

University of Tübingen
Working Papers in
Business and Economics

No. 134

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by

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Recruitment Strategies and Match Quality – New Evidence from Representative Linked Employer-Employee Data*

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This version: February 29, 2020

Abstract

In economics, the recruitment process of firms is largely treated as a black box. To shed light on this process, we use new representative linked employer-employee data for German private-sector establishments to explore search, selection and screening activities over the years 2012-2018. We document longitudinal changes in hiring policies and address the heterogeneity across establishments relating to size, ownership, sector, and unobserved heterogeneity. Firms' recruitment strategies have sizeable effects on the composition of worker productivity, worker-firm match quality, the number of open vacancies, as well as expected staffing problems. Finally, we outline potential mechanisms and research gaps for future work, where there is room for more detailed and causal evidence.

Keywords: Recruitment, Hiring Policies, Linked Employer-Employee Data, Worker Productivity, Vacancies, Match Quality

JEL Codes: J21, J63, M51

* We thank Martin Biewen, Peter Eppinger, Christian Manger, Valeria Merlo, Dirk Sliwka, Susanne Steffes, and Georg Wamser for helpful comments and suggestions. Claudius Härdle and Mariella Misch provided excellent research assistance. Patrick Kampkötter thanks the German Research Foundation (DFG) for financial support through priority program SPP 1764 (KA 4591/1-2).

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1 Introduction

The hiring and recruitment process, with its ultimate goal of identifying the best matches of workers to firms, has long been one of the main challenges for companies (Alonso, 2018). Understanding this process is crucial, since a firm's hiring costs can be significant when filling a vacancy: Muehleemann and Strupler Leiser (2018) show that, in Switzerland, the average hiring costs amount to about 16 weeks of wage payments, with the major part being post-match hiring costs. As Oyer and Schaefer (2011, p. 1784) argue, although the fundamental economic problems in hiring, namely costly search and asymmetric information, are well understood, “the methods that firms use to solve hiring problems still need a lot more research”. This is particularly true for the last two decades, as many areas of the labour market have undergone significant changes due to innovation in information technology. A recent development, which we also document in our employer survey, has been the rise of the internet and social media as a means to find workers, who can, e.g. signal certain skills in online platforms. It could potentially matter where a worker is recruited from, e.g. from the internet, from a poaching agency, or through referrals. On the one hand, employer and employee search processes have become more *complex* through, for instance, the advent of information technology resulting in an increasing number of recruitment channels. On the other hand, recruiting *suitable* workers has potentially become easier through, for instance, the use of algorithms in personnel selection, giving firms more opportunity to create economic surplus through efficient worker-firm matching (Oyer and Schaefer, 2011).

Complementary to the magnitude of studies on employees' job search behaviour, i.e. the supply side, we want to take the perspective of the firm and shed light on the much less explored demand side. In detail, we want to focus on the prevalence of employer search and employee selection instruments and their determinants. Furthermore, we analyse the impact of recruitment practices¹ on employee and match quality as well as on establishments' assessments of future labour market problems such as problems to fill vacancies. Our measures for employee quality are employee fixed effects (based on the framework by Abowd et al. (1999) and Card et al. (2013)), while match quality is proxied by vacancy duration (time to fill a qualified position) and involuntary turnover during probationary periods.

¹ In this study, we subsume all job search strategies, screening measures such as employment interviews and assessment centres, and turnover during the probationary period under the umbrella term *recruitment practices*.

Although some studies have identified positive effects of employee selection and pre-hire screening instruments on different outcome variables (Autor and Scarborough, 2008; Huang and Cappelli, 2010; Hoffman et al. 2018), we lack representative evidence on the variety of recruitment practices that firms use, and on their development over time (Alonso, 2018). This gap in the literature has also been advocated by Oyer and Schaefer (2011), who claim that previous papers “do not generally make careful distinctions between, say, hiring practice A and hiring practice B” and that research should invest more effort into “gathering information about firm-level differences in specific hiring strategies.” (p. 1816). The main reason for this gap in the literature has been the absence of panel data on detailed recruitment practices that is representative for firms of an entire economy.

The labour economics literature has extensively studied the matching process with costly search and asymmetric information, i.e. the challenge to improve the quality of the worker-firm match (e.g., Jovanovic, 1979; Mortensen and Pissarides, 1999; Rogerson et al., 2005; Eckstein and van den Berg, 2007). But the literature typically treats firms as homogeneous and as a black box (Oyer and Schaefer, 2011, p. 1771), and often does not document across-firm variation in hiring strategies in detail. A different strand of the literature analyses how active labour market policy programs affect firms' hiring strategies as well as job seekers' search incentives and match quality (e.g., Gaure et al., 2012; Blasco and Pertold-Gebicka, 2013). Researchers have also analysed the impact of labour market regulation (such as minimum wage adjustments) on firms' hiring behaviour and worker selection (for a recent paper, see Butschek, 2019).

We complement this literature by taking the perspective of the firm, and by analysing heterogeneity in establishments' actual hiring practices and outcomes related to these differences. We make use of the Linked Personnel Panel (LPP), a representative linked-employer-employee panel data set for German establishments spanning the years 2012 to 2018. The employer survey covers private-sector establishments with at least 50 employees liable to social security contributions. Our data set includes a rich number of employer search, employee screening and selection as well as on-the-job-screening measures, the majority of which has been asked repeatedly in each survey wave.

Our study is divided into three main parts. In the first part, we provide a longitudinal description of changes in the use of recruitment instruments. We emphasize that this part is rather explorative. Our broad coverage of establishments' recruitment activities and the use of the panel dimension of our data is complementary to the labour economics literature² as other surveys such as the IAB Job Vacancy Survey cannot track establishments across several survey waves. Hence, we contribute to a more detailed understanding of a firm's recruitment and employee selection process. In the second part of the study, we examine heterogeneity of recruitment practices across firms. The literature on management practices emphasizes that structural firm characteristics, such as ownership structure and competition play a large role in determining the use of management practices, which ultimately explain across-firm productivity (Bloom and van Reenen, 2007). However, there is a lack of more detailed and representative evidence on recruitment practices of firms. In detail, we investigate how these strategies are determined by structural characteristics such as establishment size, industry, and ownership structure. Further complementing our main analysis of observables, we estimate how much variation in the data can be explained by unobservable time-constant heterogeneity across establishments. Thus, our findings support the validity of recent theoretical contributions to business cycle models of vacancies that allow for firm level heterogeneity (Kaas and Kircher, 2015).

In the third part, we complement the macroeconomic literature on employer search and matching by analysing how firms assess worker quality. This is important as firms' assessment of worker quality is fundamental to how they set the hiring standard. Do establishments succeed at filling vacancies not only through offering higher wages, but through searching for workers and screening workers in a different fashion (Kaas and Kircher, 2015)? Carrillo-Tudela et al. (2020) use rich data of the IAB Job Vacancy Survey, a representative survey of unmet labour demand in Germany, to assess the relation between hiring rates and wages, worker quality, and job search effort. They show that hiring standards account for the majority of variation in the vacancy yield (hires per vacancy), emphasizing their importance. We assess which role recruiting practices play in this context. For some recruitment strategies, within-establishment variation complements variation in the cross-section, allowing us to assess if certain establishments and if so, which establishments

² Other surveys investigating recruitment practices in firms include the "Workplace Employment Relations Study", a panel study representative of British workplaces. As the most recent survey wave has already been conducted in 2011, we provide a more recent overview here.

become more successful in filling vacancies with well-suited employees. This translates into our third research question, whether and how different recruitment channels for hiring workers affect the quality of matches.

Our results show that the use of many recruitment practices is quite persistent across establishments and over time. The largest aggregate change in recent years has been the advent of social networks such as LinkedIn and Xing to find workers. Their use has increased for our sample from 27% of establishments in 2012 to 54% in 2018. On the other hand, the use of personality and cognitive ability tests has decreased in recent years. A topic which is receiving increasing attention in both the media and in academic literature is the use of artificial intelligence, algorithms, and machine learning techniques in the recruitment process (Horton, 2017; Hoffman et al, 2018; Erel et al., 2019). We document only a small number of establishments using algorithms to assess workers in 2018. Furthermore, there has been a slight decrease in involuntary turnover during probationary periods (due to being unsuited for the job).

The cross-sectional heterogeneity of recruitment practices can largely be attributed to size: larger establishments use both more and more diverse recruitment strategies. We also find sectoral differences in the use of recruiting practices. For instance, the services sectors are more likely to use social networks than establishments in manufacturing. Further, ownership type also predicts the use of some screening measures. Importantly, family and founder firms are less likely to use interviews, while establishments owned by financial investors are more likely to use them.

Focusing on employee and match quality, we find that poaching and employment interviews increase average worker productivity per establishment, even in establishment fixed effects regressions. In contrast, the use of short work samples decreases worker productivity, indicating that short work samples generally identify lower ability workers. Assessment centres and cognitive ability tests, on the other hand, do not seem to be correlated with ability. Finally, the use of personality or integrity tests is, on average, associated with a reduction in the share of workers who are dismissed within their probationary period.

The paper proceeds as follows. Chapter two reviews related literature, followed by chapter three that describes the data used in this study and the variables of interest. Chapter four presents descriptive results about the use of recruitment practices over time. Chapter five presents results of cross-sectional heterogeneity of recruitment practices, and chapter six

presents results on the effects of recruitment practices on related establishment-level outcomes. Chapter seven provides future research gaps and concludes.

2 Related literature

The impact of recruitment practices has been studied in the literature from different angles. One strand has focused on the role of sorting or self-selection of employees into firms and jobs. These mechanisms refer to a process where job offers are intentionally designed such that individuals with certain attributes are more likely to apply for the job than those lacking these attributes. A number of scholars adapted this framework to several questions related to recruitment processes. Autor (2001), among others, investigates the role of temporary help firms as a screening device, Cappelli (2004) and Manchester (2012) analyse the self-selection process in firms offering a tuition reimbursement program. Finally, Lazear (2000), among others, shows self-selection of employees into firms with variable pay schemes.

Another strand has been tackled in the literature on employer search. The focus has been on the means employers use to collect information about potential hires (DeVaro, 2005). Rees (1966) established a distinction between formal (e.g. newspaper ads, poaching agencies) and informal recruitment methods (e.g. employee referrals) that employers use to collect this information. This distinction has, however, become somewhat complicated as establishments that advertise a job on a professional social network such as LinkedIn and receive a response can also utilize the network of the applicant, which might work very similar to a referral (Montgomery, 1991; Casella and Hanaki, 2008; Burks et al., 2015; Dustmann et al., 2016). Moreover, Hensvik and Nordström Skans (2016) provide empirical evidence that firms use the social ties of their productive employees (co-worker networks) to hire socially connected employees with high unobserved productivity.

Another strand of the literature is emphasizing the role of information. Early contributions made a distinction between extensive and intensive information (Rees and Schultz, 1970). Extensive information refers to employers posting ads to gain information about more applicants, whereas intensive information provides more detail about specific applicants. Barron et al. (1985) further differentiate between extensive search (number of interviews per job offer) and intensive search (number of hours spent recruiting an applicant). In this regard, empirical work has, for instance, studied the nexus between search costs and the role of information in the search process, exploring how advanced knowledge of vacancies might impact search costs and the likelihood to fill the position (Barron et al. 1997; Burdett and

Cunningham, 1998). Theoretical work, on the other hand, has addressed, for instance, the role of dismissals during the probationary period as post-hire screening instrument (Bull and Tedeschi, 1989).

In a stream of closely related studies, DeVaro and others use a cross-sectional survey of employers in four US metropolitan regions to assess the relation between recruitment strategies and vacancy duration. DeVaro (2005) finds that informal recruitment methods reduce the vacancy duration, whereas formal methods increase it. He also documents some heterogeneity in the use of practices according to size and industry. Using the same data, DeVaro and Fields (2005) do not find an effect of screening activities (such as number of applications, interviews, and reference checks) on worker performance. We aim to add to this stream of literature by exploiting the panel dimension of our data set, which allows to use, for instance, lagged dependent variable and fixed effects approaches. Further, we include recent recruitment strategies that have received little attention in representative analyses on hiring.

Research in management and applied psychology is primarily focusing on employee screening, i.e. the process of selecting good matches out of a pool of job applicants. This research analyses post-hire outcomes such as turnover intention, commitment, and job-satisfaction of employees hired through different screening policies (see Breughe (2013) for a review). Most of the studies in this strand, such as Moser (2005) and Irving and Montes (2009) analyse the effects of individual attributes and candidates' information about the job on turnover or employee attitudes. Furthermore, a huge literature in personnel psychology assesses the so-called criterion validity of specific selection procedures (Schmidt and Hunter, 1998; Van Iddekinge et al., 2012). A key insight from this literature is that more intensive screening increases the reliability of the assessment and, in turn, can increase the predictive validity of the recruitment procedure.

