Informal On-the-job Training and Turnover of New Hires

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ABSTRACT

We analyze the relationship between informal on-the-job training and turnover of new hires. To this end, we use unique survey data on various aspects of informal co-worker training and merge it to individual-level administrative data. We find that informal training is negatively associated with turnover of new hires within the first six months of entering the firm. However, this relationship grows less substantial and statistically weaker after 12 months. We find that higher wage premia paid by firms are related to lower turnover rates of new hires. Our analyses further reveal a trade-off as higher informal training investments during onboarding do contribute to increased retention in firms with a lower wage premium.

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1. Introduction

Informal on-the job training, such as learning by doing and learning from colleagues, is key to knowledge acquisition. There is evidence that it plays an even more important role in workers' human capital development than formal training (Barron et al., 1997; Ferreira et al., 2017; Fialho et al., 2019). Informal co-worker training is critical for new hires to help them adapt to the new workplace and acquire new skills to meet the job requirements effectively. High employee turnover in the first year of employment imposes substantial recruitment, screening, and training costs on firms, while also representing significant human capital losses for the departing workers. Despite these economic consequences, the impact of informal on-the-job training on early retention outcomes remains underexplored. We argue that the paucity of empirical evidence stems primarily from the absence of good data. By leveraging unique and detailed data on the costs of informal co-worker training, our study provides new evidence on the relationship between informal co-worker training and turnover of new hires.

Evidence suggests that productivity gaps between new hires and incumbents are substantial while informal training improves performance considerably among new hires. In the United States (US), the initial productivity gap is reported to be approximately 40% (Bishop, 1997), while in Switzerland, the average productivity shortfall during the onboarding period is estimated at 29% (Blatter et al., 2012). Recent evidence from Switzerland shows that this gap varies considerably across industries (Muehlemann and Strupler Leiser, 2018). De Grip et al. (2016) demonstrate a 64% increase in the performance of new hires during their first year of employment and attribute it primarily to human capital accumulation through on-the-job learning. Our data and study add to this strand of literature, with a specific focus on the neglected relation between informal training investments and retention of new hires. Informal training can shape retention on both sides, affecting employees' choice to stay and employers' decision to retain them. This can happen through three key mechanisms: developing job-specific skills necessary for effective performance, generating information about worker–firm match quality through peer interactions, and eliciting positive reciprocal responses of employees in the form of loyalty since informal on-the-job training can foster a psychological contract. Last, well-integrated new employees are not only better prepared for their tasks on the job, but proper onboarding enhances the meaningfulness and identity-building aspects of work, which could explain the improved retention of workers.

We address the research lacuna by linking a unique firm-level survey with administrative data. Our primary data source is the Cost-Benefit Survey 2017/18 of the Federal Institute for Vocational Education and Training (BIBB-CBS), which includes detailed information of onboarding costs of new hires. We match this with administrative employer–employee records from the Integrated Employment Biographies (IEB)[1] of all employees in the survey firms. Our merged data thus enables an individual-level analysis of the relationship between the amount of informal training received by new hires and their subsequent turnover.

[1] This data is provided by the Institute for Employment Research (IAB).

Our primary outcome is the labor market status of new hires within six and 12 months after joining a firm in our survey. To address endogeneity concerns, we estimate firm–level fixed effects related to turnover and include the Abowd, Kramarz, and Margolis (AKM) effects. First introduced by Abowd et al. (1999), they are derived from a Mincerian wage equation including fixed effects for workers and firms. We use these worker- and firm fixed effects to capture unobserved heterogeneity. To account for task complexity within occupations, that might determine the amount of training new hires receive, we control for an index of the cognitive requirement level for apprenticeship occupations.

Our data show that firms provide on average 4.5 weeks of informal training to a new hire during the average onboarding period of 14.5 weeks. Informal training, we show, is thus a substantial cost component in the external recruitment of skilled workers. Analyzing the first six months of employment, we find that a one standard deviation increase in informal training is associated with a nearly five percentage points (ppt) reduction in turnover probability. However, this relationship weakens over time and loses statistical significance within 12 months. After one year, the primary factor associated with retention is the firms' wage premium, with new hires being more likely to continue in firms offering higher wage premia. Exploring heterogeneity across firm types reveals a trade-off: investing in informal training appears to be an effective strategy to reduce the risk of costly early turnover for firms offering lower wage premia.

The contributions of this paper are threefold. First, we provide novel empirical evidence on the relationship between informal training and turnover of newly hired workers, enabled by detailed individual-level data capturing both these indicators. To the best of our knowledge, such data is unique and has not been used in previous studies. Second, we quantify the interaction between informal training and firms' wage premia and show that they can act as substitutes. Our findings suggest that lower-paying, less productive firms can benefit from investing in informal training to mitigate costly turnover without direct competition on wages. Third, we add to the literature contrasting different economic theories concerning the relationship between training and turnover (e.g., Sieben, 2007; Koster et al., 2011). Specifically, the observed variation in the training–turnover relationship by tenure suggests different underlying mechanisms. The remainder of the paper is organized as follows. Section 2 provides a review of the relevant literature. In section 3, we describe our data sources, data preparation and measures of informal training. We present descriptive statistics in Section 4 and our empirical model in Section 5. We then discuss our results in Section 6 and present robustness checks in Section 7. Section 8 offers a brief discussion and conclusion.

2. Review of Literature

2.1 Theoretical Mechanisms

Drawing on the literature, we elaborate the three mechanisms through which informal training is associated with lower turnover. First, since informal training is primarily firm-specific, the human capital theory predicts that it creates mutual rents for worker and firm, reducing turnover incentives for both. It posits that training enhances workers' future productivity and distinguishes between two main types of training: general and firm-specific. This distinction dates back to Becker (1962), who argues that general training leads to competencies that are useful across firms. When a firm invests

in general training for its employees, their market value increases, raising the risk of costly turnover (e.g., Hillmer et al., 2004; Moon et al., 2023; Silva and Toledo, 2009). By contrast, firm-specific training equips workers with skills that are not easily transferable to other firms, thereby increasing productivity within the firm. Becker (1962) further argues that the costs of firm-specific training should be shared between workers and firms. Sharing both the costs and benefits of firm-specific training incentivize maintaining the relationship after training, allowing both workers and firms to reap the returns (Hashimoto, 1981; Jovanovic, 1979a).

Second, we draw on the job match theory wherein one perspective posits that match quality is an "experience good" that is ex-ante unknown but becomes known over time (Jovanovic, 1979b). Those who are well matched remain on the job, and poor matches will more likely end. A key mechanism through which firms can assess match quality is training. This argument is grounded in Autor (2001), who, observing that firms supplying temporary help invest in general human capital, argues that training induces worker self-selection and also allows firms to screen the ability of new hires. Based on this, we argue that informal on-the-job training during onboarding facilitates timely quality assessments of the worker-firm match through peer interactions. Poor matches are identified and terminated quickly, while high-quality matches are reinforced. Infor-mal training at the beginning of the job is thus associated with a reduced probability of turnover among the remaining, i.e., well-matched, cohort.

Third, we draw on the social exchange theory to elucidate our hypothesized negative relationship between informal training and employee turnover. Central to this theory is the notion that relationships evolve over time into trusting, loyal, and mutual commitments, forming a psychological contract (Cropanzano and Mitchell, 2005). The best-known form of social exchange is reciprocity, which involves mutually contingent exchanges of gratifications that occur without explicit agreements or bargaining (Gouldner, 1960). Investments in employee development by organizations may enhance employees' confidence and job satisfaction, eliciting positive reciprocal behaviors such as increased productivity and organizational loyalty (e.g., Lee and Bruvold, 2003; Koster et al., 2011). Informal training can thereby encourage employees' reciprocal responses like their choice to stay.[2]

2.2 Empirical Literature

There is no uniform definition of informal training in the empirical literature. Drawing on the first individual-level survey in this area, the Employment Opportunity Pilot Project (EOPP), informal on-the-job training is typically characterized as comprising three main components: (1) time spent by a worker observing co-workers doing their jobs, (2) time managers or supervisors allocate away from their regular duties toward informal individualized training or extra supervision, and (3) time co-workers do like-wise (Liu and Batt, 2007).[3] Since the terms informal training and informal learning are closely related and frequently used interchangeably in the literature, we review studies that use both terms.

[2] We refer to Koster et al. (2011) and Kampkötter and Marggraf (2015) for extensive reviews of related literature.
[3] These questions originate from EOPP and were asked to firms with regard to a typical new hire (Loewenstein and Spletzer, 1999).

Since this is the first study of this kind to focus on informal on-the-job training and early retention outcomes in the context of new hires, this review draws on more general and broader evidence on the relationship between informal training and turnover. Four studies on young workers in the US using the National Longitudinal Survey Youth (NLSY) find somewhat varied results: Exploring different types of training among young workers, Lynch (1991) finds that those who have received on-the-job training are less likely to leave the firm, while those with off-the-job training are more likely to do so. This leads her to conclude that on-the-job training tends to be firm-specific. Parent (1999) estimates both off-the-job and on-the-job training to have a negative effect on the probability of separation. Loewenstein and Spletzer (1997) confirm the evidence on on-the-job training by showing that individuals who have ever received it show a mobility rate 15% lower than those who have not. The authors emphasize that the positive relationship between tenure and firm-specific training in pooled cross-sections is mainly due to firm-specific training later in the course of employment. By contrast, Veum (1997) does not find evidence that workers who have received firm-paid on-the-job training have lower turnover rates. Recent evidence from Germany, based on employer–employee panel data, shows that participation in mainly firm-specific training increases retention considerably (Dietz and Zwick, 2020).[4] However, the retention effect is reduced by the portability and visibility of training contents. Similarly, based on individual-level longitudinal data in South Korea, Ju and Li (2019) report a negative relationship between on-the-job training and employees' turnover intentions.

The literature pertaining to the social exchange theory broadly shows a positive correlation between training incidence and reciprocal attitudes (e.g., Leuven et al., 2005; Non, 2020). Lee and Bruvold (2003) find that employees show greater job satisfaction, and higher emotional attachment with and involvement in the organization when the employer commits to developing their skills and competences. This reduces their turnover intentions. Analyzing firms' investments in general training, Koster et al. (2011) show that employees' perception of employer support through training is negatively related to their intentions of quitting and that this is primarily mediated by job satisfaction. Kampkötter and Marggraf (2015) also document that general training leads to reduced turnover rates, with the most pronounced effects observed among employees with shorter firm tenure. Evidence from survey data shows that firm-specific training has a negative association with the mobility expectations of employees (Green et al., 2000), and that a perceived breach in the psychological contract can lower the job satisfaction level (Georgellis and Lange, 2007).

In sum, previous studies broadly indicate a negative relationship between informal training and turnover. Most, however, rely on individual-level longitudinal data without reference to the extent or type of firm-specific training investments. As these studies generally focus on (informal) training and turnover, self-selection bias is probable.

[4] Details of the nature of the training are not provided by the authors.

3. Data

3.1 Data Sources

We merge survey data from the BIBB-CBS 2017/18 with individual-level administrative data. The BIBB-CBS is a representative survey of German firms that includes detailed information on the recruitment and training of their most recently hired skilled worker (Schoenfeld et al., 2020). Skilled workers are those with a middle qualification level, mostly holding a vocational training degree. Our administrative data, the IEB, enable us to track the employment status of all workers in the survey firms (Antoni et al., 2019). The literature indicates that engagement in informal learning depends on the task content of jobs (e.g., Ferreira et al., 2018) and we expect this relationship to be particularly salient during onboarding. We thus incorporate a measure of the complexity of the occupations through a five-level index reflecting the requirements of various training occupations (Friedrich et al., 2023). The index draws on three data sources: (1) a measure of the cognitive abilities of individuals who have successfully completed apprenticeship in their respective occupations, (2) the average educational attainment prior to the apprenticeship and, (3) expert assessments by vocational training professionals. To capture labor market tightness, we merge official statistics on posted vacancies and job seekers from the Federal Employment Agency (FEA) at the regional level across occupations and months.[5]

3.2 Data Preparation

We describe the steps undertaken to link the BIBB-CBS to the IEBs and to identify the most recently hired skilled worker in Linckh et al. (2025). The firms were first asked about their last hire during the period 2015 to 2019. We restrict our data to new hires in small and medium-sized firms (SME) with no more than 250 employees.[6] To analyze labor market outcomes one year after hiring, we define employment spells within CBS-firms following Boockmann and Steffes (2010). An employment relationship is considered terminated if both of the following conditions apply: (1) The new hire is either registered in another firm, registered unemployed, or leaves the labor market within 60 days after separating from the CBS-firm,[7] and (2) The new hire is not re-registered at the original CBS-firm within 90 days.

