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Dynamics and Endogeneity of Firms' Recruitment Behaviour

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Dynamics and Endogeneity of Firms' Recruitment Behaviour

Abstract

Models of random search, directed search, or stock-flow matching differ substantially in the way they assume that job seekers and firms behave during the recruitment process. In this paper we identify new patterns about the recruitment behaviour of firms using the entropy balancing technique and argue that stock-flow matching models - if suitably amended by a time-consuming screening technology - are best able to explain why the vacancy-filling hazard is increasing during the planned search period and decreases thereafter, why most applicants arrive early in the recruitment process, and why the willingness to pay higher wages or to hire less qualified or experienced applicants increases for firms, which have been unlucky and unable to hire until the intended starting date.

JEL-Codes: J630, J640.

Keywords: recruitment, planned search duration, stock-flow matching.

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1 Introduction

Search and matching models have been used excessively in labour economics to explain worker and firm behaviour, to model macroeconomic trends, and to evaluate labour market policies. The various types of models - random search, directed search, stock-flow matching - used in the literature differ substantially in the way they assume that job seekers and firms behave during the recruitment process.¹ While many studies investigate the search behaviour of workers and gives us some guidance to assess which type of model fits workers' behaviour best,² relatively little empirical work has been done in order to understand the recruitment process of firms and to get an idea which theories are best able to explain it.

The little evidence we have on the recruitment process of firms is on the arrival rate of applicants and on the shape of the vacancy-filling hazard. van Ours and Ridder (1992) find for the Netherlands that in the first two weeks after the announcement of a vacancy the majority of applicants apply. Then the arrival rate of applicants drops. The evidence on the shape of the hazard is mixed. Using the standard approach of calculating the vacancy-filling hazard Coles and Smith (1998), Coles and Petrongolo (2008), Kuo and Smith (2009), or Andrews et al. (2013) provide support for stock-flow matching by showing that the hazard rate is highest in the first two weeks after registering the vacancy with the UK Job Centre and drops sharply thereafter. Davis et al. (2017) apply the standard approach to the German Job Vacancy Survey (the same data-set as we use) and find that the hazard is rather stable, first increasing a bit and then decreasing slightly. Using data on vacancies registered with the Austrian Public Employment Service Kettemann et al. (2017) find that if the hazard is centred around the intended starting date that the hazard

¹In the classical random sequential search model workers and firms meet at random and only one potential partner at a time (see Pissarides (2000), and Cahuc et al. (2014) for an overview). In directed search models firms post wages and workers direct their applications to those jobs offering the highest utility (see Wright et al. (2017) for an overview). In stock-flow matching models the inflow of vacancies (job seekers) matches with the stock of job seekers (vacancies) and if a vacancy (job seeker) was unsuccessful initially, it (she) becomes part of the stock (see Coles and Muthoo (1998), Coles and Smith (1998), Ebrahimi and Shimer (2010), and Carrillo-Tudela and Hawkins (2017)).

²The early literature concentrated on the use and return of different search channels (see Holzer (1988), and Blau and Robins (1990) for the US, Osberg (1993) for Canada, and Gregg and Wadsworth (1996) for the UK). More recent evidence on the time spend on searching for a job is provided by Krueger and Mueller (2012) and on the use of different search channels by Kuhn and Skuterud (2004) and Kuhn and Mansour (2014). Kuo and Smith (2009), Andrews et al. (2013), and Kettemann et al. (2017) show that the longer a worker is unemployed the higher the probability that she matches with a newly posted vacancy. This rejects random search in favour of the stock-flow-matching. Kettemann et al. (2017) also find supportive evidence for directed search by showing that workers direct their search towards more productive firms.

is first increasing up to the intended starting date and decreasing thereafter. In the first part of the paper we also estimate the shape of vacancy-filling hazard by centring the hazard around the intended starting date and find the same shape using the German Job Vacancy Survey. We also show that our approach and the standard approach only coincide if firms intend to hire immediately.

Since the shape of the vacancy-filling hazard and the arrival rate of the number of (suitable) applicants documented by literature can be explained by competing theories, we investigate in our main analysis how firms, which are unlucky during the search process, respond by adjusting their search intensity, their qualification and/or experience requirements, and the wages they pay. This allows us to say more about which theory is best able to predict the observed patterns.

To identify the effect of being unlucky in the search process on the recruitment strategy of firms we use the entropy balancing technique developed by Hainmueller (2012) to construct synthetic control groups. We use the information on the planned search duration of a vacancy to control for unobserved differences in firm and vacancy characteristics. By comparing vacancies with similar planned search durations we are able to control for all unobserved characteristics which firms expect to influence their search duration. We therefore assume that after controlling for the planned search duration and other observable firm and vacancy characteristics the need to search longer than the expected (planned) search duration is due to random bad luck shocks in the search process.

Using this strategy we split our sample into four groups. The group *early* includes all vacancies, which successfully finished their search process at least four weeks prior to the intended starting date, the group *in time* includes all vacancies, which successfully finished their search process around the intended starting date, the group *delayed* includes all vacancies, which successfully finished their search process after the first week of the intended starting date, and the final group *failed* is made up of vacancies, which could not be filled at all.³

³Heckmann et al. (2013) divide vacancies in similar groups (but without considering failed vacancies in the analysis) using the same data set. They use a multinomial logit regression to show which factors are associated with which group. They find that industry, firm size and certain vacancy characteristics have a high influence on the group a vacancy belongs to. They also include potentially endogenous variables in the same regression like the number and type of search channels used, an indicator for wage concessions made, and the recruitment of a previously unemployed worker. The correlations found suggest that vacancies, which hire after the intended starting date, are associated with the use of more search channels and a higher willingness to pay more than initially intended and to hire previously unemployed workers.

We find that firms, which are able to hire an applicant some time ahead of the intended starting date, are contacted by a significantly higher fraction of suitable applicants and report to have faced significantly fewer recruitment problems due to an insufficient number of suitable applicants or due to high wage demands of applicants than firms, which hire *in time*, *delayed*, or *fail* to hire. We can also show that those firms, which hire *in time*, activate additional search channels compared to firms, which hire relatively *early*. Firms, which hire *delayed* or *failed* to hire, activate even more search channels.⁴ The use of the public employment agency and of news papers and online ads experience the highest increase. Furthermore, firms, which are only able to hire *delayed*, make significantly more concessions in terms of the required qualification and experience and the willingness to hire previously unemployed workers than the firms, which hire *in time*, and even more compared to firms, which hire some time before the intended starting date. Firms with a *delayed* recruitment also increase their willingness to bargain over pay and pay more often more than initially intended, compared to firms, which hire *early* or *in time*. This also holds if we account for match-quality by dropping firms, which make concessions in terms of qualification and experience required.⁵

Stock-flow matching models⁶ if combined with a time-consuming screening technology fit this recruitment pattern best. If one introduces a time-consuming screening technology in a stock-flow matching model, firms will screen sequentially and use a reservation productivity to decide on whether or not to hire. Given the number of applicants a newly opened vacancy receives from the stock of unemployed job seekers the firm will decrease the reservation productivity as the number of unscreened applicants decreases. The likelihood that one of the screened applicants passes the reservation productivity threshold then increases as time passes. A time-consuming screening technology can therefore explain why the vacancy-filling hazard increases during the planned search and screening period. The

⁴Russo et al. (2000) find that the use of more search channels is associated with a longer vacancy duration. Our results suggest that this is due to reverse causality, i.e., that firms activate additional search channels after having failed to hire a worker within the planned search duration.

⁵Faberman and Menzio (2017) find for the US that higher wages are positively correlated with vacancy duration. They build a directed search model, which - under certain parameter constellations - is able to explain their findings, if they assume that some degree of worker and job heterogeneity is unobserved in their empirical analysis. In light of the stock-flow matching model and our results their findings can also be explained by reverse causality, i.e., that firms pay higher wages because they have been unsuccessful in finding a worker initially.

⁶See Coles and Muthoo (1998), Coles and Smith (1998), Ebrahimi and Shimer (2010), and Carrillo-Tudela and Hawkins (2017)

decline in the arrival rate of applicants over time and the decrease in the vacancy-filling hazard after the intended starting date can be explained by the basic stock-flow matching model. Newly posted vacancies initially receive many applications from the stock of job seekers. If a vacancy cannot be filled by matching with an applicant from the stock of job seekers, it has to wait until new workers start to search. Since the inflow of new job seekers is small compared to the stock of job seekers, the number of new applicants and the vacancy-filling hazard drops after a vacancy was unable to match initially. This decrease in the matching probability decreases firms' outside option and is therefore also able to explain why firms – after the intended starting date – are more willing to bargain over pay, pay higher wages, or to make concessions by accepting workers with a lower qualification or experience than initially posted.

Other theories are only partially able to explain the observed pattern. The use of planned search durations and the increase in the vacancy-filling hazard during this period can be explained by advanced notice or the intention of firms to gather applicants either because they want to induce competition among applicants or because economies of scale in screening makes it profitable to gather workers before starting to screen. Burdett and Cunningham (1994) and Burdett and Cunningham (1998) explain the increasing vacancy-filling hazard by showing that firms lower their reservation productivity as the time of advance notice draws down. A Poisson arrival rate of applicants – as generally assumed in dynamic search models – can also explain this pattern, since it implies that the number of firms, which have gathered sufficiently many applicants for whatever reason increases as time passes. A Poisson arrival rate of applicants is, however, unable to explain that most applicants arrive early and that the arrival rate of applications and subsequently the vacancy-filling rate decreases after the intended starting date. Phantom vacancies combined with a dynamic directed search model can explain this pattern as shown by Albrecht et al. (2017). The idea here is that applicants anticipate that the likelihood that an application is considered by a firm decreases the longer the vacancy has been posted. Applicants therefore apply more to young vacancies than to older ones. Phantom vacancies with screening could therefore explain the initially increasing and later decreasing vacancy-filling hazard. However, this theory is unable to explain why firms should be more willing to make concessions in terms of qualification or experience or by paying higher wages if they are not successful initially. Instead of making concessions it would be optimal to

signal to the market that their vacancies are no phantoms by posting the vacancies again.

The remainder of this paper is organized as follows. Section 2 describes the data-set we use, i.e., the German Job Vacancy Survey. Section 3 presents the estimated hazard of finding a worker in different specifications and explains how we form the four groups of vacancies depending on when the search process was successful or failed. Our identification strategy is laid out in section 4. Section 5 contains our main results and describes the dynamics and the adjustments made by firms during the recruitment process. In section 6 we discuss which theory is best suited to explain our empirical findings. Section 7 concludes.

2 The data

For our analysis we use the German Job Vacancy Survey collected by the Institute for Employment Research.⁷ The survey is conducted each year since 1989. The quality of the data and the depth of questions increased over the years. We use the years 2005 to 2014, since most of the information we need for our analysis is not available before. This period covers good and bad labour market periods. The German Job Vacancy Survey is a repeated cross section. The representative samples are drawn from German establishments, which employ at least one person subject to social security contribution. For confidentiality reasons the data does not contain establishment identifiers.

The yearly cross-sectional survey delivers detailed information on the interviewed establishment like the number of employees, the industry, the number of vacancies, the number of hires and quits in the previous year, and the region the establishment is located. The firm's current economic condition is measured by binary indicators for "low sales", "financial constraints" and "skilled labour shortage". In the second part of the survey the firm is interviewed in detail on the last case of a successfully filled vacancy and (if applicable) on the last case of a cancelled recruitment attempt. The questionnaire for vacancies, which failed to hire a worker, is limited and the number of observations is relatively low (5.6%).⁸ We include information on failed vacancies if the respective

⁷The data used in this article is made available to us by the Research Data Centre of the German Federal Employment Agency at the Institute for Employment Research (IAB), Nuremberg. For details see Kettner et al. (2011) or Brenzel et al. (2016).

⁸Since the Institute for Employment Research (IAB) does not provide weights, we are unable to calculate the representative number of failed vacancies.

information is available.

In the second part of the survey, detailed information on the characteristics of a vacancy is collected, for example on the occupation, on the qualification and experience required for the job, whether the position is permanent or temporary and if temporary, whether it is a seasonal job or replaces another worker temporarily, and whether the job is a full- or part-time job. Moreover, the firm is asked when it started to search for applicants, when it stopped searching (signed an agreement with the later hired worker), when the intended starting date was, and when employment actually started. This unique feature of the German Job Vacancy Survey allows us to estimate the baseline hazard over the recruitment process and to compare the recruitment strategies of vacancies, which found a suitable applicant some time ahead of the intended starting date, with vacancies, which found a suitable applicant in time or some time after the intended starting date, and with vacancies, which failed to hire.

Firms were also asked to provide information on the search and hiring channels used. Binary variables, to indicate which channels were used, are available for the following channels: Advertisement in print media, on company's website, on online job platforms, on social media platforms (Facebook, Twitter etc.), public employment agency (online and offline services), speculative applications to the firm, private employment agencies, internal postings, interns, apprentices, or referrals by employees (network). In our empirical analysis we group these channels into five main groups as shown in Table 1.

Table 1: Grouping of search channels

| Name of main group | Assigned search channels |
|---------------------------|--|
| Classic | -Advertisement in print media -Advertisement on company's website -Advertisement on online job platforms -Advertisement on social media platforms |
| Internal | -Internal postings -Interns -Apprentices |
| Network | -Referrals by employees |
| Speculative appl. | -Speculative applications |
| PEA | -Public employment agency (PEA) |

All advertisements of the company – on- and offline – are grouped into the group *classic*. We group on- and offline advertisements because of the high overlap in content and the similarity in how they address applicants. If a company nowadays decides to publish an advertisement in a newspaper, the same job advertisement will typically be displayed on the newspaper’s website and on the company’s website as well. The group *internal* refers to all search channels, which address all groups of employees, who are already known to the firm, such as all regular employees (addressed by internal postings), and interns or apprentices. The groups *network*, *speculative applications* and *public employment agency (PEA)* refer one to one to the respective search channel. The channel private employment agency is dropped since this search channel is only used by 7.28% of firms and is hence of minor importance in the German context.

Besides the information on the timing of the search process and the search channels used, the survey provides information on problems, which can arise during the search process. Firms can indicate via binary variables whether they had problems in finding enough suitable applicants, and whether they had problems in hiring workers, because pay claims of applicants were too high. The survey also includes questions on how many persons applied overall and how many are regarded as suitable for the job.

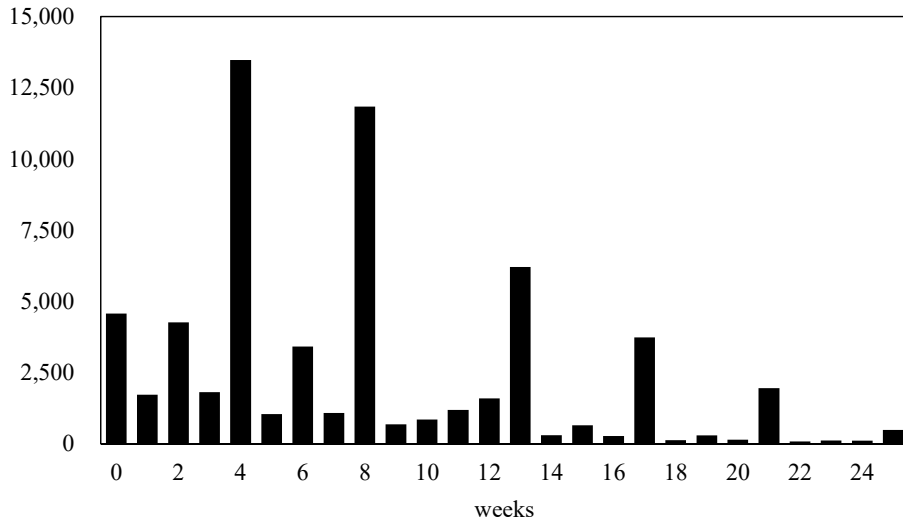
Additionally, the survey contains several questions, which can be used to evaluate how firms reacted if they were unable to find a suitable applicant within the intended search period. The first set of questions concerns the firm’s willingness/need to adjust the wage. We know whether the firm bargained over pay, the wage it paid to the hired worker, and whether it paid more than initially intended. The second set of questions concerns the firm’s willingness/need to make concessions in terms of qualification and experience required. The respective information is provided by firms, if they answer the question whether the hired worker’s qualification and experience level was below what was initially expected. Finally, we can use the information on the number and types of search channels used to evaluate whether firms, which were unable to hire a suitable worker in time, increased their search effort.