In economics, there is a recent surge of interest in the impact of management practices, amongst them also recruiting and staffing measures. Large-scale survey studies have been conducted to investigate the connection between rather general management practices and firm performance. In a number of papers, Bloom and van Reenen (see 2010 for an overview) use telephone interviews to evaluate firms' HR practices along different dimensions such as monitoring, target setting, and people management. Recruitment-wise, they aim to measure whether senior managers discuss attracting and developing talented people, and use a few open-ended questions to assess how well firms recruit, retain, and provide incentives to attract workers. Their work is complementary to ours, as we can cross-validate which recruitment

mechanisms should be seen as “best-practices” in a representative sample. We do not take for granted, e.g. that intensively searching for workers on professional networking websites is a “best-practice”, but rather test whether it leads to a better match quality. It is convenient for us that management practices do have a similar effect across countries (Bloom and van Reenen, 2007), so we do not necessarily see the conclusions from our findings being limited to Germany.³

A recent study using data from the IAB Job Vacancy Survey by Rebien et al. (2017) finds that larger firms are relatively more likely to use formal than informal search activities, and also more likely to use formal search for high-skilled positions. Further, a firm’s formal search intensity is positively correlated with the number of applicants per vacancy. We also assess which channels and whether social networks and head-hunters used by the employer generate more applications per vacancy. Carrillo-Tudela et al. (2020) show that the firm’s hiring rate is negatively correlated with worker match quality, i.e. the hiring standard. As firms lower their hiring standard, they are able to employ workers at a faster rate. Further, hiring standards account for about 60% of the variation in the vacancy yield. This suggests raising hiring standards can increase match quality. We complement this research by studying the use of heterogeneous instruments to assess worker quality.

3 Data

3.1 Data sets

In order to present an encompassing overview of hiring policies of German firms, we use multiple representative data sets, which can be linked to each other and to administrative data from the German social security records. The first data set we use is the Linked Personnel Panel (LPP), a recent, longitudinal linked employer-employee survey data set, which is representative for German establishments in the private sector with at least 50 employees (Kampkötter et al., 2016).⁴ The LPP links employee-level information (e.g., about attitudes, preferences and personality) with establishment-level information on management practices

³ Mainly in management research a related but somewhat older strand of research has studied the connection between the use of so-called high-performance work practices and employee or organisational outcomes such as workforce turnover and (labour) productivity (Huselid, 1995; Way, 2002). These studies typically only have a very limited focus on recruitment practices and face identification problems due to their mainly cross-sectional data sets.

⁴ The LPP has been implemented by a research cooperation between the German Federal Ministry of Labour and Social Affairs, the Institute for Employment Research (IAB), the Centre for European Economic Research (ZEW) and the Universities of Cologne and Tübingen.

and structural firm characteristics. The LPP contains information on more than 7,000 randomly drawn employees aged between 18 and 74 working in 700 to 1,200 establishments in four survey waves 2012, 2014, 2016, and 2018. The LPP employee survey is conducted via phone (CATI), whereas the employer survey is based on face-to-face interviews with establishment managers or HR executives.

The employer survey is conducted subsequently to the regular IAB Establishment Panel (IAB EP) interview, an annual representative survey covering the universe of German establishments with at least one employee subject to social security (Ellguth et al., 2014). The IAB Establishment Panel has been conducted by the Institute for Employment Research (IAB) since 1993 in West Germany and since 1996 in East Germany and currently comprises 15,000-16,000 establishment interviews per year. We use the IAB EP since it provides detailed information on the demand side of the labour market – in particular, concerning the structure of the establishment’s workforce, fundamental establishment characteristics such as the type of management and establishment age as well as labour turnover, which can be linked to the LPP.

Third, these data sets can further be matched to an additional administrative data source, the Integrated Employment Biographies (IEB). The IEB cover all employees liable to social security contributions in Germany and contain individual employment spells with information about earnings, employers, job switching, and basic qualifications. They are available since 1975 (1991) for West (East) Germany or, if later, since each individual’s entry into the labour market (vom Berge et al., 2013). Individual employment biographies are not only available for all surveyed employees in the LPP, but also for their non-surveyed co-workers in the establishments covered by both the LPP and the IAB EP employer survey.

3.2 Measures

Recruitment and selection instruments

The LPP employer survey offers a range of items measuring an establishment’s recruitment behaviour and employee selection process. Table 10 in the Appendix provides a detailed overview of all survey items and their wording. We distinguish three recruitment phases: employer search (i.e. search for recruits by employers), pre-hire screening and employee selection, as well as on-the-job screening activities such as terminations during the probationary period.

Structural covariates

One challenge of our analysis is the fact that a quasi-random use of recruitment policies by firms is rather unlikely to be observed. Our approach to address potential endogeneity problems will be the use of control variables on the establishment and individual level that are rather exogenous in nature, such as the type of ownership, an establishment's age, its industry and region. These structural covariates should not be influenced by an establishment's recruitment strategy.⁵ We only consider controls which are time-invariant, i.e. variables a firm decides for the long-run or before or independent from its decision on hiring strategies. We are confident that problems of reverse causality are less severe in this setup. In our regressions in Chapter 6, we also implement a lagged dependent variable and fixed effects approach to tackle potential endogeneity problems.

We use a rich set of control variables based on merged information from our LPP employer survey with IAB Establishment Panel data. As a result, we are able to control for several structural variables including establishment size (50-99 employees (base); 100-249; 250-499; larger than or equal to 500 employees), region (north (base); south; east; west), city size (small village (base); mid-size town; metropolitan area), industry (manufacturing (base); metal, electrical and automotive industry; retail, logistics, and media; company-related and financial services; IT, communication and other services; healthcare and social services), ownership structure (family and founder firm (base); dispersed ownership; manager firm; financial investor, other types), type of management (exclusively owners or members of owner families (base); exclusively employed managers; both), independent establishment (vs. subsidiary), Chief Human Resource Officer in executive board (vs. below executive level), establishment age (0-5 years (base), 6-10, 11-20, greater than 20 years), works council (1 if present), establishment trains apprentices (1 if yes), collective agreement (no (base), sectoral-wide collective agreement, firm-wide collective agreement). Furthermore, we control for time fixed effects.

⁵ One could argue that firm size is endogenous to the recruiting practices used. If a firm is better at hiring than competitors, then one can increase the firm size faster. We circumvent this problem by using four size brackets, so a firm's size category is very unlikely to change in the short run in response to hiring strategies.

Establishment-level outcome variables

To measure the impact of establishments' hiring policies, we look at different establishment-level outcomes, reflecting the explorative character of our study. From the LPP, we use the number of applications per open position and involuntary turnover during probationary period (as described above). From the IAB Establishment Panel, we use expectations of establishment managers regarding potential staffing problems. The item reads as follows: "Which personnel problems do you expect for your establishment within the next two years?" We use the following three response categories: high employee turnover, difficulties to recruit required skilled employees from the labour market, and staff shortages. Furthermore, we use the number of open vacancies for qualified positions in the first half of the fiscal year, which require vocational training, comparable professional experience or a university degree. Finally, we employ the total number of employees an establishment is trying to recruit immediately.

As a proxy for individual productivity or ability of employees, we calculate time-invariant individual wage premia (which we call individual fixed effects) based on the framework by Abowd et al. (1999), and as applied to German establishments by Card et al. (2013). We employ the average of those estimated individual fixed effects for full-time employees per establishment (Bender et al., 2018) as an outcome variable that we interpret as the average productivity of an employer's staff. Since the individual fixed effects are time-invariant by design, changes over time can only result from alterations in workforce composition. To tackle potential endogeneity concerns, we calculate individual fixed effects for the period 2003 through 2010, i.e. prior to our estimation period. Summary statistics for all dependent and independent variables are shown in Table 11 in the appendix.

4 The prevalence of recruitment and employee selection instruments

This chapter gives a detailed, representative overview of the instruments German establishments use to recruit, screen, and select new employees. We categorize the different survey items with respect to three stages of a typical staffing process. These stages start with the opening of a vacant position and finish with the resulting employer-employee job match after the probationary period. The first part of this process is the recruitment process comprising activities such as recruiting and addressing candidates via online and social networks, as well as poaching activities via head-hunters or employment agencies (EA). After having received applications by potential candidates, firms start to screen and test their

applicants, which constitutes the second phase of the staffing process. Here, we are interested in the use of selection instruments, the importance of different selection criteria, and the heterogeneity in screening intensity, i.e. the total amount of time an establishment invests into testing and screening of applicants. The last step of the staffing process deals with on-the-job screening. Due to German dismissal legislation, we are particularly interested in employee turnover during the probationary period, i.e. within the first six months of an employment relationship. For this paper, we put a special focus on voluntary and involuntary quits during probation.

For the following analyses, we use an unbalanced panel data set of all LPP establishments from 2012 to 2018. Furthermore, we calculate weighted averages to provide representative results (recall that our results are representative for German establishments with at least 50 employees liable to social security in each wave of the survey).

4.1 Employer search

The job search strategies of firms encompass a wide range of traditional instruments, such as advertising in newspapers or using employee networks to recruit potential applicants. As young professionals increasingly use the World Wide Web and, especially, social media to communicate and search for jobs, we also expect firms to react to this trend.

As shown in Figure 1, the use of social networks for recruitment purposes has risen sharply during the last decade. While only 27% of establishments used social networks in 2012, this proportion has doubled, such that more than half of the establishments (54%) use this tool in 2018. We can also go into further detail on how employers use social networks as a recruitment tool. Conditional on using social networks for recruiting, Figure 6 in the Appendix shows that the vast majority of establishments uses social networks as a means to list vacancies (85% in 2018), followed by representation and advertising motives of the company (71% in 2018). Slightly more than half of the establishments in 2018 state that they use social networks for search, selection and direct approach of potential recruits.

A more direct approach for the use of social media as a recruitment tool is the personal contact of workers already employed in other firms via social networks such as XING or LinkedIn. The share of firms having used this method has been fairly stable over time at just below or at 30 %, with the exception of 2016, where it has been at just below 40 %. Fairly stable over time has also been the use of head-hunters or employment agencies, with a slight increase in the two most recent waves, leading to a usage rate of 28% in 2018.

An advantage of our data is that we can separate our items addressing potential new hires via social networks and poaching using an agency or a head-hunter into managerial and non-managerial employees. Further analyses show that slightly more establishments among those employing this strategy use it for head-hunting managerial employees rather than for non-managerial employees (65-73% versus 52-59%). Also, roughly 25% of establishments between 2012 and 2016 and 32% of establishments in 2018 use head-hunters and employment agencies for both types of employees (multiple answers were possible). So while the use of social networks in general has sharply risen over time as a (new) hiring tool, other new forms of job search strategies remain stable.

*** Insert Figure 1 about here ***

4.2 Employee selection

We now turn to the second phase of a typical staffing process, namely the employee selection process. The incidence of possible instruments used to screen workers in the selection process is laid out in Figure 2, while the intensity of the selection process is laid out in Figure 3.⁶ From Figure 2 we can see that almost all establishments use job interviews to screen workers ex-ante. The share ranges between 85% in 2014 and 87% in 2018, and is rather constant across time. On the contrary, only a minority of establishments uses assessment centres, cognitive ability (general mental ability (GMA)) tests, or personality tests during their employee selection process. The share of establishments using assessment centres is again rather constant over time, whereas for cognitive and personality tests, we see a sharp decline. The usage rate of GMA tests almost halves (decrease of 9 percentage points) from 2014 to 2018. This is surprising given the fact that “GMA can be considered the primary personnel measure for hiring decisions” (Schmidt and Hunter, 1998, p. 266), as it shows the highest validity (correlations between test scores and desired job outcomes) and lowest application cost. The share of personality and integrity tests shows a decrease of about 70% (decrease of 8 percentage points), which is again not in line with academic research showing that personality and integrity tests show high validities (Ones et al., 2007). One explanation for the decreasing trend in establishments might be the problem of transferring academic results into practitioner-oriented sources of information or a reluctance of applicants against these tests (Rynes et al., 2007; Alonso, 2018).

⁶ Note that information on selection instruments is available since wave 2014.

The importance of short work samples is rather constant over time, ranging from 52% in 2014 to 57% in 2018. Concerning the use of new technologies, the LPP employer questionnaire 2018 asks for the first time about the use of algorithms for determining suitable candidates during the recruitment process. We observe that only about 2% of establishments make use of this new technology.

*** Insert Figure 2 about here ***

Looking at screening intensity in Figure 3, our results reveal differences in the time used to screen managers and non-managerial employees. While for non-managers between 2.6 and 3.2 hours of screening are allocated on average, this amount is much higher for managerial employees (between 4.5 and 5.4 hours). The graph also shows that there is no clear time trend observable.

*** Insert Figure 3 about here ***

4.3 On-the-job screening

The final stage in firms' hiring policies is on-the-job screening, which some firms might use to assess employees' skills, effort, and output while working. The German Protection Against Dismissal Act (KSchG) allows on-the-job screening for a so-called probationary period of six months. During these six months working contracts can be terminated relatively easy. In contrast, after this period, terminations become much more difficult, if even almost impossible. This kind of employer learning may act as a substitute for pre-hire screening activities, which will be assessed in Chapter 6 of the study.