Interruptions of employment in the CBS-firm might indicate shorter breaks, parental leave, extended illness, or sabbatical. Short interruptions are treated as continuous employment under two conditions: (1) if only one intervening spell occurs, (2) if despite multiple interruptions, the new hire either maintains a secondary job at the CBS-firm or is not registered with another employer

[5] Data are accessible via the following link: https://statistik.arbeitsagentur.de/SiteGlobals/Forms/Suche/Einzelheftsuche_Formular.html?gtp=15084_list%253D7&submit=Suchen&topic_f=berufe-heft-kldb2010

[6] Since SMEs seldom hire multiple employees with similar characteristics at the same time, the likelihood of identifying the most recent hire is very high.

[7] Note that employers are obliged to give a reason for the notification, e.g., a regular notification or the cancellation of employment. Our definition of a terminated employment relationship comprises cases where the employer reports the end of the employment relationship as well as those that are terminated via a yearly notification by the employer. Although this definition is broader than the conditions of Boockmann and Steffes (2010), we believe it is justifiable for two reasons. First, the vast majority of leavers in our data were explicitly stated by the employer. Second, Bender et al. (2018) define job-to-job leavers and leavers to unemployment in exactly the same extended way.

throughout the break. Interruptions exceeding 90 days are also considered continuous employment if the new hire remains unregistered elsewhere or holds a secondary job at the CBS-firm throughout the period.[8] We label interruptions of a worker's tenure at the CBS-firm of more than 90 days as recalls (see Boockmann and Steffes, 2010).[9]

IAB data are unique in that they include all parallel employment relationships and provide wage information on a daily basis. If we observe a separation but the hire is simultaneously registered with the CBS-firm, we adjust the termination date accordingly. To ensure comparability of the wage information, we focus on new hires who began the employment relationship full-time, yielding 675 worker-firm matches. The daily wages are only comparable for full-time workers as the data do not include exact information on the hours worked.

Employment relationships that are potentially affected by firm closures are excluded. Although data on firm closures are not directly available in the data, they can be deduced from the date on which the firm last appears in the data.[10] We exclude employment relationships that end in the same year or the year preceding a firm's apparent disappearance from the dataset. These exclusions bring down our working sample to 661 matches.

To investigate if employer-financed informal training is associated with employment stability, we determine whether the most recent hire remains employed at the CBS-firm six and 12 months after entry, ensuring that the analyzed tenures fall in the pre-Covid period. A more nuanced exploration of this relationship necessitates distinguishing among types of turnover. However, as noted by Bender et al. (2018); Boockmann and Steffes (2010) Hirsch et al. (2010), and Hirsch (2016), the IEB data do not allow for differentiation between voluntary quits and dismissals. Following Bender et al. (2018), we categorize leavers into three groups: (1) Job-to-job movers who are registered with another firm within 60 days after separation,[11] (2) Movers to unemployment who enter a spell of registered unemployment within the first 60 days after separation, and (3) Movers to non-employment who are registered neither employed, nor unemployed within the first 60 days after separation.

To avoid COVID-19-related labor market distortions (Bauer and Weber, 2021), we restrict the sample to hires made prior to May 2019, yielding 653 matches. To account for job complexity, we merge the occupation-specific requirement index for apprentice-ship occupations (Friedrich et al., 2023) at the occupation level in which the new hire works. Table B.8 shows that the requirement varies within occupational groups.

The final working sample comprises 649 worker-firm matches. The majority of these occur in 2017 and 2018, the years closest to the interview date (see Figure A.2).

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[8] The employment histories of two hires in our data hint at maternity leave (Müller et al., 2022). However, we do not consider these separately, as the possible maternity leave only occurs after our one-year observation period.
[9] In our data, we see very few recalls. However, undertake robustness checks on whether recalls influence our estimations.
[10] Note that a disappearance of the firm ID can also have other causes like changes in the ownership or legal form.
[11] Note that we do not consider registered unemployment spells that lasts only a day and take place before the move to another firm.

3.3 Informal Training in Survey Data

The BIBB-CBS records informal training as part of overall firm-side hiring costs for the most recently hired skilled worker. These costs are categorized into the pre-match (search and recruitment) and post-match (onboarding) components. Post-match costs include productivity losses, expenses towards non-formal training, and opportunity costs due to informal training. Non-formal training refers to external training courses. Informal training is provided by incumbent colleagues and managers who allocate time for this away from own tasks.[12] The survey measure of informal training might under-estimate the total informal learning among new hires, as they may additionally learn from peers without negatively affecting co-worker productivity (e.g., "job shadowing"). We argue that despite the correlation between the two learning forms, our estimates would be a lower bound to the true relationship.

Table 1 presents hiring costs for both the working sample and recruiting firms in the full BIBB-CBS. On average, it costs firms around 10,000 EUR to hire a skilled worker from the external labor market. Colleagues and managers provide on average 11.47 hours of informal training to the new hire during an average week in the onboarding period (question 112 in Table C.1). The onboarding takes on average 14.45 weeks (question 108 in Table C.1). If the time spent on non-formal training is deducted from this, a total of 179.72 hours of informal training are provided to new hires by managers and skilled workers. Since the average work week comprises 39.55 hours, this results in 4.54 weeks' worth of informal training. The total cost for informal training is the product of the overall time spent on it and the hourly wage of skilled workers and managers. This amounts to nearly 5,000 EUR on average, which represents approximately 90% of total post-match hiring costs. The overall similarity of cost components between the working and full samples suggests that our linked survey-administrative data sample is representative.

Data on informal training is generally scarce. A firm-level survey similar to the BIBB-CBS conducted in Switzerland shows on average 100 hours of informal training for a newly hired skilled worker (Muehlemann and Strupler Leiser, 2018). This survey also measures informal training in terms of the time invested by incumbent workers during which they do not work productively.

At the individual level, two international surveys provide insights into informal learning on the job. The Program for the International Assessment of Adult Competencies (PIAAC) surveys of the Organization for Economic Cooperation and Development (OECD) conducted in 2011 and 2012 include information on the frequencies of a workers' learning from colleagues or supervisors, learning by doing, and keeping up to date with new products or services (OECD, 2014).[13] For Germany, over 40% of workers report learning from others at least once a week, aligning with the OECD average. This corresponds to around 100 hours of informal learning a year (Fialho et al., 2019). The second international data source is Cedefop's European Skills and Jobs Survey (ESJS)

[12] Arguably, this informal training capture both time devoted to low level induction processes (e.g., firm's health and safety policy, and HR systems) and time devoted to core production processes.

[13] Note that the questions are designed on a 5-level scale (never, less than once a month, less than once a week, at least once a week, every day).

undertaken in 2014 and 2021 among EU workers.[14] The results for 2021 show that 56% of EU workers learn new things at work always, very often or often (Cedefop, 2022). While these individual-level surveys support the plausibility of the values in our dataset, they measure informal learning only in broad terms and lack a direct link to firm-level behavior.

Table 1: Hiring costs for a skilled worker by pre- and post-match components

	Working Sample		Overall Sample	
	Mean	SD	Mean	SD
Cost of job posting	583.03	1,009.63	626.00	1,043.20
Cost for external advisors/headhunters	401.41	1,969.36	349.56	1,794.59
Time spent for job interviews (in hours)	17.16	21.10	18.52	23.70
Total pre-match hiring cost	1,541.86	2,714.07	1,568.30	2,603.96
Duration of onboarding period (in weeks)	14.45	12.94	15.83	15.46
Cost due to lower prodductivity during onb.	3,037.45	5,023.66	3,419.17	5,458.02
Weekly informal training (in hours/week)	11.47	10.89	12.11	12.12
Total informal training (in hours)	179.72	292.71	200.37	309.07
Average weekly working time (in hours)	39.55	1.56	39.44	2.23
Total informal training (in weeks)	4.54	7.36	5.10	7.90
Total cost for informal training	4,953.03	8,719.97	5,707.27	9,642.15
Costs for non-formal training	230.57	713.86	287.80	885.07
Labor cost due to non-formal training	226.32	796.78	344.89	1,259.49
Total post-match hiring cost	8,447.38	12,879.84	9,759.12	14,140.28
Total hiring cost	9,989.24	13,738.72	11,327.42	15,066.17
Observations	649		2,874	

Note: Cost in EUR if not otherwise stated. The overall sample comprises all recruiting firms in the BIBB-CBS whether they could be linked or not. The volume of informal training equals the duration of the onboarding period. To calculate the cost for evaluating job interviews, the time spent in hours is multiplied by the hourly wage of the persons involved.
Source: BIBB-CBS 2017/18, IEB.

4. Descriptive Statistics

4.1 Summary Statistics

Table 2 gives an overview of the key characteristics of the worker-firm matches in our sample. 15% of the firms are located in East Germany and nearly a fourth have fewer than 10 employees. Most vacancies (67%) are filled in the service sector. To check the quality of our data linkage, we compare

[14] The ESJS seeks information on informal training by asking "How often, if at all, does your job involve learning new things?" The response options are always, usually, sometimes, and never.

the firm characteristics between the working sample and the entire BIBB-CBS with all recruiting firms. The matched data set contains 9.2 ppt fewer service sector firms and 7.5 ppt more construction sector firms than the overall data. This is attributable to minor sector-specific distortions in the approval of data linkage and the identification of the lastly hired skilled worker (compare Table B.2). Since the differences are modest, selection bias owing to data linkage is likely to be limited.

Table 2: Summary Statistics

	Working Sample	Recruiting firms in entire CBS
New Hire Characteristics		
Female (%)	33.28	
Age group		
20 – 34	50.39	
35 – 49	31.74	
50 – 65	17.41	
Highest Education (%)		
Vocational training (%)	80.28	
University (of applied sciences) degree (%)	12.02	
Regular employment s.t. social security prior to firm entrance (%)	66.72	
Real daily entry wage (in EUR)	86.80 (36.86)	
Firm Characteristics		
Firm located in East Germany (%)	14.95	12.63
Very small firms (%)	23.88	22.48
Industry		
Service (%)	67.33	76.48
Construction (%)	17.72	10.26
Manufacturing (%)	12.33	10.09
Job Characteristics		
Cognitive requirement level of job	4.91 (1.01)	
Labor market tightness (v/u) at entry stage	0.28 (0.22)	
Observations	649	2,874

Notes: Daily wages in EUR are deflated by the Consumer Price Index (CPI) to 2015 levels. The index for the cognitive requirement level ranges from 3 to 7 in increments of one. Standard deviations are in parentheses.
Source: BIBB-CBS 2017/18, IEB, Official Statistics of the FEA.

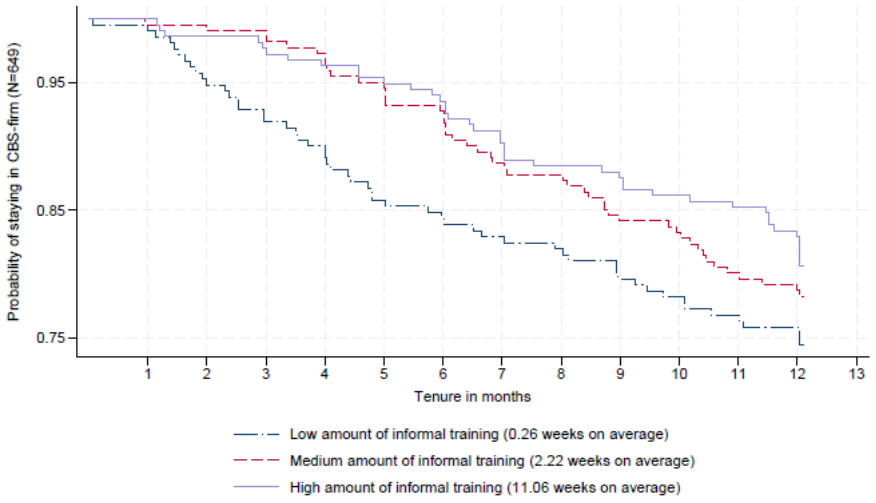
4.2 Turnover in our Data

We first present the evolution of matches over time. Our data show that one year after entering the firm, 78% of the new hires in the reference occupation stay in the CBS-firms, 12% directly move to another job after leaving the CBS-firm, 8% move into unemployment and 2% to non-employment or self-employment (Table B.7). We check the credibility of the proportion of stayers through comparison with cross-sectional in-formation from the BIBB-CBS and other comparable data sources. The BIBB-CBS asks how many new hires have entered the firm within the last hiring year and how many of those have left after 12 months. The results show that in 79% of the CBS-firms, none of the newly hired skilled workers left the firm within the first year. The share of stayers we find is also comparable to findings from other research using the same administrative data source

(Schnabel et al., 2011; Giannelli et al., 2013),[15] and a large individual-level longitudinal survey (Wolff, 2004).[16]

A key criterion for the analysis is that all new hires must have at least completed their onboarding period at the survey firm. This is important because the onboarding duration is included in the calculating the total informal training. The questionnaire design and our data linkage eliminate any distortion caused by incomplete onboarding periods, as data is sought on the onboarding duration and potential productivity de-ductions after the end of the onboarding period of the one, most recently hired skilled worker. This implies that the new hire in question will have stayed at least as long as the onboarding duration. We presuppose this in our data linkage.[17] Table 1 shows that duration of the onboarding in our matched sample is 1.4 weeks (9%) shorter than the average in the overall sample. Table A.1 shows that this deviation is mainly attributable to a lower incidence of very long onboarding periods.