Not all variables are available in the years 2005 to 2014. The years on which the respective analysis is based are shown below the respective Tables and Figures.

3 Planned search duration and the vacancy-filling hazard

Figure 1 shows the frequency of vacancies with different planned search durations. The planned search duration is measured by the difference between the intended employment starting date and the starting date of the search process. In our sample 52.1% of firms start their recruitment process at least eight weeks before the intended starting date and 18.7% of firms start their recruitment process less than four weeks ahead. The planned search duration is longer for vacancies offering permanent jobs, full-time jobs, and jobs, which require a high qualification and experience level, and shorter for temporary jobs, especially seasonal jobs. The respective OLS-estimates are shown in Table A1 in the Appendix.

Figure 1: Frequency of vacancies according to planned search duration

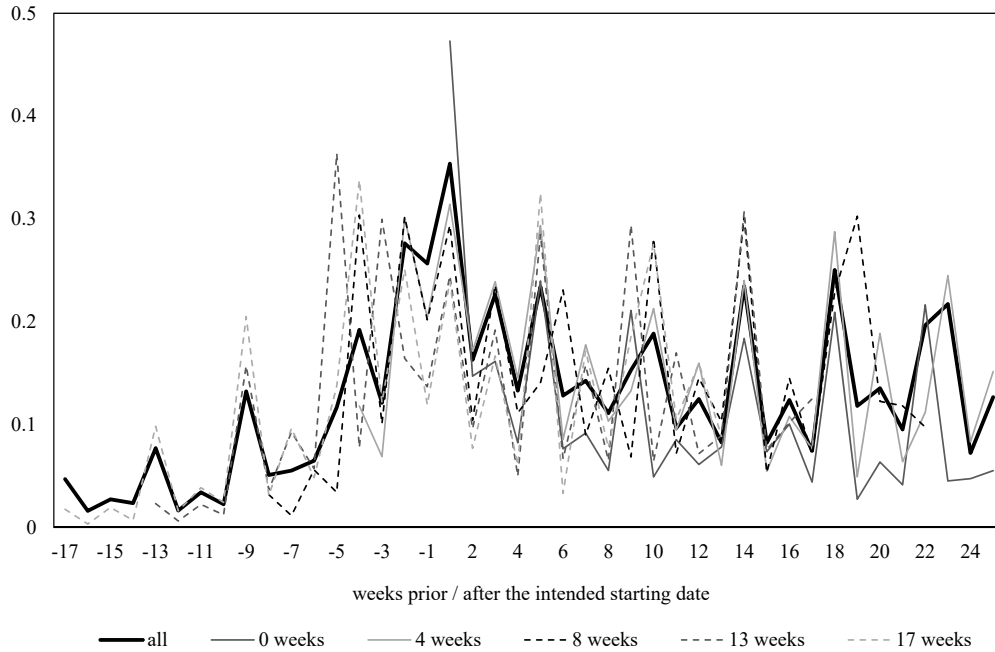


Data: German Job Vacancy Survey 2005-2014

So far the literature has paid very little attention on how the planned search duration shapes the hazard of filling a vacancy. Figure 2 shows the weekly recruiting hazard rates of vacancies with 17, 13, 8, 4 and 0 weeks of planned search duration. The hazard rates are calculated as the number of vacancies which stopped searching (signed an agreement with an applicant) in a given week divided by the number of vacancies at risk (i.e., still searching) at the beginning of the week. In order to emphasis the role of the planned search duration we centred the hazard rates around the intended starting date. The hazard rates

of vacancies with 17, 13, and 8 weeks of planned search duration are highest around the 5th to 2nd week in advance of the intended starting date. The hazard rates for vacancies with 4 weeks planned search durations have their highest hazard rates in the two weeks prior to the intended starting date and the hazard rate of vacancies with no planned search duration is highest in the first week after the intended starting date (which coincides with the first week after the search process started). The black solid line shows the hazard rate of all vacancies. The respective hazard is again calculated by dividing the number of vacancies hiring in the respective week by the number of vacancies at risk at the beginning of the respective week. Note that the number of firms at risk in a specific week consist of firms, which searched unsuccessfully in the previous week and new firms, which started to search in the respective week. The respective number of firms at risk are shown in Table A2 in the Appendix. The overall hazard of filling a vacancy is first increasing until the intended starting date. It stays high for several weeks around the intended starting date and declines thereafter.

Figure 2: Vacancy-filling hazard for different planned search durations



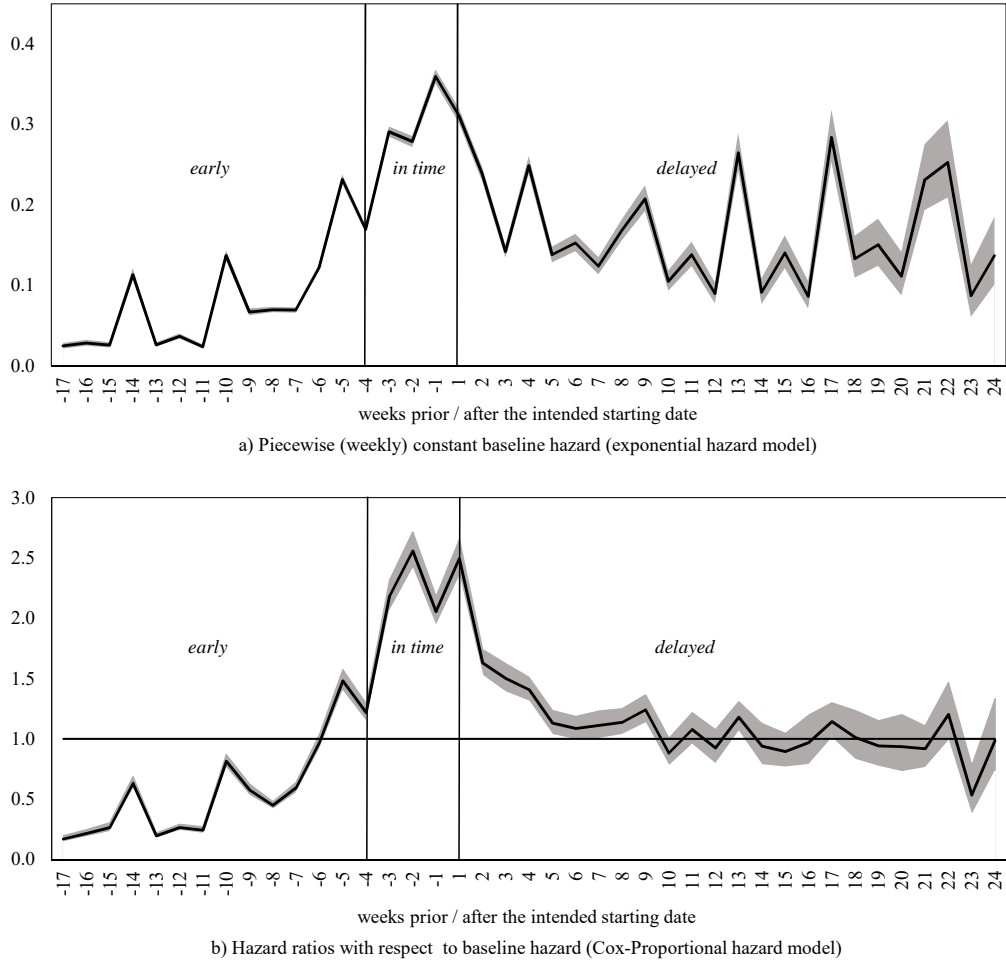
Data: German Job Vacancy Survey 2005-2014

Also in the estimation of the hazard we allow the distance to the intended starting date to have an effect on the baseline hazard. To do so we split the search duration at the weeks prior and after the intended starting date (18th, 17th, and so on week before the intended starting date, and 1st, 2nd, 3rd and so on week after the intended starting date) and estimate the hazard by defining week-indicators in such a way that the indicator is one if the vacancy is searching in the respective week and zero otherwise. In Figure 3 we present the estimates of the piecewise-constant (weekly) proportional hazard estimated using an exponential hazard model⁹ and the hazard ratios for the respective weeks based on a Cox-Proportional Hazard model. In the estimation we control for a host of vacancy characteristics as well as for year-, industry-, and region-fixed effects. The respective estimates are shown in Table A3 in the Appendix.

The estimated weekly baseline hazard rates shown in Figure 3a) starts from very low values around 0.02 to 0.06, which indicate that between 2% to 6% of those firms at risk hire somebody within the respective week. The hazard increases until the intended starting date up to values beyond 0.3 indicating that around one third of firms searching in the respective week are able to hire an applicant. Shortly after the intended starting date the hazard decreases again. The estimated hazard ratios based on the Cox-Proportional Hazard model in Figure 3b) show a similar pattern. The hazard-ratios start from very low values around 0.2, which implies that a vacancy, which is searching 17 weeks prior to the intended starting date, has a baseline hazard 5-times smaller than the baseline hazard of other vacancies, which searched equally long. The hazard-ratio increases during the planned search duration to values up to 2.5 around the intended starting date. This implies that vacancies around the intended starting date have a baseline hazard 2.5-times above the baseline hazard of other vacancies, which searched equally long. After the first week after the intended starting date the hazard ratios decrease again to values around 1, which implies that the baseline hazard is comparable to the baseline hazard of other vacancies, which searched equally long. The pattern of the estimated hazard ratios remains almost the same, if we treat the exit of unsuccessful vacancies as a competing risk and estimate the Cox-Proportional Hazard accordingly (see Table A3 in the Appendix for the respective results).

⁹The standard approach (see e.g. Wooldridge, 2010, ch.20) uses week-indicators, which are equal to one if the vacancy is searching in the respective week and zero otherwise. The week-indicators are defined as searching in 1st, 2nd, 3rd, 4th, ... week after search started.

Figure 3: Hazard estimates centred around the intended starting date



The grey shaded areas represent the 95% confidence interval. Data: German Job Vacancy Survey 2005-2014

Since the main objective of the paper is to investigate how firms' recruitment behaviour changes before, around, and after the intended starting date, we split our sample into four groups. We label the first group *early*. This group includes all vacancies, which successfully finished their search process at least 4 weeks prior to the intended starting date. The second group is labelled *in time*. It includes all vacancies, which successfully finished their search process at most 28 days (four weeks) prior to the intended starting date and no later than one week after the intended starting date. The third group, which we label *delayed*, includes all successful vacancies, which need longer than one week after the intended starting date to recruit an applicant. The fourth group includes all vacancies, which failed to hire a worker and cancelled the recruitment process. This fourth group is

labelled *failed*. 37.6% of all vacancies in our sample (with all covariates available) belong to the group *early* hires, 37.0% to the group *in time* hires, 18.1% to the group *delayed* hires, and 7.3% to the group *failed* to hire. The results shown below are not sensitive to slight changes in the thresholds defining the different groups.

We are not the first to show that the vacancy-filling hazard is increasing up to the intended starting date and decreasing thereafter. Kettemann et al. (2017) show a similar picture for vacancies registered with the Austrian Public Employment Service. Other studies like Coles and Smith (1998), Gregg and Petrongolo (2005), and Coles and Petrongolo (2008) show that the hazard rate of vacancies registered with UK Job Centres is highest in the first month after the start of the search process. Kuo and Smith (2009) and Andrews et al. (2013) use weekly data from UK Job Centres and show that the hazard rate of vacancies is highest in the first two weeks. If we calculate the weekly vacancy-filling hazard from using the standard piecewise-constant (weekly) estimation approach, we obtain a fluctuating hazard with no clear pattern (see Figure A1a) in the Appendix). Also Davis et al. (2017) obtain a similar shape of the vacancy-filling hazard using the same data set as we do. Only if they divide the sample along the search channels used by vacancies (formal search channels versus informal search channels, which include only network or internally known workers), they find a decreasing hazard for the latter. If we split the data accordingly, we find the same pattern. This also holds if we only consider vacancies, which require only a low qualification level (see Figure A1b) in the Appendix). If we take our approach, we always find a hazard rate, which is increasing up to the intended starting date and decreasing thereafter. The only exception is if we take firms with no planned search duration (see Figure A1a) in the Appendix). In this case our approach and the standard approach coincide and give the same estimates. The differences in the shape of the vacancy-filling hazard between the standard and our approach can be explained by the fact that the hazard is centred around the intended starting date. It is not driven by the difference in the number of firms at risk as the shape of the sub-sample hazard rates for those vacancies searching exactly 17, 13, 8, 4, and 0 weeks in Table A2 shows.

4 Identification of firm recruitment behaviour

The aim of the paper is to evaluate how firms' recruitment behaviour changes if they are unlucky during the recruitment process. We regard those firms, which hire *early*, as being

lucky and those which hire *in time* or *delayed*, or those which *failed* to hire as being hit by bad luck. Ideally, we would have liked to have data on the points in time when firms, which are not successful in the early recruitment phase, adjusted their strategy, e.g. the points in time when they start to use certain search channels or the point in time when they start to make concessions. Unfortunately, in our data-set - and this holds (to the best of our knowledge) for all vacancy data-sets currently available - only information on whether or not e.g. a search channel has been used or a concession has been made is available, but not the point in time when this event took place.¹⁰ We therefore have to compare the recruitment behaviour of vacancies, which hired *in time* or *delayed*, or *failed* to hire, with the recruitment behaviour of vacancies, which hired *early*. In order to be able to interpret our results as changes in recruitment behaviour we need to rule out that the observed differences are driven by selection.

In order to identify the effect of being unlucky in the recruitment process on firms' recruitment behaviour we use the entropy balancing reweighting technique developed by Hainmueller (2012). Entropy balancing, like e.g. propensity score matching, takes care of selection on observables by producing weights, which are subsequently used to reweight the comparison (control) observations in an OLS regression. In the entropy balancing step we match on a host of vacancy characteristics, like the required qualification and experience level, whether the job is permanent, temporary or seasonal, requires weekend work, and whether it is full- or part-time. On the firm level we include the number of employees (log), and the binary indicator variables "low sales", "financial constraints", and "skilled labour shortage" to control for the economic condition of the firm. The entropy balancing is done year by year. This ensures that vacancies are always matched within the same year. This accounts for possible differences in labour market conditions over time.

We are also able to account for selection along unobservable characteristics by matching on planned search duration. By conditioning on planned search duration we control for all factors firms take into account when forming expectations on their likely search duration. Take, for example, the case where an unobservable characteristic - like bad reputation - is positively correlated with the search duration of a vacancy. As long as a firm takes this fact into account by increasing its planned search duration accordingly, we are able to control for this effect. Only if the firm is unable to adjust its planned search duration

¹⁰The only exception is the use of the PEA search channel for the years 2013 and 2014. We analyse the respective information in section 5.

accordingly - maybe because a worker left without advanced notice and has to be replaced immediately, or if the firm already has a suitable candidate for the vacancy when starting to search, we are unable to account for the underlying unobserved characteristic. If in such a case the unobserved characteristic is correlated with some outcome variables, then the respective estimates are biased. To avoid such cases we restrict our sample to vacancies with a planned search duration of more than 28 days. For our identification we, therefore, assume that firms with a planned search duration of more than 28 days take expected recruitment difficulties into account when deciding on their planned search duration.

