamm (2016) get a Pseudo R squared of 0.15 for training incidence in the past 12 months in a model with individual and job characteristics (including tasks) and firm-fixed effects. Grund and Martin (2012) show with the German Socio-Economic Panel a decreasing goodness of fit over the observation period 1989-2008. With individual data on the training incidence in the past year they report a McFadden's Pseudo R squared which decreases from 0.17 in 1989 to 0.13 in 2008. Their probit estimates include individual, job status, and firm information (at least firm size and industry).

And finally, an analysis of the European Community Household Panel (ECHP) showing that about half of the total variance explained by their covariates (including individual, job status, occupation, workplace and firm information) is explained by cross-country differences (Bassanini et al., 2007). Overall, the Pseudo R squared is 0.20 for overall training incidence. According to Bassanini et al. (2007), in an estimation which in addition includes a lagged training dummy, the fraction which is explained by the model increases to 28 per cent. The much better explanatory power of the model including past training participation suggests that it is extremely important to take into account not only firm and job characteristics but also (unobservable) individual heterogeneity.[5]

The outline of the paper is as follows: In section 2 we introduce the data and in section 3 we describe the empirical methods we apply. In section 4 we show and discuss the empirical results and in section 5 we conclude with implications for future research and policy making.

2 Data

We use the German linked employer-employee dataset WeLL (Further training as a part of lifelong learning, see Huber and Schmucker, 2012) which comprises of four waves of a worker survey conducted between 2007 and 2010. The sample of survey participants was selected in two steps. First, a random sample of 149 establishments in the manufacturing and service sector was drawn from those which participated in the IAB Establishment Panel in 2005.[6] This sample is stratified to establishments with 100 to 2,000 employees from three West-German and two East-German states. Second, an employee sample was randomly drawn from all employees

[5]While Bassanini et al. (2007) use information about lagged training participation to take into account unobserved individual heterogeneity, we will make use of worker (and firm) random effects which accomplish a similar purpose.

[6]The IAB Establishment Panel is an annual employer survey of approximately 16,000 businesses (see Kölling, 2000).

who were covered by the social security system and were employed on December 31st 2005 in one of the 149 establishments.

Survey participants were asked about the number of job-related training courses they had attended since a reference date. Basic information about participation in training is available for all training courses while detailed information has been collected for up to three most recent training courses per wave. In addition, the survey includes questions about socio-demographic characteristics, personality traits and other job-related issues. The survey data is linked to administrative records of each employee which include information on wages per day as well as the duration of employment and to the IAB Establishment Panel (Schmucker et al., 2014).

We limit the analyses to individuals still working in one of the 149 establishments. We also exclude observations with missing information in relevant variables. In addition, we disregard all workers who attended more than three training courses as information is not adequately detailed.[7] Finally, we limit the analyses to workers aged 21-64 and exclude apprentices and workers in partial retirement. We focus on full-time or regular part-time workers and disregard those with normal working hours of less than 15 hours a week. We are subsequently left with 5,785 workers and 12,560 observations.[8]

The main variable of interest is the participation in formal training courses. In the first wave, individuals were asked "Did you participate between January 1st, 2006 and now in any job-related seminars or training courses?". We further distinguish between firm-financed and worker co-financed training courses, by identifying whether a worker participated in training exclusively during his or her working hours or whether training also took place during workers' leisure time.[9]

60% of all training courses took place during working hours only. 20% occurred either partially or only in leisure time.[10] If we take participants into account who did not attend any training course, we find that 24.4% of workers participate in firm-financed training only, whilst 14.9% participate in training overlapping into leisure time and 5.3% of workers participate in a given wave in both forms of training (e.g. attend at least two courses where one is completely in

[7]This concerns about 4.0% of all workers. Sensitivity analyses regarding participation in any training course are available upon request.

[8]The mean number of unique WeLL-participants per establishment is 39 (median 24) with an interquartile range of 15 to 45.

[9]We exclude mandatory training such as obligatory first-aid courses, fire safety training and equal opportunities courses from analysis. This reduces the number of training courses by around 15.1% in the first wave. We also disregard training courses completed on advice from a third party (ca. 1%). This gives us an average training participation rate of 44.7% per wave which is comparable to other sources such as the Adult Education Survey (e.g. Autorengruppe Bildungsberichterstattung, 2012).

[10]We do not consider a monetary investment by the worker because only 16.2% of all training courses are not completely paid by the firm and often workers only contribute a small sum. This is also in line with conversations with practitioners: Firms often pay for training even if this is not directly relevant for the tasks involved in a job itself, but for which attendance is required at the weekend or in the evening.

working hours and the other overlaps into leisure time).

As covariates we include individual as well as establishment characteristics with possible relevance for participation in training. We distinguish between establishment, worker and job attributes. Given that the time period about which workers are retrospectively asked differs between and within waves (depending on the month of the (last) interview) we add a variable to each specification which captures the length of the time period in months.

3 Methods

We analyze establishment and worker determinants of participation in training by using multilevel generalized linear models.[11] These models allow us to simultaneously consider firm and worker heterogeneity in training participation. We combine the advantages of individual level data (rich information, not only about the individual worker, but also about workers in the same firm) with attributes of the firms. Hence, we can estimate the relevance of firms' and workers' observable and unobservable heterogeneity with regard to training.