Figure 4 shows the share of individuals who left the establishment during the probationary period, either voluntarily (left panel) or involuntarily (right panel). We observe that voluntary quits as well as involuntary quits are less frequently used in recent years, ranging at 4.5% and 7.4% at the end of 2018, respectively. A feature of our data is that from survey wave 2016 onwards, we can further distinguish between the following four reasons for involuntary quits during the probationary period: not suited for job (professional and/or personal reasons), new workers not needed due to changing economic conditions, gross misconduct of employee (extraordinary termination), and other reasons (e.g., severe illness).⁷ Figure 7 in the Appendix shows that the vast majority of involuntary quits during probationary periods are caused by an employee-job mismatch (around 80), whereas severe misbehaviour plays a minor, but

⁷ Note that the relative proportions sum up to 100%.

growing role (12% in 2016 and 14% in 2018). Thus, we can assume unsuitability to be the driving force behind involuntary quits during probationary periods in the remainder of the paper. This validates the use of involuntary turnover during probation as a proxy for match quality.

*** Insert Figure 4 about here ***

4.4 Importance of personal characteristics

Apart from different hiring strategies, establishments can have certain attitudes towards hiring employees, which are characterised in the following. We measure the importance of the following individual characteristics for the hiring process: professional competence, personal competence, ethical standards and cognitive ability. The items were asked in 2016 and 2018 and are measured on a five-point Likert scale from 1 “not important at all” to 5 “very important”. Figure 5 shows a similar, slight downward trend in the importance of all hiring criteria. Professional and personal competence are the most important criteria for recruitment decisions (4.4 and 4.1 in 2018), followed by cognitive ability. Ethical standards are of lowest importance (3.6 in 2018). This is actually in line with the results in Figure 2, which shows a declining use of cognitive ability and personality tests. This result might be a bit surprising as cognitive ability but also different facets of personality can be tested nowadays by means of rather cheap and standardized test instruments (Schmidt and Hunter, 1998).

*** Insert Figure 5 about here ***

5 Hiring behaviour and establishment characteristics

The descriptive analyses above suggest that not all employers use the same or the same amount of hiring methods, i.e. there is heterogeneity across establishments. In the following, we show in more detail which establishment characteristics determine the use of specific hiring policies. As dependent variables, we use each of the staffing and recruitment instruments described in Chapter 4. To investigate the extent of cross-sectional heterogeneity, we run multivariate, pooled logistic and OLS regressions. In case of logistic regressions, we report average marginal effects (AME) to interpret the coefficients in magnitude. Standard errors are clustered at the establishment level. The general specification explains the recruitment strategies as binary variables in a logistic regression (where F is a logistically distributed cdf), or as continuous variables using OLS (where F is a linear function), on the

structural covariates of interest, other structural covariates as controls, as well as time and region fixed effects,

$$F^{-1}(\text{RecruitStrategy}_f) = \beta_0 + \beta_1 \text{Sector}_f + \beta_2 \text{Size}_f + \beta_3 \text{Ownership}_f + \boldsymbol{\gamma} \mathbf{X}_f + \theta_r + \vartheta_t + \varepsilon_{f,t}.$$

We use our rich set of independent variables, which has been presented in Chapter 3.2. The covariates cover a broad range of establishment-level characteristics usually applied in previous literature (e.g., DeVaro, 2005). In detail, we are interested in the sector, establishment size, and the ownership structure, as these have shown to have significant impact on search behaviour of firms (Rebien et al., 2017) and the take-up of management practices (Bloom and van Reenen, 2007). We also control for management structure, region, time effects, size of city where the firm is located, whether the establishment is independent, whether the chief human resource officer is a member of the executive board, the establishment age, whether there is a works council, whether the establishment trains apprentices, and the membership to collective bargaining agreements.⁸

5.1 Employer search

The results in column 1 of Table 1 show that service sector establishments are significantly more likely to use social networks as a means to recruit employees than the manufacturing sector (reference category), holding observable factors constant. For instance, the company-related services & financial services and IT & communication sector establishments are, on average, 23 and 26 percentage points (pp) more likely to use social networks. For the retail, logistics and media sector, we find a 9 pp higher likelihood. This constitutes an economically sizeable difference. However, this pattern does not apply to health and social sector establishments, where the coefficient is not statistically significant.

Columns 2 and 3 reveal that sectoral differences in addressing and poaching employees of other companies using social networks are by far not as large. Only the company-related services & financial services sector is around 10 pp more likely to address potential recruits on social networks, compared to manufacturing establishments. For poaching activities via employment agencies or head-hunters, we observe almost no statistically significant industry differences.

⁸ An important further control variable is competition in the industry an establishment is operating in. We hand-collected information on imports from the UN Comtrade database at the two-digit sector level, and merged this information to our data. Including these variables as a robustness check shows that all results remain qualitatively the same.

Table 1: Determinants of employer search instruments

	(1) Recruiting via social networks	(2) Address via social networks	(3) Poaching via EA or head-hunter
Metal, electrical, automotive	0.0373 (0.0247)	-0.0282 (0.0243)	0.0395 (0.0248)
Retail, logistics, media	0.0946*** (0.0301)	0.0321 (0.0295)	-0.0520* (0.0281)
Company-related & financial services	0.2260*** (0.0333)	0.0959*** (0.0329)	-0.0203 (0.0300)
IT, communication, other services	0.2596*** (0.0477)	0.0466 (0.0443)	0.0123 (0.0455)
Healthcare & social services	0.0431 (0.0434)	0.0047 (0.0495)	0.0390 (0.0493)
Est. size (100-249 empl.)	0.0862*** (0.0218)	0.0818*** (0.0205)	0.1037*** (0.0217)
Est. size (250-499 empl.)	0.1527*** (0.0301)	0.1078*** (0.0272)	0.1573*** (0.0307)
Est. size (>=500 empl.)	0.2705*** (0.0383)	0.1784*** (0.0351)	0.3460*** (0.0386)
Est. age (6 to 10 years)	-0.0706 (0.0568)	0.0512 (0.0567)	-0.0387 (0.0534)
Est. age (11 to 20 years)	-0.1156** (0.0550)	0.0293 (0.0501)	-0.0748 (0.0471)
Est. age (>20 years)	-0.1510*** (0.0519)	0.0294 (0.0468)	-0.0756* (0.0440)
Manager firm	-0.0377 (0.0260)	0.0060 (0.0255)	-0.0296 (0.0259)
Financial investor	-0.0017 (0.0366)	0.1118*** (0.0378)	0.1602*** (0.0390)
Dispersed ownership	0.0931** (0.0410)	0.0672 (0.0414)	0.0007 (0.0385)
Other form of ownership	-0.0838*** (0.0279)	-0.0220 (0.0279)	-0.0546** (0.0278)
Observations	3,431	2,140	3,469
Pseudo R-squared	0.128	0.167	0.093

This table reports average marginal effects of a logistic regression using the unbalanced panel. Additional control variables include collective agreements (3 dummies), works council, apprenticeship training firm, CHRO in executive board, city size (3 dummies), type of management, independent establishment, year and region fixed effects. Robust standard errors clustered on establishment-level in parentheses. * p < .1, ** p < .05, *** p < .01.

For all employer search instruments, we observe a frequency of use that strongly increases in establishment size. Size effects are largest for the use of poaching agencies (35 pp more likely to be used by large establishments), followed by recruiting via social networks (27 pp), and lower for addressing workers directly online (18 pp). Controlling for establishment size, we find that establishment age is negatively correlated with the use of social networks as a recruitment tool. Furthermore, the ownership type is a good predictor of employer search activities. Establishments with dispersed ownership are 9 pp more likely to use social networks compared to family and founder firms. An interesting pattern can be observed for establishments owned by financial investors. These firms are 11 pp more likely to address employees via social networks, and even 16 pp more likely to poach employees using an

agency or a head-hunter compared to the reference group. This reveals that more direct and targeted recruitment behaviour can rather be found in establishments owned by capital investors.

Differentiating between managerial and non-managerial employees, regression results (untabulated) show that the heterogeneity in establishment size (i.e. higher usage rates in larger establishments) is largely driven by managerial employees as a target group. Besides these results, we observe no distinctive patterns between managerial and non-managerial employees. Potentially, firms need a higher level of talent for higher positions, and aim to attract more workers to apply for managerial positions. Assignment models of managers to firms predict that managers with a larger degree of talent can run firms with a higher amount of capital and labour. In this setting, larger establishments have a higher return than smaller firms in finding more talented managers, if their talent is a factor of production, and thus aim to find more applicants (Gabaix and Landier, 2008).

5.2 Employee selection

In Table 2, we address the use of various pre-hire screening (employee selection) measures used at the hiring stage. Concerning the use of employment interviews, we observe no significant differences across industries, but the use of employment interviews is positively correlated with establishment size. Establishments with over 500 employees are 12 pp more likely to use them compared to the smallest establishments. Compared to the base category of family and founder firms, owner-managed establishments are 5 pp less likely to use interviews, and establishments with dispersed ownership are around 8 pp more likely to use interviews.

The use of assessment centres (ACs) is more heterogeneous between industries. ACs are significantly more likely to be used in service-related sectors than in manufacturing. Establishment size is also positively correlated with the use of assessment centres, stronger than for employment interviews. Large establishments are, on average, 20 pp more likely to use them than smallest establishments. A potential explanation is that assessment centres have more setup costs, i.e. fixed costs, involved than cognitive ability and other standardized, less customized tests (Schmidt and Hunter, 1998). Thus, returns to using an AC may be greater for larger firms. We again find that establishments with dispersed ownership show a significantly higher usage rate compared to family and founder firms (around 7 pp).

There is almost no observable heterogeneity based on the structural covariates across establishments in the use of cognitive ability testing, as shown in column 3. One striking result is that establishments in the healthcare and social services sector are 12 pp less likely to use standardized GMA tests compared to manufacturing. Similarly, there are only few significant establishment characteristics that explain the use of personality and integrity tests. One exception is that the retail, logistics, and media sectors are 9 pp more likely to use these tests. One potential explanation is that these industries, particularly retailing and logistics, are characterized by high levels of customer interaction, for which certain personality types and ethical behaviour can be important. Additionally, there is a slight tendency that personality tests are rather used in larger establishments.

Turning to the use of short work samples, the IT and communication sector as well as healthcare and social services are 15 pp and 25 pp more likely to ask for short work samples during recruitment, respectively. Taken together with the results in column 3, the health care and social services sector shows the following pattern: It is reasonable to expect that social skills are more important in those jobs than cognitive ability, which might explain why IQ tests are significantly less used in this sector, but the sector shows the highest coefficient in magnitude when it comes to short work samples. This indicates that health and social sector establishments try to assess their required social skills with the use of work samples.

Concerning the use of algorithms for determining suitable candidates during recruitment, we see almost no statistically significant differences across establishments. One striking result is the missing coefficient for the healthcare and social services sector indicating that there is no single establishment in this sector which makes use of algorithms during the recruitment process. Overall, one has to note that due to the low number of observations that already use this recruitment technology, we most likely have a problem of statistical power.

The results until now support the interpretation that establishment characteristics are correlated with different facets of hiring behaviour, but there is no homogeneous pattern for each of our considered employer search and selection instruments.

Table 2: Determinants of employee selection instruments

	(1) Employment interview	(2) Assessment centre	(3) Cognitive ability (GMA)	(4) Personality or integrity test	(5) Short work sample	(6) Selection algorithms
Metal, electrical, automotive	0.0176 (0.0199)	0.0315* (0.0181)	-0.0250 (0.0223)	0.0024 (0.0226)	0.0004 (0.0322)	0.0126 (0.0177)
Retail, logistics, media	-0.0277 (0.0267)	0.1160*** (0.0255)	0.0433 (0.0304)	0.0856*** (0.0299)	0.0708* (0.0382)	-0.0172 (0.0257)
Company-related & financial services	0.0319 (0.0247)	0.1093*** (0.0309)	-0.0186 (0.0272)	-0.0000 (0.0267)	-0.0166 (0.0406)	0.0335 (0.0209)
IT, communication, other services	0.0466 (0.0296)	0.0885** (0.0420)	0.0211 (0.0423)	0.0291 (0.0386)	0.1531*** (0.0528)	0.0087 (0.0352)
Healthcare & social services	-0.0588 (0.0414)	-0.0152 (0.0286)	-0.1159*** (0.0238)	-0.0238 (0.0347)	0.2536*** (0.0467)	
Est. size (100-249 empl.)	0.0630*** (0.0201)	0.0406** (0.0175)	0.0036 (0.0206)	-0.0365* (0.0189)	-0.0011 (0.0284)	0.0418* (0.0217)
Est. size (250-499 empl.)	0.0697*** (0.0260)	0.0923*** (0.0232)	0.0120 (0.0277)	0.0325 (0.0295)	-0.0143 (0.0374)	0.0383* (0.0230)
Est. size (>=500 empl.)	0.1197*** (0.0237)	0.2022*** (0.0394)	0.0230 (0.0363)	0.0773* (0.0425)	-0.0539 (0.0469)	0.0402 (0.0258)
Est. age (6 to 10 years)	0.0297 (0.0478)	0.0997 (0.0659)	0.0796 (0.0644)	0.0621 (0.0644)	-0.0273 (0.0873)	-0.0275 (0.0447)
Est. age (11 to 20 years)	-0.0145 (0.0472)	0.0149 (0.0547)	0.0013 (0.0574)	-0.0395 (0.0573)	0.0154 (0.0799)	-0.0383 (0.0412)
Est. age (>20 years)	0.0024 (0.0444)	0.0180 (0.0508)	0.0015 (0.0539)	-0.0243 (0.0546)	-0.0092 (0.0758)	-0.0420 (0.0380)
Manager firm	-0.0487** (0.0221)	0.0196 (0.0199)	-0.0122 (0.0215)	-0.0053 (0.0222)	-0.0523 (0.0320)	-0.0096 (0.0216)
Financial investor	0.0260 (0.0284)	0.0191 (0.0297)	-0.0289 (0.0286)	0.0417 (0.0362)	0.0312 (0.0456)	-0.0016 (0.0242)
Dispersed ownership	0.0814*** (0.0279)	0.0721** (0.0303)	0.0361 (0.0387)	-0.0147 (0.0343)	-0.0874* (0.0474)	-0.0307 (0.0380)
Other form of ownership	0.0179 (0.0225)	0.0351 (0.0251)	-0.0120 (0.0250)	-0.0041 (0.0275)	-0.0675* (0.0389)	0.0149 (0.0180)
Observations	2,264	2,264	2,264	2,264	2,264	699
Pseudo R-squared	0.090	0.156	0.034	0.034	0.062	0.150