Figure 1: Tenure of new hires by quantity of informal training



Notes: The figure plots nonparametric Kaplan-Meier turnover estimates by quantity of informal training provided (low, medium, high).
Source: BIBB-CBS 2017/18, IEB.

We start our analysis with Kaplan-Meier estimates of the probability that new hires stay within the CBS-firm for different quantities of informal training (Figure 1). The graph shows that more informal training is generally associated with a lower turnover probability during the first year after firm

[15] Schnabel et al. (2011) use linked employer-employee data from the IAB (IAB-establishment panel + IEBs) and analyze firm joiners in the years 1995/1996. They find for all employees that 63.7% of employees that join a non-startup firm in West Germany and 44.3% in East Germany stay in that firm after one year. Giannelli et al. (2013) analyze the quality of newly started jobs between 1998 and 2010 using IEBs. They find survival probabilities (those who stay in firm after 12 months) for the new matches in 2009 of skilled workers aged 25-34 to be 59% and of those aged 35-54 63% among women, with the comparative figures being 50% and 54% respectively among men.

[16] Wolff (2004) compares the duration of new job matches in East and West Germany that were formed in 1990-2000 using data of the German Socio-Economic Panel (SOEP). He excludes marginal employment and vocational training and finds that 77% of jobs in West Germany and 72% in East Germany last for at least one year.

[17] We assume that the onboarding period lasts at least as long as the person is in the CBS-firm. We also presuppose that the onboarding period extends to a maximum of one month beyond the date of the interview. However, the results look similar if we reduce this interval to two weeks.

entrance. This relationship is pronounced during the first six months compared to after one year, and for the group receiving high levels of total informal training compared to the group of new hires that receive a low level of informal training.

5. Empirical Analysis

5.1 Regression Model

To investigate whether match stability is related to informal training, we estimate the following probit model:

$$P_i = \alpha + \beta_1 InfTrain_i + \beta_2 X_i + \beta_3 X_j + \beta_4 \tau_t + \beta_5 \gamma_o + \beta_6 \left(\frac{v}{u}\right)_{tor} + \epsilon_i, \qquad (1)$$

The binary outcome variable P_i takes the value of 1 if new hire i entering CBS-firm j in year t has left the firm within the first year. $Inf\ Train_i$ represents the total informal training (in weeks) that incumbent workers provide for hire i during the onboarding period. X_i is a vector including worker-specific characteristics (AKM worker effects, gender, age, employment status before firm entrance, entry wage). Employment status prior to entering the firm is an important control variable as studies show that individuals who enter employment from unemployment or non-employment face a higher risk of exit than individuals with a job-to-job transition (e.g., Boockmann and Steffes, 2010 for Germany, and Boeheim and Taylor, 2002 for UK). X_j includes firm- and job-specific characteristics (firm size, AKM firm effects, location in East or West Germany, turnover firm fixed effects, job complexity, fixed-term contract). We also control for year- and occupation fixed effects (represented by τ_t and γ_o, respectively). Occupation fixed effects are at the one-digit level of the German Classification of Occupations 2010 (KldB2010) with nine groups. $(v/u)_{tor}$ represents the vacancy-unemployment ratio of a filled vacancy at time t in occupation o and federal state r. ϵ_i is the error term.

5.2 Threats to Identification

The relationship between informal training and turnover of new hires could be subject to potential endogeneity caused by reverse causality and omitted variables.

Firms that experience a high level of turnover may therefore invest a great deal or very little in informal training resulting in reverse causality. To capture this, we determine turnover-specific firm fixed effects on the basis of all employees in the survey firms within the years 2015 to 2019 and add them as control variables in the main estimations. More precisely, we estimate the following fixed-effects panel regression for firm j in year t:

$$s_{j-i^{new},t} = \alpha_j + \beta X_{j-i^{new},t} + \epsilon_{j,t}. \qquad (2)$$

The turnover rate $S_{j-i^{new},t} = \frac{S_{j-i^{new},t}}{N_{j-i^{new},t}}$ is defined as the number of full-time workers who leave firm j in year t excluding the newly hired skilled worker i^{new}, denoted by $S_{j-inew,t}$, relative to the total number of full-time workers registered in firm j and year t excluding the newly hired skilled worker i^{new}, denoted by $N_{j-inew,t}$.[18] The term a_j represents the firm-fixed effects that are included in our main estimations later on, while $X_{j-i}new_{,t}$ contains the mean of the workers' AKM effects and log wages in firm j excluding the new hire i^{new} as well as year fixed effects. $\epsilon_{j,t}$ is the residual. We restrict the analysis to full-time employees for two main reasons: first, wage information for this group is considered reliable. Second, turnover captured under this definition closely aligns with that observed in our main working sample. To identify employment spells and firm leavers across all workers in CBS-firms, we apply the same definition and time frame as described above. Given the skewed distribution of firm fixed effects, we divide the measure of the firm's turnover-related fixed effect into deciles and use each firm's position within this distribution for the estimation.

To mitigate endogeneity arising from the omitted variable bias, we control for a comprehensive set of covariates, including both AKM worker- and firm effects estimated by Bellmann et al. (2020). AKM worker effects capture the proportion of unobserved workers' individual skills and other time-invariant factors that are rewarded equally across employers in their wage earnings. AKM firm effects reflect firm-specific pay premia or discounts and are strongly correlated with the firm's productivity (Lochner and Schulz, 2024). The AKM approach has been extensively used by studies to examine trends in labor market sorting (e.g., Lochner and Schulz, 2024; Card et al., 2013; Song et al., 2019).

However, some time-invariant factors correlated with both the firm's wage premium (AKM firm effect) and informal training may persist. For instance, a firm with an average AKM firm effect might experience a positive productivity shock and thus invest more in onboarding, including informal training.[19] This could lead to overestimation of the coefficient on the wage premium. To address this, we include measures from the survey data that can provide insights into the firm's sales trends and other factors potentially related to turnover or informal training (compare Table B.6).

6. Results

6.1 Turnover within First Six Months

This subsection examines worker turnover within the first six months of tenure. Table 3 shows marginal effects evaluated at the mean values of the explanatory variables of a probit estimation with the dependent variable being 1 if the new hire leaves within the first six months. Models 1 and 2, which exclude control variables, correspond to the Kaplan-Meier estimates displayed in Figure 1. Newly hired workers who received medium or high levels of informal training exhibit a lower

[18] We calculate the number of workers as the average of the number of registered workers at the beginning and at the end of each calendar year.

[19] Note that the AKM effects are determined on the basis of data for the years 2010-2017.

probability of turnover compared to those who received low levels of informal training (Model 1). To facilitate better comparison of the coefficient of informal training with the coefficients of other determinants, we standardize informal training here on. Model 2 indicates a generally negative and statistically significant association between informal training and turnover without any control variables. Firms that invest more in worker search or non-formal training might experience lower turnover rates as these investments can lead to a higher match quality independent of informal training. However, Models 4 and 5 do not show a significant negative correlation between investments in search and non-formal training and turnover within the first six months. Model 6, our preferred specification, reveals a statistically significant negative relationship between informal training and turnover: an increase in informal training by one standard deviation is associated with a 4.6 ppt decrease in turnover six months within the first six months. Given that the standard deviation of informal training is 7.4 weeks (Table 1), this corresponds to a decrease in turnover by 0.62 ppt when informal training increases by one week. Including search and non-formal training costs in the regression does not alter the results substantially (Model 7). Controlling for firm-level turnover fixed effects estimated as per equation 2 has no effect on the magnitude of coefficients but increases the Pseudo R2 (compare Models 2 and 4 in Table B.5).

Table 3: Probit model: Informal training and turnover within first six months

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Medium amount of total informal training	-0.084*** (0.031)						
High amount of total informal training	-0.092*** (0.031)						
Total informal training (std)		-0.052** (0.020)				-0.046*** (0.017)	-0.043*** (0.017)
AKM worker effects (std)			0.003 (0.015)	0.003 (0.015)	0.001 (0.015)	0.001 (0.013)	0.001 (0.014)
AKM firm effects (std)			-0.014 (0.014)	-0.013 (0.014)	-0.014 (0.014)	-0.013 (0.013)	-0.013 (0.013)
Search cost (in 1000 EUR)				-0.005 (0.006)			-0.002 (0.005)
Cost for non-formal training (in 1000 EUR)					-0.017 (0.024)		-0.009 (0.024)
Firmsize	No	No	Yes	Yes	Yes	Yes	Yes
Occupation controls	No	No	Yes	Yes	Yes	Yes	Yes
Gender	No	No	Yes	Yes	Yes	Yes	Yes
East Germany	No	No	Yes	Yes	Yes	Yes	Yes
Year controls	No	No	Yes	Yes	Yes	Yes	Yes
Fixed-term contract	No	No	Yes	Yes	Yes	Yes	Yes
Firm-level turnover fixed effects (quintiles)	No	No	Yes	Yes	Yes	Yes	Yes
Employment prior to entrance in CBS-firm	No	No	Yes	Yes	Yes	Yes	Yes
Entry wage	No	No	Yes	Yes	Yes	Yes	Yes
(v/u) at entry stage (std)	No	No	Yes	Yes	Yes	Yes	Yes
Task complexity of job	No	No	Yes	Yes	Yes	Yes	Yes
Age	No	No	Yes	Yes	Yes	Yes	Yes
Pseudo R2	0.010	0.021	0.142	0.145	0.145	0.166	0,.167
Observations	649	649	649	649	649	649	649

Notes: Probit regression where the outcome is an indicator variable (1 if the newly hired skilled worker leaves within the first six months of tenure at the CBS-firm). Coefficients are marginal effects evaluated at the mean values of the explanatory variables. The firm-level turnover fixed effects from equation 2 include the firm's position in the distribution of all turnover-related firm fixed effects. Estimation based on 1000 bootstrap replications and standard errors are in parentheses. Significance levels are * p<0.1, ** p<0.05, *** p<0.01.
Source: BIBB-CBS 2017/18, IEB, Official Statistics of the FEA.

6.2 Turnover within First 12 Months

The regression results on the relationship between informal training and turnover within one year are seen in Table B.3, organized analogously to Table 3. Models 1 and 2 indicate a negative but statistically insignificant association between informal training and turnover. Model 3, which includes control variables along with AKM worker- and firm fixed effects, shows that the firm's wage premium is negatively and statistically significantly correlated to turnover within the first year. Consistent with results for the six-month period, we do not observe a negative correlation between other components of hiring costs and turnover (Models 4 and 5). Model 6 examines the relevance of total informal training and finds no statistically significant relationship with turnover.[20]

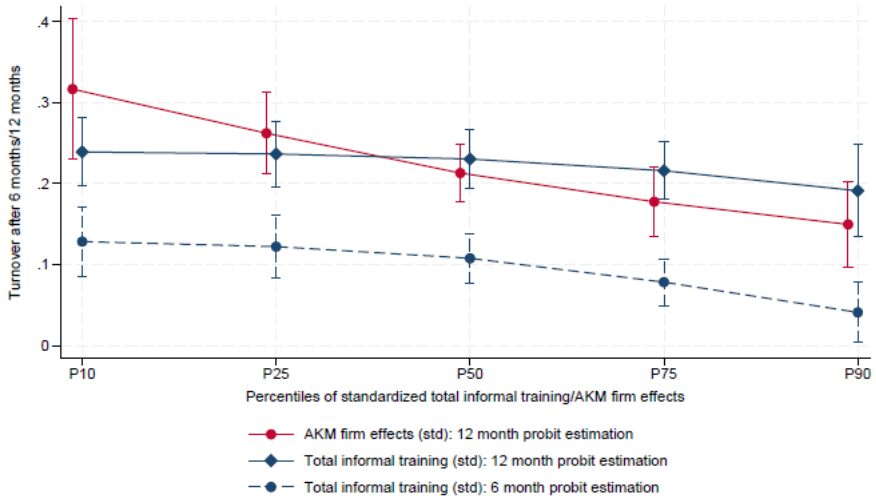
The importance of the firms' wage premium is confirmed in all the main models: a one standard deviation increase in the firm's wage premium is associated with an approximately 7 ppt decrease

[20] Note, again, that including firm-level turnover fixed effects has no effect on the magnitude of coefficients but increases the Pseudo R2 (compare Models 2 and 4 in Table B.4)

in turnover probability within 12 months. This sizable magnitude of association is consistent with the findings of Carrillo-Tudela et al. (2023).[21]

The firms' wage premium exhibits a comparably strong negative association with turnover within 12 months as informal training does with turnover within six months. Figure 2 illustrates the economic relevance of these relationships by presenting the predicted turnover probabilities within 12 months across different percentiles of AKM firm effects (solid red line), alongside turnover probabilities within six months (dashed blue line) and 12 months (solid blue line) across percentiles of informal training. For all levels of informal training, turnover rates within 12 months of tenure exceed those observed within six months. However, there is no statistically significant difference between the coefficients for informal training in relation to turnover within the first six months (Table 3) and first 12 months (Table B.3).[22] Notably, the slope of the relationship between the firm's wage premium and turnover within 12 months closely resembles that of informal training and turnover within six months.