As our outcome is binary, we use a random effects logit model. The model gives us an estimate of the total variation in training participation between establishments and between workers within the same establishment. We use the variance of establishment and worker random effects to assess the variation attributable to each dimension.[12] In our basic model we examine whether worker i in establishment $J(i,t)$ participates in training at period t:

$$\Pr\big[\,\text{Training=1}_{it}\,\big|\,\alpha_{J(i,t)},\,\theta_i,\,\tau_t\,\big] = \text{logit}^{-1}\big(\alpha_{J(i,t)} + \theta_i + \tau_t\big) \tag{1}$$

$\boldsymbol{\alpha}_{J(i,t)}$ and $\boldsymbol{\theta}_i$ are establishment respective worker random effects and $\boldsymbol{T}$ are year dummies.[13] We assume that $\alpha \sim \mathcal{N}(0, \sigma_\alpha^2)$ and $\theta \sim \mathcal{N}(0, \sigma_\theta^2)$. Furthermore, mutual independence of the random effects is necessary, i.e. we have to assume that workers do not self-select into certain firms.[14]

We first estimate a *basic* model without any control variables other than time effects. We then sequentially add establishment characteristics $\boldsymbol{Z}$, worker characteristics $\boldsymbol{X}$ and job characteristics

[11] Other terms are for example mixed or two-way random effects models. For a textbook introduction see Gelman and Hill (2007)

[12] Establishment random effects are identified by observing multiple workers per establishment (within and across waves), whilst it is the panel structure of the data which enables us to identify worker random effects.

[13] We approximate the log-likelihood, which has no closed form solution, by Gauss-Hermite quadrature (see StataCorp, 2013).

[14] This excludes for example job mobility related to the idiosyncratic training provision of an establishment. Results of a further specification using establishment fixed effects are available upon request.

$\boldsymbol{W}$ (in diverse combinations) to investigate how well these levels explain inter- and intra-firm variation in training.[15] The full model is described as follows:

$$\begin{aligned}\Pr\big[\text{Training=1}_{it} \,\big|\, \alpha_{J(i,t)},\, \theta_i,\, \tau_t,\, \boldsymbol{X}_{it},\, \boldsymbol{Z}_{J(i,t),t},\, \boldsymbol{W}_{J(i,t),t}\big] = \\ = \text{logit}^{-1}\big(\alpha_{J(i,t)} + \theta_i + \tau_t + \boldsymbol{X}_{it}\beta + \boldsymbol{Z}_{J(i,t),t}\,\delta + \boldsymbol{W}_{J(i,t),t}\,\gamma\big)\end{aligned} \tag{2}$$

To investigate the importance of establishments and workers with regard to training, we use a variance decomposition approach. The variance decomposition for mixed models without random coefficient is easily derived as the covariance in participation in training between two workers of the same establishment is $\text{Cov}\big(\text{Train}_{i_1 t}\,,\, \text{Train}_{i_2 t}\big) = \sigma^2_\alpha$. We are therefore able to partition the total variance $\sigma^2 = \sigma^2_\alpha + \sigma^2_\theta + \frac{\Pi^2}{3}$ into the three variance terms - the variance of the establishment random effects σ^2_α, the variance of the worker random effects σ^2_θ and the variance of the latent error which is assumed to be equal to the variance of the logistic distribution $\frac{\Pi^2}{3}$.[16] This gives us an estimate of the relevance of inter-establishment training differences compared to heterogeneity of participation in training between workers of the same establishment over time (this measure is usually called the intra-class correlation). Equation (3) shows a measure of the overall or unconditional relevance of establishments for workers' participation in training, whilst equation (4) shows the relevance of establishments after controlling for establishment, worker and job characteristics:

$$\frac{\sigma^2_{\alpha^1}}{\sigma^2_{\alpha^1} + \sigma^2_{\theta^1} + \frac{\Pi^2}{3}} \tag{3}$$

$$\frac{\sigma^2_{\alpha^5}}{\sigma^2_{\alpha^5} + \sigma^2_{\theta^5} + \frac{\Pi^2}{3}} \tag{4}$$

In order to investigate the role of unobserved firm and worker heterogeneity, we look at the variance of worker and firm random effects before and after adding observable information. The reduction of the variance of the random effects in the full model compared to the basic model gives an estimate of the relevance of observable vs. unobservable heterogeneity.[17]

Finally, we investigate the relationship of firm- and worker-financed training. Workers might participate in both firm- and worker co-financed training, or indeed, in neither of them. We analyze whether establishments which provide a great deal of training are also those in which many workers participate in co-financed training. We hereby run the specifications from equation (1) and equation (2) for participating in training entirely during working hours and for training

[15] As all workers of the same establishment share the same establishment attributes, establishment characteristics $\boldsymbol{Z}$ can only explain the variation between establishments and not between workers within the same firm.

[16] This is a standard assumption in the literature, see for example Hox (2010). In the next section we show results using a linear approximation as suggested in Goldstein et al. (2002).

[17] We abstract here from the complication that observable heterogeneity is time-varying while random effects are, by definition, constant over time.

which overlaps into workers' leisure time. We then correlate the establishment random effects $\text{Corr}\left(\alpha^{(1)}_{\text{firm financed}}, \alpha^{(1)}_{\text{worker co-financed}}\right)$ in order to shed light on the relationship between aggregated firm- and worker co-financed training rates in a first step.