This table reports average marginal effects of a logistic regression using the unbalanced panel. Additional control variables include collective agreements (3 dummies), works council, apprenticeship training firm, CHRO in executive board, city size (3 dummies), type of management, independent establishment, year and region fixed effects. Robust standard errors clustered on establishment-level in parentheses. * $p < .1$, ** $p < .05$, *** $p < .01$

5.3 Importance of personal characteristics

We now assess whether there is also cross-sectional heterogeneity in the importance of personal criteria for the hiring process. Here, we regress the importance of these recruitment criteria, which are measured on a five-point Likert scale, on our set of establishment characteristics using pooled OLS.⁹ Column 1 of Table 3 shows that the retail, logistics, and media sector as well as company-related and financial services sector put less weight on professional competencies than the manufacturing sector, whereas the health and social services sector put significantly higher weight on this competence. Furthermore, establishments with dispersed ownership put a significantly larger weight on professional competencies than family and founder firms.

Turning to the importance of personal competencies for recruitment, results in column 2 show that mid-size establishments with 250-499 employees put a higher weight on personal competencies. Furthermore, there is a tendency that younger establishments put more weight on personal competencies. Interestingly, we only find two significant coefficients for ethical values. First, ethical standards are significantly more important for recruitment decisions in the healthcare and social services sector, which is intuitively in line with prosocial types being more likely to work in this area (Brock et al., 2016). The magnitude of the correlation (0.50 scale points) is also very large, compared to our other results. Also, manager-owned establishments put more weight on ethical values compared to family and founder firms. Surprisingly, our last criterion, cognitive ability, shows no statistically significant heterogeneity among establishments based on observables. To conclude, we observe much less heterogeneity across establishments in the importance of recruitment criteria compared to the use of recruitment and selection instruments.

⁹ Here, we can only interpret the sign and not the magnitude of the correlation, as we cannot be sure that there is a linear effect. However, the results remain qualitatively similar if we use Poisson regressions or ordered logistic regression models.

Table 3: Determinants of recruitment criteria

	(1) Professional competence	(2) Personal competence	(3) Ethical standards	(4) Cognitive ability
Metal, electrical, automotive	0.0905* (0.0544)	-0.0245 (0.0578)	0.0341 (0.0700)	0.0650 (0.0520)
Retail, logistics, media	-0.1959*** (0.0700)	-0.0121 (0.0699)	0.0123 (0.0795)	-0.0446 (0.0636)
Company-related & financial services	-0.1581** (0.0803)	0.0278 (0.0788)	-0.0012 (0.0884)	-0.1089 (0.0684)
IT, communication, other services	-0.0769 (0.1200)	0.1744 (0.1087)	0.0448 (0.1112)	0.1210 (0.0970)
Healthcare & social services	0.1741** (0.0828)	0.1284 (0.1037)	0.4986*** (0.0978)	0.0029 (0.0928)
Est. size (100-249 empl.)	0.0032 (0.0546)	0.0564 (0.0536)	-0.0111 (0.0615)	-0.0252 (0.0479)
Est. size (250-499 empl.)	0.0478 (0.0663)	0.2095*** (0.0657)	-0.0003 (0.0853)	0.0159 (0.0647)
Est. size (>=500 empl.)	-0.0320 (0.0928)	0.0910 (0.0869)	0.1262 (0.0959)	-0.0282 (0.0752)
Est. age (6 to 10 years)	-0.0318 (0.1634)	-0.2779** (0.1392)	-0.2424 (0.1761)	-0.1736 (0.1549)
Est. age (11 to 20 years)	-0.0482 (0.1346)	-0.1773 (0.1293)	-0.0827 (0.1672)	-0.0357 (0.1461)
Est. age (>20 years)	0.0442 (0.1265)	-0.2021 (0.1231)	-0.1002 (0.1572)	0.0519 (0.1394)
Manager firm	0.0678 (0.0641)	0.0240 (0.0639)	0.1559** (0.0685)	0.0327 (0.0560)
Financial investor	0.0230 (0.0938)	-0.0142 (0.0772)	0.0085 (0.1055)	-0.0316 (0.0739)
Dispersed ownership	0.2062** (0.0820)	0.0457 (0.0893)	0.1267 (0.1046)	0.0916 (0.0781)
Other form of ownership	-0.0091 (0.0686)	0.0079 (0.0683)	0.0678 (0.0797)	0.0189 (0.0655)
Observations	1,564	1,563	1,562	1,562
Adjusted R-squared	0.029	0.026	0.037	0.013

This table reports results of a pooled OLS regression of the importance of various recruitment criteria measured on a five-point Likert scale on our set of controls using the unbalanced panel. Additional control variables include collective agreements (3 dummies), works council, apprenticeship training firm, CHRO in executive board, city size (3 dummies), type of management, independent establishment, year and region fixed effects. Robust standard errors clustered on establishment-level in parentheses. * $p < .1$, ** $p < .05$, *** $p < .01$

5.4 Pre-hire screening intensity

Our final measure of pre-hire screening activities is screening intensity, measured as the logarithm of the average number of hours spent on testing a successful applicant during the employee selection process. Columns 1 and 2 of Table 4 present the corresponding OLS regression results, differentiated between managerial and non-managerial employees. We observe strong correlations of establishment size and the logarithm of screening intensity mainly for managerial employees. For this group, the largest establishments invest, on average, 31%¹⁰ more time into testing an applicant in the selection process than the smallest establishments, mid-size establishments (250-499 employees) spend about 20% more time. This result again seems intuitively in line with larger firms having more capacity to screen workers, and returns to managerial talent increasing in firm size (Gabaix and Landier, 2008). Our previous results, which show that larger establishments are more likely to address and poach managerial employees (and not non-managerial ones), are also in line with this interpretation.

Table 4 shows that the size effects are much weaker for job testing of non-managerial employees. Here, the size of the coefficient for the largest establishments amounts to 14% for screening intensity of non-managerial employees, whereas the coefficients for the other size dummies are statistically and economically not significant. Interestingly, establishments with dispersed ownership and financial investor ownership show higher screening intensity for both types of employees.

¹⁰ $(e^{0.2722} - 1) \cdot 100$

Table 4: Determinants of screening intensity and employee turnover during probation

Dep. var.:	(1)	(2)	(3)	(4)
	Screening intensity		Turnover during probationary period	
	Managerial employees	Non-manag. employees	Voluntary	Involuntary
Metal, electrical, automotive industry	-0.0196 (0.0365)	-0.0009 (0.0304)	-0.4242 (0.5500)	-1.0787* (0.6210)
Retail, logistics, communication	-0.0756 (0.0482)	-0.0194 (0.0404)	1.2859* (0.7231)	2.0386** (0.9618)
Company-related & financial services	-0.1115** (0.0512)	-0.0126 (0.0436)	3.7340*** (0.7963)	6.7131*** (1.1208)
IT, communication, other services	-0.1218 (0.0808)	0.0717 (0.0675)	1.2278 (1.1770)	1.4762 (1.5114)
Healthcare and social services	-0.0759 (0.0735)	-0.0426 (0.0648)	3.6425*** (1.3682)	2.5776 (0.1236)
Est. size (100-249 empl.)	0.1450*** (0.0366)	0.0095 (0.0305)	-0.4062 (0.6266)	-0.3957 (0.7552)
Est. size (250-499 empl.)	0.1822*** (0.0456)	0.0076 (0.0374)	0.1705 (0.7312)	0.0538 (0.9371)
Est. size (>=500 empl.)	0.2722*** (0.0487)	0.1218*** (0.0437)	0.0854 (0.8826)	-0.3081 (1.0842)
Est. age (6 to 10 years)	0.0258 (0.0896)	0.0560 (0.0720)	-1.5444 (1.5178)	-2.3519 (2.5767)
Est. age (11 to 20 years)	-0.0289 (0.0843)	0.0070 (0.0643)	-1.6079 (1.4225)	-2.2451 (2.4412)
Est. age (>20 years)	0.0088 (0.0781)	0.0481 (0.0613)	-2.0522 (1.3506)	-5.1432** (2.2885)
Manager firm	-0.0281 (0.0420)	0.0094 (0.0352)	-0.8742 (0.5741)	-0.5267 (0.8817)
Financial investor	0.1259** (0.0533)	0.1046** (0.0477)	-0.1659 (0.9968)	0.4493 (1.3282)
Dispersed ownership	0.0977* (0.0555)	0.0859* (0.0505)	-1.0448 (0.7369)	-2.8857*** (0.8078)
Other form of ownership	0.0020 (0.0437)	-0.0021 (0.0368)	-1.3220** (0.6709)	-2.3895*** (0.8777)
Observations	3,088	3,330	3,214	3,212
Adjusted R-squared	0.063	0.040	0.038	0.062

This table reports results of a pooled OLS regression of the logarithm of the number of hours spent on testing a successful applicant during the employee selection process (columns 1 and 2) and turnover during probationary period (columns 3 and 4) on our set of controls using the unbalanced panel. Additional control variables include collective agreements (3 dummies), works council, apprenticeship training firm, CHRO in executive board, city size (3 dummies), type of management, independent establishment, year and region fixed effects. Robust standard errors clustered on establishment-level in parentheses. * $p < .1$, ** $p < .05$, *** $p < .01$.

5.5 On-the job screening

Now we turn to the last phase of the recruitment process, which is on-the-job screening, and assess which observable establishment characteristics explain turnover during probationary periods. Here, we are able to distinguish between voluntary, i.e. employee-initiated, and involuntary turnover, and for the latter, also know more about the reasons. As can be seen in columns 3 and 4 of Table 4, both types of turnover are more likely in the retail, logistics, and media sector as well as in company-related and financial services. These correlations are also of economically significant magnitude, ranging from 1.3 to 6.7 percentage points. Voluntary turnover is also significantly higher (3.6 pp) in healthcare and social services compared to manufacturing. We also find some evidence that older establishments and those with dispersed ownership make less use of involuntary turnover.

5.6 The role of establishment fixed effects

Finally, we analyse inter-establishment variation in our outcome variables in more detail. Similar to Haylock and Kampkötter (2019), column 2 of Table 12 in the Appendix shows incremental changes in the explanatory power of our estimation mode, measured via pseudo (adjusted) R-squared, when adding establishment fixed effects. To further illustrate the influence of establishment characteristics in explaining total variation, we quantify the relative importance of establishment fixed effects by dividing incremental pseudo (adj.) R-squared from column 2 by total pseudo (adj.) R-squared. The results in column 4 show that the relative importance of establishment fixed effects is highest for recruitment criteria, screening intensity, and variations in turnover during probationary period. Here, establishment fixed effects explain a large proportion of total variation, even after controlling for industry, size, ownership, and other structural characteristics. However, time-constant establishment effects in explaining employment interviews and assessment centres or poaching behaviour via head-hunters or agencies are rather small. To conclude, we observe considerable heterogeneity between establishments in their use of recruitment strategies.

6 The performance of recruitment strategies

In this chapter we investigate the relationship between an establishment's use of recruitment strategies and its success in hiring the right employees. Apart from measuring the quality of the workforce and the matches, we focus on the ability to fill vacancies and the evaluation of the establishment's own hiring policy.

Our main hypotheses for the effects of firm's recruitment strategies are the following. First, we hypothesize that, after weighing costs and benefits, a recruitment strategy generally leads to an increase in a firm's hiring success. This is equivalent to saying filling a vacancy is beneficial for a firm, but that due to frictions it cannot reap the whole value of it. Hiring success is measured by worker quality, match quality, (an inverse measure of) vacancies and (the absence of) HRM problems associated with recruiting. Second, we hypothesize that formal employer search strategies, such as poaching, benefit establishments more than informal strategies, such as recruiting via social networks. Establishments potentially face a trade-off in a sense that informal strategies (formal strategies) may attract more (fewer) employees for a given position, but these employees might be less (better) suited to the job. Accordingly, formal strategies, such as poaching, have higher costs per applicant, making them potentially more cost-effective for high-skilled jobs. Third, we hypothesize that pre-hire screening intensity is associated with a decrease in turnover during the probationary period. We focus on the probationary period here, as firms potentially substitute pre-hire and post-hire screening.