Figure 2: Predicted turnover within first six months/12 months



Note: Corresponding marginal effects at means for AKM firm effects and informal training for 12-month turnover are shown in Model (6) in Table B.3 and for informal training for 6-month turnover in Model (6) in Table 3.
Source: BIBB-CBS 2017/18, IEB, Official Statistics of the FEA.

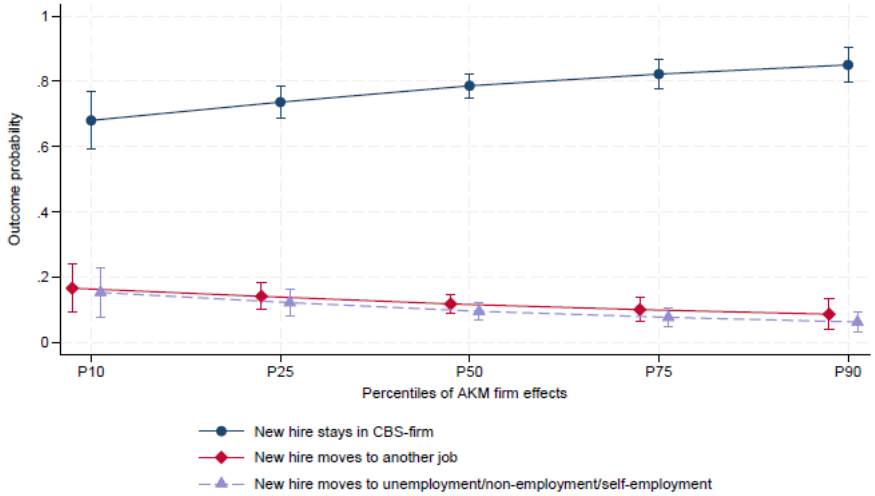
Type of firm exit

We now investigate the association between one-year tenure and informal training in greater depth. Specifically, we distinguish among the exit states of newly hired workers by modelling transitions to (1) employment in another firm, and (2) unemployment, non-employment, or self-employment using a multinomial probit model. Transitions to unemployment or non-employment are assumed

[21] Carrillo-Tudela et al. (2023) find that an increase of AKM firm effects by one unit (not standardized) increases the probability of staying after one year by 12%-16%. Our coefficient size compares to an increase of 38 ppt when AKM firm effects increase by one unit.
[22] We apply the formal statistical test following Paternoster et al. (1998) to assess whether the coefficients on informal training differ significantly for the Models 2, 6 and 7 between Table 3 and Table B.3.

to primarily reflect involuntary separations initiated by the firm.[23] The multinomial model is essential, as the effect of explanatory variables might differ depending on the nature of the transition. For instance, Boockmann and Steffes (2010) show that the probability of a job-to-job transition tends to decline with age, whereas age appears to have little association with transitions into unemployment. We expect unobserved abilities of new hires to be positively correlated with both retention and transition to another job, and negatively correlated with transitions into unemployment or non-employment.

Figure 3: Labor market outcome probabilities within first year for different percentiles of AKM firm effects



Notes: Corresponding marginal effects at means are shown in Table B.9.
Source: Source: BIBB-CBS 2017/18, IEB, Official Statistics of the FEA.

The results underscore the central role of the firm's wage premium in retaining workers after one year and offer insights into mobility patterns by worker and firm type. New hires in firms offering higher wage premia are statistically significantly more likely to remain with the firm and less likely to move to unemployment/non-employment or self-employment within the first year (Figure 3). The coefficients indicate that informal training tends to be positively associated with retention and negatively with both forms of turnover, but not statistically significantly (Figure A.3 and Table B.9). A critical finding from the multinomial framework is that new hires with higher unobserved abilities (captured by AKM worker effects) are more likely to move to another job within the first year. Specifically, a one standard deviation increase in AKM worker effects is associated with a 4.8 ppt increase in the probability of a job-to-job move. This suggests that firms face challenges in retaining their most capable new hires, and the evidence does not indicate that a higher wage premium can prevent job-to-job moves.

[23] Note that the administrative data do not allow to differentiate between non-employment and self-employment.

Quality of Informal Training

Learning from more experienced or more capable co-workers is assumed to be more productive (Liu and Batt, 2007; Nix, 2020; De Grip et al., 2016; Jarosch et al., 2021; Kamei and Ashworth, 2023). To assess the potential moderating role of informal train-ing quality within our framework, we use AKM worker effects and age of colleagues and construct proxies for training quality as follows:

$$\gamma_{j-i^{new},t} = \frac{1}{N_{j-i^{new},t}} \sum_{i \in N_{j-i^{new},t}} \gamma_i. \qquad (3)$$

$\gamma_{j-i}{}^{new}{}_{,t}$ denotes the mean AKM effects of co-workers employed in the same firm and occupation as the new hire during new hire's year of entry ($N_{j-i}{}^{new}{}_{,t}$). These co-workers will probably provide the informal training. This measure is based on the somewhat narrowly defined concept of a team proposed by Jarosch et al. (2021). We calculate the mean age of the colleagues to serve as a proxy for their experience. To assess moderating effects, we include interaction terms between total informal training and both the average innate ability and experience of co-workers.[24] The results in Table B.11 demonstrate no evidence that the innate ability or experience of colleagues moderate the relationship between informal training and turnover probability. Our analysis, how-ever, does suggest a lower turnover probability for new hires in firms where colleagues exhibit above-median AKM worker effects. Although the estimated coefficient is not statistically significant, it points to a correlation between turnover and the unobserved ability of incumbent workers who provide informal training.

Heterogeneity Analyses

In this subsection, we explore potential heterogeneity with respect to informal training. The main grouping we consider is firms categorized by their wage premium, and we divide firms at the median of the AKM firm effect distribution. The descriptive analysis shows that firms paying a wage premium above the median invest more in informal training (Table B.1) and have lower turnover rates within the first year (Figure A.6). To ensure adequate variation in the subsample estimations, we replace the one-digit occupational controls with broader occupational sector classifications following Tiemann et al. (2008). Model 1 in Table 4 replicates our main estimation (Model 6 in Table B.3) with these broader occupational controls and shows no meaningful difference. Model 2 shows the relationship between informal training and turnover among firms that pay at least the median wage premium. In this subsample, the coefficient on informal train-ing is relatively small and lacks statistical significance. By contrast, Model 3, which pertains to firms paying below-median wage premia, reveals that a one standard deviation increase in informal training is associated with a decrease in turnover probability by 9.1 ppt. This estimate is statistically significant at the 10% level and has nearly twice the magnitude of the corresponding coefficient in the full sample. Our results

[24] Note that the coefficient of the interaction effect in nonlinear models does not equal the marginal effect of the interaction term (Ai and Norton, 2003). We thus refer to Norton et al. (2004) and estimate the mean cross-partial derivative.

are robust to the inclusion of controls for search- and non-formal training costs (Models 4 and 5).[25] Overall, the results indicate that informal training is negatively associated with turnover in lower-wage-premium firms, but not in higher-wage-premium firms. For the former, therefore, investing in informal training during onboarding is strategically useful to reduce costly turnover in the longer term.

Table 4: Probit model: Informal training and turnover within first 12 months including sample-splits according to AKM firm effects

	Baseline	Sample split by AKM firm effects			
		>= median	< median	>= median	< median
	(1)	(2)	(3)	(4)	(5)
Total informal training (std)	-0.033	0.010	-0.091*	0.011	-0.100**
	(0.023)	(0.028)	(0.048)	(0.030)	(0.051)
AKM worker effects (std)	0.013	-0.007	0.055	-0.010	0.062
	(0.032)	(0.047)	(0.048)	(0.045)	(0.049)
AKM firm effects (std)	-0.063**				
	(0.025)				
Cost for non-formal training (in 1000 EUR)				-0.017	0.153**
				(0.045)	(0.077)
Search cost (in 1000 EUR)				0.001	-0.026
				(0.009)	(0.028)
Pseudo R2	0.125	0.171	0.182	0.172	0.212
Observations	649	325	324	325	324

Notes: Probit regression where the outcome is an indicator variable (1 if the newly hired skilled worker leaves within the first 12 months of tenure at the CBS-firm). Coefficients are marginal effects evaluated at the mean values of the explanatory variables. The firm-level turnover fixed effects from equation 2 include the firm's position in the distribution of all turnover-related firm fixed effects. We use the same control variables as in Models 3-7 in Table B.3, but occupational fields defined in Tiemann et al. (2008) instead of 1-digit occupational groups. Estimation based on 1000 bootstrap replications and standard errors are in parentheses. Significance levels are * p<0.1, ** p<0.05, *** p<0.01.
Source: BIBB-CBS 2017/18, IEB, Official Statistics of the FEA.

Given these results, a broader question is whether firms can substitute informal training with higher wage premia to achieve comparable turnover outcomes. To test this, we include an interaction term between informal training and AKM firm effects in our probit model (Table B.10). Although this term in Model 2 is not statistically significant, its sign indicates a potential substitution effect. Figure A.4 presents the predicted probabilities of turnover at two levels of informal training (25th and 75th percentiles) across various percentiles of AKM firm effects. A negative association is illustrated only among firms in the lower wage premium percentiles, offering tentative evidence of a substitutive relationship between informal training and wage premium in reducing turnover probability within the first year.

Other important axes of heterogeneity include sector, occupation, task complexity, and labor market tightness. Existing evidence suggests that firms increase their investment in informal training as labor market tightness rises (Linckh et al., 2025, Table B.1), while turnover probabilities within the first year tends to be lower when tightness at the hiring stage exceeds the median (Figure A.6). Although tighter labor markets improve workers' outside options and could theoretically raise turnover, the observed patterns suggest otherwise, necessitating a more detailed empirical

[25] Note that estimated coefficients do not change meaningfully if we include controls for AKM firm effects in the subgroup estimations.

analysis. Descriptive evidence by sector shows that manufacturing firms invest above-average time in informal training and exhibit lower turnover (Table B.1; Figure A.6), aligning with prior findings (Federal Employment Agency, 2025). Informal training may be particularly effective in filling initial skills and knowledge gaps in occupations that involve a high proportion of non-routine and cognitive tasks. Le Barbanchon et al. (2023) report that firm employment is particularly sensitive to hiring frictions in such occupations. Our current sample does not permit us examine in detail these sources of heterogeneity, which could be important areas for future research.

7. Robustness

7.1 Different model specifications

We assess the robustness of our results through different model specifications to rule out the possibility that our findings are confounded by firm-level recruitment strategies shaped by institutional employment protection regulations.

We begin by modifying the probit model with one year tenure in Table B.13 with Model 1 as our preferred reference model. Table B.13 shows that our main findings are not meaningfully affected when we (i) include a dummy variable for recalls, defined as employment relationships that are interrupted by more than 90 days (Model 2), (ii) control for sectors instead of occupations (Model 3), (iii) include an indicator for whether the new hire holds a university degree (Model 4), and (iv) exclude job-matches with onboarding periods of 12 months or longer (Model 5). The probit estimates for the six-month period are also robust to these modifications (Table B.14).

7.2 Survival model

Our data include detailed information on both inflow and outflow dates, making them well-suited for survival analysis. As a robustness check, and to further explore the relationship between the wage premium and the expected tenure of new hires, we estimate a parametric Accelerated Failure Time (AFT) model. The underlying assumption of the AFT framework is that covariates exert a proportional effect on survival time (Kleinbaum and Klein, 2020).[26] While this assumption cannot be tested directly, we evaluate model adequacy through goodness-of-fit analyses.