4 Results

4.1 Decomposition

We first compare the intra-class correlation for establishments and workers by looking at the relative importance of firms (inter-firm correlation), and workers (correlation of workers within the same establishment) within the overall variance in participation in training. Table 1 shows the intra-class correlation of establishments and workers for all job-related training courses. Our estimate of the unconditional intra-establishment correlation (basic model) attributes 12% of the total variation in participation in training to differences between establishments (across-firm heterogeneity). The importance of workers is more than twice that size (28%) (within-firm heterogeneity), while according to the latent-response formulation, most of the variance is not attributed to firm or worker heterogeneity (slightly above 60%). According to a likelihood-ratio test, both establishment and worker random effects are highly significant.

Table 1: Intra-class Correlation (job-related training in general)

Level	Basic Model	Firm Char.	Worker Char.	Firm+Worker	+ Job Char.
Establishment	11.9%	6.4%	9.5%	5.6%	1.4%
Worker	27.6%	29.4%	25.7%	26.9%	19.3%
Latent Error	60.5%	65.6%	65.0%	69.0%	79.6%

Note: This table shows the estimated intra-class correlation for different specifications of a multilevel logit model for participation in job-related training courses (full estimation output is found in table 3 in the Appendix). Standard errors are clustered on the establishment level. Establishment and worker random effects are statistically significant in all specifications according to a likelihood-ratio test.

Next, we compare intra-class correlation of the basic models with other specifications. A comparison of the first column (basic model) and the last column (full model with establishment, worker and job characteristics) in the first row of table 1 indicates that almost 90% of the across-establishment correlation can be explained by observables. The comparison of the basic model with other specifications (columns 2-4) shows that the variation in average training rates between establishments is reduced mostly by establishment and job characteristics, and to a lesser extent by worker characteristics. This indicates that establishment-variation, in terms of workers' participation in training courses, can primarily be explained by firm-level or job-level differences, but to a smaller extent by the composition of the workforce itself.[18]

[18] In our final specification, including establishment, worker and job characteristics, the intra-establishment cor-

Now, we look at training differences between workers within the same establishment (second row of table 1). Here, we can only explain 30% of the variance in worker random effects by including a large set of observables ($1 - 19.3/27.6 = 0.30$). This is, in stark contrast to the previous results for the establishment level, where little unexplained heterogeneity remained.[19] For the explanation of training incidence differences between workers, we find that job characteristics are more powerful predictors than worker characteristics (establishment characteristics cannot explain training heterogeneity of workers within an establishment by construction). Note, however, that the set of observed job characteristics is also larger than the set of observed worker characteristics (36 vs. 10).

The variance decomposition of training, which is either fully financed by the firm or at least partially financed by the worker, delivers very similar results.[20] Again, we find that the worker dimension is more important than the establishment dimension, and we can explain a much larger share of the variance on the establishment level with reference to observables than we can on the worker level. Most interesting, perhaps, is the finding that co-financed training exhibits a larger share of worker level variance compared to training which is purely financed by the firm. The share of the establishment level, is ≈11%, being similar across all types of training.

Table 2: Variance Partitioning (firm-financed / worker co-financed training)

	Firm-financed Training		**Worker co-financed Training**	
Level	**Null**	**Occ**	**Null**	**Occ**
Establishment	11.2%	2.3%	10.8%	3.7%
Worker	23.4%	18.0%	34.8%	30.4%

Note: Table 2 reports the estimated intra-class correlation for different specifications of a multilevel logit model for participation in job-related training courses either completely in working hours of partly in leisure time (full estimation output is found in table 4 and table 5 in the Appendix). Standard errors are clustered on the establishment level. Establishment and worker random effects are statistically significant in all specifications according to a likelihood-ratio test.

To examine whether workers in establishments which provide a lot of training during working hours also often co-finance training, we correlate the 149 establishment random effects of the basic and the full model. The results indicate a small complementarity between both forms of training on the establishment level before adding establishment, worker and job characteristics. After conditioning on observable heterogeneity, this positive association becomes very small and close to zero, indicating that worker and job heterogeneity contradict this picture.

relation drops to a meager 1.4%. However, the establishment random effects variation remains still significant according to a likelihood-ratio test (as do worker random effects).

[19] Of course, the number of observations per establishment is much larger than this is the case for workers.

[20] Here, we only show the comparison between the basic and the full model. Results of the other specifications can be supplied on request.

4.2 Discussion

Theories on firm investments into the human capital of their workers, often rely on firm-level monopsony power in order to explain firm heterogeneity. One of the main results of this paper is that in comparison to worker heterogeneity, firm heterogeneity is far less important. This means that differences between co-workers in a given firm have a much greater impact on determining investments in training than aggregated differences between the workforce of two firms. We will take a deeper look into worker and job heterogeneity below. As even firm variation is large, let us discuss briefly how the variance of establishment random effects is reflected in average training rates between establishments.[21] The estimated training probability for the worker-firm match in the basic model is 41%.[22] This means that an establishment with an unobserved random effect which is one standard deviation below the average has an unconditional training probability of just 26%.[23] This difference is economically huge and considerable, as only medium-sized firms with at least 100 employees are covered in the sample. We additionally find that occupational differences as well as the sector, the economic performance and the amount of wage compression within the firm are important drivers of the establishment heterogeneity.