We estimate cross-sectional and panel regressions using the different recruitment strategies, as well as structural establishment characteristics as independent variables. Our first specification is purely contemporaneous, i.e. we explain outcome variables in period t using recruitment practices and control variables from the same period. To address a potential reverse causality problem, we switch to dependent variables in period $t + 1$ (lead dependent variable) in the second specification and follow it up using a lagged dependent variable approach in the third specification. Finally, the fourth specification is a panel regression with establishment fixed effects controlling for time-constant heterogeneity such as the skill composition of the workforce. However, we caution that this approach requires within-variation to identify an effect, i.e. variation of certain hiring strategies over time, which is not always present (see Chapter 4 and Table 13 in the Appendix, which decomposes variation

into between and within components).¹¹ Standard errors are clustered at the establishment level.

6.1 Employee quality

We first test which recruitment strategies affect the average worker ability in an LPP establishment, as proxied by the standardised average employee fixed effect p per establishment. Importantly, we measure productivity for each employee i in the establishment f at time t in the time frame 2003 to 2010 from their Individual Employment Biography data. This ensures that the worker-level productivity is predefined and thus exogenous to the establishment hiring the worker. Since worker productivity is fixed, if the outcome variable changes, this must be due to new hires entering and/or incumbent workers leaving the establishment in fixed effects specifications. Specifically, we regress

$$\frac{1}{N} \sum_{i=1}^N p_{i,t}^{IEB,2003-2010} = \beta_0 + \beta_{1-3} Search_{f,t} + \beta_{4-9} Select_{f,t} + \beta_{10} Intensity_{f,t} + \gamma X_{f,t} + \vartheta_t + \varepsilon_{f,t},$$

in the baseline OLS specification, where our explanatory variables are divided into search and selection instruments as well as screening intensity. Depending on the specification, a different model is used. We also include all controls in our vector \mathbf{X} of covariates, which includes time dummies.

Results in Table 5 reveal a relatively coherent picture for three recruitment practices across our set of specifications. First, poaching via EAs or head-hunters, on average, increases the composition of average worker ability in the establishment. This relationship is also of economic significance, showing a 5% of a SD increase in the composition of employee productivity in the fixed effects specification. One potential explanation of the use and success of poaching agencies is that they have better access to workers in other firms. Poaching agencies can sell knowledge of which employees may suit other employers to hiring firms, making them a valuable labour market intermediary.

Positive coefficients can also be found for employment interviews; its use is associated with a 3% of a SD increase in the composition of worker productivity in fixed effects specifications. Time-variation in the use of employment interviews is rather small, suggesting this is a lower bound. Nevertheless, the relatively large coefficient of almost 20% of a standard deviation for

¹¹ Furthermore, using survey data in fixed effects estimations may likely cause an attenuation bias due to measurement error in the independent variable (Angrist and Pischke, 2008).

the baseline OLS specification suggests that employment interviews indeed work well on average, which is in line with the findings of Schmidt and Hunter (1998).

Third, the use of short work samples decreases average worker ability, indicating that short work samples generally identify lower ability workers. The size of the coefficient ranges from 3.6% (LDV) to 15% (OLS) of a SD decrease. Since work samples are typically rather short, they do not reflect the worker's long-run performance. A worker may put in a substantially larger amount of effort into a short work sample, only to later slack-off on the job, reducing the effectivity of this hiring practice. This runs contrary to predictions from personnel psychology literature showing that work samples have very high predictive validity (Schmidt and Hunter, 1998). However, we caution that our measure of individual ability might suffer from measurement error and, hence, attenuation bias.

Table 5: Recruitment practices and employee quality

Dep. var.:	Average individual fixed effects (pre-period) per establishment and year (standardised)			
	(1) Contemp.	(2) Lead DV	(3) LDV	(4) FE
Recruiting via social networks	0.0334 (0.0565)	0.0329 (0.0960)	0.0074 (0.0181)	0.0178 (0.0160)
Address via social networks	0.1701* (0.0910)	0.0433 (0.1483)	0.0109 (0.0336)	-0.0223 (0.0237)
Poaching via EA or head-hunter	0.1181** (0.0498)	0.1917** (0.0913)	0.0071 (0.0134)	0.0468** (0.0226)
Employment interview	0.2029*** (0.0645)	0.2042** (0.0982)	0.0110 (0.0178)	0.0342* (0.0208)
Assessment centre	0.0154 (0.0819)	0.0031 (0.1214)	-0.0087 (0.0258)	-0.0045 (0.0274)
Cognitive ability test	0.0168 (0.0675)	-0.0266 (0.1150)	-0.0001 (0.0237)	0.0117 (0.0168)
Personality or integrity test	0.0207 (0.0646)	0.1017 (0.0887)	-0.0139 (0.0231)	-0.0013 (0.0186)
Short work sample	-0.1472*** (0.0477)	-0.1652** (0.0798)	-0.0356** (0.0151)	-0.0110 (0.0122)
Others	-0.0264 (0.0572)	-0.0141 (0.1011)	0.0040 (0.0171)	-0.0026 (0.0153)
Average pre-hire screening intensity	0.0056 (0.0059)	0.0064 (0.0100)	0.0010 (0.0015)	-0.0001 (0.0016)
Observations	1,446	478	1,169	1,446
Adjusted R-squared (within)	0.402	0.378	0.940	0.041

Additional control variables: log establishment size, collective agreements (3 dummies), works council, apprenticeship training firm, establishment age, ownership type, CHRO in executive board, type of management, independent establishment, industry, year and region fixed effects. Robust standard errors clustered on establishment-level in parentheses. * $p < .1$, ** $p < .05$, *** $p < .01$

Assessment centres and cognitive ability tests are not significant determinants of the composition of worker-level productivity. Assessment centres may select workers more on grit or endurance required to go through a long recruitment process, and less on ability, which may still be beneficial (Duckworth and Seligman, 2005, Borghans et al., 2008, Almlund et al., 2011).

6.2 Match quality

We next test which recruitment strategies affect the percentage share of involuntary turnover during the probationary period in establishment f in time t to measure the firm's ability to fill a position with a well-suited worker. Specifically, we estimate an analogous regression to the above specification. Results in Table 6 show that the use of personality or integrity tests is, on average, associated with a 1.6-2.1 pp reduction (columns 1-3) in the share of workers being fired within their probationary period. The size of this correlation is quite large, as we observe 7.4-8.7% of workers leaving firms involuntarily on average, depending on the survey wave. The magnitude and sign of the coefficient in the fixed effects regression is consistent with these findings, but we do not find a significant effect there, presumably due to low within-variation.

Short work samples tend to be associated with an increase of involuntary turnover by about 1.5 pp to 1.8 pp, consistently estimated across our cross-sectional specifications. This result reflects that short work samples may sort lower ability workers into the firm, who may be sorted out during the probationary period, which might act here as an employer-learning device. Again, once we account for unobserved heterogeneity across establishments, the coefficient approaches zero and estimates become noisy.

Table 6: Recruitment practices and match quality

Dep. var.:	Involuntary turnover during probationary period			
	(1)	(2)	(3)	(4)
	Contemp.	Lead DV	LDV	FE
Recruiting via social networks	-0.2213 (0.8077)	0.3297 (1.1609)	-0.7394 (0.8504)	-0.5051 (1.4008)
Address via social networks	0.2450 (1.0947)	-0.8967 (1.6327)	1.1583 (1.2775)	-0.0137 (1.8286)
Poaching via EA or head-hunter	0.7606 (0.7618)	-1.2047 (1.1332)	0.8514 (0.8532)	3.5497** (1.7288)
Selection interview	-0.4291 (1.1311)	-1.5048 (1.7734)	-0.5667 (1.2904)	-0.1169 (2.2568)
Assessment centre	0.0680 (1.0566)	0.0367 (1.3272)	-0.6940 (1.0278)	-1.0643 (1.6294)
Cognitive ability test	-0.6359 (0.8587)	-0.4579 (1.1702)	-1.0562 (0.9427)	-0.1947 (1.4717)
Personality or integrity test	-1.5795* (0.8712)	-1.8502* (1.0056)	-2.1076** (0.9951)	-1.0218 (1.7656)
Short work sample	1.5767** (0.6767)	1.7577* (0.9730)	1.4665** (0.7278)	0.1592 (1.3147)
Others	0.2657 (1.0151)	1.0241 (1.4860)	0.3579 (1.1962)	0.3465 (2.1303)
Average pre-hire intensity	0.0152 (0.0931)	0.0112 (0.1285)	0.1511 (0.1130)	0.1124 (0.1944)
Observations	2,068	897	1,475	2,068
Adjusted R-squared	0.068	0.082	0.083	0.014

Additional control variables: log establishment size, collective agreements (3 dummies), works council, apprenticeship training firm, establishment age, ownership type, CHRO in executive board, type of management, independent establishment, industry, year and region fixed effects. Robust standard errors clustered on establishment-level in parentheses. * $p < .1$, ** $p < .05$, *** $p < .01$.

6.3 Vacancy duration

In Table 7, we test whether recruitment strategies have an impact on the average time required to fill a position for qualified tasks (4 categories: less than 1 month, from 1 up to under 3 months, from 3 up to under 6 months, 6 months or more). Note that we control for the average pre-hiring screening intensity per establishment here. Poaching instruments significantly increase the time needed to fill a position. This highlights a central trade-off made by establishments: using poaching firms to fill vacancies takes considerably longer to fill vacancies, although it, on average, leads to higher worker quality. This is in line with recent literature on directed search and firm's hiring strategies (Wolthoff, 2018). Furthermore, use of social networks, interviews and assessment centres can be significant determinants of time to fill a position, but do not have a causal effect. Thus, firms aiming to fill vacancies with higher qualified workers must wait longer to fill the position.

Table 7: Recruitment practices and time to fill vacancies for qualified tasks

Dep. var.:	Average time required to fill vacancies for qualified tasks			
	(1)	(2)	(3)	(4)
	Contemp.	Lead DV	LDV	FE
Recruiting via social networks	0.0793 (0.0643)	0.0794 (0.1050)	0.1051 (0.0746)	0.0430 (0.0755)
Address via social networks	0.1959** (0.0854)	0.1572 (0.1478)	0.1614 (0.1042)	0.1945* (0.1005)
Poaching via EA or head-hunter	0.1927*** (0.0599)	0.1684* (0.0924)	0.1321* (0.0734)	0.2523*** (0.0726)
Employment interview	0.1996* (0.1072)	0.2098 (0.1582)	0.2009 (0.1249)	0.1909 (0.1276)
Assessment centre	0.1391* (0.0777)	0.2184* (0.1196)	0.0931 (0.0927)	0.0876 (0.0931)
Cognitive ability test	-0.1104 (0.0724)	-0.0867 (0.1110)	-0.0343 (0.0916)	-0.1013 (0.0927)
Personality or integrity test	-0.0108 (0.0787)	0.2020* (0.1186)	-0.0947 (0.0980)	-0.0514 (0.0978)
Short work sample	-0.0219 (0.0561)	-0.0673 (0.0874)	-0.0106 (0.0656)	-0.0070 (0.0658)
Others	0.1859** (0.0752)	0.0945 (0.1175)	0.1469 (0.0901)	0.2190** (0.0909)
Average pre-hire intensity	-0.0078 (0.0076)	-0.0140 (0.0104)	-0.0113 (0.0092)	-0.0071 (0.0093)
Observations	1,957	839	1,390	1,957
Pseudo R-squared	0.055	0.061	0.109	

This table reports results of an ordered probit regression (columns 1 to 3) and random-effects ordered probit regression (column 4). Additional control variables: log establishment size, collective agreements (3 dummies), works council, apprenticeship training firm, establishment age, ownership type, CHRO in executive board, type of management, independent establishment, industry, year and region fixed effects. Robust standard errors clustered on establishment-level in parentheses. * $p < .1$, ** $p < .05$, *** $p < .01$.

In Table 8, we test whether recruitment practices affect different vacancy measures, in detail the number of positions to fill for qualified tasks, vacancies to be filled as soon as possible, and the number of applicants per vacancy. The first two variables measure whether the firm has vacancy problems in general, and the last variable shows whether this advertising attracts more attention to the firm. Turning to vacancy problems, we find that in four out of eight specifications, the coefficient on using social networks is positive and significant. The results indicate that establishments, which recruit via social networks, have more vacant positions for qualified tasks in the subsequent period (columns 2) and more positions to fill immediately (column 8) in the fixed effects estimation. Hence, it seems not to be the case that establishments switch to using social networks in recruitment as a response to having many vacant and urgent positions to be filled. Together with our previous findings that recruiting via social networks is not significantly correlated with employee ability, match quality and

vacancy duration, this suggests that recruiting via social networks has not yet been fully worked for the establishments in our sample. Poaching, on the other hand, does not lead to higher vacancies in the future and also seems to lead to an increase in applications per vacancy (with the significance of estimates being more consistent across specifications).