The main advantage of entropy balancing compared to standard matching and weighting techniques like propensity score weighting or nearest neighbour matching is its higher effectiveness in reducing covariate imbalance. This is accomplished by, generally speaking, reweighting the observations of the different comparison groups such that predefined moments (in our case mean and variance) are similar to the ones of the reference group. While many weights potentially fulfil such requirements, entropy balancing chooses those which deviate as little as possible from uniform weights. Thereby, entropy balancing is advantageous since it overcomes the cumbersome rechecking in propensity score methods where “researchers ‘manually’ iterate between propensity score modelling, matching, and balance checking until they attain a satisfactory balancing solution” (Hainmueller, 2012, p.25). Unlike propensity score matching methods, entropy balancing improves the covariate balance of all conditioning variables¹¹ and is fully nonparametric.¹² Entropy balancing perfectly fits the covariates as shown in Table A4 in the Appendix. For robustness checks, however, we also employ in subsection 5.5 weights obtained from a combination of propensity score and nearest neighbour matching, the so-called radius matching approach proposed by Huber et al. (2015), Lechner et al. (2011), and Lechner and Wunsch (2009).

Entropy balancing assigns all observations in the reference group a weight equal to one. The observations in the comparison groups are assigned the respective entropy balancing weights. In order to ensure a common support of planned search duration we choose to define the vacancy group *in time* as the reference (treatment) group. The vacancy groups *early*, *delayed*, and *failed* are the comparison (control) groups. Besides the conditional in-

¹¹Using propensity score matching and similar methods can lead to a better balance between some covariates at the cost of a worse balance between other conditioning variables. See e.g. King and Nielsen (2016).

¹²We implement entropy balancing by using the program “ebalance” (Hainmueller and Xu, 2013) in Stata 14.2.

dependence assumption an important condition for propensity score methods to be valid is the assumption of common support, meaning that for any conditioning variable there exist observations for both, treatment and control group. Whereas for propensity score methods this condition is reached by simply selecting only those observations in the treatment group which have a propensity score not bigger than the maximum propensity score of the observations in the control group (Caliendo and Kopeinig, 2008), it is unclear how to ensure this condition for entropy balancing. By choosing the group *in time* as the reference group we ensure common support on planned search duration. For the radius matching approach used as a robustness check in subsection 5.5 we enforce the common support assumption. When comparing the number of observations from radius matching with the number of observations from entropy balancing, we find that the number of observations in entropy balancing is only 3.2% higher than in radius matching, i.e., 3.2% of our observations are not on the common support.

Calculating the entropy weights for all covariates including the planned search duration to match unobservable characteristics is the first step. The second step is the estimation of the treatment effect, implemented by an OLS regression based on the reweighted sample. Given our formal definition of the group *in time* as the reference (treatment) group and the groups *early*, *delayed*, and *failed* as comparison (control) groups we estimate the average treatment effect on the untreated, which can be obtained from,

$$\hat{\beta} = (X'WX)^{-1} X'y,$$

where y is the vector of outcomes, W a diagonal matrix with 1 in the diagonal cells for vacancies in the *in time* group and entropy balancing weights in the diagonal cells for the comparison (control) groups. X is a $n \times (k + 3)$ matrix, where the first column is a vector of 1s, the second column a vector indicating the comparison group *early* and the third column a vector indicating the comparison group *delayed*. The k additional columns in X contain all remaining control variables. Since for the vacancies in the group *failed* the information on the planned search duration is only available for certain years and some covariates are not available at all, our sample would be relatively small, if we restrict it to observations with information on all three comparison groups. Therefore we estimate the behaviour of *failed* vacancies separately (where X is a $n \times (k + 2)$ matrix).

The OLS regressions allow us to account for additional explanatory variables. We also control for occupation-fixed effects (according to 3 digit ISCO-classification) and for time-

varying effects on the regional level (180 labour market regions) by including interaction terms for years and regions. In regressions, where we investigate outcomes related to the hired person (e.g. wages paid), we include gender and experience (and experience squared) of the hired worker. We also include all covariates used in the first entropy balancing step. This allows us to investigate whether balancing is effective by testing whether the estimated treatment effects change if we exclude the covariates from the first step. The coefficients are not statistically significantly different, if we omit the covariates used for entropy balancing. If all factors, which jointly determine the outcome y and when a vacancy hires (fails to hire) $D \in \{early, in_time, delayed, failed\}$ are observable (either directly or indirectly via the planned search duration) and controlled for by the weights from entropy balancing, $EB(X)$, we can interpret our results causally. This is properly formalized in the conditional independence assumption,

$$E[y|EB(X), D = m] = E[y|EB(X), D = in_time],$$

where $m \in \{early, delayed, failed\}$. We assume that this assumption holds.

5 Dynamics of the recruitment process

We describe our results by chronologically “following” firms through their search process. First, we show which problems might occur whilst firms look for suitable applicants. Then we investigate how many (suitable) candidates apply and how firms adjust their search behaviour. Finally, we show how firms change their wage policy and make concessions in order to increase the likelihood of filling the vacancy.

5.1 Problems during the recruitment process

Firms, which were not able to hire up to the intended starting date, have been unlucky in the search process. If firms are unlucky, we would expect that they report having problems in finding suitable applicants. That this is indeed the case is shown in Table 2, which shows the respective mean for the reference group *in time* and the estimated difference for the three comparison groups (*early*, *delayed* and *failed*). While the fraction of firms, reporting problems in finding enough suitable applicants is around 12.4% for the *in time* group, this value increases by 17.7 percentage points for the *delayed* group, i.e., 30.1% of the firms in the *delayed* group report such difficulties. For firms, which *failed* to hire, the increase is

with 41.0 percentage points a lot higher, meaning that around 53.4% of *failed* firms report this problem. The opposite holds for the firms, which are able to fill their vacancy *early*. Here only 6.7% report this problem.

Table 2: Problems in the recruitment process - OLS with Entropy Balancing

| | Group <i>In Time</i> (Mean) (1) | Difference between <i>In Time</i> and | | |
|--|---------------------------------------|---------------------------------------|-----------------------|-----------------------|
| | | <i>Early</i> (2) | <i>Delayed</i> (3) | <i>Failed</i> (4) |
| Not enough suitable applicants (Standard Error) | 0.1239 | -0.0572*** (0.0043) | 0.1768*** (0.0061) | 0.4102*** (0.0124) |
| Nr. of Obs. | 15,870 | 15,480 | 7,920 | 4,005 |
| Pay claim of applicants too high (Standard Error) | 0.0522 | -0.0236*** (0.0025) | 0.0804*** (0.0040) | 0.2542*** (0.0109) |
| Nr. of Obs. | 20,579 | 20,256 | 9,878 | 4,005 |

Differences are the coefficients of the respective indicator variables for belonging to the group *Early*, *Delayed* or *Failed* in an OLS regression with entropy balancing weights and a restricted sample, including only vacancies with at least 28 days of planned search duration. Standard errors are reported in the parentheses. Covariates on firm and vacancy level are not reported. Interaction dummies between region and year are not reported. 3 digit occupational dummies (based on ISCO-88 classification) are not reported. * indicates $p < 0.1$, ** indicates $p < 0.05$, *** indicates $p < 0.01$. Data for “Not enough suitable applicants”: German Job Vacancy Survey 2009-2014. Data for “Pay claim of applicants too high”: German Job Vacancy Survey 2010-2014.

A similar picture arises for the variable which indicates whether firms had problems in the recruitment process due to higher pay claims of their applicants. For the *in time* group only 5.2% report recruitment problems due to higher wage demands. For vacancies hiring *early* the fraction is only 2.9%. At the same time 13.3% of those firms hiring *delayed* report recruitment problems because applicants demand higher wages. This problem is again most prominent for *failed* vacancies, where around 30.6% report too high pay claims by applicants.

We interpret the increase in problems reported during the recruitment process as evidence that random matching frictions are driving longer search durations. In other words, the increase in problems reported during the recruitment process supports our identification strategy that longer search durations are driven by random bad luck shocks and not by unobserved heterogeneity.

5.2 Adjustments during the recruitment process

The following Table 3 shows the average number of applicants, the average number of suitable applicants and the fraction of suitable applicants for the *in time* group and the

estimated difference for the three comparison groups (*early*, *delayed* and *failed*). Our estimates suggest that a vacancy, which hires *early* receives on average 13.9 applicants. This number increases to 16.2 applicants on average for vacancies in the *in time* group. The increase in the number of applicants for those vacancies, which hire *delayed*, is only minor (only 0.9 applicants more). This evidence is in line with the results reported by van Ours and Ridder (1992), who show for the Netherlands, that the majority of applicants arrive within the first two weeks after the announcement of the vacancy. Then the arrival rate of applicants drops almost to zero. Our results also suggest that *failed* vacancies are unlucky and receive 3.8 fewer applicants than the *in time* group.

Table 3: Number of (suitable) applicants and fraction of suitable applicants - OLS with Entropy Balancing

| | Group <i>In Time</i> (Mean) (1) | Difference between <i>In Time</i> and | | |
|---------------------------------|---------------------------------------|---------------------------------------|-----------------------|----------------------|
| | | <i>Early</i> (2) | <i>Delayed</i> (3) | <i>Failed</i> (4) |
| Number of applicants | 16.1968 | -2.3076*** | 0.8971** | -3.8181*** |
| (Standard Error) | | (0.5321) | (0.4107) | (0.8043) |
| Nr. of Obs. | 18,375 | 17,466 | 9,095 | 1,732 |
| Number of suitable applicants | 4.6472 | -0.6383*** | -0.2827** | N.A. |
| (Standard Error) | | (0.1131) | (0.1300) | |
| Nr. of Obs. | 18,237 | 17,353 | 8,971 | |
| Fraction of suitable applicants | 0.5035 | 0.0745*** | -0.0795*** | N.A. |
| (Standard Error) | | (0.0048) | (0.0044) | |
| Nr. of Obs. | 17,942 | 16,963 | 8,879 | |

Differences are the coefficients of the respective indicator variables for belonging to the group *Early*, *Delayed* or *Failed* in an OLS regression with entropy balancing weights and a restricted sample, including only vacancies with at least 28 days of planned search duration. Standard errors are reported in the parentheses. Covariates on firm and vacancy level are not reported. Interaction dummies between region and year are not reported. 3 digit occupational dummies (based on ISCO-88 classification) are not reported. * indicates $p < 0.1$, ** indicates $p < 0.05$, *** indicates $p < 0.01$. Data: German Job Vacancy Survey 2005-2014.

The average number of suitable applicants increases from 4.0 suitable applicants for vacancies, which hire *early*, to 4.6 suitable applicants for vacancies, which hire *in time*, and decreases to 4.4 suitable applicants for vacancies, which hire *delayed*. The average fraction of suitable applicants, however, decreases monotonically from 57.8% for vacancies, which hire *early*, to 50.4% and 42.4% for vacancies, which hire *in time* and *delayed*, respectively.¹³

¹³The average fraction of suitable applicants is substantially higher than the ratio of the average number of suitable applicants to the average number of applicants. This difference results from the fact that firms with a large number of applicants receive relatively few suitable applicants while firms with a small number of applicants receive a relatively high share of suitable applicants.

For *failed* vacancies we have no information on the number of suitable applicants.

The first adjustment measure used by “unlucky“ firms is to increase the search effort by activating more search channels. Vacancies, which hire *early*, use on average 1.67 search channels and vacancies, which hire *in time*, 1.84 search channels. If a firm is not able to hire *in time* it activates additional search channels. *Delayed* vacancies use 0.34 search channels more, failed vacancies 0.54.

Table 4: Number of search channels used and the use of each channel - OLS with Entropy Balancing

| | Group <i>In Time</i> (Mean) (1) | Difference between <i>In Time</i> and | | |
|---|---------------------------------------|---------------------------------------|-----------------------|------------------------|
| | | <i>Early</i> (2) | <i>Delayed</i> (3) | <i>Failed</i> (4) |
| Number of search channels activated (Standard Error) | 1.8411 | -0.1740*** (0.0121) | 0.3403*** (0.0136) | 0.5441*** (0.0587) |
| Nr. of Obs. | 20,579 | 20,256 | 9,878 | 786 |
| Use of search channel: Classic (Standard Error) | 0.5291 | -0.0891*** (0.0061) | 0.1064*** (0.0063) | -0.1352*** (0.0097) |
| Nr. of Obs. | 20,579 | 20,256 | 9,878 | 4,005 |
| Use of search channel: Internal (Standard Error) | 0.2416 | -0.0001 (0.0055) | 0.0553*** (0.0058) | 0.0352*** (0.0106) |
| Nr. of Obs. | 20,579 | 20,256 | 9,878 | 4,005 |
| Use of search channel: Speculative (Standard Error) | 0.2660 | -0.0212*** (0.0057) | 0.0374*** (0.0061) | 0.0110 (0.0268) |
| Nr. of Obs. | 20,579 | 20,256 | 9,878 | 786 |
| Use of search channel: Network (Standard Error) | 0.4047 | 0.0602*** (0.0065) | 0.0202*** (0.0066) | 0.0473* (0.0283) |
| Nr. of Obs. | 20,579 | 20,256 | 9,878 | 786 |
| Use of search channel: PEA (Standard Error) | 0.4000 | -0.1238*** (0.0061) | 0.1210*** (0.0067) | 0.2166*** (0.0147) |
| Nr. of Obs. | 20,579 | 20,256 | 9,878 | 2,360 |

Differences are the coefficients of the respective indicator variables for belonging to the group *Early*, *Delayed* or *Failed* in an OLS regression with entropy balancing weights and a restricted sample, including only vacancies with at least 28 days of planned search duration. Standard errors are reported in the parentheses. Covariates on firm and vacancy level are not reported. Interaction dummies between region and year are not reported. 3 digit occupational dummies (based on ISCO-88 classification) are not reported.

* indicates $p < 0.1$, ** indicates $p < 0.05$, *** indicates $p < 0.01$. Data: German Job Vacancy Survey 2005-2014.

Firms most commonly use print or online media or internet platforms to advertise their vacancies. These channels, summarised as classic search channel, are used by 44.0% of vacancies hiring *early* and increases for 8.9 and 10.6 percentage points for vacancies hiring *in time* or *delayed*. The internal search channel, i.e., the practice to fill the position with another employee or to hire an intern or apprentice, seems to be used relatively

rarely by vacancies (24.2% of those hiring *early* or *in time*). Both, *delayed* and *failed* vacancies, use this channel significantly more often (increase of 5.5 and 3.5 percentage points, respectively), which suggests that the internal search channel is only used if hiring via other search channels fails. The fraction of firms receiving (and using) speculative applications increases slightly from 24.5% for *early* hiring firms to 26.6% for firms hiring *in time* to 30.3% for *delayed* hiring firms. Since job seekers – not vacancies – decide on whether or not to send a speculative application, this increase is most likely due to the increased search duration. Contacts initiated by own employees (network search channel) are most frequently observed in the group of vacancies hiring *early* (46.5%). The use of the network then decreases for vacancies hiring *in time* (40.5%) and increases again for vacancies, which hire *delayed* (42.5%) or *failed* to hire (45.2%). The search channel with the highest increase in usage is the intermediation service provided by the public employment agency (*early* 27.6%, *in time*, *delayed* 40.0%, and *failed* 61.7%).

Table 5: **The timing of registering with the PEA**

| | Group <i>In Time</i> | Difference between <i>In Time</i> and | | |
|-------------------------------|----------------------|---------------------------------------|----------------|---------------|
| | (Mean) | <i>Early</i> | <i>Delayed</i> | <i>Failed</i> |
| | (1) | (2) | (3) | (4) |
| Use of search channel: PEA | 0.428 | -0.121 | 0.121 | N.A. |
| Nr. of unregistered vacancies | 3,486 | 5,930 | 1,231 | |
| Nr. of registered vacancies | 2,229 | 2,449 | 1,104 | |

The “fraction of registered vacancies” is calculated by dividing the “number of registered vacancies” by the sum of the “number of unregistered vacancies” and the “number of registered vacancies”. The fraction of registered vacancies for the groups *early* and *delayed* is not reported, only the difference of the fraction to the *in time* group.