While firms of the same sector, which are in a similar economic situation, do show similar training rates, this does not hold for peers within the same establishment and job. In contrast to the firm-level, most of the worker-level variance remains unexplained even after adding a large set of control variables. The relevance of the variation in worker random effects can be expressed with another simple statistical example. Let us take a look at 1,090 workers who participate in all four waves of the survey.[24] If we ignore the establishment dimension here, we can expect slightly more than 9% of workers to never participate in training. If training were to be randomly allocated, we could expect 4% of workers to participate in training in all waves.[25] The actual numbers are strikingly greater, 27% never participate in training during the observation period, whilst 9% of workers participate in training in all four waves. Here we see a much larger variation than we would have expected from a random allocation. This exercise shows that inequality in training participation is also huge among workers even if they are working in the same establishment. In line with the findings of Sousounis and Bladen Hovell (2010) and Bassanini et al. (2005), we observe some workers participating on a regular basis while more than a quarter are never participating in training. Hence, the persistence of training

[21] Random effects variance components are available in table 3 in the Appendix. One must bear in mind that all variables, including binaries, are standardized such that we can read the estimated training probability for the worker-firm match simply by considering the intercept (and of course, the logit link function).

[22] $\frac{1}{1+\exp(-0.38)} \approx 40.6\%$. The variance of establishment random effects is 0.65:$\sigma^2_{\theta^{(1)}} = 0.65$.

[23] $\frac{1}{1+\exp(-0.38-0.65)} \approx 26.3\%$

[24] 18.8% of all survey participants.

[25] With a probability of 45%: $(1-0.45)^4 \approx 0.0915$ and $0.45^4 \approx 0.041$.

participation is also remarkably large here.

These results are not only found for job-related training in general but also hold if we distinguish between purely firm-financed and worker co-financed training. Unsurprisingly, worker heterogeneity plays a more significant role in determining training investments where courses are co-financed by workers. One might think that firms exploit the worker's willingness to personally invest into training by reducing their own investment. Though we do find some complementarities between purely firm-financed and worker co-financed training at the firm level, this relationship is not observed at the worker-level, i.e. we do not find evidence for a substitution effect.[26]

We do not aim to discuss the importance of single characteristics here, but we should briefly discuss the job heterogeneity w.r.t. occupations because it is the main source of observed inequalities. If we look at occupations, we find remarkable differences in participation in training (see Figure 1). The reference occupations are *other services* which consist mostly of low-skilled white-collar jobs such as security contractors and cleaners. We see that many occupations show significantly higher training rates (only assembling and food processing jobs have actual insignificantly lower participation rates) than *other services*. Training is particularly common in certain female-dominated occupations such as health and education professions in which more than two-thirds of all workers are female.[27] In addition, rates of training are high amongst engineers and electricians, as well as in certain white-collar jobs, including merchants, and in a number of professions such as consultancy and accountancy. Training differences between workers who perform certain tasks or work in certain occupations are significant, as illustrated by the large (standardized) coefficients. In addition, we find large occupational differences between training in working hours and training overlapping into leisure time. Figure 1 shows, on the one hand, that higher training rates in most occupations (compared to *other services*) are driven by worker co-financed training. Only four occupational groups, engineers, merchants, clerical professionals and teaching professions, are provided with significantly more training. On the other hand, workers in many other jobs are trained more often in their leisure time. This is particularly true for health-related professions.

5 Conclusion

A large amount of empirical literature addresses determinants and returns to training, but few studies have looked simultaneously at multiple firms and their individual workers. The reason for this is clear. Such an approach requires precise linked employer-employee data including

[26] Technically, we correlate the establishment random effects $\text{Corr}\left(\alpha^{(1)}_{\text{firm financed}}, \alpha^{(1)}_{\text{worker co-financed}}\right)$ of equation (2) in order to shed light on the relationship between aggregated firm- and worker co-financed training rates.

[27] For a comprehensive overview on gender differences in training participation see De Pinto et al. (2019).

detailed training information on the individual level which has yet been barely available. The lack of such empirical studies is clearly a shortcoming in this field as theory predicts that training investment decisions of firms and workers are interlinked.

In this study we investigate the firm- and worker-level heterogeneity of training investments made by firms and workers respectively. Using linked employer-employee data and multilevel methods, we decompose variation in training participation into firm-level, worker-level and random variation. We then use a huge set of predictors in order to further investigate how much of the heterogeneity can be explained by observable characteristics. Since the job-level variation is highly correlated with firm and worker heterogeneity, we capture this by including detailed information on the occupation and the performed task structure.

5.1 Implications for Future Research

The contribution of this paper to the economic literature is threefold. First, we contribute to the empirical literature on the returns to training. Unobserved heterogeneity is shown to be a significant cause of differences between workers in terms of whether or not they participate in training. This does not hold, however for establishment differences (or at least to a much lesser extent). We therefore conclude that it is more important to address worker and job unobserved heterogeneity than firm heterogeneity (if employer information is available) if one aims to estimate a causal effect. This implies for instance that worker selection has to be addressed if an instrumental variable approach is planned to be applied.