As a robustness check for the above interpretations using quantitative data, we test the impact of recruitment practices on human resource management problems expected during the next two years following a survey interview in Table 9. These outcome variables are indicators of high turnover, difficulties to find qualified personnel, and staff shortages, as expected by the establishment manager. These variables rate the overall success of the hiring strategy from the establishment's own perspective complementary to the quantifiable measures used above. The results are estimated using probit regressions and panel probit regression (random effects probit), with analogous specifications to above regressions.

Using social networks as a recruitment tool is more likely to lead to personnel problems across all outcome variables, with large and significant coefficients in the majority of specifications, which partly supports our previous results. This is a puzzling result, given that this instrument shows the highest increase in usage rates over time (see Figure 1). One interpretation is that using social networks is a "management fashion" and establishments are triggered by benchmarking surveys or imitating other firms in the market, but many of them are still learning how to effectively use the online job market to recruit the right employees. In line with the findings above, cognitive ability tests are positively correlated with expectations about hiring difficulties. The use of short work samples also increases most HRM problems, in line with findings above that they may increase turnover during probation. Personality and integrity tests show significant relationships only in two specifications, but coefficient signs are all negative, showing that they possibly work well. This is consistent with our above results.

Summing up our analyses, it appears that the recent advent of social networks has not yet been entirely successful in filling vacancies and solving firms' hiring problems in Germany. This may be because they have not yet been implemented properly. Further, our filter question, asking firms whether they directly target workers online from other firms, does not show any effects on vacancies or personnel problems. This supports our suggestion that firms have not successfully implemented online recruitment systems, or that it does not work well as a recruitment strategy in general. The most standard and long used practices, such as using poaching agencies and running employment interviews, seem to identify high-ability

personnel quite well, on the contrary. Although the use of personality tests has decreased in recent years, we find a positive relation between their use and match quality. There is also indicative evidence that personality testing reduces turnover in the long run, which is in line with Ones et al. (2007). Interestingly, short work samples seem to sort an adverse selection of lower ability workers into the establishment ultimately leading to higher turnover in the probationary period.

Our most robust null-result belongs to the use of assessment centres, which have nearly zero correlation with worker and match quality over most specifications. This is remarkable, since they are implemented by a stable 11% of establishments. Although one could identify a causal effect of using assessment centres and other tests by running field experiments, we see our evidence as important from a general equilibrium perspective, as applicants are potentially aware of firms using certain kinds of tests and may change their application behaviour. It is likely that this knowledge only dissipates through the labour market over time.

Table 8: Recruitment practices and vacancies

Dep. var.:	Vacant positions for qualified tasks				Positions to fill asap				Applications per vacancy			
	(1) Contemp.	(2) Lead DV	(3) LDV	(4) FE	(5) OLS	(6) Lead DV	(7) LDV	(8) FE	(9) OLS	(10) Lead DV	(11) LDV	(12) FE
Recruiting via social networks	1.0408*** (0.3938)	1.3130** (0.6309)	0.2704 (0.4491)	0.1672 (0.2751)	3.4662* (1.9818)	5.7224 (3.7830)	3.8013 (2.5860)	1.4760** (0.7241)	2.5480 (2.2064)	4.0809 (3.3532)	4.0157* (2.3421)	3.0287 (1.8606)
Address via social networks	3.2365*** (1.2008)	1.6686 (1.5275)	0.8738 (0.5941)	-0.0210 (0.4187)	3.8526 (3.7486)	-4.5060 (6.8886)	-0.1024 (3.6300)	1.1861 (1.0289)	-0.1779 (2.7653)	-3.0575 (5.3571)	0.5914 (3.3545)	2.5094 (3.6599)
Poaching via EA or head-hunter	0.4163 (0.4657)	1.1974** (0.5015)	-0.2473 (0.3419)	-0.8388 (0.5611)	-1.6075 (2.5400)	2.3097 (1.6261)	-3.1828 (3.4802)	-2.1880 (1.6072)	2.9585* (1.6974)	1.0234 (1.9650)	1.3520 (1.6020)	3.7544* (2.1599)
Observations	3,439	1,723	1,702	3,439	3,468	1,738	1,728	3,468	3,006	1,527	1,371	3,006
Adjusted R-squared	0.150	0.125	0.427	0.024	0.097	0.089	0.146	0	0.041	0.045	0.083	0.024

Additional control variables: log establishment size, collective agreements (3 dummies), works council, apprenticeship training firm, establishment age, ownership type, CHRO in executive board, type of management, independent establishment, industry, year and region fixed effects. Robust standard errors clustered on establishment-level in parentheses. * p < .1, ** p < .05, *** p < .01.

Table 9: Recruitment practices and human resource management problems

Dep. var.:	High turnover				Difficult to find qual. personnel				Staff shortage			
	(1) OLS	(2) Lead DV	(3) LDV	(4) FE	(5) OLS	(6) Lead DV	(7) LDV	(8) FE	(9) OLS	(10) Lead DV	(11) LDV	(12) FE
Recruiting via social networks	0.1944** (0.0839)	0.1906 (0.1375)	0.2066** (0.0996)	0.2604*** (0.1000)	0.1418* (0.0757)	0.0702 (0.1191)	0.1387 (0.0887)	0.1733* (0.0973)	0.0936 (0.0774)	0.2120* (0.1211)	0.1790** (0.0908)	0.0952 (0.0928)
Address via social networks	-0.0266 (0.1108)	0.1463 (0.1747)	0.0117 (0.1313)	-0.0435 (0.1277)	0.0596 (0.1075)	-0.1098 (0.1657)	-0.1055 (0.1285)	0.0827 (0.1400)	0.1679* (0.0971)	0.0822 (0.1587)	0.0881 (0.1168)	0.2125* (0.1187)
Poaching via EA or head-hunter	0.1385 (0.0870)	0.0400 (0.1275)	0.1573 (0.1000)	0.1442 (0.1011)	0.1122 (0.0719)	0.1601 (0.1147)	-0.0215 (0.0799)	0.1058 (0.0918)	0.2404*** (0.0776)	0.1285 (0.1160)	0.1638* (0.0895)	0.2404** (0.0938)
Selection interview	0.0319 (0.1200)	-0.1889 (0.1605)	0.0839 (0.1340)	0.0470 (0.1416)	0.0963 (0.0985)	-0.0339 (0.1478)	0.0172 (0.1100)	0.1475 (0.1259)	0.0643 (0.1046)	0.0610 (0.1462)	0.0118 (0.1186)	0.0105 (0.1233)
Assessment centre	-0.0140 (0.1131)	0.1409 (0.1830)	-0.0190 (0.1277)	-0.0500 (0.1339)	0.0580 (0.1042)	0.0635 (0.1627)	0.1151 (0.1173)	-0.0401 (0.1309)	0.0169 (0.1067)	0.3449** (0.1637)	0.1437 (0.1162)	-0.0760 (0.1283)
Cognitive ability test	0.0877 (0.1050)	-0.0446 (0.1634)	0.0668 (0.1197)	0.1135 (0.1247)	0.1909* (0.0985)	0.1226 (0.1531)	0.2283** (0.1108)	0.2492** (0.1258)	0.0019 (0.0966)	-0.0248 (0.1406)	0.0573 (0.1099)	-0.0045 (0.1140)
Personality or integrity test	-0.1915* (0.1163)	-0.1175 (0.1621)	-0.2243* (0.1319)	-0.2194 (0.1364)	-0.0044 (0.0907)	0.2127 (0.1367)	-0.0292 (0.1044)	-0.0047 (0.1209)	-0.0744 (0.0948)	0.0422 (0.1443)	-0.1652 (0.1090)	-0.0987 (0.1137)
Short work sample	0.1265 (0.0772)	0.0327 (0.1153)	0.0779 (0.0881)	0.1807** (0.0883)	0.1660*** (0.0642)	0.1806* (0.1005)	0.0763 (0.0733)	0.2066** (0.0834)	0.1538** (0.0673)	0.2099** (0.1005)	0.0934 (0.0780)	0.2179*** (0.0808)
Others	-0.0452 (0.1031)	-0.0564 (0.1631)	0.0428 (0.1116)	-0.0294 (0.1208)	0.0181 (0.0865)	0.2053 (0.1444)	0.0517 (0.0981)	0.0434 (0.1121)	0.1449 (0.0889)	0.4759*** (0.1341)	0.1593 (0.1030)	0.1660 (0.1110)
Average pre-hire intensity	-0.0041 (0.0102)	-0.0434** (0.0181)	-0.0079 (0.0116)	-0.0043 (0.0119)	0.0118 (0.0084)	-0.0244** (0.0117)	0.0025 (0.0093)	0.0193* (0.0109)	-0.0053 (0.0091)	-0.0149 (0.0133)	-0.0074 (0.0103)	-0.0059 (0.0113)
Observations	2,204	938	1,664	2,204	2,204	960	1,669	2,204	2,195	956	1,664	2,204
Pseudo R-squared	0.104	0.119	0.145		0.072	0.075	0.145		0.137	0.157	0.170	

This table reports results of probit regressions and random-effects probit regression (columns 4, 8, 12). Additional control variables: log establishment size, collective agreements (3 dummies), works council, apprenticeship training firm, establishment age, ownership type, CHRO in executive board, type of management, independent establishment, industry, year and region fixed effects. Robust standard errors clustered on establishment-level in parentheses. * p < .1, ** p < .05, *** p < .01.

7 Conclusion

Our goal was to provide a representative overview of recruitment strategies for a large industrialised country. We first document across-establishment heterogeneity of hiring practices for a variety of establishments and industries in Germany. Second, we show that heterogeneity is linked to observable and unobservable establishment-level characteristics. Third, we measure the performance of different recruitment strategies using a variety of establishment-level outcomes related to hiring success.

We find that, with some exceptions, the average use of recruitment practices has been quite persistent in recent years. The use of social networks to recruit has increased, and the use of cognitive ability and personality testing has decreased over our observations period of six years in the last decade. We show that differences in recruitment strategies exist between economic sectors, establishment size, and ownership in the cross-section. A substantial amount of variation in recruitment practices remains unexplained, implying that structural covariates do not capture all nuances of establishment-specific effects. Controlling for establishment fixed effects in addition to structural covariates leads to a large increase in explained variation of recruitment strategies, showing how prominent establishment-level heterogeneity (the black box) still is.

Besides the effectiveness of poaching agencies that are rather slow at filling vacancies, a main takeaway of our study is that traditional screening measures such as interviews have the largest positive impact on the composition of worker quality. It remains to be seen, whether algorithms used to test an employee's future productivity can outperform humans in testing for complex jobs with high match specificity. Further, our results emphasize the importance of personality in the recruiting process, as personality testing outperforms cognitive ability testing. This is in line with recent literature advocating personality as a key success factor in the labour market (Duckworth and Seligman, 2005, Borghans et al., 2008, Almlund et al., 2011). One could guess that the hiring channel is mainly determined by the type of the job vacancy. Unfortunately, more detailed information on vacancies is not available in our data sets (LPP and IAB Establishment Panel), but, for instance, in the IAB Vacancy Survey. Unfortunately, it is not possible to merge these data sets.

Further, we show that due to persistence in some hiring strategies, representative causal evidence on the impact of recruitment practices on hiring success can be difficult to identify. Where there are substantial changes in establishment's hiring strategies, we do find some

economically relevant relationships. It is important from a hiring perspective to answer the question whether establishments can succeed at filling vacancies not only through posting higher wages, but also through searching for workers and screening workers in a different fashion (Kaas and Kircher, 2015). Until now, there is evidence for the importance of different search strategies, but little causal evidence of a positive effect of screening mechanisms.

To conclude, the recruiting behaviour of establishments still remains at least partly a black box. To shed more light on recruitment-related questions, researchers need to apply multiple complementary research methods such as formal economic models on specific mechanisms, laboratory and field experiments, as well as representative employee and firm surveys (Kampkötter and Sliwka, 2016). Our paper has collected representative evidence about the relevance and frequency of recruitment strategies in companies. To understand the underlying mechanisms at work, recent theoretical work on the demand side of the labour market and recruitment strategies is promising (Wolthoff, 2018; Carrillo-Tudela et al., 2020). To estimate causal effects of an implementation of certain practices, we can rely on a rather small, but growing number of field experiments on topics such as the extent of discrimination in hiring practices (Kaas and Manger, 2012; Becker et al., 2019; Carlsson and Eriksson, 2019) or information provision about job search strategies (Altmann et al., 2018).

Future empirical research could collect more detailed information on how screening mechanisms are implemented and which types of employees are targeted with these instruments to test hypotheses at the intensive margin. It is likely that firms are not aware of how well their recruitment strategies work in general, and some costly practices, such as assessment centres, may be inefficient.