Data: German Job Vacancy Survey 2013-2014.

For the years 2013 and 2014 we have for the public employment agency search channel additional information on the date when the vacancy was registered with the PEA. This allows us to calculate when the PEA search channel was actually activated. The respective fractions of registered vacancies shown in Table 5 are close to our estimates based on entropy balancing.

The increase in search effort can explain the increase in the number of applicants, which we observe for vacancies in the groups *in time* and *delayed* compared to vacancies in group *early* (see Table 3). That additional information on open vacancies can increase the number of applicants is also shown by Skandalis (2018), who shows that media news

spreading the information that an expanding plant needs to hire many workers leads to a 60% increase in job applications in the following month. Some firms, however, remain unlucky although they increase their search intensity as the lower number of applications arriving at *failed* vacancies shows.

The numbers presented in Table 3 and Table 4 suggest that the increase in the average number of search channels of 0.17 from the group *early* to the group *in time* and of 0.34 from the group *in time* to the group *delayed* is leading to an increase in the number of applications by 2.3 and 0.9, respectively. This suggests decreasing returns. That additional search channels have a lower return than the ones chosen initially is not surprising, since it is rational to choose first the search channels, which are most efficient, and activate the less efficient ones later. This suggests that the classic search channels and the PEA are not the most efficient search channels to start with. This is in line with evidence from the workers' side. Holzer (1988), and Blau and Robins (1990) for the US, Osberg (1993) for Canada, and Gregg and Wadsworth (1996) for the UK show that the productivity of the classic search channels and the PEA (in generating offers and acceptances) is lower than the productivity of networks and speculative applications.

5.3 Willingness to make concessions

Increasing the number of search channels to receive more (suitable) applications is one way to increase the chances to hire somebody. Another way is to offer those suitable worker, who applied, a higher wage or to consider less suitable applicants as well. The German Job Vacancy Survey contains a set of questions regarding wage bargaining, wage payments, and qualification, experience, and previous labour market status of the hired worker, which allow us to evaluate whether a firm was willing to make such concessions.

While vacancies in the group *early* hire only few workers with an experience level below the initially required level, this fraction is significantly higher (9.6% and 16.0%) for firms, which hired *in time* or *delayed*, respectively, as shown in Table 6. A similar pattern emerges for the qualification level required. The respective fractions of firms, which hired a worker with a qualification level below the required level, is 5.0% for *early* hires, 7.6% for *in time* hires, and 13.2% for *delayed* hires. Unemployed individuals are often thought of as being less productive than employed individuals with the same observable characteristics. If we take unemployment as a signal for lower productivity, then hiring an unemployed worker

Table 6: **Hiring applicants with experience and qualification below the required level and hiring of previously unemployed applicants - OLS with Entropy Balancing**

| | Group <i>In Time</i> (Mean) | Difference between <i>In Time</i> and | | |
|-----------------------------------|--------------------------------|---------------------------------------|----------------|---------------|
| | | <i>Early</i> | <i>Delayed</i> | <i>Failed</i> |
| | (1) | (2) | (3) | (4) |
| Experience lower than required | 0.0957 | -0.0322*** | 0.0640*** | N.A. |
| (Standard Error) | | (0.0036) | (0.0048) | |
| Nr. of Obs. | 19,615 | 19,410 | 9,236 | |
| Qualification lower than required | 0.0759 | -0.0264*** | 0.0561*** | N.A. |
| (Standard Error) | | (0.0033) | (0.0044) | |
| Nr. of Obs. | 19,400 | 19,270 | 8,988 | |
| Hired previously unemployed | 0.3571 | -0.0773*** | 0.0081 | N.A. |
| (Standard Error) | | (0.0059) | (0.0063) | |
| Nr. of Obs. | 20,579 | 20,256 | 9,878 | |

Differences are the coefficients of the respective indicator variables for belonging to the group *Early*, *Delayed* or *Failed* in an OLS regression with entropy balancing weights and a restricted sample, including only vacancies with at least 28 days of planned search duration. Standard errors are reported in the parentheses. Covariates on firm and vacancy level are not reported. Interaction dummies between region and year are not reported. 3 digit occupational dummies (based on ISCO-88 classification) are not reported. * indicates $p < 0.1$, ** indicates $p < 0.05$, *** indicates $p < 0.01$. Data: German Job Vacancy Survey 2005-2014.

can be regarded as a concession. The fraction of hired workers, who have previously been unemployed, increases from 28.0% for vacancies, which hire *early*, to 35.7% and 36.5% for vacancies, which hire *in time* or *delayed*, respectively. For *failed* vacancies data on these variables is obviously not available since no hiring took place.

The results in Table 6 show that firms are less willing to hire somebody with lower qualification or experience or a previously unemployed worker if they are lucky and have enough suitable applicants already before the intended starting date. Once this date is approaching or even exceeded, firms are more willing to hire a less qualified or experienced worker or somebody, who is unemployed before.

Another way to make concessions is to adjust wages. The pattern, which we observe for hourly wages, can be explained with a *match-quality effect* and a *bargaining effect*. The *match-quality effect* predicts that wages paid by vacancies hiring workers with high qualification and experience are higher than wages paid by vacancies hiring workers with low qualification and experience. The *bargaining effect* predicts that wages paid by firms hiring after the intended starting date should be higher, since the bargaining power decreases as the hazard of hiring a worker decreases after the intended starting date.

The first row in Table 7 on wage bargaining supports the hypothesis of the *bargaining*

effect. Firms, which hire *early* or *in time*, bargaining over wages in 32.9% and 31.8% of all cases. For vacancies, which hire *delayed*, the fraction, which report that they bargained over pay, increases significantly by 5.7 percentage points. A similar pattern is shown in the second row, which presents the fraction of firms, which report that they paid more than initially intended. They show that the fraction of firms, which reported to have paid higher wages than initially expected, increases from around 8.1% and 9.2% for vacancies, which hire *early* or *in time*, to 13.7% for vacancies, which hire *delayed*.

Table 7: **Wage bargaining, hourly wages and paid more than intended - OLS with Entropy Balancing**

| | Group <i>In Time</i> | Difference between <i>In Time</i> and | | |
|-------------------------|----------------------|---------------------------------------|----------------|---------------|
| | (Mean) | <i>Early</i> | <i>Delayed</i> | <i>Failed</i> |
| | (1) | (2) | (3) | (4) |
| Wage bargaining | 0.3177 | -0.0110 | 0.0570** | N.A. |
| (Standard Error) | | (0.0109) | (0.0110) | |
| Nr. of Obs. | 6,040 | 5,964 | 3,127 | |
| Paid more than intended | 0.0861 | -0.0059 | 0.0508*** | N.A. |
| (Standard Error) | | (0.0036) | (0.0042) | |
| Nr. of Obs. | 20,370 | 20,023 | 9,777 | |
| Hourly wage (Euro) | 13.1879 | 0.3552*** | 0.4060*** | N.A. |
| (Standard Error) | | (0.1377) | (0.1298) | |
| Nr. of Obs. | 2,578 | 2,496 | 1,508 | |

Differences are the coefficients of the respective indicator variables for belonging to the group *Early*, *Delayed* or *Failed* in an OLS regression with entropy balancing weights and a restricted sample, including only vacancies with at least 28 days of planned search duration. Standard errors are reported in the parentheses. Covariates on firm and vacancy level are not reported. Interaction dummies between region and year are not reported. 3 digit occupational dummies (based on ISCO-88 classification) are not reported. * indicates $p < 0.1$, ** indicates $p < 0.05$, *** indicates $p < 0.01$. Data for “Wage bargaining took place”: German Job Vacancy Survey 2011-2013. Data for “Average hourly wage”: German Job Vacancy Survey 2014. Data for “Paid more than intended”: German Job Vacancy Survey 2005-2014.

The pattern for average hourly wages shown in Table 7 can be explained as follows. The group of vacancies, which hire *early*, make less often concessions and thus hire workers with on average higher qualification and experience and less often unemployed workers. This results in a significantly higher wage (13.54 Euros) compared to the group of vacancies, which hire *in time* (13.19 Euros). Firms, which hire *delayed*, pay again significantly higher wages (13.59 Euros). Given that these firms make concessions as shown in Table 6 the higher wage can be explained by the *bargaining effect* dominating the *match-quality effect*.

Table 8 controls for the *match-quality effect* by conditioning on vacancies, which made no concessions in terms of qualification and experience. To account for the wage-difference

due to unemployment the results are presented separately for vacancies which hired a previously unemployed worker and for vacancies which hired a previously employed worker. If a previously employed worker is hired, bargaining over wages and payment above the initially intended level increases again only if the firm is not able to hire until the intended starting date. This can be explained by the *bargaining effect*. Wages paid by firms hiring *early* are still somewhat higher than wage paid by firms hiring *in time*, but the effect is not statistically significant. The wage pattern for previously unemployed workers is the same.

Table 8: **Wage bargaining, hourly wages and paid more than intended - controlled for qualification and experience of hired workers - OLS with Entropy Balancing**

| | Group <i>In Time</i> (Mean) (1) | Difference between <i>In Time</i> and | | |
|-------------------------------|---------------------------------------|---------------------------------------|-----------------------|----------------------|
| | | <i>Early</i> (2) | <i>Delayed</i> (3) | <i>Failed</i> (4) |
| previously employed workers | | | | |
| Wage bargaining | 0.3243 | -0.0020 | 0.0748*** | N.A. |
| (Standard Error) | | (0.0135) | (0.0148) | |
| Nr. of Obs. | 3,623 | 4,458 | 1,714 | |
| Paid more than intended | 0.0810 | 0.00137 | 0.0519*** | N.A. |
| (Standard Error) | | (0.0047) | (0.0058) | |
| Nr. of Obs. | 11,089 | 13,651 | 5,014 | |
| Hourly wage (Euro) | 13.93 | 0.1741 | 0.3872** | N.A. |
| (Standard Error) | | (0.1964) | (0.1897) | |
| Nr. of Obs. | 1,558 | 1,810 | 826 | |
| previously unemployed workers | | | | |
| Wage bargaining | 0.2671 | -0.0466** | 0.0587** | N.A. |
| (Standard Error) | | (0.0249) | (0.0251) | |
| Nr. of Obs. | 1,460 | 792 | 606 | |
| Paid more than intended | 0.0542 | -0.0155*** | 0.0322*** | N.A. |
| (Standard Error) | | (0.0060) | (0.0075) | |
| Nr. of Obs. | 5,742 | 3,530 | 2,103 | |
| Hourly wage (Euro) | 11.85 | 0.3485 | 0.7894*** | N.A. |
| (Standard Error) | | (0.2712) | (0.2438) | |
| Nr. of Obs. | 536 | 356 | 264 | |

Differences are the coefficients of the respective indicator variables for belonging to the group *Early*, *Delayed* or *Failed* in an OLS regression with entropy balancing weights and a restricted sample, including only vacancies with at least 28 days of planned search duration. Standard errors are reported in the parentheses. Covariates on firm and vacancy level are not reported. Interaction dummies between region and year are not reported. 3 digit occupational dummies (based on ISCO-88 classification) are not reported. * indicates $p < 0.1$, ** indicates $p < 0.05$, *** indicates $p < 0.01$. Data for “Wage bargaining took place”: German Job Vacancy Survey 2011-2013. Data for “Average hourly wage”: German Job Vacancy Survey 2014. Data for “Paid more than intended”: German Job Vacancy Survey 2005-2014.

For previously unemployed workers, firms are generally less willing to bargain or increase payment above the initially intended level. This can be explained by the generally worse outside option that unemployed have compared to employed workers or by selection, i.e., that unemployed workers are worse in bargaining or related skills. Most interestingly, however there is a different trend in wage bargaining over the recruitment process if we compare previously employed and previously unemployed hires. The fact that bargaining over wages and payment above the initially intended level is less often observed by vacancies hiring a previously unemployed workers *early* compared to vacancies, which hire a previously unemployed *in time*, can be explained if we assume that unemployed workers prefer an earlier employment start over higher wages. If this is the case than we should not only see lower levels of wage bargaining in the comparison between the vacancy groups *early* and *in time* as shown in Table 8, we should also see that firms, which hire *early* are more willing to bargain about when employment starts with previously unemployed than with previously employed workers. We have no information on whether or not firms and workers bargained about the date when employment should start. However, we observe when employment actually started and can therefore investigate this hypothesis by analysing how the fraction of new hirings, which started employment prior to the intended starting date, differs according to the previous employment status with the hired worker.

Table 9: **Employment start prior or after intended starting date and employment status**

| | Vacancies hiring <i>delayed</i> | |
|-------------------------------|--|---|
| | all <i>delayed</i> vacancies (1) | at least 3 months between hiring and intended starting date (2) |
| previously unemployed workers | 0.0653*** (0.0060) | 0.0860** (0.0337) |
| Nr. of Obs. | 18,779 | 2,109 |
| R^2 | 0.0895 | 0.4080 |

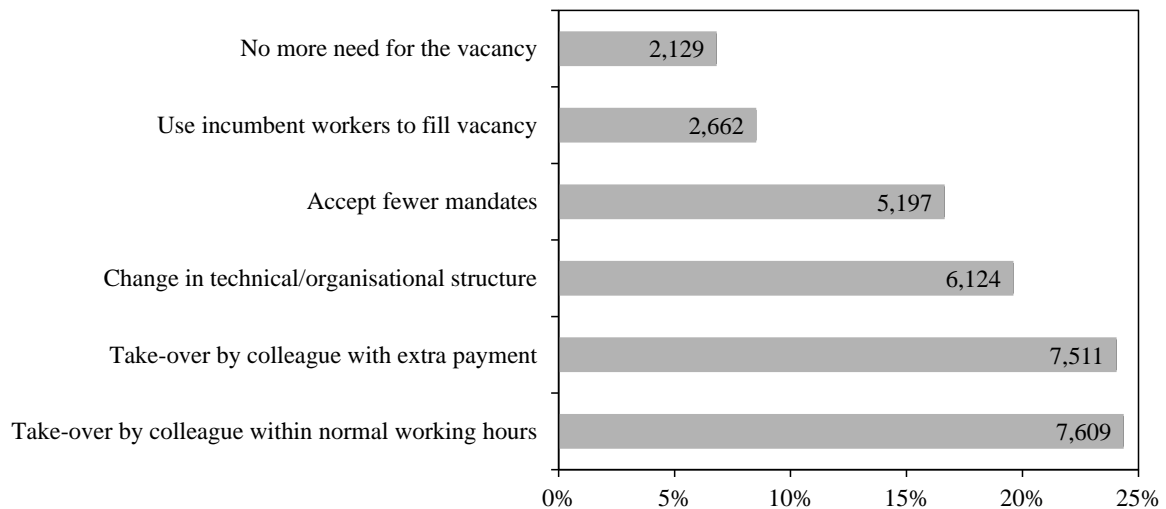
Estimated with OLS. Standard errors are reported in the parentheses. Covariates on firm and vacancy level are not reported. Interaction dummies between region and year are not reported. 3 digit occupational dummies (based on ISCO-88 classification) are not reported. * indicates $p < 0.1$, ** indicates $p < 0.05$, *** indicates $p < 0.01$. Data: German Job Vacancy Survey 2005-2014.

In Table 9 we present OLS estimates of the effect that the previous employment status has on the fraction of new hirings, which started employment prior to the intended starting

date (the indicator variable is 1 if employment started prior to the intended starting date and 0 otherwise). The sample consists only of vacancies, which hire *delayed*. We control for the same set of firm- and vacancy characteristics as in Tables 7 to 8. Column (1) in Table 9 shows that the fraction of new hirings, which started employment prior to the intended starting date, is 6.5 percentage points higher if the hired worker was previously unemployed. To rule out that this result is due to the legal notice period of 3 months for employed workers in Germany, we restrict in column (2) the sample to *delayed* hiring firms, which hired (signed the employment contract) at least 3 months ahead of the intended starting date. The result is robust. This supports our hypothesis that previously unemployed worker prefer earlier employment over higher wages and thus bargain less over wages as the estimates in Table 8 show.