Furthermore, and maybe more interesting, even though we can use a huge set of explanatory variables we are not able to assign the majority of training differences to either firm- or worker-level heterogeneity. A huge amount of investments seem to take place by chance. In future research, potential sources should be detected. It is for instance likely, that workers participate once in a decade in a training course but the timing of this event is completely random. With the data at hand we would not observe such a frequency but with data covering a longer period, for instance the German Socio Economic Panel (GSOEP), one could investigate such a relationship. Our finding additionally implies the opportunity to find exogenous shocks which can be used to find appropriate identification strategies. One example for such a strategy, is the cancelation of training courses due to temporary sickness (Leuven and Oosterbeek, 2008). Other exogenous variations, which are due to the economic cycle or policy regulations, are also potential sources for our findings.

Second, we add to the empirical literature on the determinants of training. It is shown that the firm dimension, but particularly the job dimension, is important if we aim to explain firm and worker heterogeneity. This finding is insofar important, as many previous studies which analyzed the determinants of training did only include few information on job characteristics.

Furthermore, we conclude that future research should focus to explain worker heterogeneity because here, a large share of variation remains unexplained even though we include a huge set of covariates. Essentially, researchers should aim to acquire better linked employer-employee data which allow further examination of the assignment of job-related training to workers within the same firm.

Third, we contribute indirectly to the theoretical literature on training investments. So far, this literature is dominated by suggesting firm-level attributes to explain firm-sponsored investments. As we show here, this can be misleading as worker- and job-level variation seems to be far more important. Several theories show that firms which are more successful in retaining their workers are expected to invest more into (general) training. They give simple descriptions of mechanisms to reduce the likelihood of workers leaving a position, for instance the monopsony power of the firm (Acemoglu and Pischke, 1998) or imperfect information on actual training investments (Katz and Ziderman, 1990; Chang and Wang, 1996). Others assume complementarities between investments in technology and human capital (Acemoglu, 1997) which mean that firms using different production processes and technologies invest to varying extents in training. Our results support the requirement regarding theoretical considerations to move from the firm-specific to a more job-specific perspective. We would therefore like to encourage theorists to further develop models which explicitly take job heterogeneity into account.

5.2 Policy Implications

This paper contains some policy implications regarding the often stressed goal of the EU and industrialized nations to further foster life-long learning opportunities. Our results indicate that inequalities of training participation among workers across and within firms exists. In the explained part of the worker heterogeneity we see that investments in high-productive, high-paid jobs are more likely compared to low productive jobs where often not even vocational training is necessary. Among those who participate in training, a split into workers who benefit from firm-sponsored training and those who partially pay themselves is common, even within the same firm.

Obviously, the existence of inequalities in training participation does not necessarily indicate that investments into training are too low for certain groups of workers. This conclusion would require a further analyses of the optimal level of investment for each worker which is hardly possible with real data (compare discussion in Bassanini et al. (2007)). It is nevertheless striking that occupations in the manufacturing and service sector, that are dominated by manual tasks, show lower training participation rates. There is an obvious overlap of these occupations and those that usually suffer more from layoffs during economic crisis, as well as from substitution as a result of technological changes. Many researchers and politicians call for more

qualifications for these groups of workers. We therefore conclude that our results at least raise the question whether more work-related training during employment in these occupations could lead to better future employment opportunities.

Even if it is not economically reasonable for a firm to invest in the human capital of certain groups of workers, policy makers should bear these inequalities in mind. Especially, because job-related training investments are accumulated over a life-cycle which leads to an increase of inequalities over the lifetime and thus to a persistence of low skills. In their comprehensive overview on workplace training in Europe, Bassanini et al. (2007) stated: "Apart from efficiency arguments, equity considerations can be relevant to justify training for groups of workers in disadvantaged economic conditions. If equity is interpreted as equality of opportunities - as in Roemer, 1998, low participation in training activities by some disadvantaged categories of workers may be not socially desirable, even if efficient. A key issue here is whether economic policy should try to correct outcomes ...".