In parametric survival models, the survival time is assumed to follow a specific distribution. Table B.15 presents AFT models for four distributions. We select the model with the best fit based on the Akaike and Bayesian information criteria (AIC and BIC, respectively with a smaller statistic suggesting a better fit) and on a graphical assessment of Cox-Snell pseudo-residuals (Figure A.5).[27] Based on these criteria, the Weibull distribution provides the best fit to the data. In terms of

[26] The most commonly applied survival time model is the Cox proportional hazards model. However, Figure 1 already suggests that the coefficient of informal training changes over time. This, in turn, implies that the hazard rate also changes over time meaning that the proportional hazard assumption that is key for Cox survival models is violated. Adding an interaction of informal training and tenure indeed shows that the proportional-(sub)hazards assumption for Cox and a competing risk models are violated.

[27] The idea goes back to Cox and Snell (1968) and says that if the model fits the data, the Cox-Snell residuals should have a standard exponential distribution with hazard rate 1, such that they follow a straight line with slope 1.

interpretation, the results in Table B.15 indicate that a one standard deviation increase in the AKM firm effect is associated with a multiplicative change in survival time of exp(0.255) = 1.290, which corresponds to an increase in tenure by 29%. This confirms that higher wage premia are associated with significantly longer employee tenure.

7.3 Selective retention

The institutional context – specifically, employment protection legislation – may influence firms' hiring and termination behavior within the probationary period. In Ger-many, firms with at least 10 full-time equivalent employees are subject to statutory dismissal protection after the probationary period of typically six months. If a firm intends to terminate an employee due to a poor match quality, it is thus likely to do so within this probationary window. By contrast, firms with fewer than 10 employees are exempt from such dismissal regulations.

Empirical evidence from other countries supports the notion that employment protection legislations influence firms' employment behavior. For example, when Sweden relaxed its employment protection laws in 2001, firms responded by moderately in-creasing both hiring and turnover (von Below and Thoursie, 2010), lowering their hir-ing threshold, and employing more workers overall (Butschek and Sauermann, 2024). This reform also led to increased labor productivity, presumably because firms retained employees with higher match quality while dismissing those with lower match quality (Bjuggren, 2018). Similarly, a 1999 UK reform that enhanced job security for workers with one to two years of tenure, led to improved match quality through more selective hiring practices (Marinescu, 2009).

We thus hypothesize that firms subject to employment protection (i.e., those firms with at least 10 employees) are more selective in retaining hires beyond the probationary period.[28] We investigate this by limiting the analysis to the first six months of tenure and include a proxy for the firm's hiring standard. This proxy is defined as the difference between the new hire's AKM worker effect and the average AKM worker effect of their colleagues in the same firm and occupation in the year of hire, corresponding to $\gamma_{j-inew,t}$ from equation 3.

To examine selective retention in firms affected by dismissal protection, we re-place the three-category firm size variable with an indicator representing the dismissal-protection threshold of 10 employees (Table B.12).[29] Model 3 confirms that turnover probability within the first six months is higher in firms subject to employment protection. Model 4 includes our proxy for the hiring standard, and shows that turnover increases with the hiring standard. This is consistent with our earlier finding that workers with a higher innate ability (higher AKM worker effects) are more likely to transition to another firm within the first year. Model 5 includes an interaction between the hiring standard and the dismissal protection threshold. The results indicate that, within the first six months, the probability of retention slightly increases with the hiring standard in firms with at least

[28] Note that labor selection is also associated with other factors like the firm's growth rate (Lochner et al., 2021; Baydur, 2017). However, we cannot control for this in our setting.

[29] Model 1 in Table B.12 shows the descriptive relationship between informal training and turnover within six months. Note that we use occupational sectors defined in Tiemann et al. (2008) and quintiles of the firm-level turnover fixed effects due to lower turnover after six months. Model 2 includes the full set of controls.

10 employees. However, the coefficient is of negligible size and statistically insignificant. Overall, we find no compelling evidence that selective retention based on worker quality plays a meaningful role during the first six months of tenure. This suggests that our main estimates are unlikely to be biased by firm-level recruitment strategies shaped by institutional employment protection thresholds.

8. Discussion and Conclusion

This paper examines the relationship between informal on-the-job training and turnover of new hires. By linking unique survey data with administrative employment biographies, we show that informal training is meaningfully associated with reduced turnover probability within the first six months. However, this relationship fades over time. After one year of tenure, the key determinant of turnover is the firm's wage premium: new hires are less likely to leave firms that offer relatively higher wage premia. Our findings indicate a substitution relationship between wage premium and informal training. Providing more informal training during onboarding can effectively reduce costly turnover in firms offering a low wage premium. This allows them to avoid direct wage competition with more productive, higher-paying competitors.

What is the underlying mechanism of our results? The statistically significant negative association between informal training and turnover that does not last beyond a year favors the argument for accelerated learning about true match quality, leading to reduced early turnover among those who remain. By contrast, if Becker's human capital theory or reciprocity-based mechanisms were the primary drivers, a more persistent negative relationship would be expected beyond the initial six months. Notably, the result that informal training has a negative and statistically significant association with turnover in firms offering lower wage premia suggests that the human capital theory or the reciprocity mechanism may be applicable in these firms.

Future research could extend our analysis in several ways. First, it would be beneficial to exploit additional sources of heterogeneity. Tighter labor markets improve workers' outside options and could theoretically raise turnover, although our tentative descriptive patterns suggest the opposite. Examining the relationships disaggregated by job task profiles, who face various demand conditions, would also be valuable. Second, a more detailed empirical analysis on the relation between informal training and other outcomes of stayers is important. For example, is informal training related to better promotion probabilities or higher wages and productivity in internal labor markets? Third, a closer look at the kind of hire – transition from unemployment or employment – would be important. We control for regular employment before entering the survey firms. However, the informal training - turnover relation might be mediated by the labor market status prior to entering the firm.

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Appendix

A Tables

Table B.1: Total informal training in weeks by sector, tightness and firm AKM effects

	Mean	SD	N
Overall	4.54	7.36	649
By sector			
Service	4.8	7.87	423
Construction	2.95	5.87	121
Manufacturing	5.05	6.06	93
By tightness			
>= Median tightness	5.22	8.87	325
<Median tightness	3.85	5.37	324
By AKM firm effects			
>= Median AKM firm effects	4.91	8.28	325
<Median AKM firm effects	4.17	6.29	324

Source: BIBB-CBS 2017/18, IEB, Official Statistics of the FEA.

Table B.2: Comparison of data sets at different levels of data linkage according to sector shares

	Recruiting firms in entire CBS	Firms that agreed to data merge	SMEs that agreed to data merge	Working sample
Service (%)	76.48	73.94	73.34	67.33
Construction (%)	10.26	11.90	12.86	17.72
Manufacturing (%)	10.09	11.39	11.15	12.33
Observations	2,874	1,773	1,579	649

Source: BIBB-CBS 2017/18, IEB.

Table B.3: Probit model: Informal training and turnover within first 12 months

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Medium amount of total informal training	-0.039 (0.043)						
High amount of total informal training	-0.062 (0.041)						
Total informal training (std)		-0.030 (0.019)				-0.031 (0.023)	-0.033 (0.024)
AKM worker effects (std)			0.010 (0.033)	0.010 (0.033)	0.011 (0.033)	0.011 (0.033)	0.014 (0.034)
AKM firm effects (std)			-0.069** (0.027)	-0.069** (0.027)	-0.069** (0.027)	-0.068** (0.027)	-0.068** (0.027)
Search cost (in 1000 EUR)				-0.003 (0.008)			-0.002 (0.009)
Cost for non-formal training (in 1000 EUR)					0.012 (0.030)		0.018 (0.030)
Firmsize	No	No	Yes	Yes	Yes	Yes	Yes
Occupation controls	No	No	Yes	Yes	Yes	Yes	Yes
Gender	No	No	Yes	Yes	Yes	Yes	Yes
East Germany	No	No	Yes	Yes	Yes	Yes	Yes
Year controls	No	No	Yes	Yes	Yes	Yes	Yes
Fixed-term contract	No	No	Yes	Yes	Yes	Yes	Yes
Firm-level turnover fixed effects (deciles)	No	No	Yes	Yes	Yes	Yes	Yes
Employment prior to entrance in CBS-firm	No	No	Yes	Yes	Yes	Yes	Yes
Entry wage	No	No	Yes	Yes	Yes	Yes	Yes
(v/u) at entry stage (std)	No	No	Yes	Yes	Yes	Yes	Yes
Task complexity of job	No	No	Yes	Yes	Yes	Yes	Yes
Age	No	No	Yes	Yes	Yes	Yes	Yes
Pseudo R2	0.004	0.004	0.134	0.134	0.134	0.137	0.138
Observations	649	649	649	649	649	649	649

Notes: Probit regression where the outcome is an indicator variable (1 if the newly hired skilled worker leaves within the first 12 months of tenure at the CBS-firm). Coefficients are marginal effects evaluated at the mean values of the explanatory variables. The firm-level turnover fixed effects from equation 2 includes the firm's position in the distribution of all turnover-related firm fixed effects. Estimation based on 1000 bootstrap replications and standard errors are in parentheses. Significance levels are * p<0.1, ** p<0.05, *** p<0.01.
Source: BIBB-CBS 2017/18, IEB, Official Statistics of the FEA.

Table B.4: Probit model: Informal training and turnover within first 12 months for different specifications

	(1)	(2)	(3)	(4)	(5)
Total informal training (std)	-0.030	-0.030	-0.032	-0.031	-0.032
	(0.022)	(0.024)	(0.022)	(0.024)	(0.024)
AKM worker effects (std)	0.025	0.023	0.011	0.011	0.008
	(0.029)	(0.030)	(0.031)	(0.032)	(0.031)
AKM firm effects (std)	-0.055**	-0.067***	-0.058**	-0.068***	-0.075***
	(0.022)	(0.023)	(0.024)	(0.025)	(0.024)
10 – 49 employees	0.078	0.073	0.067	0.065	0.076
	(0.048)	(0.052)	(0.049)	(0.053)	(0.051)
50 – 249 employees	0.142***	0.132**	0.124**	0.120*	0.136**
	(0.055)	(0.060)	(0.056)	(0.062)	(0.060)
Occupation controls	No	Yes	No	Yes	Yes
Gender	Yes	Yes	Yes	Yes	Yes
East Germany	Yes	Yes	Yes	Yes	Yes
Year controls	Yes	Yes	Yes	Yes	Yes
Fixed-term contract	Yes	Yes	Yes	Yes	Yes
Firm-level turnover fixed effects (deciles)	No	No	Yes	Yes	Yes
Empl. prior to entrance in CBS-firm	Yes	Yes	Yes	Yes	Yes
Entry wage	Yes	Yes	Yes	Yes	Yes
(v/u) at entry stage (std)	Yes	Yes	Yes	Yes	Yes
Task complexity of job	Yes	Yes	Yes	Yes	No
Age	Yes	Yes	Yes	Yes	Yes
Pseudo R2	0.090	0.113	0.121	0.137	0.131
Observations	649	649	649	649	649

Notes: Probit regression where the outcome is an indicator variable (1 if the newly hired skilled worker leaves within the first 12 months of tenure at the CBS-firm). Coefficients are marginal effects evaluated at the mean values of the explanatory variables. The firm-level turnover fixed effects from equation 2 includes the firm's position in the distribution of all turnover-related firm fixed effects. Estimation based on 1000 bootstrap replications and standard errors are in parentheses. Significance levels are * p<0.1, ** p<0.05, *** p<0.01.
Source: BIBB-CBS 2017/18, IEB, Official Statistics of the FEA.

Table B.5: Probit model: Informal training and turnover within first six months for different specifications

	(1)	(2)	(3)	(4)	(5)
Total informal training (std)	-0.049**	-0.047**	-0.049**	-0.046***	-0.050***
	(0.020)	(0.018)	(0.019)	(0.018)	(0.018)
AKM worker effects (std)	0.005	0.006	-0.000	0.001	-0.001
	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)
AKM firm effects (std)	-0.007	-0.013	-0.007	-0.013	-0.016
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)
10 – 49 employees	0.047*	0.042	0.051*	0.048*	0.054**
	(0.027)	(0.027)	(0.026)	(0.026)	(0.026)
50 – 249 employees	0.056*	0.050	0.056*	0.053	0.063**
	(0.031)	(0.033)	(0.030)	(0.032)	(0.032)
Occupation controls	No	Yes	No	Yes	Yes
Gender	Yes	Yes	Yes	Yes	Yes
East Germany	Yes	Yes	Yes	Yes	Yes
Year controls	Yes	Yes	Yes	Yes	Yes
Fixed-term contract	Yes	Yes	Yes	Yes	Yes
Firm-level turnover fixed effects (quintiles)	No	No	Yes	Yes	Yes
Empl. prior to entrance in CBS-firm	Yes	Yes	Yes	Yes	Yes
Entry wage	Yes	Yes	Yes	Yes	Yes
(v/u) at entry stage (std)	Yes	Yes	Yes	Yes	Yes
Task complexity of job	Yes	Yes	Yes	Yes	No
Age	Yes	Yes	Yes	Yes	Yes
Pseudo R2	0.109	0.146	0.135	0.166	0.158
Observations	649	649	649	649	649

Notes: Probit regression where the outcome is an indicator variable (1 if the newly hired skilled worker leaves within the first six months of tenure at the CBS-firm). Coefficients are marginal effects evaluated at the mean values of the explanatory variables. The firm-level turnover fixed effects from equation 2 includes the firm's position in the distribution of all turnover-related firm fixed effects. Estimation based on 1000 bootstrap replications and standard errors are in parentheses. Significance levels are * p<0.1, ** p<0.05, *** p<0.01.
Source: BIBB-CBS 2017/18, IEB, Official Statistics of the FEA.