5.4 Reaction of the failed vacancies

Figure 4: Reaction of firms towards failure in filling their vacancy



No. of Obs.: 17,084. Data: German Job Vacancy Survey 2005-2014

The German Job Vacancy Survey includes some information on how *failed* firms react, if they stopped searching. The survey asks how firms handle the tasks, which should originally be done by the newly employed worker. Figure 4 summarises the replies to this question. Multiple answers are allowed. Most firms spread the tasks among incumbent

workers either with or without an extra compensation (24.1% and 24.4% respectively) or delegate the work entirely to one incumbent worker (8.5%). Other firms try to overcome the labour shortage by increasing technical or organisational efficiency (19.6%). 16.6% of firms accept fewer orders and reduce output, because they do not have the labour force needed. Only few firms (6.8%) indicate that they do not need the vacancy any longer due to changes in the product market situation.

5.5 Robustness Checks

Whereas the previous section 5 presented results based on entropy balancing and considered only those vacancies, which had more than 28 days (or 4 weeks) of planned search duration, this section investigates whether the results are robust to including also vacancies with a shorter planned search duration or if we use instead of entropy balancing radius matching.

5.5.1 Sample including vacancies with shorter planned search duration

In the previous section we restricted the sample to vacancies with more than 28 days of planned search duration to account for unobservable characteristics of a vacancy. E.g. a firm indicating a shorter planned search period might be exposed to a certain limitation (e.g. a short term order which has to be fulfilled) and simply needs a new employee as fast as possible. Therefore, such firms might differ in their way of searching for a worker or in their willingness to accept less qualified candidates in contrast to other firms which do not suffer such restrictions.

Table A5 in the Appendix displays the results for problems during the recruitment process for the unrestricted sample with entropy balancing weights. As in our benchmark specification in section 5 *early* hires report significantly fewer problems because of not having enough suitable applicants or higher wage demands by applicant in contrast to the *in time* group and even more so in contrast to the *delayed* and *failed* groups. The results are also similar for the number of (suitable) applicants and the fraction of suitable applicants as shown in Table A6 in the Appendix, i.e., the number of applicants increases from the groups *early* to the groups *in time* and *delayed* and decreases again for the group *failed*. The fraction of suitable applicants among all applicants decreases from the highest value for the *early* group down to the lowest value for the *delayed* group (suitable

applicants are not available for *failed* vacancies). The picture remains also unchanged for the increase in search intensity, which we observed in the restricted sample (see Table A7 in the Appendix). Also the pattern of how firms adjust the single search channels remains the same. Table A8 in the Appendix shows that vacancies, which are not able to hire *early*, are like in the benchmark case more and more willing to hire applicants, who are unemployed or have an experience or a qualification lower than initially required. Also wage bargaining, payment above the initially intended level, and the hourly wage of all hired workers follows a similar pattern as in the benchmark case (see Table A9 in the Appendix). The difference in hourly wages between the groups *early* and *in-time* is no longer statistically significant, but the sign is the same.¹⁴ The results for the sub-sample of matches, in which no concessions were made, are also generally in line with the benchmark case. That the results are robust to including vacancies with a planned search duration shorter than 28 days is comforting and shows that the documented dynamics of the recruitment pattern holds in general.

5.5.2 Radius matching with the baseline sample

As an alternative to the entropy balancing approach we use a radius matching approach to match the *in time* group with the *early*, *delayed* and *failed* hires. The literature on propensity score matching suggests to use radius matching proposed by Huber et al. (2015), Lechner et al. (2011), and Lechner and Wunsch (2009), because it allows for a relatively high precision especially in settings when many good comparison observations are available. The approach is a combination of propensity score matching and nearest neighbour matching. After calculating the propensity score of belonging to the groups *early*, *delayed* or *failed* hires respectively a radius is formed around each observation in group *in time*. Every observation in this radius is then used to form a synthetic control observation in the group *early*, *delayed* or *failed* hires respectively, where all control observations are weighted by inverse probability weighting, based on their distance towards the observations in the *in time* group. This approach is applied onto the restricted sample with vacancies, which have more than 28 days of planned search duration to control also unobservable

¹⁴For hourly wages of previously unemployed workers hired *early*, we are unable to present results, because the entropy balancing weights obtained for this small sample (wages are only available in 2014) are due to the lack of common support (the planned search duration in the *early* group has to be longer than 28 days by definition, while the planned search duration in the *in time* group includes a majority of vacancies with less than 28 days of planned search duration) are equal to zero.

dimensions.¹⁵

The radius matching approach is unlike the entropy balancing approach not always able to match the mean of the covariates. The reported t-statistics in Table A11 in the Appendix suggest that the means of the planned search duration, the low and high qualification requirement, full-time job, temporary job, firm size, low sales, financial constraints, and skilled labour shortage between the *in time* group and at least for one of the comparison groups *early*, *delayed* or *failed* are statistically significantly different. In the respective OLS-regressions we control again for the set of covariates used in the matching. Not surprisingly we find that in some cases the coefficients with and without the control of the matching covariates differ significantly. However, the differences are small in size.

Despite the insufficient balancing of covariates due to radius matching the results are qualitatively the same as with entropy balancing. This can be seen by comparing the respective Tables A12 to A17 in the Appendix with the respective Tables in section 5.

6 Theoretical explanations

In the following section we discuss in how far different theories are able to explain the recruitment pattern, which we observe.

6.1 Planned search duration and the increasing hazard

Our results show that more than 80% of firms plan to need more than four weeks to recruit a worker. During firms' planned search duration the estimated weekly vacancy-filling hazard increases. This suggests that most firms do not start to hire immediately. They rather screen and gather applications until they have enough suitable applicants so that the chances of hiring one of them is high enough.

One obvious reason for not hiring immediately is to screen applicants. We are not aware of a theory, which explicitly models the time needed to screen applicants. However, directed search models or stock-flow matching models, in which sorting and screening of workers is assumed to take place instantaneously,¹⁶ could be easily amended to account

¹⁵We also used the standard propensity score and nearest neighbour matching estimator. The results are very similar.

¹⁶See Guerrieri et al. (2010), Shao (2014), Chang (2018), Guerrieri and Shimer (2014), Chen et al. (2016), Williams (2016), Davoodalhosseini (2018), Holzner and Watanabe (2018) for directed search models with screening and Coles and Muthoo (1998), Coles and Smith (1998), Ebrahimi and Shimer (2010), and Carrillo-Tudela and Hawkins (2017) for stock-flow matching models with screening.

for a planned search duration. And heterogeneity in planned search durations could be explained with heterogeneity in the time needed to screen applicants. Another explanation for observing why firms want to delay employment is advance notice of workers, who will leave the firm and need to be replaced only in a few weeks/months time (see Burdett and Cunningham (1994) and Burdett and Cunningham (1998)). A third reason for observing planned search durations is that firms decide to gather a sufficiently high number of suitable applicants before starting to negotiate over pay. Albrecht et al. (2006) or Gautier and Holzner (2016) show that firms are able to pay lower wages, if their applicants, who apply at different firms simultaneously, are able to bring workers into competition for the vacant job. This is, however, only possible, if the number of applicants exceeds the number of connected firms.

If applicants arrive at a Poisson rate – as dynamic search models generally assume – then advance notice and gathering applicants could explain the increasing vacancy-filling hazard during the planned search duration. The Poisson arrival rate of applicants predicts over time an increasing number of firms, which have gathered sufficiently many applicants to let them compete for the job. Thus an increasing number of firms will hire as time passes. In a random search model with advance notice Burdett and Cunningham (1994) and Burdett and Cunningham (1998) show – in the spirit of van den Berg (1990) – that the longer the advance notice the pickier firms are and that firms lower their reservation productivity as the intended starting date approaches. This explains also the increasing hazard rate as the intended starting date approaches.

Also a directed search model with screening – if suitably adjusted – can explain the increasing hazard. If directed search is embedded in a dynamic model, where workers randomly (at a Poisson rate) receive notice about an available vacancy, then workers apply at a Poisson rate. If one further assumes economies of scale in screening, then firms will again wait until they have enough applications collected. The increasing hazard during the planned search duration can then again be explained by the Poisson arrival rate, which predicts that the number of firms, which have gathered sufficiently many applicants, increases over time.

Stock-flow matching models as proposed by Coles and Muthoo (1998) and Coles and Smith (1998) and more recently by Ebrahimi and Shimer (2010) and Carrillo-Tudela and Hawkins (2017) are based on the assumption that new vacancies have a frictionless access

to a stock of unemployed job seekers. Only if a new vacancy is not able to find a suitable applicant among the stock of unemployed, then it has to wait for new unemployed to arrive (inflow) in order to be able to find a suitable candidate. If screening takes place instantaneously, then the vacancy-filling hazard is initially very high, since the inflow of new vacancies are matched with the stock of unemployed job seekers and drops sharply afterwards. If one introduces a screening period, then an increase in the vacancy-filling hazard during the planned search duration can be explained if firms follow a sequential screen policy. Such a policy is optimal if screening is time-consuming and time is costly. Firms will then use a reservation productivity rule in order to decide when to stop screening. Given the number of applicants a firm received (from the stock of unemployed job seekers) and the expected low inflow of new job seekers the reservation productivity decreases as less and less unscreened applicants are left. As time progresses it will therefore be more and more likely that one of the screened applicants passes the reservation productivity threshold and hiring takes place.

Thus, a multitude of theories - if suitably extended - can explain why firms do not hire immediately but plan that they need some time to find, screen and hire a suitable applicant. These theories can also explain why the vacancy-filling hazard is increasing during the planned search duration.

6.2 Number of (suitable) applicants, search intensity, and decreasing hazard after the intended starting date

Our results also show in the line with the evidence by van Ours and Ridder (1992) for the Netherlands that the majority of applicants arrive *early*. Close and especially after the intended starting date the number of additionally arriving applicants is low. This goes together with a decreasing vacancy-filling hazard after the intended starting date. At the same time the fraction of suitable applicants decreases indicating that firms, which hire later are unlucky in receiving suitable applicants. If firms have not received enough applications from suitable candidates, they activate additional search channels to increase the number of applications. The additionally activated search channels have a lower return than the initially activated ones.

Traditional search models, which assume that workers randomly search, have difficulties in explaining the decline in applicants over time and the decrease in the vacancy-filling hazard after the intended starting date. Models with stock-flow matching, instead, are

build to explain this pattern. Newly posted vacancies initially receive many applications from the stock of job seekers. If a vacancy cannot be filled by matching with an applicant from the stock of job seekers, it has to wait until new workers start to search. This could be young or inactive workers, who enter the labour market, or currently employed workers, who are laid off. Since the inflow of new job seekers is small compared to the stock of job seekers, the number of new applicants and the vacancy-filling hazard drops after a vacancy was unable to match with somebody from the stock of job seekers.

Another explanation for the decreasing number of applicants and the decreasing vacancy-filling hazard over time is the literature on phantom vacancies by Cheron and Decreuse (2016) and Albrecht et al. (2017). Especially the latter paper, which combines directed search with phantom vacancies, is able to explain this pattern. Phantom vacancies are vacancies, which are still advertised, although they are no longer available either because somebody has already been hired or because the screening process is already at such an advanced stage that it is unlikely that the firm will consider late arriving applications. Albrecht et al. (2017) show that workers are therefore more likely to apply to newly posted vacancies than to older vacancies and that the number of arriving applicants and the vacancy-filling hazard are therefore decreasing over time.

The stock-flow matching literature and the directed search literature with phantom vacancies are well suited to explain the observed pattern in the number of arriving applicants and the vacancy-filling hazard. They could also be extended to account for the use of additional search channels, if the initially chosen search channels are not generating the number of suitable applicants necessary.

6.3 Reservation productivity and wages

We therefore need further evidence to be able to distinguish between the respective theories. Firms, which are unable to hire until the intended starting date, are more willing to hire workers with a qualification or experience below the initially required level or a previously unemployed workers. In addition firms, which are not able to hire until the intended starting date, become more and more willing to bargain over wages and pay wages above the initially intended level. Furthermore, the shape of the vacancy-filling hazard suggests that the higher willingness to bargain over wages increases as the likelihood to hire somebody decreases.

This pattern can be explained by the stock-flow matching theory. The decline in potential matching partners after a firm failed to hire somebody from the stock of job seekers decreases its outside option. Thus, firms, which remain unlucky and cannot find a suitable worker until the intended starting date, are willing to make concessions by accepting workers with a lower qualification or experience or by increasing their willingness to bargain over pay and to pay higher wages than initially intended.

The increased willingness to make concessions or pay higher wages is difficult to explain with a directed search model with phantom vacancies. If firms fail to find a suitable worker until the intended starting date, then it would be optimal for them to post this information and signal to job seekers, that they are no phantoms. They would then receive equally many applications as new vacancies and there would be no need to make concessions.

This suggests that stock-flow matching models, if amended by a screening period, would be most suitable to explain the recruitment pattern, which we observed.

6.4 Behaviour of failed vacancies

Vacancies, which fail to hire, have been unlucky. They received not enough applications from suitable candidates even if they activated additional search channels. They also report that applicants were not willing to accept their low wage offers and they were apparently not willing to meet the higher wage demands to secure a hire. The fact that most firms, which failed to hire, spread the tasks of the vacant position among incumbent workers with or without extra pay suggests this is the cheaper option for those firms.

We are not aware of a theory, which considers this inside option when deciding on the wage they offer to an applicant.

7 Conclusion

In this paper we identify new patterns about the recruitment behaviour of firms. We use entropy balancing on observable vacancy characteristics to generate synthetic control groups for firms, which have been unlucky in the search process. In addition we are able to control for unobserved vacancy characteristics by controlling for planned search durations. Using this method we show that the vacancy-filling hazard is increasing during the planned search period and decreases thereafter, that most applicants arrive early in the recruitment process, and that the willingness to pay higher wages or to hire less qualified

or experienced applicants increases for firms, which have been unlucky and unable to hire until the intended starting date.

We compare our findings with the predictions of different theories and argue that stock-flow matching models – if suitably amended by a time-consuming screening technology – are best able to explain the whole recruitment pattern, which we observe. Other theories are only partly able to explain our findings. The second best fit provides a dynamic directed search model with phantom vacancies and screening. While it is able to explain the initially increasing and later decreasing vacancy-filling hazard, it is, however, unable to explain why firms should be willing to make concessions once they fail to hire initially.