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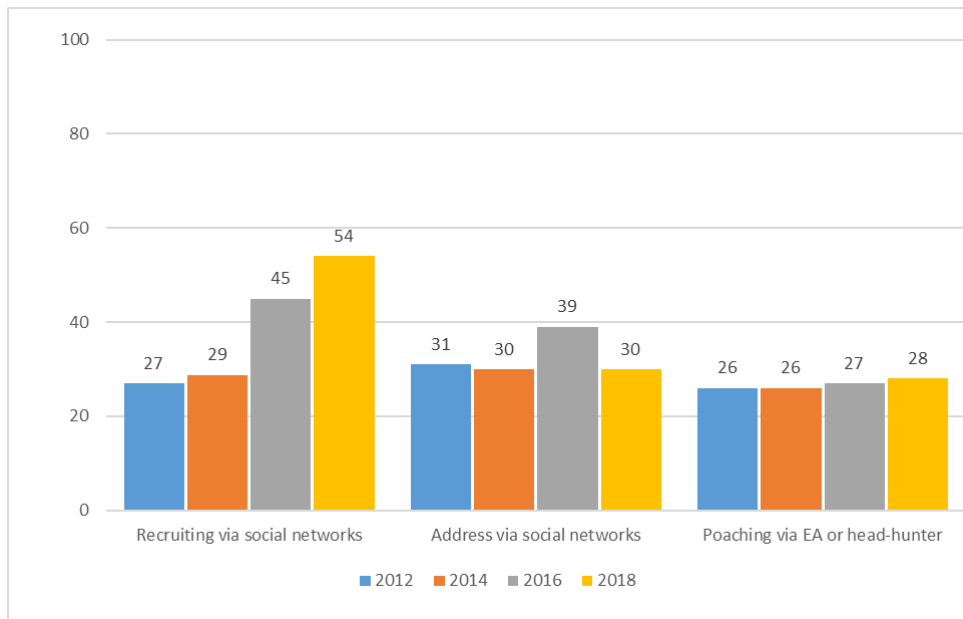
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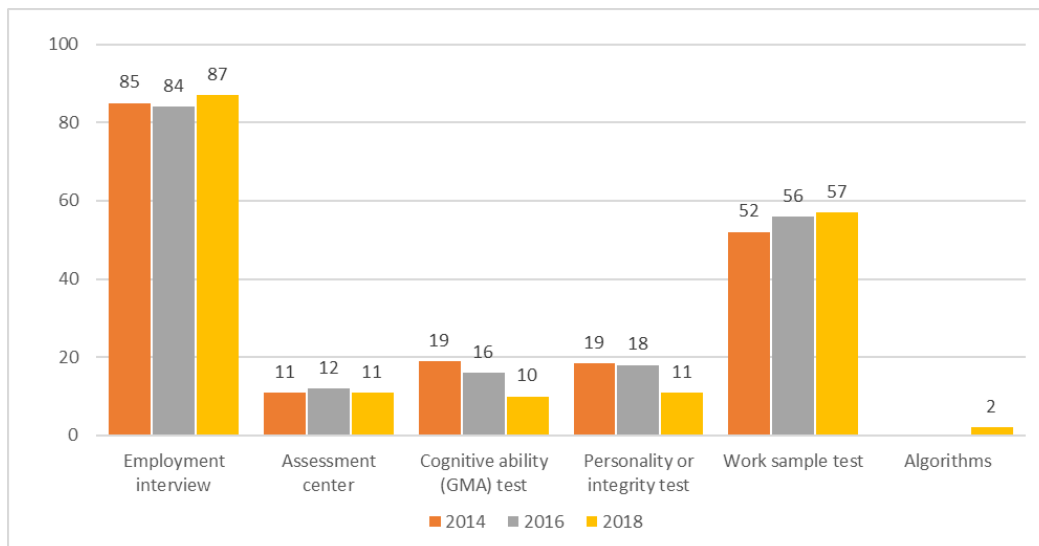
Figures (to be included in main text)

Figure 1: Employer search instruments by wave (in %)



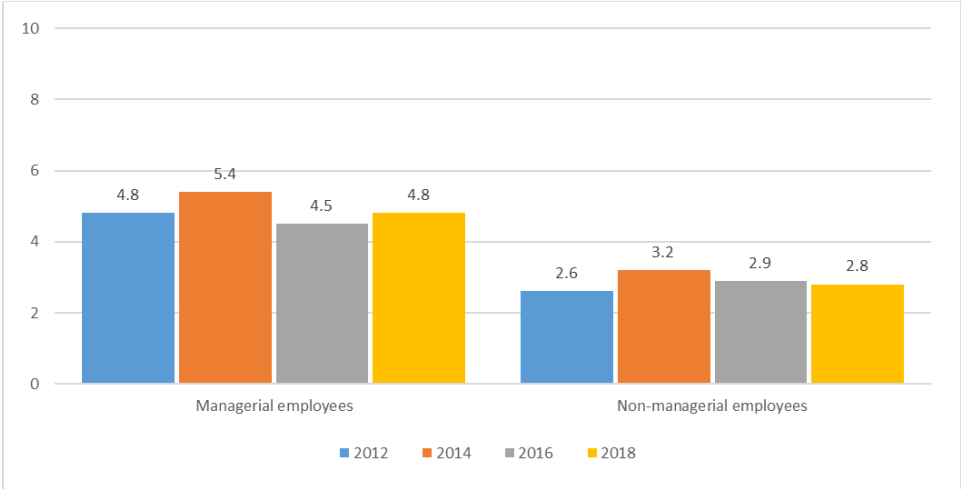
Note: Average establishment frequencies (in %) calculated using representative sample weights and an unbalanced panel.

Figure 2: Employee selection instruments by wave (in %)



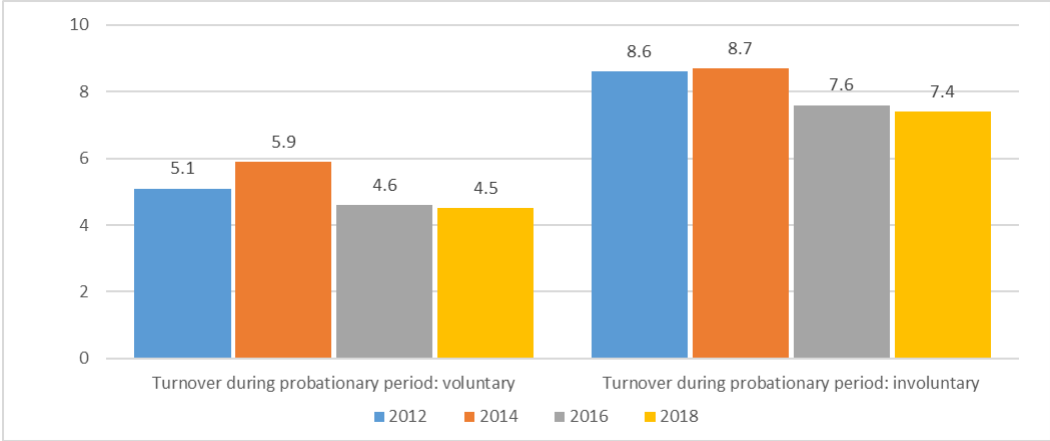
Note: Average establishment frequencies (in %) calculated using representative sample weights and an unbalanced panel.

Figure 3: Screening intensity by wave (average hours of screening)



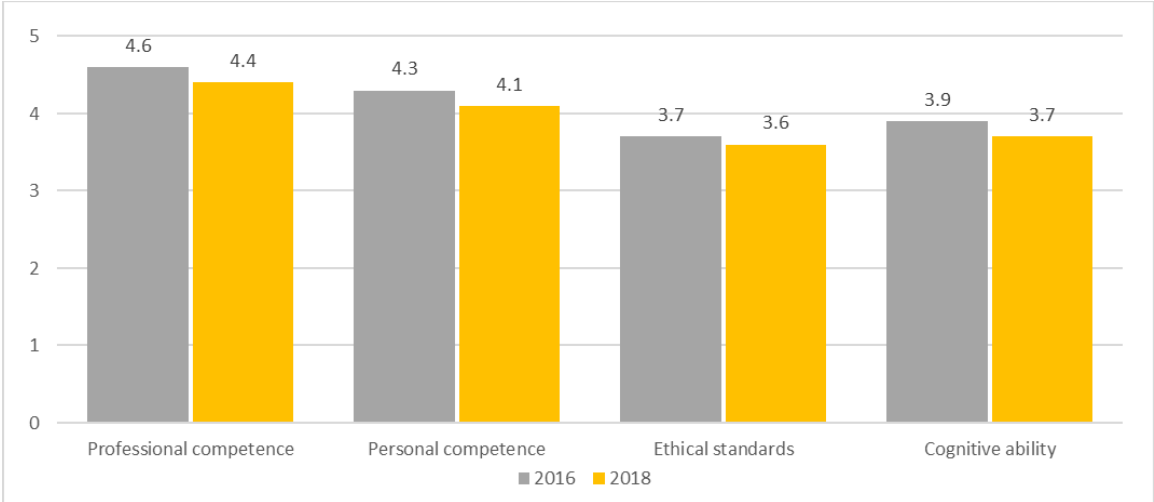
Note: Average hours of screening per establishment, calculated using representative sample weights and an unbalanced panel.

Figure 4: Employee turnover during probationary period (in %)



Note: Average establishment frequencies (in %) calculated using representative sample weights and an unbalanced panel.

Figure 5: Importance of recruitment criteria by wave (average of 5-point Likert scale)



Note: Average of establishment 5-point Likert scale answers, calculated using representative sample weights and an unbalanced panel.

Appendix

Table 10: Description of survey items, scales and availability across waves

Exact wording of survey item (1)	Short label used in our analyses (2)	Scale (and response categories) (3)	Available in waves (4)
Employer search instruments:			
Does your company use social networks to recruit staff, such as Facebook, XING or LinkedIn?	Recruiting via social networks	Yes/No/I don't know	all
In the last two years, have you directly addressed potential applicants who were employed by another company via social networks such as Xing, LinkedIn, etc.? *	Address via social networks	Yes/No	all
In the last two years, have you directly recruited potential applicants who were employed by another company via a private employment agency or a human resource consultancy?	Poaching via EA or head-hunter	Yes/No	all
Pre-hire (off-the-job) screening/ employee selection instruments			
Which of the following selection instruments do you use to recruit candidates for qualified positions? A) Employment interview, B) Assessment Centre, C) Cognitive ability test, D) Personality or integrity test, E) Short work sample, F) Algorithms for determining suitable candidates ** G) Others ***	Selection instruments	Multiple answers possible	2014, 2016, 2018
For the following criteria, please indicate how important they are when filling a position in your establishment. A) Professional competence, B) Personal competence, e.g. communication, presentation, self-management skills, C) Ethical standards, e.g. integrity, social responsibility, D) General intelligence and cognitive ability	Recruitment criteria	Likert scale ranging from 1 "unimportant" to 5 "very important"	2016, 2018

On average, how many hours do you spend testing a successful candidate in employment interviews, tests, etc.? This refers to the average total time an applicant spends in the selection process. Please state this separately for positions with management responsibility and for positions without management responsibility.

Screening
intensity

in hours (for managerial
and non-managerial
employees)

all

On-the-job screening process

Based on all new hires in your establishment in the last two years: How high is the proportion of employees who *voluntarily* left during probationary period? And how high is the proportion of employees who *involuntarily* left during probationary period? Or have you had no employees during probationary period or no new hires in the last two years?

Turnover during
probationary
period

in % (voluntary and
involuntary exits)

all

Notes: * From 2014 on, only establishments were asked that have stated that they use social networks for recruitment purposes. As this filter question is also available in 2012, we have adjusted the values in 2012 accordingly so that this item is comparable across all waves. ** Response category only available in 2018. *** Not analysed here.