Table B.6: Probit model: Informal training and turnover within first 12 months controlling for additional variables

	(1)	(2)	(3)	(4)	(5)
Total informal training (std)	-0.031	-0.032	-0.031	-0.030	-0.039
	(0.024)	(0.024)	(0.024)	(0.024)	(0.026)
AKM worker effects (std)	0.011	0.012	0.011	0.011	0.008
	(0.032)	(0.032)	(0.033)	(0.032)	(0.034)
AKM firm effects (std)	-0.068***	-0.070***	-0.069***	-0.066***	-0.068**
	(0.025)	(0.026)	(0.025)	(0.025)	(0.026)
10 – 49 employees	0.065	0.061	0.064	0.071	0.067
	(0.053)	(0.054)	(0.053)	(0.053)	(0.054)
50 – 249 employees	0.120*	0.112*	0.117*	0.126**	0.117*
	(0.062)	(0.068)	(0.063)	(0.063)	(0.066)
High competitive pressure		0.050			
		(0.041)			
Performance-related pay			0.013		
			(0.039)		
Flexible working times				-0.049	
				(0.042)	
Number of significantly improved products/services					-0.030
					(0.060)
Occupation controls	Yes	Yes	Yes	Yes	Yes
Gender	Yes	Yes	Yes	Yes	Yes
East Germany	Yes	Yes	Yes	Yes	Yes
Year controls	Yes	Yes	Yes	Yes	Yes
Fixed-term contract	Yes	Yes	Yes	Yes	Yes
Firm-level turnover fixed effects (deciles)	Yes	Yes	Yes	Yes	Yes
Empl. prior to entrance in CBS-firm	Yes	Yes	Yes	Yes	Yes
Entry wage	Yes	Yes	Yes	Yes	Yes
(v/u) at entry stage	Yes	Yes	Yes	Yes	Yes
Task complexity of job	Yes	Yes	Yes	Yes	Yes
Age	Yes	Yes	Yes	Yes	Yes
Pseudo R2	0.137	0.141	0.138	0.140	0.145
Observations	649	646	649	649	595

Notes: Probit regression where the outcome is an indicator variable (1 if the newly hired skilled worker leaves within the first 12 months of tenure at the CBS-firm). Coefficients are marginal effects evaluated at the mean values of the explanatory variables. The firm-level turnover fixed effect from equation 2 includes the firm's position in the distribution of all turnover-related firm fixed effects. Models also include a constant. The variables high competitive pressure, performance-related pay and flexible working times are dummy variables. Estimation based on 1000 bootstrap replications and standard errors are in parentheses. Significance levels are * p<0.1, ** p<0.05, *** p<0.01.
Source: BIBB-CBS 2017/18, IEB, Official Statistics of the FEA.

Table B.7: Evolution of new matches over time

	No. of workers	Share in %
Labor market transition within first 366 days:		
Employed in CBS-firm	505	77.81
Job-to-Job transition to another firm	80	12.33
Move to unemployment	49	7.55
Move to non-employment	15	2.31
Worker-firm matches in working sample	649	

Notes: Three of the 80 individuals that move to another firm are right-censored implying that they do not appear in the data for the entire first year after joining the CBS-firm. However, these individuals move to another firm before disappearing. Four of the 15 individuals that move to non-employment disappear completely from the administrative data during the first year after joining whereas the other 11 individuals reappear in the data after a break without any records.
Source: BIBB-CBS 2017/18, IEB.

Table B.8: Cognitive requirement levels for occupational groups

	Mean	SD	Min	Max	N
Agriculture, forestry, farming, and gardening	4.07	0.26	4	5	28
Production of raw materials and goods, and manufacturing	5.07	0.97	4	7	193
Construction, architecture, surveying and technical building services	4.22	0.74	3	7	101
Natural sciences, geography and informatics	6.58	0.78	5	7	24
Traffic, logistics, safety and security	4.68	0.98	3	6	34
Commercial services, trading, sales and hotel business and tourism	4.65	1.05	3	6	103
Business organization, accounting, law and administration	5.49	0.50	5	6	108
Health care, social sector, teaching and education	4.62	0.92	4	6	47
Philology, literature, humanities, social sciences, economics, media, art, culture, and design	5.91	0.70	5	7	11
Total	4.91	1.01	3	7	649

Notes: Occupations are grouped at the 1-digit code according to the German KldB 2010. The index for the cognitive requirement level ranges from 3 to 7 in increments of one.
Source: BIBB-CBS 2017/18, IEB.

Table B.9: Multinomial probit model: Informal training and turnover within first 12 months

Staying in CBS-firm (N=505)	
Total informal training (std)	0.028
	(0.021)
AKM firm effects (std)	0.066***
	(0.024)
AKM worker effects (std)	-0.010
	(0.029)
Reference: Moving to another job (N=80)	
Total informal training (std)	-0.022
	(0.018)
AKM firm effects (std)	-0.031
	(0.019)
AKM worker effects (std)	0.048**
	(0.022)
Moving to unemployment/non-/self-employment (N=64)	
Total informal training (std)	-0.007
	(0.015)
AKM firm effects (std)	-0.035**
	(0.017)
AKM worker effects (std)	-0.038*
	(0.020)
Occupation controls	Yes
Gender	Yes
East Germany	Yes
Year controls	Yes
Fixed-term contract	Yes
Firm-level turnover fixed effects (deciles)	Yes
Employment prior to entrance in CBS-firm	Yes
Entry wage	Yes
(v/u) at entry stage	Yes
Firmsize	Yes
Task complexity of job	Yes
Age	Yes
Log Pseudolikelihood	-370.568
Observations	649

Notes: Multinomial probit regression where the dependent variable has three outcomes. Coefficients are marginal effects evaluated at the mean values of the explanatory variables. The firm-level turnover fixed effects from equation 2 includes the firm's position in the distribution of all turnover-related firm fixed effects. Models also include a constant. Standard errors in parenthesis estimated using jackknife. Significance levels are * p<0.1, ** p<0.05, *** p<0.01.
Source: BIBB-CBS 2017/18, IEB, Official Statistics of the FEA.

Table B.10: Probit model: Informal training and turnover within first 12 months including moderating role of AKM firm effects

	(1)	(2)
Total informal training (std)	-0.031	-0.040*
	(0.024)	(0.023)
Total informal training (std) x AKM firm effects (std)		0.039
		(0.026)
AKM firm effects (std)	-0.068***	-0.065**
	(0.025)	(0.026)
AKM worker effects (std)	0.011	0.008
	(0.032)	(0.032)
Occupation controls	Yes	Yes
Firmsize	Yes	Yes
Gender	Yes	Yes
East Germany	Yes	Yes
Year controls	Yes	Yes
Fixed-term contract	Yes	Yes
Firm-level turnover fixed effects (deciles)	Yes	Yes
Employment prior to entrance in CBS-firm	Yes	Yes
Entry wage	Yes	Yes
(v/u) at entry stage	Yes	Yes
Task complexity of job	Yes	Yes
Age	Yes	Yes
Pseudo R2	0.137	0.144
Observations	649	649

Notes: Probit regression where the outcome is an indicator variable (1 if the newly hired skilled worker leaves within the first 12 months of tenure at the CBS-firm). Model 1 corresponds to our preferred specification (Model 6 in Table B.3). Coefficients are marginal effects evaluated at the mean values of the explanatory variables. The marginal effects of interaction terms are calculated according to Norton et al. (2004). The firm-level turnover fixed effects from equation 2 includes the firm's position in the distribution of all turnover-related firm fixed effects. Models also include a constant. Estimation based on 1000 bootstrap replications and standard errors are in parentheses. Significance levels are * p<0.1, ** p<0.05, *** p<0.01.
Source: BIBB-CBS 2017/18, IEB, Official Statistics of the FEA.

Table B.11: Probit model: Informal training and turnover within first 12 months including proxies for the training quality

	(1)	(2)	(3)
Total informal training (std)	-0.031	-0.015	-0.010
	(0.024)	(0.039)	(0.038)
Mean AKM worker effects of colleagues >= median		-0.077	
		(0.048)	
Total informal training (std) x		-0.027	
(Mean AKM worker effects of colleagues >= median)		(0.051)	
Mean age of colleagues >= median			0.024
			(0.043)
Total informal training (std) x			-0.042
(Mean age of colleagues >= median)			(0.051)
AKM firm effects (std)	-0.068***	-0.062**	-0.072***
	(0.025)	(0.026)	(0.026)
AKM worker effects (std)	0.011	0.019	0.011
	(0.032)	(0.033)	(0.033)
Firmsize	Yes	Yes	Yes
Occupation controls	Yes	Yes	Yes
Gender	Yes	Yes	Yes
East Germany	Yes	Yes	Yes
Year controls	Yes	Yes	Yes
Fixed-term contract	Yes	Yes	Yes
Firm-level turnover fixed effects (deciles)	Yes	Yes	Yes
Employment prior to entrance in CBS-firm	Yes	Yes	Yes
Entry wage	Yes	Yes	Yes
(v/u) at entry stage	Yes	Yes	Yes
Task complexity of job	Yes	Yes	Yes
Age	Yes	Yes	Yes
Pseudo R2	0.137	0.143	0.139
Observations	649	649	649

Notes: Probit regression where the outcome is an indicator variable (1 if the newly hired skilled worker stays within the CBS firm at least 12 months). Coefficients are marginal effects evaluated at the mean values of the explanatory variables. The marginal effects of interaction terms are calculated following Norton et al. (2004). The mean of colleagues' worker AKM-effects and age pertains to employees in the same firm and occupation as the newly hired skilled worker in the hiring year. Models also include a constant. The firm-level turnover fixed effects from equation 2 includes the firm's position in the distribution of all turnover-related firm fixed effects. Models also include a constant. Estimation based on 1000 bootstrap replications and standard errors are in parentheses. Significance levels are * p<0.1, ** p<0.05, *** p<0.01.
Source: BIBB-CBS 2017/18, IEB, Official Statistics of the FEA.

Table B.12: Probit model: Informal training and turnover within first six months including interaction of firmsize and hiring standard

	(1)	(2)	(3)	(4)	(5)
Total informal training (std)	-0.052***	-0.046***	-0.046***	-0.046***	-0.049**
	(0.020)	(0.017)	(0.017)	(0.015)	(0.018)
10 – 49 employees		0.048**			
		(0.024)			
50 – 249 employees		0.053*			
		(0.030)			
(v/u) at entry stage (std)		0.014	0.014	0.016	0.017
		(0.012)	(0.013)	(0.012)	(0.012)
>= 10 employees			0.048*	0.054**	0.056**
			(0.026)	(0.026)	(0.027)
AKM worker effects (std)		0.001	0.001		
		(0.015)	(0.014)		
AKM firm effects (std)		-0.013	-0.013	-0.006	-0.005
		(0.013)	(0.013)	(0.013)	(0.013)
Hiring standard (std)				0.021*	0.036
				(0.011)	(0.025)
>= 10 employees x hiring standard (std)					-0.004
					(0.030)
Occupation controls	No	Yes	Yes	Yes	Yes
Gender	No	Yes	Yes	Yes	Yes
East Germany	No	Yes	Yes	Yes	Yes
Year controls	No	Yes	Yes	Yes	Yes
Fixed-term contract	No	Yes	Yes	Yes	Yes
Firm-level turnover fixed effects (quintiles)	No	Yes	Yes	Yes	Yes
Empl. prior to entrance in CBS-firm	No	Yes	Yes	Yes	Yes
Entry wage	No	Yes	Yes	Yes	Yes
Task complexity of job	No	Yes	Yes	Yes	Yes
Age	No	Yes	Yes	Yes	Yes
Pseudo R2	0.021	0.166	0.166	0.174	0.176
Observations	649	649	649	643	643

Notes: Probit regression where the outcome is an indicator variable (1 if the newly hired skilled worker leaves within the first six months of tenure at the CBS-firm). Coefficients are marginal effects evaluated at the mean values of the explanatory variables. The marginal effects of interaction terms are calculated following Norton et al. (2004). The firm-level turnover fixed effects from equation 2 includes the firm's position in the distribution of all turnover-related firm fixed effects. The hiring standard is defined as person AKM effect of the new hire minus the mean value of AKM-effects of colleagues in the same firm and occupation. Estimation based on 1000 bootstrap replications and standard errors are in parentheses. Significance levels are * p<0.1, ** p<0.05, *** p<0.01.
Source: BIBB-CBS 2017/18, IEB, Official Statistics of the FEA.