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Appendix

Table 3: Participation in Job-related Training Courses

Dependent Variable:	**Participation in Job-related Training Courses**									
Variable	Null Model		+Firm Variables		+Worker Variables		+Firm & Worker Var.		+Firm & Worker + Occ.	
Year 2008	-0.15	(0.09)	-0.14	(0.09)	-0.13	(0.09)	-0.13	(0.09)	-0.13	(0.08)
Year 2009	-0.01	(0.08)	-0.01	(0.08)	0.01	(0.08)	0.01	(0.08)	-0.02	(0.07)
Year 2010	-0.16**	(0.07)	-0.16**	(0.07)	-0.13*	(0.07)	-0.13*	(0.07)	-0.14**	(0.06)
State Saxony			0.16	(0.12)			0.09	(0.11)	0.11	(0.09)
State Bavaria			-0.01	(0.07)			-0.01	(0.07)	0.03	(0.05)
State NRW			-0.09	(0.08)			-0.06	(0.08)	-0.02	(0.06)
State MV			-0.06	(0.09)			-0.1	(0.09)	-0.02	(0.06)
Service Sector			0.32***	(0.06)			0.31***	(0.06)	0.09*	(0.05)
Public Sector			0.23***	(0.08)			0.19**	(0.07)	0.03	(0.06)
Employees 200-500			-0.05	(0.06)			-0.05	(0.06)	0.00	(0.04)
Employees 500-2000			-0.06	(0.08)			-0.07	(0.07)	-0.04	(0.05)
Founded before 1975			-0.09	(0.08)			-0.07	(0.08)	0.00	(0.06)
Founded after 1991			0.02	(0.06)			0.02	(0.06)	0.03	(0.04)
Worker Council			0.00	(0.04)			0.02	(0.04)	0.05	(0.04)
Median Wage			0.28***	(0.07)			0.2***	(0.06)	0.07*	(0.04)
Median Wage Trend			0.22***	(0.05)			0.19***	(0.05)	0.14***	(0.03)
Wage Compression			0.21***	(0.07)			0.17**	(0.07)	0.05	(0.06)
Women					0.00	(0.04)	-0.02	(0.04)	-0.07**	(0.03)
Cohabiting					0.04*	(0.03)	0.05*	(0.03)	0.01	(0.02)
Tertiary Educ.					0.32***	(0.04)	0.31***	(0.04)	0.03	(0.04)
No Voc. Qualification					-0.16***	(0.03)	-0.15***	(0.03)	-0.06**	(0.03)
Age					-0.02	(0.23)	0.01	(0.23)	0.37	(0.24)
Age Sq.					-0.27	(0.22)	-0.29	(0.22)	-0.59**	(0.23)
Unempl. Exp.					-0.09**	(0.03)	-0.08**	(0.03)	-0.06	(0.04)
Labor Attachment					0.09***	(0.02)	0.08***	(0.02)	0.03	(0.02)
Foreign Citizenship					-0.05*	(0.03)	-0.04	(0.03)	-0.03	(0.02)
Health Status					-0.09***	(0.03)	-0.1***	(0.03)	-0.06**	(0.02)
Limited Contract									-0.04	(0.03)
Managerial Resp.									0.15***	(0.03)
Part-Time									-0.04	(0.03)
Tenure									-0.2	(0.21)
Tenure Squared									0.1	(0.18)
Recently Hired									0.04	(0.04)
Constant	-0.38***	(0.08)	-0.25***	(0.06)	-0.36***	(0.07)	-0.26***	(0.05)	-0.31***	(0.04)
Occupations	No		No		No		No		Yes	
Tasks	No		No		No		No		Yes	
σ^2_{Firm}	0.65	(0.10)	0.22	(0.06)	0.48	(0.08)	0.18	(0.05)	0.05	(0.02)
σ^2_{Worker}	1.5	(0.16)	1.5	(0.16)	1.29	(0.14)	1.3	(0.14)	0.79	(0.1)
N	12560		12560		12560		12560		12560	
Wald χ^2	207		358		606		743		2141	
Log Likelihood	-8058		-8006		-7898		-7852		-7453	

Note: Own calculations; Multilevel logit estimation; cluster-robust standard errors are in parentheses (on the firm-level); Mandatory-job training courses are excluded. Regression includes a variables capturing the number of months a worker has been asked retrospectively. Significance levels: *= significant at 10%-level, **= significant at 5%-level, ***= significant at 1%-level

Table 4: Participation in Training Courses during Working Hours

Dependent Variable:	**Participation in Job-related Training Courses during Working Hours**									
Variable	Null Model		+Firm Variables		+Worker Variables		+Firm & Worker Var.		+Firm & Worker + Occ.	
Year 2008	-0.1	(0.08)	-0.1	(0.08)	-0.09	(0.08)	-0.09	(0.08)	-0.1	(0.08)
Year 2009	0.04	(0.08)	0.05	(0.08)	0.06	(0.07)	0.06	(0.08)	0.03	(0.07)
Year 2010	-0.05	(0.06)	-0.05	(0.06)	-0.03	(0.06)	-0.03	(0.06)	-0.05	(0.06)
State Saxony			0.34**	(0.13)			0.27**	(0.13)	0.23**	(0.11)
State Bavaria			0.1	(0.09)			0.08	(0.09)	0.13*	(0.07)
State NRW			-0.05	(0.11)			-0.03	(0.10)	0.00	(0.08)
State MV			0.06	(0.09)			0.01	(0.09)	0.04	(0.07)
Service Sector			0.14**	(0.07)			0.15**	(0.06)	0.07	(0.06)
Public Sector			0.11	(0.08)			0.1	(0.08)	0.00	(0.07)
Employees 200-500			-0.01	(0.06)			0.00	(0.06)	0.05	(0.05)
Employees 500-2000			-0.02	(0.08)			-0.04	(0.07)	-0.01	(0.05)
Founded before 1975			0.00	(0.09)			0.02	(0.08)	0.04	(0.08)
Founded 1976-1991			0.03	(0.06)			0.03	(0.06)	0.04	(0.05)
Worker Council			0.03	(0.04)			0.03	(0.04)	0.05	(0.04)
Median Wage			0.41***	(0.07)			0.33***	(0.07)	0.2***	(0.06)
Median Wage Trend			0.2***	(0.06)			0.18***	(0.06)	0.14***	(0.05)
Wage Compression			0.25***	(0.06)			0.22***	(0.06)	0.13***	(0.05)
Women					-0.08**	(0.03)	-0.09***	(0.03)	-0.09***	(0.03)
Cohabiting					0.04	(0.03)	0.04	(0.03)	0.02	(0.03)
Tertiary Educ.					0.22***	(0.04)	0.21***	(0.04)	0.00	(0.04)
No Voc. Qualification					-0.14***	(0.04)	-0.13***	(0.04)	-0.06	(0.04)
Age					-0.42*	(0.22)	-0.38*	(0.22)	-0.19	(0.21)
Age Sq.					0.21	(0.21)	0.18	(0.21)	0.00	(0.21)
Unempl. Exp.					-0.1***	(0.03)	-0.08**	(0.03)	-0.03	(0.04)
Labor Attachment					0.08***	(0.02)	0.07***	(0.02)	0.02	(0.02)
Foreign Citizenship					-0.06*	(0.03)	-0.05*	(0.03)	-0.04	(0.03)
Health Status					-0.09***	(0.03)	-0.1***	(0.03)	-0.06**	(0.02)
Limited Contract									-0.09***	(0.03)
Managerial Resp.									0.13***	(0.03)
Part-Time									-0.12***	(0.04)
Tenure									-0.22	(0.21)
Tenure Squared									0.19	(0.18)
Recently Hired									0.02	(0.04)
Constant	-1.26***	(0.08)	-1.11***	(0.06)	-1.24***	(0.08)	-1.12***	(0.05)	-1.14***	(0.05)
Occupations	No		No		No		No		Yes	
Tasks	No		No		No		No		Yes	
σ^2_{Firm}	0.56	(0.10)	0.22	(0.05)	0.46	(0.09)	0.19	(0.05)	0.09	(0.03)
σ^2_{Worker}	1.18	(0.13)	1.18	(0.13)	1.06	(0.12)	1.06	(0.12)	0.74	(0.09)
N	12560		12560		12560		12560		12560	
Wald χ^2	73		181		264		397		1642	
Log Likelihood	-7262		-7216		-7164		-7123		-6877	