Table 11: Descriptive statistics

Variable	Obs.	Mean	Median	SD	Min	Max
Vacant positions for qualified tasks	3,564	2.619	0	11.514	0	300
Positions to fill immediately	3,595	6.641	2	38.716	0	1,694
Applications per vacancy	3,107	24.000	15	43.260	0	1,000
Involuntary turnover during probationary period (in %)	3,332	6.706	0	15.700	0	100
<i>Average time to fill positions for qualified tasks</i>						
less than 1 month	3,270	0.139	0	0.346	0	1
from 1 up to under 3 months	3,270	0.597	1	0.491	0	1
from 3 up to under 6 months	3,270	0.224	0	0.417	0	1
6 months or more	3,270	0.040	0	0.197	0	1
<i>Personnel issues expected during next two years</i>						
High turnover	3,600	0.119	0	0.323	0	1
Staff shortage	3,600	0.215	0	0.411	0	1
Difficult to find qual. personnel	3,600	0.676	1	0.468	0	1
<i>Recruiting measures</i>						
Average individual fixed effect (CHK)	2,753	4.715	4.72	0.197	4	6
Recruiting via social networks	3,562	0.366	0	0.482	0	1
Address via social networks	3,575	0.128	0	0.334	0	1
Poaching via EA or head-hunter	3,603	0.311	0	0.463	0	1
<i>Pre-hire screening instruments</i>						
Employment interview	2,371	0.871	1	0.335	0	1
Assessment centre	2,371	0.131	0	0.337	0	1
Cognitive ability test	2,371	0.146	0	0.353	0	1
Personality or integrity test	2,371	0.152	0	0.359	0	1
Short work sample	2,371	0.544	1	0.498	0	1
Others	2,371	0.157	0	0.364	0	1
Average pre-hire intensity (in hours)	3,474	4.045	3	3.619	0	32
<i>Recruitment criteria</i>						
Importance of ethical standards	1,613	3.692	4	0.911	1	5
Importance of profess. competence	1,615	4.473	5	0.821	1	5
Importance of personal competence	1,614	4.204	4	0.821	1	5
Number of employees (log)	3,604	5.152	4.94	0.997	1	11
Apprenticeship training establish.	3,605	0.735	1	0.441	0	1
CHRO in executive board	3,581	0.460	0	0.498	0	1
Managed by owner	3,605	0.469	0	0.499	0	1
Independent establishment	3,593	0.745	1	0.436	0	1
<i>Industrial relations</i>						
No collective agreement	3,598	0.405	0	0.491	0	1
Sectoral-level collective agreement	3,598	0.465	0	0.499	0	1
Firm-level collective agreement	3,598	0.130	0	0.337	0	1
Works council	3,599	0.637	1	0.481	0	1
<i>Establishment age</i>						
Est. age (<6 years)	3,605	0.032	0	0.176	0	1
Est. age (6 to 10 years)	3,605	0.063	0	0.243	0	1
Est. age (11 to 20 years)	3,605	0.174	0	0.380	0	1
Est. age (>20 years)	3,605	0.730	1	0.444	0	1
<i>Industry</i>						
Mining, energy, water, disposal, recycl.	3,604	0.019	0	0.138	0	1
Food, consumables	3,604	0.048	0	0.214	0	1
Consumer goods	3,604	0.038	0	0.192	0	1
Production goods	3,604	0.160	0	0.367	0	1

Variable	Obs.	Mean	Median	SD	Min	Max
Capital and durable goods	3,604	0.276	0	0.447	0	1
Construction	3,604	0.049	0	0.215	0	1
Wholesale, automotive	3,604	0.062	0	0.241	0	1
Retail	3,604	0.044	0	0.205	0	1
Transport and storage	3,604	0.055	0	0.227	0	1
Information and communications	3,604	0.018	0	0.134	0	1
Hospitality	3,604	0.013	0	0.113	0	1
Financial and insurance services	3,604	0.034	0	0.180	0	1
Economic and scientific services	3,604	0.114	0	0.318	0	1
Education and training	3,604	0.005	0	0.071	0	1
Health and social affairs	3,604	0.046	0	0.209	0	1
Other services	3,604	0.015	0	0.120	0	1
Interest groups	3,604	0.004	0	0.064	0	1
<i>Year</i>						
2012	3,605	0.338	0	0.473	0	1
2014	3,605	0.214	0	0.410	0	1
2016	3,605	0.235	0	0.424	0	1
2018	3,605	0.213	0	0.410	0	1

Table 12: Incremental changes in pseudo (adjusted) R-squared when adding further controls

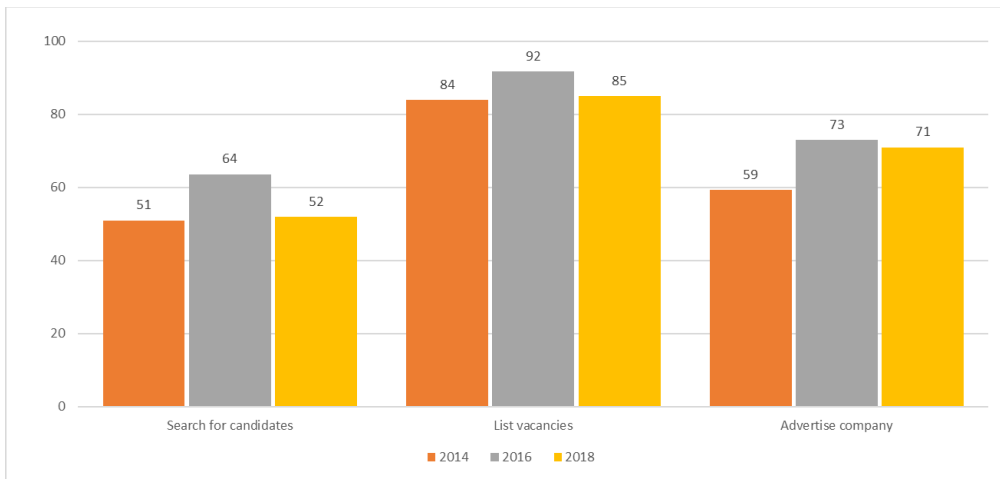
	Pseudo (adj.) R ²		Total pseudo (adj.) R ²	Δ pseudo (adj.) R ² establishment FE / total pseudo (adj.) R ²
	All covariates (1)	(1) + Establishment FE (2)	(3)	(2) / (3) (in %) (4)
<i>Employer search</i>				
Recruiting via social networks	0.130	0.081	0.211	38.4
Address via social networks	0.168	0.121	0.289	41.9
Poaching via EA or head-hunter	0.095	0.027	0.122	22.1
<i>Employee selection</i>				
Employment interview	0.090	0.023	0.113	20.4
Assessment centre	0.159	0.031	0.190	16.3
Cognitive ability tests	0.034	0.102	0.136	75.0
Personality & integrity tests	0.034	0.128	0.162	79.0
Short work samples	0.064	0.047	0.111	42.3
Professional competence	0.029	0.213	0.242	88.0
Personal competence	0.026	0.199	0.225	88.4
Ethical values	0.037	0.299	0.336	89.0
Cognitive skills	0.013	0.194	0.207	93.7
Screening intensity managerial employees	0.063	0.307	0.370	83.0
Screening intensity non-managerial employees	0.040	0.311	0.351	88.6
<i>On-the-job screening</i>				
Turnover during probationary period: voluntary	0.038	0.281	0.319	88.1
Turnover during probationary period: involuntary	0.062	0.202	0.264	76.5

Table 13: Descriptive statistics for outcomes as well as recruitment and hiring measures for panel data (decomposition of standard deviation into between and within components)

Variable		Mean	Std. Dev.	Min	Max	Observations
Vacant positions for qualif. tasks	overall	2.618687	11.51378	0	300	N = 3,564
	between		13.15632	0	300	n = 1,773
	within		3.8636	-97.38131	102.6187	T-bar = 2.01015
Positions to fill immediately	overall	6.641168	38.71621	0	1694	N = 3,595
	between		34.25239	0	1000	n = 1,780
	within		22.69017	-406.1088	1102.891	T-bar = 2.01966
Applications per vacancy	overall	24	43.26033	0	1000	N = 3,107
	between		47.16763	0	1000	n = 1,622
	within		20.9732	-211	314	T-bar = 1.91554
Involuntary turnover during probationary period	overall	6.706483	15.70049	0	100	N = 3,332
	between		14.35809	0	100	n = 1,706
	within		9.440374	-43.29352	81.70648	T-bar = 1.95311
Involuntary turnover due to misbehaviour	overall	6.273842	18.94256	0	100	N = 1,468
	between		18.11927	0	100	n = 1,044
	within		8.750869	-43.72616	56.27384	T-bar = 1.40613
Involuntary turnover due to lacking suitability	overall	39.1233	45.61418	0	100	N = 1,468
	between		42.29306	0	100	n = 1,044
	within		19.66356	-10.8767	89.1233	T-bar = 1.40613
Expected issue: High turnover	overall	0.1186111	0.3233753	0	1	N = 3,600
	between		0.2837958	0	1	n = 1,779
	within		0.2021007	-0.6313889	0.8686111	T-bar = 2.02361
Expected issue: Staff shortage	overall	0.2147222	0.4106865	0	1	N = 3,600
	between		0.3573864	0	1	n = 1,779
	within		0.2541678	-0.5352778	0.9647222	T-bar = 2.02361
Expected issue: Difficulty of finding qual. personnel	overall	0.6761111	0.4680232	0	1	N = 3,600
	between		0.4060185	0	1	n = 1,779
	within		0.2800852	-0.0738889	1.426111	T-bar = 2.02361
Individual wage fixed effects (CHK)	overall	4.714581	0.197098	3.90155	5.65265	N = 2,753
	between		0.1981429	4.125272	5.641122	n = 1,490
	within		0.0257604	4.395166	5.345781	T-bar = 1.84765
Recruit via social networks	overall	0.365525	0.4816447	0	1	N = 3,562
	between		0.4354085	0	1	n = 1,769
	within		0.261092	-0.384475	1.115525	T-bar = 2.01357

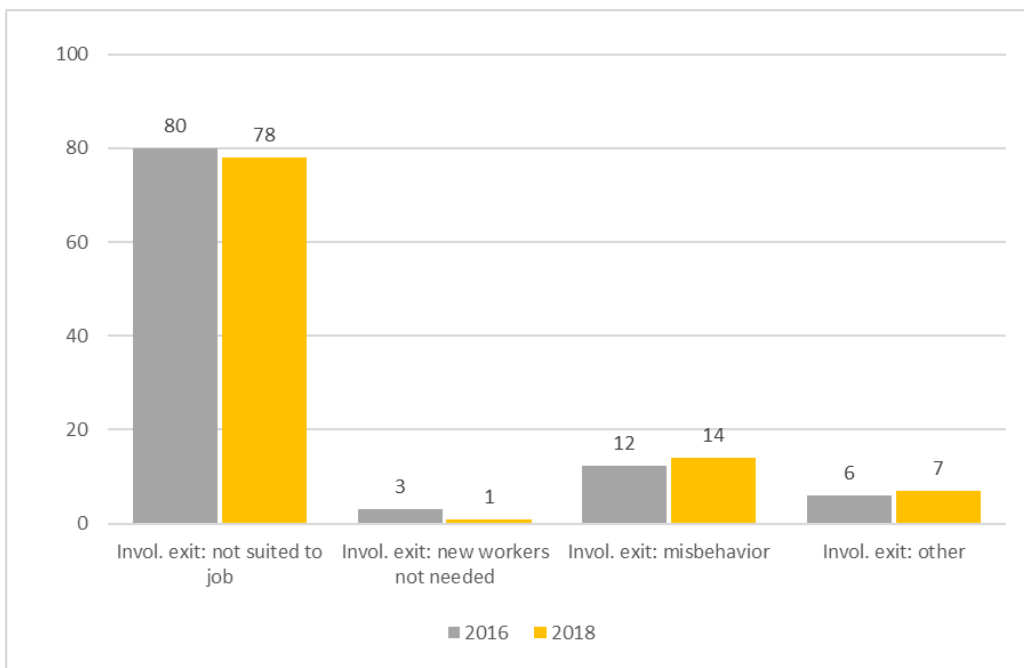
Variable		Mean	Std. Dev.	Min	Max	Observations
Address via social networks	overall	0.1278322	0.3339495	0	1	N = 3,575
	between		0.2988271	0	1	n = 1,776
	within		0.1894312	-0.6221678	0.8778322	T-bar = 2.01295
Poach via EA or head-hunter	overall	0.3114072	0.4631331	0	1	N = 3,603
	between		0.4176348	0	1	n = 1,783
	within		0.2491889	-0.4385928	1.061407	T-bar = 2.02075
Selection interview	overall	0.8713623	0.3348691	0	1	N = 2,371
	between		0.2930066	0	1	n = 1,361
	within		0.1837261	0.2046956	1.538029	T-bar = 1.7421
Assessment centre	overall	0.1307465	0.337194	0	1	N = 2,371
	between		0.3153039	0	1	n = 1,361
	within		0.1532581	-0.5359201	0.7974132	T-bar = 1.7421
Cognitive ability test	overall	0.1455082	0.3526869	0	1	N = 2,371
	between		0.3109296	0	1	n = 1,361
	within		0.1945097	-0.5211584	0.8121749	T-bar = 1.7421
Personality or integrity test	overall	0.1518347	0.3589363	0	1	N = 2,371
	between		0.3264979	0	1	n = 1,361
	within		0.1904913	-0.514832	0.8185013	T-bar = 1.7421
Short work sample	overall	0.5440742	0.4981587	0	1	N = 2,371
	between		0.4496285	0	1	n = 1,361
	within		0.258743	-0.1225924	1.210741	T-bar = 1.7421
Other selection measures	overall	0.1568958	0.3637792	0	1	N = 2,371
	between		0.3199934	0	1	n = 1,361
	within		0.2089758	-0.5097708	0.8235625	T-bar = 1.7421
Pre-hire intensity (amount of time for screening)	overall	4.044934	3.618881	0	32	N = 3,474
	between		3.100331	0	24	n = 1,741
	within		2.136113	-11.58007	19.66993	T-bar = 1.9954

Figure 6: Motives for the use of social networks as recruitment tool



Note: Establishment shares (in %) calculated using representative sample weights and unbalanced panel. Source: Linked Personnel Panel waves 2014-2018.

Figure 7: Reasons for involuntary turnover during probationary period (in %)



Note: Establishment shares (in %) calculated using representative sample weights and unbalanced panel. Source: Linked Personnel Panel waves 2016-2018.