Table B.13: Probit model: Informal training and turnover within first 12 months - Robustness

	(1)	(2)	(3)	(4)	(5)
Total informal training (std)	-0.031	-0.031	-0.033	-0.032	-0.013
	(0.024)	(0.024)	(0.022)	(0.024)	(0.032)
AKM worker effects (std)	0.011	0.011	0.017	0.009	0.006
	(0.032)	(0.032)	(0.033)	(0.033)	(0.035)
AKM firm effects (std)	-0.068***	-0.068***	-0.061**	-0.069***	-0.076***
	(0.025)	(0.025)	(0.027)	(0.025)	(0.027)
10 – 49 employees	0.065	0.065	0.060	0.065	0.066
	(0.053)	(0.053)	(0.054)	(0.053)	(0.055)
50 – 249 employees	0.120*	0.119*	0.122*	0.119*	0.124*
	(0.062)	(0.063)	(0.065)	(0.062)	(0.067)
University degree				0.027	
				(0.067)	
Occupation controls	Yes	Yes	No	Yes	Yes
Sector controls	No	No	Yes	No	No
Gender	Yes	Yes	Yes	Yes	Yes
East Germany	Yes	Yes	Yes	Yes	Yes
Year controls	Yes	Yes	Yes	Yes	Yes
Fixed-term contract	Yes	Yes	Yes	Yes	Yes
Firm-level turnover fixed effects (deciles)	Yes	Yes	Yes	Yes	Yes
Empl. prior to entrance in CBS-firm	Yes	Yes	Yes	Yes	Yes
Entry wage	Yes	Yes	Yes	Yes	Yes
(v/u) at entry stage (std)	Yes	Yes	Yes	Yes	Yes
Task complexity of job	Yes	Yes	Yes	Yes	Yes
Age	Yes	Yes	Yes	Yes	Yes
Recall	No	Yes	No	No	No
Pseudo R2	0.137	0.137	0.167	0.138	0.132
Observations	649	649	648	649	626

Notes: See footnotes in Table B.3. Columns 1 shows our preferred baseline-specification (Model 6 in Table B.3). In Model 2, we include a dummy variable for recalls. In Model 3, we control for the economic sector instead of occupations. Model 4 includes a dummy variable indicating a university degree of the new hire. In Model 5, we drop matches in which the onboarding period lasts 12 months or longer. Estimation based on 1000 bootstrap replications and standard errors are in parentheses. Significance levels are * p<0.1, ** p<0.05, *** p<0.01.
Source: BIBB-CBS 2017/18, IEB, Official Statistics of the FEA.

Table B.14: Probit model: Informal training and turnover within six months - Robustness

	(1)	(2)	(3)	(4)	(5)
Total informal training (std)	-0.046***	-0.047**	-0.051***	-0.046**	-0.050**
	(0.018)	(0.018)	(0.019)	(0.018)	(0.023)
AKM worker effects (std)	0.001	0.001	0.003	0.001	-0.000
	(0.016)	(0.016)	(0.016)	(0.016)	(0.019)
AKM firm effects (std)	-0.013	-0.013	-0.011	-0.014	-0.015
	(0.013)	(0.014)	(0.014)	(0.013)	(0.013)
10 – 49 employees	0.048*	0.047*	0.050*	0.048*	0.052*
	(0.026)	(0.027)	(0.028)	(0.026)	(0.029)
50 – 249 employees	0.053	0.053	0.055*	0.053	0.060
	(0.032)	(0.033)	(0.032)	(0.032)	(0.037)
University degree				0.005	
				(0.034)	
Occupation controls	Yes	Yes	No	Yes	Yes
Sector controls	No	No	Yes	No	No
Gender	Yes	Yes	Yes	Yes	Yes
East Germany	Yes	Yes	Yes	Yes	Yes
Year controls	Yes	Yes	Yes	Yes	Yes
Fixed-term contract	Yes	Yes	Yes	Yes	Yes
Firm-level turnover fixed effects (quintiles)	Yes	Yes	Yes	Yes	Yes
Empl. prior to entrance in CBS-firm	Yes	Yes	Yes	Yes	Yes
Entry wage	Yes	Yes	Yes	Yes	Yes
(v/u) at entry stage (std)	Yes	Yes	Yes	Yes	Yes
Task complexity of job	Yes	Yes	Yes	Yes	Yes
Age	Yes	Yes	Yes	Yes	Yes
Recall	No	Yes	No	No	No
Pseudo R2	0.166	0.166	0.161	0.166	0.159
Observations	649	643	605	649	626

Notes: See footnotes in Table 3. Columns 1 shows our preferred baseline-specification (Model 6 in Table 3). In Model 2, we include a dummy variable for recalls. In Model 3, we control for the economic sector instead of occupations. Model 4 includes a dummy variable indicating a university degree of the new hire. In Model 5, we drop matches in which the onboarding period lasts 12 months or longer. Estimation based on 1000 bootstrap replications and standard errors are in parentheses. Significance levels are * p<0.1, ** p<0.05, *** p<0.01. Source: BIBB-CBS 2017/18, IEB, Official Statistics of the FEA.

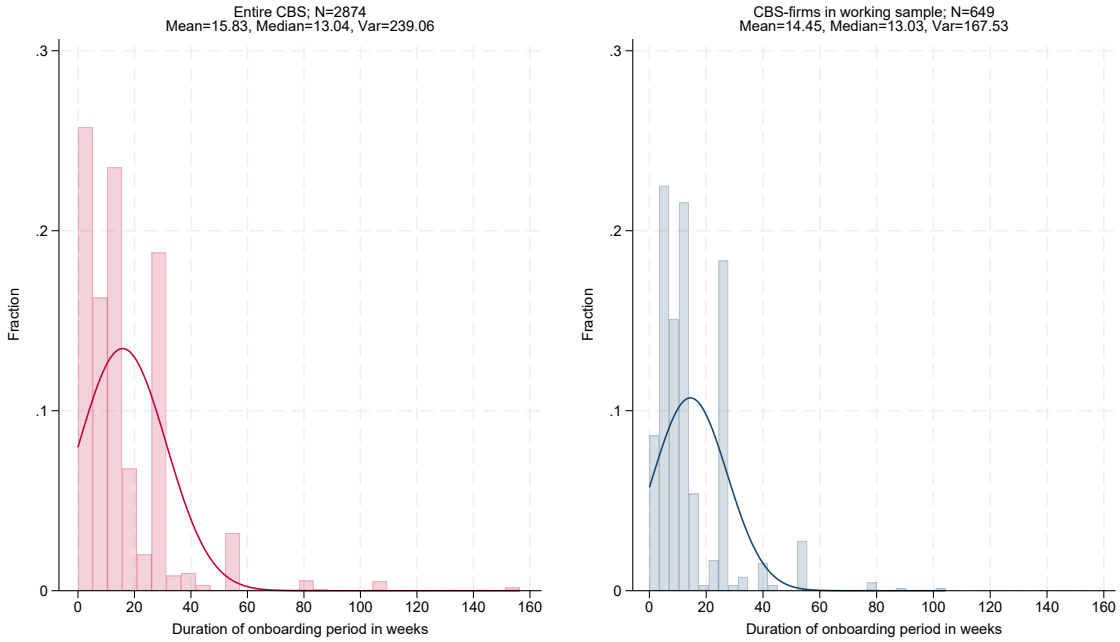
Table B.15: Parametric Survival model (AFT): Estimations on staying at firm > 12 months for different survival distributions

	Exponential	Weibull	Lognormal	Loglogistic
Total informal training (std)	0.203	0.152	0.201**	0.160
	(0.131)	(0.097)	(0.101)	(0.098)
10 – 49 employees	-0.359	-0.267	-0.276	-0.246
	(0.298)	(0.217)	(0.226)	(0.223)
50 – 249 employees	-0.545	-0.400	-0.487*	-0.410
	(0.346)	(0.253)	(0.277)	(0.266)
AKM worker effects (std)	-0.036	-0.028	-0.094	-0.061
	(0.183)	(0.137)	(0.144)	(0.143)
AKM firm effects (std)	0.343***	0.255**	0.243**	0.230**
	(0.133)	(0.100)	(0.114)	(0.103)
Constant	2.840	2.714	1.082	1.775
	(4.481)	(3.258)	(2.813)	(3.203)
Occupation controls	Yes	Yes	Yes	Yes
Gender	Yes	Yes	Yes	Yes
East Germany	Yes	Yes	Yes	Yes
Year controls	Yes	Yes	Yes	Yes
Fixed-term contract	Yes	Yes	Yes	Yes
Firm-level turnover fixed effects (deciles)	Yes	Yes	Yes	Yes
Empl. prior to entrance in CBS-firm	Yes	Yes	Yes	Yes
Entry wage	Yes	Yes	Yes	Yes
(v/u) at entry stage (std)	Yes	Yes	Yes	Yes
Task complexity of job	Yes	Yes	Yes	Yes
Age	Yes	Yes	Yes	Yes
Observations	649	649	649	649
No. of movers	144	144	144	144
Log likelihood	-414.05	-406.00	-407.24	-405.64
AIC	904.11	889.99	892.49	889.29
BIC	1074.18	1064.53	1067.03	1063.83
Pseudo R2	0.357	0.276	0.323	0.299

Notes: Results are coefficients. The firm-level turnover fixed effect from equation 2 includes the firm's position in the distribution of all turnover-related firm fixed effects. Estimation based on 1000 bootstrap replications and standard errors are in parentheses. Significance levels are * p<0.1, ** p<0.05, *** p<0.01.
Source: BIBB-CBS 2017/18, IEB, Official Statistics of the FEA.

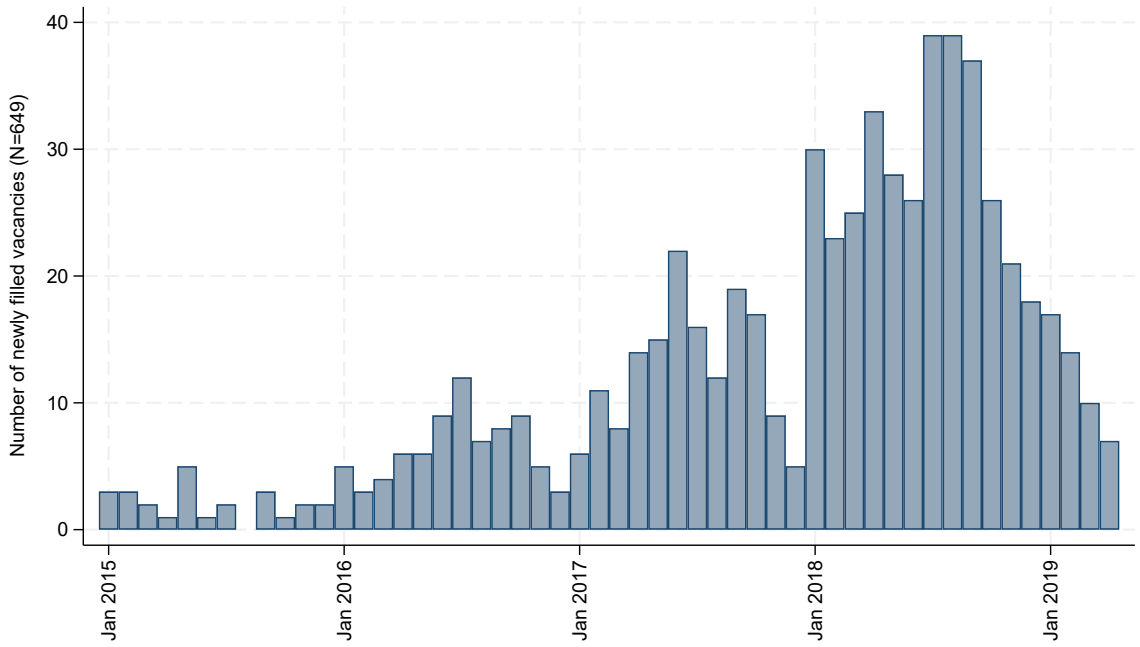
B Figures

Figure A.1: Histograms of duration of onboarding period: Comparison of entire CBS and working sample