References

- Albrecht, J., Decreuse, B., and Vroman, S. (2017). Directed Search with phantom vacancies. *mimeo*.
- Albrecht, J., Gautier, P. A., and Vroman, S. (2006). Equilibrium directed search with multiple applications. *Review of Economic Studies*, 73(4):869–891.
- Andrews, M. J., Bradley, S., Stott, D., and Upward, R. (2013). Estimating the Stock-Flow Matching Model Using Micro Data. *Journal of the European Economic Association*, 11(5):1153–1177.
- Blau, D. M. and Robins, P. K. (1990). Job search outcomes for the employed and unemployed. *Journal of Political Economy*, 98(3):637–655.
- Brenzel, H., Czepek, J., Kiesl, H., Kriechel, B., Kubis, A., Moczall, A., Rebien, M., Röttger, C., Szameitat, J., Warning, A., and Weber, E. (2016). Revision of the IAB Job Vacancy Survey: Backgrounds, methods and results. *IAB-Forschungsbericht*, (4/2016).
- Burdett, K. and Cunningham, E. (1994). The duration of a vacancy. In Muysken, J., editor, *Measurement and Analysis of Job Vacancies: An International Comparison*, chapter 8, pages 147–168. Aldershot: Avebury.
- Burdett, K. and Cunningham, E. J. (1998). Toward a Theory of Vacancies. *Journal of Labor Economics*, 16(3):445–478.
- Cahuc, P., Carcillo, S., and Zylberberg, A. (2014). *Labor Economics*. MIT Press.
- Caliendo, M. and Kopeinig, S. (2008). Some practical guidance for the implementation of propensity score matching. *DIW Discussion Paper*, 22(1):31–72.
- Carrillo-Tudela, C. and Hawkins, W. (2017). A Stock-Flow Theory of Unemployment with Endogenous Match. *mimeo*.
- Chang, B. (2018). Adverse selection and liquidity distortion. *Review of Economic Studies*, 85(1):275–306.
- Chen, Y., Doyle, M., and Gonzalez, F. M. (2016). Skill mismatch in competitive search equilibrium. *mimeo*.
- Cheron, A. and Decreuse, B. (2016). Matching with phantoms. *Review of Economic Studies*, 1:1–33.
- Coles, M. and Petrongolo, B. (2008). A test between stock-flow matching and the random matching function approach. *International Economic Review*, 49(4):1113–1141.
- Coles, M. G. and Muthoo, A. (1998). Strategic Bargaining and Competitive Bidding in a Dynamic Market Equilibrium. *Review of Economic Studies*, 65(2):235–260.
- Coles, M. G. and Smith, E. (1998). Marketplaces and Matching. *International Economic Review*, 39(1):239–254.
- Davis, S. J., Röttger, C., Moczall, A., and Warning, A. (2017). Duration dependence and returns to scale in job vacancies in Germany, 2000 - 2013. *mimeo*.
- Davoodalhosseini, S. M. (2018). Constrained Efficiency with Adverse Selection and Directed Search. *mimeo*.
- Ebrahimi, E. and Shimer, R. (2010). Stock-flow matching. *Journal of Economic Theory*, 145(4):1325–1353.

- Faberman, R. J. and Menzio, G. (2017). Evidence on the relationship between recruiting and the starting wage. *Labour Economics*, (forthcoming).
- Gautier, P. A. and Holzner, C. L. (2016). Maximum matching in the labor market under incomplete information. *mimeo*.
- Gregg, P. and Petrongolo, B. (2005). Stock-flow matching and the performance of the labor market. *European Economic Review*, 49(8):1987–2011.
- Gregg, P. and Wadsworth, J. (1996). How effective are state employment agencies? Jobcentre use and job matching in Britain. *Oxford Bulletin of Economics and Statistics*, 58(3):443–467.
- Guerrieri, V. and Shimer, R. (2014). Dynamic Adverse Selection: A theory of liquidity, fire sales, and flight to quality. *American Economic Review*, 104(7):1875–1908.
- Guerrieri, V., Shimer, R., and Wright, R. (2010). Adverse Selection in Competitive Search Equilibrium. *Econometrica*, 78(6):1823–1862.
- Hainmueller, J. (2012). Entropy balancing for causal effects: A multivariate reweighting method to produce balanced samples in observational studies. *Political Analysis*, 20(1):25–46.
- Hainmueller, J. and Xu, Y. (2013). Ebalance: a Stata package for entropy balancing. *Journal of Statistical Software*, 54(7):1–18.
- Heckmann, M., Noll, S., and Rebien, M. (2013). Stellenbesetzungen mit Hindernissen: Bestimmungsfaktoren für den Suchverlauf. *AStA Wirtschafts- und Sozialstatistisches Archiv*, 6(3-4):105–131.
- Holzer, H. J. (1988). Search Method Use by Unemployed Youth. *Journal of Labor Economics*, 6(1):1–20.
- Holzner, C. and Watanabe, M. (2018). Understanding the Role of Public Employment Agency. *mimeo*.
- Huber, M., Lechner, M., and Steinmayr, A. (2015). Radius matching on the propensity score with bias adjustment: tuning parameters and finite sample behaviour. *Empirical Economics*, 49(1):1–31.
- Kettemann, A., Mueller, A. I., and Zweimüller, J. (2017). Wages, Workers and Vacancy Durations: Evidence from Linked Data. *mimeo*.
- Kettner, A., Heckmann, M., Rebien, M., Pausch, S., and Szameitat, J. (2011). Die IAB-Erhebung des gesamtwirtschaftlichen Stellenangebots - Inhalte, Daten und Methoden (The IAB Job Vacancy Survey - content, data and methods). *Journal for Labour Market Research*, 44(3):245–260.
- King, G. and Nielsen, R. (2016). Why propensity score should not be used for matching. *mimeo*, (617):32.
- Krueger, A. B. and Mueller, A. I. (2012). The lot of the unemployed: A time use perspective. *Journal of the European Economic Association*, 10(4):765–794.
- Kuhn, P. and Mansour, H. (2014). Is Internet Job Search Still Ineffective? *Economic Journal*, 124(581):1213–1233.
- Kuhn, P. and Skuterud, M. (2004). Internet Job Search and Unemployment Durations. *American Economic Review*, 94(1):218–232.
- Kuo, M. Y. and Smith, E. (2009). Marketplace matching in Britain: Evidence from individual unemployment spells. *Labour Economics*, 16(1):37–46.

- Lechner, M., Miquel, R., and Wunsch, C. (2011). Long-run effects of public sector sponsored training in West Germany. *Journal of the European Economic Association*, 9(4):742–784.
- Lechner, M. and Wunsch, C. (2009). Are Training Programs More Effective When Unemployment Is High? *Journal of Labor Economics*, 27(4):653–692.
- Osberg, L. (1993). Fishing in different pools: job-search strategies and job-finding success in Canada in the early 1980s. *Journal of Labor Economics*, 11(2):348–386.
- Pissarides, C. (2000). *Equilibrium unemployment theory*. MIT Press.
- Russo, G., Rietveld, P., Nijkamp, P., and Gorter, C. (2000). Recruitment channel use and applicant arrival: An empirical analysis. *Empirical Economics*, 25(4):673–697.
- Shao, E. (2014). The threat of counterfeiting in competitive search equilibrium. *Journal of Economic Dynamics and Control*, 47:168–185.
- Skandalis, D. (2018). Breaking News: The Role of Information in Job Search and Matching. *mimeo*.
- van den Berg, G. J. (1990). Nonstationarity in Job Search Theory. *Review of Economic Studies*, 57(2):255.
- van Ours, J. and Ridder, G. (1992). Vacancies and the Recruitment of New Employees. *Journal of Labor Economics*, 10(2):138–155.
- Williams, B. (2016). Search, Liquidity, and Retention: Signaling Multidimensional Private Information. *mimeo*.
- Wooldridge, J. M. (2010). *Econometric analysis of cross section and panel data*. MIT Press.
- Wright, R., Kircher, P., Julien, B., and Guerrieri, V. (2017). Directed Search: A Guided Tour. *mimeo*.

A Appendix

Table A1: Determinants of planned search duration (OLS-regression)

| Dependent Variable: | Log of planned search duration |
|------------------------------|--------------------------------|
| Low qualification required | -0.2794*** (0.0207) |
| High qualification required | 0.1331*** (0.0159) |
| Experience required | 0.0481*** (0.0101) |
| Permanent position | 0.0628*** (0.0115) |
| Full-time employment | 0.0419*** (0.0128) |
| Seasonal employment | -0.0735*** (0.0247) |
| Temporary employment | -0.2207*** (0.0168) |
| Log of firm size (employees) | -0.0086** (0.0037) |
| Financial constraints | -0.0240 (0.0202) |
| Low sales | -0.0309** (0.0147) |
| Skilled labour shortage | -0.0785*** (0.0190) |
| Nr. of Obs. | 52,336 |
| R^2 | 0.1392 |

Results represent OLS-results with robust standard errors in parentheses. Control variables for year, industry, region, month of search start and day within month of search start are not reported. Data: German Job Vacancy Survey 2005-2014. * indicates $p < 0.1$, ** indicates $p < 0.05$, *** indicates $p < 0.01$.

Table A2: Hazard rates for different planned search duration

| Weeks relative to the intended starting date | Weeks of planned search duration | | | | | | all nr. at risk |
|---|----------------------------------|--------|--------|--------|--------|--------|--------------------|
| | 0 | 4 | 8 | 13 | 17 | | |
| | (1) | (2) | (3) | (4) | (5) | (6) | |
| -18 | | | | | | 0.3196 | 7,620 |
| -17 | | | | | 0.0177 | 0.0469 | 8,918 |
| -16 | | | | | 0.0033 | 0.0161 | 8,779 |
| -15 | | | | | 0.0194 | 0.0273 | 9,282 |
| -14 | | | | | 0.0070 | 0.0237 | 9,329 |
| -13 | | | | 0.0232 | 0.0983 | 0.0771 | 15,314 |
| -12 | | | | 0.0063 | 0.0162 | 0.0165 | 15,727 |
| -11 | | | | 0.0224 | 0.0386 | 0.0341 | 16,651 |
| -10 | | | | 0.0122 | 0.0244 | 0.0226 | 16,932 |
| -9 | | | | 0.1571 | 0.2050 | 0.1323 | 17,230 |
| -8 | | | 0.0318 | 0.0365 | 0.0310 | 0.0511 | 26,791 |
| -7 | | | 0.0115 | 0.0929 | 0.0964 | 0.0553 | 26,501 |
| -6 | | | 0.0560 | 0.0572 | 0.0485 | 0.0649 | 28,452 |
| -5 | | | 0.0341 | 0.3636 | 0.1377 | 0.1169 | 27,656 |
| -4 | | 0.1181 | 0.3037 | 0.0778 | 0.3377 | 0.1921 | 37,888 |
| -3 | | 0.0690 | 0.1008 | 0.2995 | 0.1214 | 0.1212 | 32,424 |
| -2 | | 0.3006 | 0.3021 | 0.1644 | 0.2510 | 0.2763 | 32,760 |
| -1 | | 0.2040 | 0.2020 | 0.1369 | 0.1194 | 0.2567 | 25,446 |
| 1 | 0.4729 | 0.3142 | 0.2937 | 0.2446 | 0.2388 | 0.3537 | 23,480 |
| 2 | 0.1472 | 0.1714 | 0.1042 | 0.0961 | 0.0770 | 0.1630 | 15,175 |
| 3 | 0.1615 | 0.2389 | 0.2357 | 0.1919 | 0.1667 | 0.2266 | 12,701 |
| 4 | 0.0824 | 0.1456 | 0.1114 | 0.0499 | 0.0605 | 0.1331 | 9,823 |
| 5 | 0.2396 | 0.2935 | 0.1408 | 0.2850 | 0.3249 | 0.2340 | 8,516 |
| 6 | 0.0765 | 0.0858 | 0.2308 | 0.0668 | 0.0332 | 0.1282 | 6,523 |
| 7 | 0.0918 | 0.1776 | 0.0899 | 0.1575 | 0.1717 | 0.1426 | 5,687 |
| 8 | 0.0555 | 0.1034 | 0.1547 | 0.0652 | 0.0777 | 0.1112 | 4,876 |
| 9 | 0.2109 | 0.1328 | 0.0686 | 0.2939 | 0.1854 | 0.1530 | 4,334 |
| 10 | 0.0492 | 0.2128 | 0.2810 | 0.0644 | 0.2759 | 0.1885 | 3,671 |
| 11 | 0.0853 | 0.0946 | 0.0721 | 0.1697 | 0.1048 | 0.0967 | 2,979 |
| 12 | 0.0612 | 0.1597 | 0.1452 | 0.0718 | 0.1596 | 0.1249 | 2,691 |
| 13 | 0.0782 | 0.0604 | 0.1029 | 0.0893 | 0.0886 | 0.0828 | 2,355 |
| 14 | 0.1837 | 0.2401 | 0.3013 | 0.3072 | 0.3056 | 0.2347 | 2,160 |
| 15 | 0.0736 | 0.0547 | 0.0534 | 0.0755 | 0.1600 | 0.0823 | 1,653 |
| 16 | 0.1005 | 0.1079 | 0.1452 | 0.1020 | 0.2857 | 0.1239 | 1,517 |
| 17 | 0.0442 | 0.0767 | 0.0708 | 0.1250 | 0.1000 | 0.0745 | 1,329 |
| 18 | 0.2092 | 0.2875 | 0.2284 | 0.4026 | 0.9259 | 0.2504 | 1,230 |
| 19 | 0.0275 | 0.0493 | 0.3026 | 0.1087 | 1.0000 | 0.1182 | 922 |
| 20 | 0.0636 | 0.1887 | 0.1226 | 0.2195 | | 0.1353 | 813 |
| 21 | 0.0415 | 0.0640 | 0.1183 | 0.1563 | | 0.0953 | 703 |
| 22 | 0.2165 | 0.1118 | 0.0976 | 0.9259 | | 0.1965 | 636 |
| 23 | 0.0452 | 0.2448 | 0.4459 | 1.0000 | | 0.2172 | 511 |
| 24 | 0.0474 | 0.0833 | 0.0976 | | | 0.0725 | 400 |
| 25 | 0.0552 | 0.1515 | 0.2432 | | | 0.1267 | 371 |

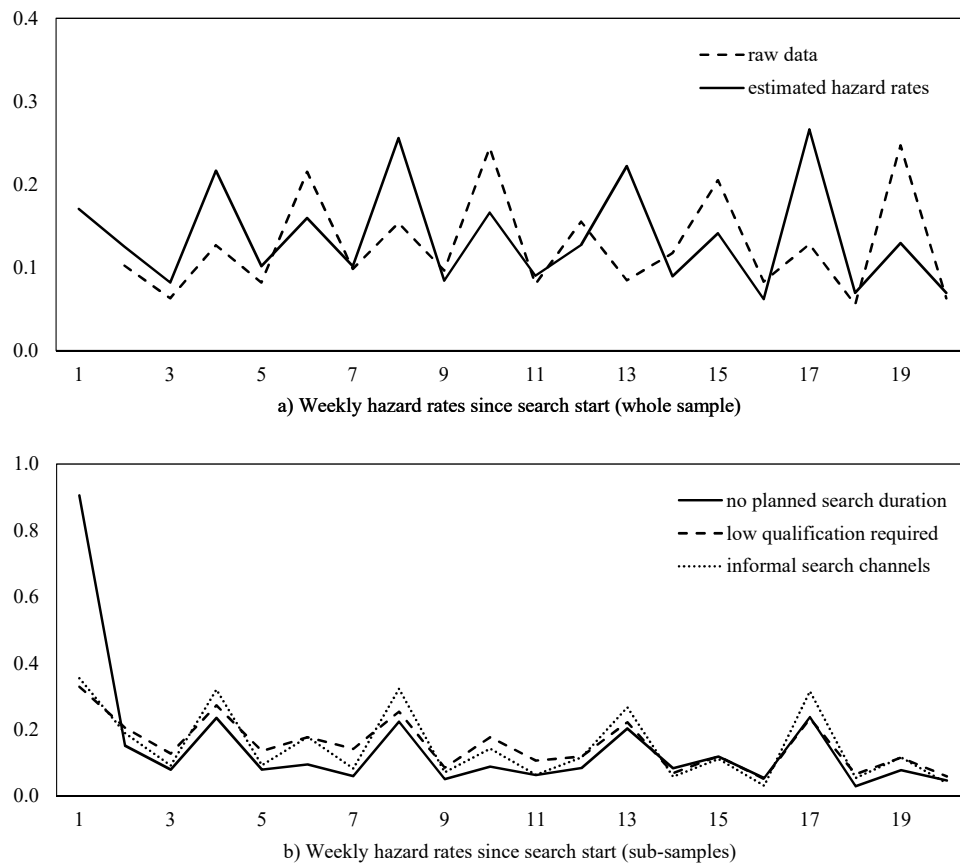
Data: German Job Vacancy Survey 2005-2014.