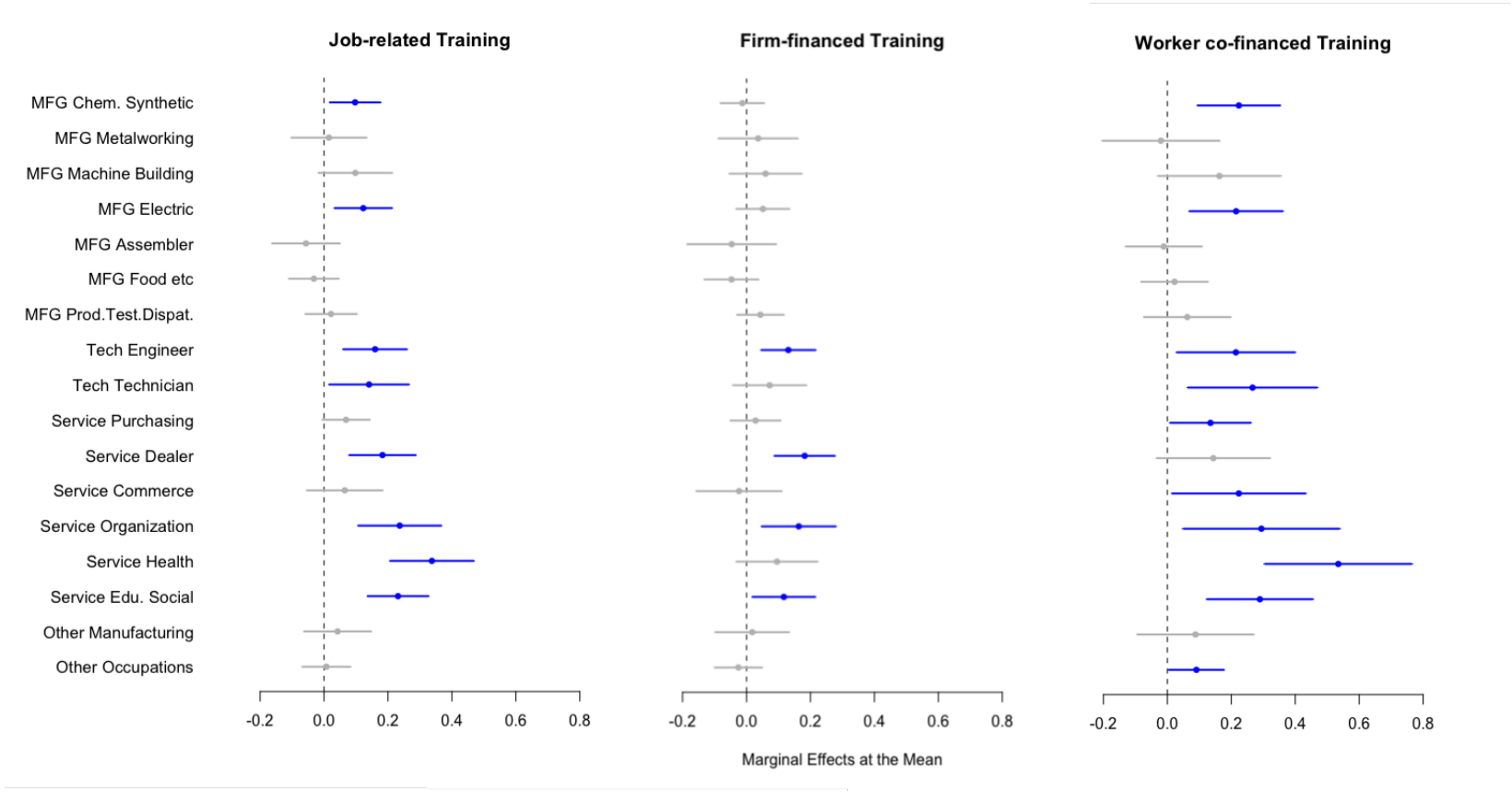
Note: Own calculations; Multilevel logit estimation; cluster-robust standard errors are in parentheses (on the firm-level); Mandatory-job training courses are excluded. Regression includes a variable capturing the number of months a worker has been asked retrospectively. Significance levels: *= significant at 10%-level, **= significant at 5%-level, ***= significant at 1%-level