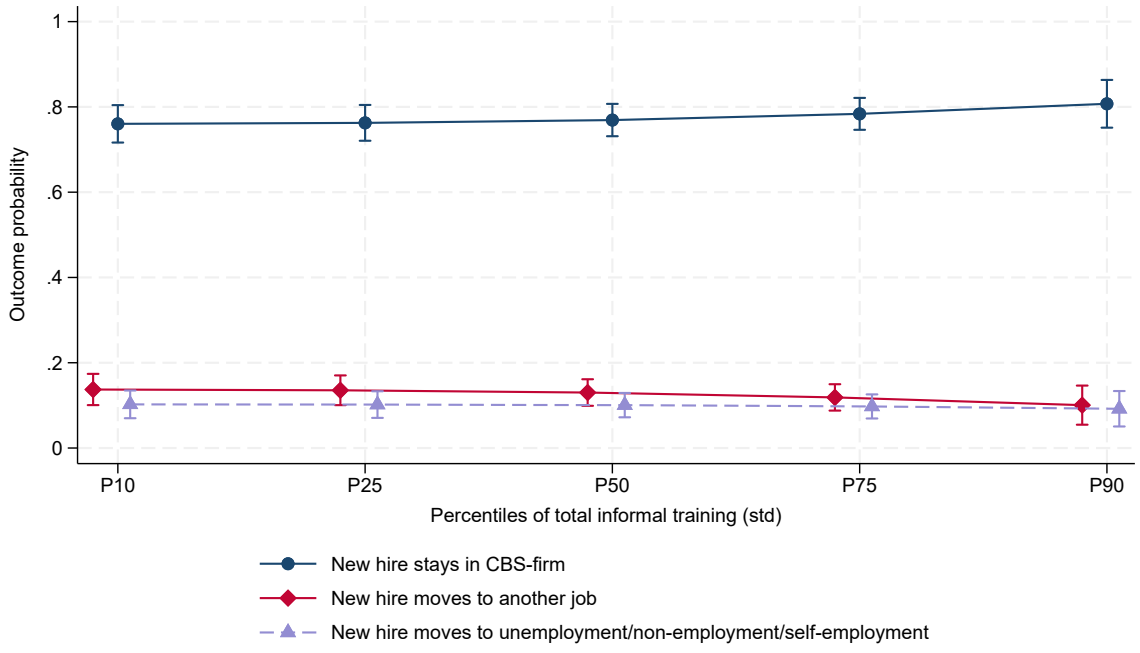
Source: BIBB-CBS 2017/18, IEB.

Figure A.2: Filled vacancies in the working sample by date of firm entrance



Source: BIBB-CBS 2017/18, IEB.

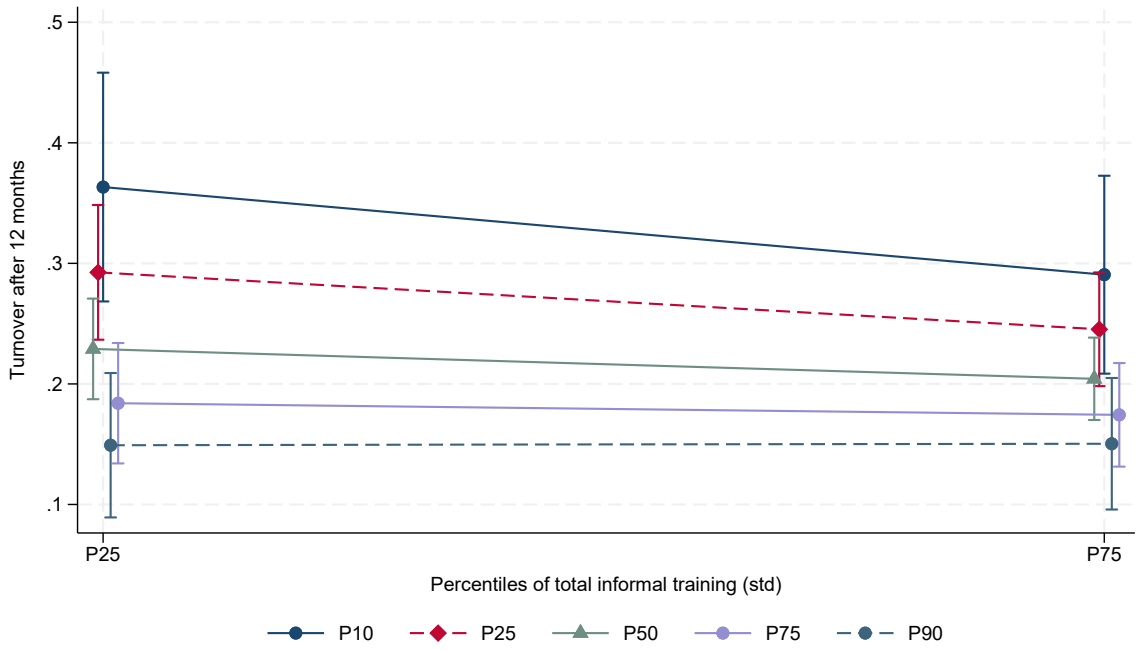
Figure A.3: Labor market outcome probabilities during first year after entrance in CBS-firms for different percentiles of total informal training



Notes: Average marginal effects are shown in Table B.9.

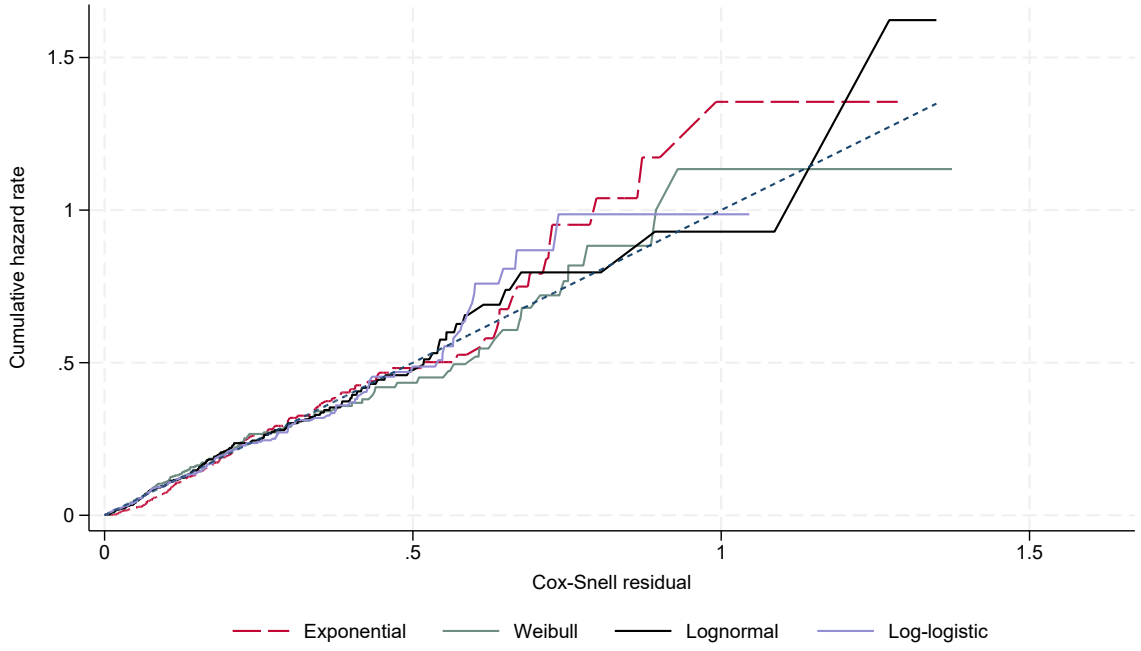
Source: BIBB-CBS 2017/18, IEB, Official Statistics of the FEA.

Figure A.4: Predicted turnover during 12 months for different percentiles of informal training and AKM firm effects



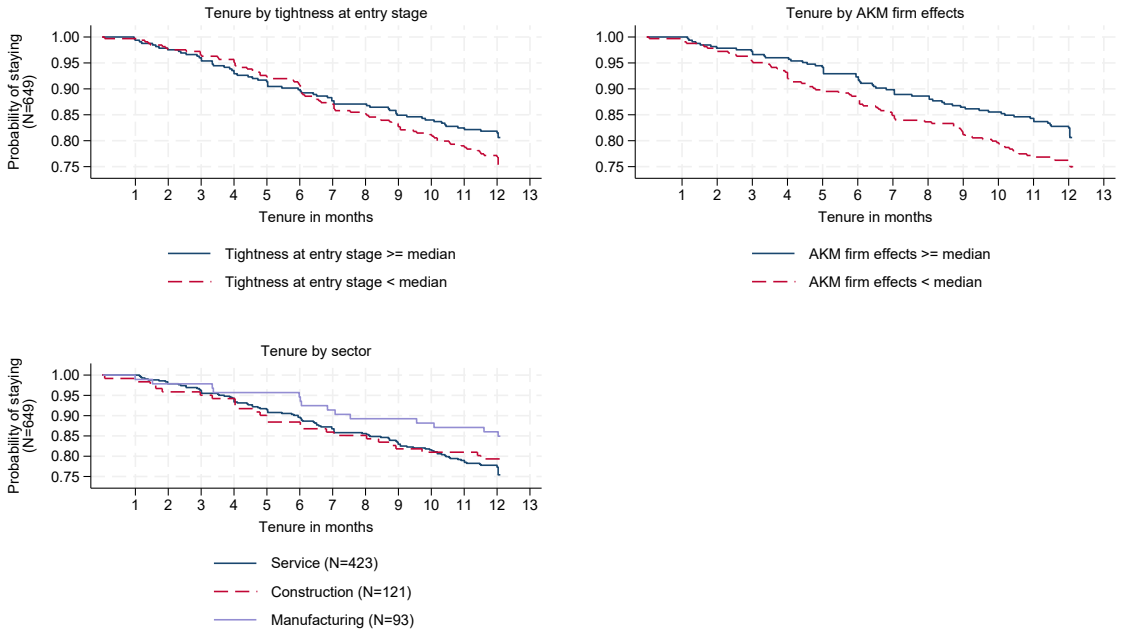
Note: Graph depicts adjusted predictions of Model in Table B.10 at two percentiles of informal training across three percentiles of AKM firm effects.
Source: BIBB-CBS 2017/18, IEB, Official Statistics of the FEA.

Figure A.5: AFT-survival model with loglogistic distribution: Graphical inspection of cumulated hazard of residuals using a one-year model



Source: BIBB-CBS 2017/18, IEB, Official Statistics of the FEA.

Figure A.6: Tenure of new hires by labor market tightness, AKM firm effects and sector



Notes: The figure plots nonparametric Kaplan-Meier turnover estimates by tightness and AKM firm effects (sample-split) and sector.
Source: BIBB-CBS 2017/18, IEB, Official Statistics of the FEA.

C Survey Questions

Table C.1: Survey questions about informal training by incumbent workers

Part of the Questionnaire	Question number	Text
Introduction to the section on recruitment costs		The following questions only concern skilled workers in the reference occupation that your firm last recruited through the labor market in the year [*of the last new hire*]. Please also answer these questions if this skilled worker has already left the firm. *Note: New hires between 2015 and 2019 are considered.*
Question about length of onboarding period	108	How many months did it take for the newly hired skilled worker to become familiar with the job (*in the reference occupation*)? Response Options: Onboarding period in months: _____ Refused Don't know
Question about weekly informal training	112	Now we are talking about those times when [*incumbent*] employees were exclusively involved in training the newly hired skilled worker (*in the reference occupation*). This refers to times when employees were unable to perform their actual duties due to the training, i.e., they did not perform any other productive work for the company apart from the training. How many hours did the employee groups spend on training in an average week of the onboarding period? *Note: This refers to the total number of hours per employee group during one week of the induction period.* Let's start with... A: The managers: Hours of all managers involved in an average week: _____ Now we come to... B: The skilled workers Hours of all skilled workers involved in an average week: _____ Additional response options: Does not apply to this employee group Declined Don't know *Note: For the sum of the two employee groups' hours, a maximum of 70 hours can be entered.*

Source: BIBB-CBS 2017/18.

This working paper was authored for Skills2Capabilities by Carolin Linckh (BIBB Bonn & ROA Maastricht), Didier Fouarge (ROA Maastricht & IZA Bonn, and Samuel Muehlemann (LMU Munich, IZA Bonn & ROA Maastricht). This paper is a deliverable from the work package 6 entitled 'the supply of skills and lifelong learning among VET graduates over the life course.', led by Didier Fouarge (ROA).

This working paper represents the views of the authors based on the available research. It is not intended to represent the views of all Skills2Capabilities affiliates.

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