Table A3: Hazard-Ratios of Filling a Vacancy

| Weeks relative to the intended starting date | Exponential Hazard-Model | | Cox-Proportion Hazard-Model | | Competing Risk Model | |
|---|-----------------------------|----------|--------------------------------|----------|-------------------------|----------|
| | Hazard-Rates | S.E. | Hazard-Ratio | S.E. | Hazard-Ratio | S.E. |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| -19 or more | 0.0282 | (0.0008) | 0.2093 | (0.0082) | 0.1654 | (0.0062) |
| -18 | 0.0669 | (0.0038) | 0.4329 | (0.0260) | 0.3687 | (0.0216) |
| -17 | 0.0247 | (0.0017) | 0.1698 | (0.0128) | 0.1364 | (0.0103) |
| -16 | 0.0284 | (0.0019) | 0.2154 | (0.0152) | 0.1761 | (0.0124) |
| -15 | 0.0257 | (0.0018) | 0.2644 | (0.0188) | 0.2294 | (0.0162) |
| -14 | 0.1135 | (0.0037) | 0.6323 | (0.0263) | 0.5368 | (0.0219) |
| -13 | 0.0262 | (0.0014) | 0.1957 | (0.0116) | 0.1603 | (0.0094) |
| -12 | 0.0367 | (0.0016) | 0.2653 | (0.0133) | 0.2161 | (0.0108) |
| -11 | 0.0237 | (0.0013) | 0.2425 | (0.0141) | 0.2079 | (0.0120) |
| -10 | 0.1372 | (0.0030) | 0.8139 | (0.0283) | 0.6941 | (0.0236) |
| -9 | 0.0669 | (0.0022) | 0.5756 | (0.0241) | 0.4911 | (0.0203) |
| -8 | 0.0697 | (0.0017) | 0.4483 | (0.0164) | 0.3667 | (0.0135) |
| -7 | 0.0693 | (0.0017) | 0.5957 | (0.0220) | 0.5052 | (0.0185) |
| -6 | 0.1221 | (0.0022) | 0.9717 | (0.0319) | 0.8147 | (0.0263) |
| -5 | 0.2318 | (0.0031) | 1.4820 | (0.0457) | 1.2302 | (0.0374) |
| -4 | 0.1698 | (0.0024) | 1.2179 | (0.0380) | 0.9903 | (0.0309) |
| -3 | 0.2911 | (0.0032) | 2.1810 | (0.0655) | 1.7837 | (0.0534) |
| -2 | 0.2788 | (0.0035) | 2.5579 | (0.0781) | 2.0416 | (0.0628) |
| -1 | 0.3598 | (0.0045) | 2.0535 | (0.0620) | 1.4553 | (0.0451) |
| 1 | 0.3111 | (0.0047) | 2.4931 | (0.0787) | 1.6870 | (0.0571) |
| 2 | 0.2384 | (0.0045) | 1.6286 | (0.0549) | 1.2189 | (0.0420) |
| 3 | 0.1419 | (0.0040) | 1.4993 | (0.0595) | 1.1897 | (0.0478) |
| 4 | 0.2490 | (0.0057) | 1.4062 | (0.0503) | 0.9384 | (0.0351) |
| 5 | 0.1380 | (0.0049) | 1.1300 | (0.0507) | 0.8260 | (0.0381) |
| 6 | 0.1529 | (0.0055) | 1.0857 | (0.0492) | 0.8964 | (0.0410) |
| 7 | 0.1239 | (0.0054) | 1.1113 | (0.0578) | 0.9368 | (0.0497) |
| 8 | 0.1682 | (0.0067) | 1.1374 | (0.0549) | 0.8054 | (0.0413) |
| 9 | 0.2076 | (0.0081) | 1.2413 | (0.0594) | 0.8321 | (0.0427) |
| 10 | 0.1050 | (0.0064) | 0.8826 | (0.0584) | 0.8366 | (0.0569) |
| 11 | 0.1383 | (0.0077) | 1.0782 | (0.0674) | 1.1162 | (0.0714) |
| 12 | 0.0898 | (0.0066) | 0.9253 | (0.0723) | 0.9493 | (0.0764) |
| 13 | 0.2649 | (0.0119) | 1.1788 | (0.0628) | 0.9754 | (0.0554) |
| 14 | 0.0913 | (0.0080) | 0.9401 | (0.0864) | 1.1557 | (0.1101) |
| 15 | 0.1403 | (0.0104) | 0.8954 | (0.0714) | 1.2167 | (0.0984) |
| 16 | 0.0864 | (0.0087) | 0.9697 | (0.1036) | 1.4527 | (0.1592) |
| 17 | 0.2840 | (0.0165) | 1.1432 | (0.0739) | 1.2510 | (0.0866) |
| 18 | 0.1330 | (0.0131) | 1.0114 | (0.1031) | 1.5258 | (0.1625) |
| 19 | 0.1506 | (0.0148) | 0.9416 | (0.0958) | 1.6744 | (0.1723) |
| 20 | 0.1113 | (0.0137) | 0.9344 | (0.1198) | 2.0282 | (0.2665) |
| 21 | 0.2310 | (0.0208) | 0.9185 | (0.0879) | 1.3928 | (0.1421) |
| 22 | 0.2528 | (0.0243) | 1.2021 | (0.1220) | 2.3795 | (0.2558) |
| 23 | 0.0874 | (0.0162) | 0.5344 | (0.1021) | 1.2468 | (0.2420) |
| 24 | 0.1370 | (0.0211) | 0.9871 | (0.1508) | 2.7707 | (0.4253) |
| 25 | 0.1885 | (0.0264) | 1.0691 | (0.1579) | 2.1814 | (0.3388) |
| Low qualification required | 1.1184 | (0.0148) | 1.1081 | (0.0141) | 1.1074 | (0.0147) |
| High qualification required | 0.8348 | (0.0089) | 0.8285 | (0.0086) | 0.8675 | (0.0085) |
| Full-time employment | 0.9335 | (0.0101) | 0.9838 | (0.0027) | 0.9865 | (0.0027) |
| Financial constraints | 0.9722 | (0.0158) | 0.9751 | (0.0155) | 0.9377 | (0.0147) |
| Low sales | 1.0173 | (0.0119) | 1.0144 | (0.0116) | 0.9884 | (0.0113) |
| Skilled labour shortage | 0.6484 | (0.0089) | 0.6447 | (0.0087) | 0.5450 | (0.0074) |

Data: German Job Vacancy Survey 2005-2014.

Figure A1: Hazard rates since search start



Data: German Job Vacancy Survey 2005-2014

Table A4: Raw and weighted covariate means with entropy balancing weights

| Variable | Means <i>In Time</i> | Means <i>Early</i> | | Means <i>Delayed</i> | | Means ¹ <i>In Time</i> | Means <i>Failed</i> | |
|------------------------------|-------------------------|-----------------------|-------------------|-------------------------|-------------------|--------------------------------------|------------------------|-------------------|
| | | Raw | EB | Raw | EB | | Raw | EB |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Planned search duration | 60.633 | 112.454 | 60.640 (0.014) | 67.474 | 60.651 (0.031) | 62.094 | 125.563 | 62.010 (0.007) |
| Low qualification required | 0.114 | 0.064 | 0.114 (-0.001) | 0.086 | 0.114 (0.008) | 0.119 | 0.091 | 0.119 (-0.015) |
| High qualification required | 0.189 | 0.256 | 0.189 (0.001) | 0.265 | 0.189 (0.005) | 0.182 | 0.238 | 0.182 (-0.011) |
| Experience required | 0.444 | 0.468 | 0.444 (0.000) | 0.493 | 0.444 (0.011) | N.A. | N.A. | N.A. |
| Permanent position | 0.444 | 0.510 | 0.444 (0.000) | 0.529 | 0.444 (0.016) | N.A. | N.A. | N.A. |
| Full time position | 0.782 | 0.789 | 0.782 (0.001) | 0.852 | 0.782 (0.026) | N.A. | N.A. | N.A. |
| Seasonal work | 0.068 | 0.041 | 0.068 (-0.001) | 0.042 | 0.068 (-0.007) | N.A. | N.A. | N.A. |
| Temporary employment | 0.171 | 0.128 | 0.171 (-0.001) | 0.101 | 0.171 (-0.011) | N.A. | N.A. | N.A. |
| Log of firm size (employees) | 3.848 | 3.813 | 3.848 (0.000) | 3.922 | 3.848 (0.020) | 3.837 | 3.710 | 3.837 (0.008) |
| Financial distress | 0.071 | 0.063 | 0.071 (0.000) | 0.070 | 0.071 (-0.001) | 0.059 | 0.080 | 0.059 (-0.007) |
| Low sales | 0.153 | 0.130 | 0.153 (0.000) | 0.168 | 0.153 (0.000) | 0.140 | 0.177 | 0.140 (-0.014) |
| Skilled labour shortage | 0.085 | 0.061 | 0.085 (0.000) | 0.193 | 0.085 (0.066) | 0.086 | 0.331 | 0.086 (-0.008) |
| No. of Obs. | 20,579 | 20,256 | | 9,878 | | 13,817 | 4,005 | |

t-statistics are reported in parentheses below respective values and refer to a two sided t-test against the unweighted mean of the *In Time* Group. Thereby, the t-statistics in row (3) and (5) refer to a t-test against the means of row (1), while the t-statistics in row (8) refer to the means in row (6). Raw means are unweighted means while the rows, marked with “EB” represent weighted means by an entropy balancing procedure. Data: German Job Vacancy Survey 2005-2014.

¹ The difference between Means *In Time* in this row and the respective means from row (1) is due to a lack of data for failed vacancies for several years in contrast to vacancies, which were filled. This also explains the difference in the number of observations for row (1) and row (6).

Table A5: Problems in the recruitment process - OLS with Entropy Balancing (full sample)

| | Group <i>In Time</i> (Mean) | Difference between <i>In Time</i> and | | |
|--|--------------------------------|---------------------------------------|-----------------------|-----------------------|
| | | <i>Early</i> | <i>Delayed</i> | <i>Failed</i> |
| | (1) | (2) | (3) | (4) |
| Not enough suitable applicants (Standard Error) | 0.1126 | -0.0553*** (0.0048) | 0.1689*** (0.0050) | 0.4287*** (0.0109) |
| Nr. of Obs. | 21,646 | 15,534 | 11,645 | 4,928 |
| Pay claim of applicants too high (Standard Error) | 0.0475 | -0.0230*** (0.0026) | 0.0753*** (0.0033) | 0.2503*** (0.0096) |
| Nr. of Obs. | 28,524 | 20,326 | 14,589 | 4,928 |

Differences are the coefficients of the respective indicator variables for belonging to the group *Early*, *Delayed* or *Failed* in an OLS regression with entropy balancing weights. Standard errors are reported in the parentheses. Covariates on firm and vacancy level are not reported. Interaction dummies between region and year are not reported. 3 digit occupational dummies (based on ISCO-88 classification) are not reported. * indicates $p < 0.1$, ** indicates $p < 0.05$, *** indicates $p < 0.01$. Data for “Not enough suitable applicants”: German Job Vacancy Survey 2009-2014. Data for “Pay claim of applicants too high”: German Job Vacancy Survey 2010-2014.

Table A6: Number of (suitable) applicants and fraction of suitable applicants - OLS with Entropy Balancing (full sample)

| | Group <i>In Time</i> (Mean) | Difference between <i>In Time</i> and | | |
|---|--------------------------------|---------------------------------------|------------------------|------------------------|
| | | <i>Early</i> | <i>Delayed</i> | <i>Failed</i> |
| | (1) | (2) | (3) | (4) |
| Number of applicants (Standard Error) | 14.4071 | -2.8221*** (0.5520) | 1.7537*** (0.3331) | -2.2941*** (0.7168) |
| Nr. of Obs. | 24,911 | 17,516 | 13,270 | 2,104 |
| Number of suitable applicants (Standard Error) | 4.3431 | -0.8496*** (0.1145) | -0.1587 (0.1060) | N.A. () |
| Nr. of Obs. | 24,801 | 17,403 | 13,097 | |
| Fraction of suitable applicants (Standard Error) | 0.5343 | 0.0795*** (0.0061) | -0.0922*** (0.0038) | N.A. () |
| Nr. of Obs. | 24,253 | 17,012 | 12,919 | |

Differences are the coefficients of the respective indicator variables for belonging to the group *Early*, *Delayed* or *Failed* in an OLS regression with entropy balancing weights. Standard errors are reported in the parentheses. Covariates on firm and vacancy level are not reported. Interaction dummies between region and year are not reported. 3 digit occupational dummies (based on ISCO-88 classification) are not reported. * indicates $p < 0.1$, ** indicates $p < 0.05$, *** indicates $p < 0.01$. Data: German Job Vacancy Survey 2005-2014.

Table A7: Number of search channels used and the use of each channel - OLS with Entropy Balancing (full sample)

| | Group <i>In Time</i> (Mean) (1) | Difference between <i>In Time</i> and | | |
|---|---------------------------------------|---------------------------------------|-----------------------|------------------------|
| | | <i>Early</i> (2) | <i>Delayed</i> (3) | <i>Failed</i> (4) |
| Number of search channels activated (Standard Error) | 1.7683 (0.0139) | -0.1836*** (0.0139) | 0.3405*** (0.0113) | 0.5547*** (0.0522) |
| Nr. of Obs. | 28,524 | 20,326 | 14,589 | 920 |
| Use of search channel: Classic (Standard Error) | 0.4691 (0.0073) | -0.0921*** (0.0073) | 0.1169*** (0.0053) | -0.1013*** (0.0081) |
| Nr. of Obs. | 28,524 | 20,326 | 14,589 | 4,928 |
| Use of search channel: Internal (Standard Error) | 0.2163 (0.0065) | 0.0036 (0.0065) | 0.0543*** (0.0047) | 0.0445*** (0.0089) |
| Nr. of Obs. | 28,524 | 20,326 | 14,589 | 4,928 |
| Use of search channel: Speculative (Standard Error) | 0.2664 (0.0068) | -0.0319*** (0.0068) | 0.0332*** (0.0051) | 0.0116 (0.0236) |
| Nr. of Obs. | 28,524 | 20,326 | 14,589 | 920 |
| Use of search channel: Network (Standard Error) | 0.4354 (0.0081) | 0.0661*** (0.0081) | 0.0003 (0.0056) | 0.0291 (0.0263) |
| Nr. of Obs. | 28,524 | 20,326 | 14,589 | 920 |
| Use of search channel: PEA (Standard Error) | 0.3811 (0.0072) | -0.1292*** (0.0072) | 0.1358*** (0.0056) | 0.2293*** (0.0133) |
| Nr. of Obs. | 28,524 | 20,326 | 14,589 | 2,860 |

Differences are the coefficients of the respective indicator variables for belonging to the group *Early*, *Delayed* or *Failed* in an OLS regression with entropy balancing weights. Standard errors are reported in the parentheses. Covariates on firm and vacancy level are not reported. Interaction dummies between region and year are not reported. 3 digit occupational dummies (based on ISCO-88 classification) are not reported. * indicates $p < 0.1$, ** indicates $p < 0.05$, *** indicates $p < 0.01$. Data: German Job Vacancy Survey 2005-2014.

Table A8: **Hiring applicants with experience and qualification below the required level and hiring of previously unemployed applicants - OLS with Entropy Balancing (full sample)**

| | Group <i>In Time</i> (Mean) (1) | Difference between <i>In Time</i> and | | |
|---|---------------------------------------|---------------------------------------|-----------------------|----------------------|
| | | <i>Early</i> (2) | <i>Delayed</i> (3) | <i>Failed</i> (4) |
| Experience lower than required (Standard Error) | 0.0905 | -0.0277*** (0.0044) | 0.0634*** (0.0039) | N.A. |
| Nr. of Obs. | 27,197 | 19,480 | 13,627 | |
| Qualification lower than required (Standard Error) | 0.0722 | -0.0194*** (0.0041) | 0.0565*** (0.0037) | N.A. |
| Nr. of Obs. | 26,932 | 19,339 | 13,312 | |
| Hired previously unemployed (Standard Error) | 0.3984 | -0.0899*** (0.0075) | 0.0037 (0.0054) | N.A. |
| Nr. of Obs. | 28,524 | 20,326 | 14,589 | |

Differences are the coefficients of the respective indicator variables for belonging to the group *Early*, *Delayed* or *Failed* in an OLS regression with entropy balancing weights. Standard errors are reported in the parentheses. Covariates on firm and vacancy level are not reported. Interaction dummies between region and year are not reported. 3 digit occupational dummies (based on ISCO-88 classification) are not reported. * indicates $p < 0.1$, ** indicates $p < 0.05$, *** indicates $p < 0.01$. Data: German Job Vacancy Survey 2005-2014.