Table 5: Participation in Training Courses Overlapping into Leisure Time

Dependent Variable:	**Participation in Job-related Training Courses at least partly in Leisure Time**									
Variable	Null Model		+Firm Variables		+Worker Variables		+Firm & Worker Var.		+Firm & Worker + Occ.	
Year 2008	-0.17*	(0.09)	-0.17*	(0.09)	-0.16*	(0.09)	-0.16	(0.09)	-0.16*	(0.09)
Year 2009	-0.13	(0.08)	-0.13	(0.08)	-0.11	(0.08)	-0.11	(0.08)	-0.14	(0.08)
Year 2010	-0.26***	(0.07)	-0.26***	(0.07)	-0.22***	(0.07)	-0.22***	(0.07)	-0.22***	(0.07)
State Saxony			-0.07	(0.16)			-0.11	(0.15)	-0.05	(0.14)
State Bavaria			-0.08	(0.10)			-0.07	(0.10)	-0.09	(0.09)
State NRW			-0.04	(0.11)			0.01	(0.11)	0.03	(0.11)
State MV			-0.11	(0.13)			-0.13	(0.12)	-0.05	(0.11)
Service Sector			0.36***	(0.07)			0.29***	(0.07)	0.03	(0.07)
Public Sector			0.18*	(0.10)			0.13	(0.09)	0.04	(0.07)
Employees 200-500			-0.08	(0.07)			-0.08	(0.06)	-0.08	(0.06)
Employees 500-2000			-0.08	(0.09)			-0.09	(0.09)	-0.06	(0.07)
Founded before 1975			-0.18	(0.12)			-0.16	(0.12)	-0.07	(0.11)
Founded 1976-1991			-0.04	(0.08)			-0.03	(0.07)	-0.01	(0.06)
Worker Council			0.00	(0.05)			0.02	(0.05)	0.06	(0.04)
Median Wage			-0.05	(0.10)			-0.09	(0.09)	-0.15*	(0.08)
Median Wage Trend			0.13**	(0.07)			0.11*	(0.06)	0.07	(0.06)
Wage Compression			0.13	(0.08)			0.07	(0.08)	-0.02	(0.07)
Women					0.21***	(0.05)	0.17***	(0.05)	0.08*	(0.04)
Cohabiting					0.02	(0.03)	0.02	(0.03)	-0.01	(0.04)
Tertiary Educ.					0.28***	(0.04)	0.28***	(0.04)	0.07*	(0.04)
No Voc. Qualification					-0.18***	(0.05)	-0.18***	(0.05)	-0.08*	(0.04)
Age					0.58**	(0.28)	0.59**	(0.28)	0.87***	(0.31)
Age Sq.					-0.85***	(0.28)	-0.86***	(0.28)	-1.06***	(0.30)
Unempl. Exp.					-0.03	(0.04)	-0.03	(0.04)	-0.05	(0.04)
Labor Attachment					0.09***	(0.03)	0.09**	(0.04)	0.04	(0.03)
Foreign Citizenship					-0.02	(0.04)	-0.02	(0.04)	-0.01	(0.03)
Health Status					-0.05*	(0.03)	-0.05*	(0.03)	-0.02	(0.03)
Limited Contract									0.05	(0.03)
Managerial Resp.									0.08**	(0.04)
Part-Time									0.09**	(0.04)
Tenure									0.11	(0.21)
Tenure Squared									-0.19	(0.20)
Recently Hired									0.1**	(0.04)
Constant	-2.02***	(0.10)	-1.97***	(0.10)	-2***	(0.09)	-1.99***	(0.09)	-2.02***	(0.08)
Occupations	No		No		No		No		Yes	
Tasks	No		No		No		No		Yes	
σ^2_{Firm}	0.66	(0.11)	0.4	(0.09)	0.47	(0.09)	0.34	(0.08)	0.18	(0.06)
σ^2_{Worker}	2.1	(0.24)	2.1	(0.24)	1.92	(0.22)	1.91	(0.22)	1.52	(0.19)
N	12560		12560		12560		12560		12560	
Wald χ^2	149		240		394		491		1185	
Log Likelihood	-5849		-5825		-5747		-5731		-5538	

Note: Own calculations; Multilevel logit estimation; cluster-robust standard errors are in parentheses (on the firm-level); Mandatory-job training courses are excluded. Regression includes a variables capturing the number of months a worker has been asked retrospectively. Significance levels: *= significant at 10%-level, **= significant at 5%-level, ***= significant at 1%-level

Figure 1: Training Participation Across Occupations



Coefficients are standardized and taken from regression in column 5 in table 3 controlling for establishment, worker and job characteristics.

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ZEW – Leibniz-Zentrum für Europäische Wirtschaftsforschung GmbH Mannheim
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L 7,1 · 68161 Mannheim · Germany
Phone +49 621 1235-01
info@zew.de · zew.de