Table A9: **Wage bargaining, hourly wages and paid more than intended - OLS with Entropy Balancing (full sample)**

| | Group <i>In Time</i> (Mean) (1) | Difference between <i>In Time</i> and | | |
|---|---------------------------------------|---------------------------------------|-----------------------|----------------------|
| | | <i>Early</i> (2) | <i>Delayed</i> (3) | <i>Failed</i> (4) |
| Wage bargaining (Standard Error) | 0.3020 | -0.0127 (0.0124) | 0.0614*** (0.0094) | N.A. |
| Nr. of Obs. | 7,854 | 5,978 | 4,406 | |
| Paid more than intended (Standard Error) | 0.0802 | -0.0072 (0.0042) | 0.0449*** (0.0034) | N.A. |
| Nr. of Obs. | 28,227 | 20,092 | 14,444 | |
| Hourly wage (Euro) (Standard Error) | 13.0253 | 0.1416 (0.1280) | 0.2223** (0.1008) | N.A. |
| Nr. of Obs. | 3,842 | 2,514 | 2,330 | |

Differences are the coefficients of the respective indicator variables for belonging to the group *Early*, *Delayed* or *Failed* in an OLS regression with entropy balancing weights. Standard errors are reported in the parentheses. Covariates on firm and vacancy level are not reported. Interaction dummies between region and year are not reported. 3 digit occupational dummies (based on ISCO-88 classification) are not reported. * indicates $p < 0.1$, ** indicates $p < 0.05$, *** indicates $p < 0.01$. Data for “Wage bargaining took place”: German Job Vacancy Survey 2011-2013. Data for “Average hourly wage”: German Job Vacancy Survey 2014. Data for “Paid more than intended”: German Job Vacancy Survey 2005-2014.

Table A10: Wage bargaining, hourly wages and paid more than intended - controlled for qualification and experience of hired workers - OLS with Entropy Balancing (full sample)

| | Group <i>In Time</i> (Mean) | Difference between <i>In Time</i> and | | |
|-------------------------------|--------------------------------|---------------------------------------|----------------|---------------|
| | | <i>Early</i> | <i>Delayed</i> | <i>Failed</i> |
| | (1) | (2) | (3) | (4) |
| previously employed workers | | | | |
| Wage bargaining | 0.3142 | -0.0014 | 0.0762*** | N.A. |
| (Standard Error) | | (0.0147) | (0.0130) | |
| Nr. of Obs. | 4,535 | 4,467 | 2,333 | |
| Paid more than intended | 0.0767 | 0.0029 | 0.0516*** | N.A. |
| (Standard Error) | | (0.0054) | (0.0050) | |
| Nr. of Obs. | 14,441 | 13,680 | 7,106 | |
| Hourly wage (Euro) | 13.86 | -0.0802 | 0.1791 | N.A. |
| (Standard Error) | | (0.1696) | (0.1440) | |
| Nr. of Obs. | 2,260 | 1,814 | 1,250 | |
| previously unemployed workers | | | | |
| Wage bargaining | 0.243 | -0.0427* | 0.0672*** | N.A. |
| (Standard Error) | | (0.0249) | (0.0196) | |
| Nr. of Obs. | 2,139 | 796 | 963 | |
| Paid more than intended | 0.0610 | -0.0112 | 0.0224*** | N.A. |
| (Standard Error) | | (0.0073) | (0.0056) | |
| Nr. of Obs. | 11,466 | 2,855 | 4,807 | |
| Hourly wage (Euro) | 13.22 | N.A. | 0.1672 | N.A. |
| (Standard Error) | | | (0.1732) | |
| Nr. of Obs. | 3,176 | | 1,710 | |

Differences are the coefficients of the respective indicator variables for belonging to the group *Early*, *Delayed* or *Failed* in an OLS regression with entropy balancing weights. Standard errors are reported in the parentheses. Covariates on firm and vacancy level are not reported. Interaction dummies between region and year are not reported. 3 digit occupational dummies (based on ISCO-88 classification) are not reported. * indicates $p < 0.1$, ** indicates $p < 0.05$, *** indicates $p < 0.01$. Data for “Wage bargaining took place”: German Job Vacancy Survey 2011-2013. Data for “Average hourly wage”: German Job Vacancy Survey 2014. Data for “Paid more than intended”: German Job Vacancy Survey 2005-2014.

Table A11: Raw and weighted covariate means with radius matching weights

| Variable | Means <i>In Time</i> | Means <i>Early</i> | | Means <i>Delayed</i> | | Means ¹ <i>In Time</i> | Means <i>Failed</i> | |
|-------------------------------|-------------------------|-----------------------|-------------------|-------------------------|-------------------|--------------------------------------|------------------------|-------------------|
| | | Raw | RM | Raw | RM | | Raw | RM |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Planned search duration (log) | 3.967 | 4.566 | 3.967 (0.035) | 4.034 | 3.934 (-5.196) | 3.971 | 4.548 | 4.230 (27.244) |
| Low qualification required | 0.113 | 0.064 | 0.125 (3.746) | 0.086 | 0.108 (-1.236) | 0.114 | 0.090 | 0.088 (-5.427) |
| High qualification required | 0.189 | 0.256 | 0.172 (-4.206) | 0.265 | 0.178 (-2.108) | 0.186 | 0.244 | 0.189 (0.542) |
| Experience required | 0.445 | 0.468 | 0.441 (-0.890) | 0.493 | 0.451 (1.028) | N.A. | N.A. | N.A. |
| Permanent position | 0.444 | 0.510 | 0.448 (0.679) | 0.529 | 0.445 (0.186) | N.A. | N.A. | N.A. |
| Full time position | 0.782 | 0.789 | 0.785 (0.620) | 0.852 | 0.798 (3.183) | N.A. | N.A. | N.A. |
| Seasonal work | 0.068 | 0.041 | 0.071 (1.121) | 0.042 | 0.063 (-1.873) | N.A. | N.A. | N.A. |
| Temporary employment | 0.171 | 0.128 | 0.176 (1.414) | 0.100 | 0.151 (-4.188) | N.A. | N.A. | N.A. |
| Log of firm size (employees) | 3.848 | 3.813 | 3.848 (-0.010) | 3.922 | 3.848 (-0.048) | 3.823 | 3.704 | 3.746 (-3.344) |
| Financial distress | 0.071 | 0.063 | 0.065 (-2.382) | 0.070 | 0.068 (-1.008) | 0.070 | 0.091 | 0.057 (-3.544) |
| Low sales | 0.153 | 0.130 | 0.148 (-1.300) | 0.168 | 0.145 (-1.644) | 0.153 | 0.191 | 0.141 (-2.115) |
| Skilled labour shortage | 0.085 | 0.061 | 0.075 (-3.477) | 0.193 | 0.083 (-0.450) | 0.084 | 0.321 | 0.162 (16.848) |
| <i>N</i> | 20,568 | 19,206 | | 9,522 | | 22,485 | 5,067 | |

t-statistics are reported in parentheses below respective values and refer to a two sided t-test against the unweighted mean of the *In Time* Group. Thereby, the t-statistics in row (3) and (5) refer to a t-test against the means of row (1), while the t-statistics in row (8) refer to the means in row (6). Raw means are unweighted means while the rows, marked with “RM” represent means calculated by using the means of a radius matching approach. Data: German Job Vacancy Survey 2005-2014.

¹ The difference between Means *In Time* in this row and the respective means from row (1) is due to a lack of data for failed vacancies for several years in contrast to vacancies, which were filled. However, fewer matching variables might also lead to a greater common support between treatment and control group. These two factors explain the difference in the number of observations for row (1) and row (6).

Table A12: Problems in the recruitment process - Radius matching

| | Group <i>In Time</i> (Mean) | Difference between <i>In Time</i> and | | |
|--|--------------------------------|---------------------------------------|-----------------------|-----------------------|
| | | <i>Early</i> | <i>Delayed</i> | <i>Failed</i> |
| | (1) | (2) | (3) | (4) |
| Not enough suitable applicants (Standard Error) | 0.1239 | -0.0563*** (0.0052) | 0.1740*** (0.0071) | 0.4296*** (0.0109) |
| Nr. of Obs. | 15,863 | 14,729 | 7,653 | 5,067 |
| Pay claim of applicants too high (Standard Error) | 0.0522 | -0.0258*** (0.0028) | 0.0833*** (0.0050) | 0.2464*** (0.0087) |
| Nr. of Obs. | 20,568 | 19,206 | 9,522 | 5,067 |

Differences are the coefficients of the respective indicator variables for belonging to the group *Early*, *Delayed* or *Failed* in an OLS regression with with weights, generated with the radius matching approach. Covariates on firm and vacancy level are not reported. Interaction dummies between region and year are not reported. 3 digit occupational dummies (based on ISCO-88 classification) are not reported. * indicates $p < 0.1$, ** indicates $p < 0.05$, *** indicates $p < 0.01$.

Data for “Not enough suitable applicants”: German Job Vacancy Survey 2009-2014. Data for “Pay claim of applicants too high”: German Job Vacancy Survey 2010-2014.

Table A13: Number of (suitable) applicants and fraction of suitable applicants - Radius matching

| | Group <i>In Time</i> (Mean) | Difference between <i>In Time</i> and | | |
|---|--------------------------------|---------------------------------------|------------------------|------------------------|
| | | <i>Early</i> | <i>Delayed</i> | <i>Failed</i> |
| | (1) | (2) | (3) | (4) |
| Number of applicants (Standard Error) | 16.1985 | -2.9223*** (0.5368) | 1.5266** (0.5393) | -4.1774*** (0.7306) |
| Nr. of Obs. | 18,366 | 16,553 | 8,770 | 1,767 |
| Number of suitable applicants (Standard Error) | 4.6477 | -0.8781*** (0.1290) | -0.0570 (0.1946) | N.A. () |
| Nr. of Obs. | 18,230 | 16,437 | 8,652 | |
| Fraction of suitable applicants (Standard Error) | 0.5035 | 0.0819*** (0.0059) | -0.0812*** (0.0050) | N.A. () |
| Nr. of Obs. | 17,935 | 16,075 | 8,564 | |

Differences are the coefficients of the respective indicator variables for belonging to the group *Early*, *Delayed* or *Failed* in an OLS regression with with weights, generated with the radius matching approach. Covariates on firm and vacancy level are not reported. Interaction dummies between region and year are not reported. 3 digit occupational dummies (based on ISCO-88 classification) are not reported. * indicates $p < 0.1$, ** indicates $p < 0.05$, *** indicates $p < 0.01$.

Data: German Job Vacancy Survey 2005-2014.

Table A14: Number of search channels used and the use of each channel - Radius matching

| | Group <i>In Time</i> (Mean) | Difference to | | |
|-------------------------------------|--------------------------------|---------------------|-----------------------|----------------------|
| | (1) | <i>Early</i> (2) | <i>Delayed</i> (3) | <i>Failed</i> (4) |
| Number of search channels activated | 1.8412 | -0.1984*** | 0.3458*** | 0.5438*** |
| (Standard Error) | | (0.0148) | (0.0156) | (0.0533) |
| Nr. of Obs. | 20,568 | 19,206 | 9,522 | 794 |
| Use of search channel: Classic | 0.5292 | -0.1033*** | 0.1133*** | -0.1538*** |
| (Standard Error) | | (0.0074) | (0.0072) | (0.0074) |
| Nr. of Obs. | 20,568 | 19,206 | 9,522 | 5,067 |
| Use of search channel: Internal | 0.2416 | -0.0039 | 0.0612*** | 0.0443*** |
| (Standard Error) | | (0.0067) | (0.0066) | (0.0092) |
| Nr. of Obs. | 20,568 | 19,206 | 9,522 | 4,082 |
| Use of search channel: Speculative | 0.2660 | -0.0282*** | 0.0377*** | 0.0180 |
| (Standard Error) | | (0.0069) | (0.0070) | (0.0243) |
| Nr. of Obs. | 20,568 | 19,206 | 9,522 | 794 |
| Use of search channel: Network | 0.4044 | 0.0738*** | 0.0135** | 0.0409 |
| (Standard Error) | | (0.0081) | (0.0076) | (0.0253) |
| Nr. of Obs. | 20,568 | 19,206 | 9,522 | 794 |
| Use of search channel: PEA | 0.3998 | -0.1367*** | 0.1201*** | 0.2040*** |
| (Standard Error) | | (0.0073) | (0.0077) | (0.0132) |
| Nr. of Obs. | 20,568 | 19,206 | 9,522 | 2,406 |

Differences are the coefficients of the respective indicator variables for belonging to the group *Early*, *Delayed* or *Failed* in an OLS regression with with weights, generated with the radius matching approach. Covariates on firm and vacancy level are not reported. Interaction dummies between region and year are not reported. 3 digit occupational dummies (based on ISCO-88 classification) are not reported. * indicates $p < 0.1$, ** indicates $p < 0.05$, *** indicates $p < 0.01$.

Data: German Job Vacancy Survey 2005-2014.

Table A15: Hiring applicants with experience and qualification below the required level and hiring of previously unemployed applicants - Radius matching

| | Group <i>In Time</i> (Mean) | Difference between <i>In Time</i> and | | |
|---|--------------------------------|---------------------------------------|-----------------------|----------------------|
| | (1) | <i>Early</i> (2) | <i>Delayed</i> (3) | <i>Failed</i> (4) |
| Experience lower than required (Standard Error) | 0.0956 | -0.0312*** (0.0044) | 0.0566*** (0.0053) | N.A. |
| Nr. of Obs. | 19,604 | 18,411 | 8,907 | |
| Qualification lower than required (Standard Error) | 0.0758 | -0.0262*** (0.0041) | 0.0526*** (0.0051) | N.A. |
| Nr. of Obs. | 19,389 | 18,278 | 8,674 | |
| Hired previously unemployed (Standard Error) | 0.3570 | -0.0839*** (0.0072) | 0.0257*** (0.0073) | N.A. |
| Nr. of Obs. | 20,568 | 19,206 | 9,522 | |

Differences are the coefficients of the respective indicator variables for belonging to the group *Early*, *Delayed* or *Failed* in an OLS regression with with weights, generated with the radius matching approach. Covariates on firm and vacancy level are not reported. Interaction dummies between region and year are not reported. 3 digit occupational dummies (based on ISCO-88 classification) are not reported. * indicates $p < 0.1$, ** indicates $p < 0.05$, *** indicates $p < 0.01$.

Data: German Job Vacancy Survey 2005-2014.

Table A16: Wage bargaining, hourly wages and paid more than intended - Radius matching

| | Group <i>In Time</i> (Mean) | Difference between <i>In Time</i> and | | |
|---|--------------------------------|---------------------------------------|-----------------------|----------------------|
| | (1) | <i>Early</i> (2) | <i>Delayed</i> (3) | <i>Failed</i> (4) |
| Wage bargaining (Standard Error) | 0.3177 | -0.0100 (0.0129) | 0.0648*** (0.0125) | N.A. |
| Nr. of Obs. | 6,037 | 5,710 | 3,025 | |
| Paid more than intended (Standard Error) | 0.0860 | -0.0016 (0.0045) | 0.0508*** (0.0049) | N.A. |
| Nr. of Obs. | 20,359 | 18,990 | 9,421 | |
| Hourly wage (Euro) (Standard Error) | 13.1913 | 0.4166** (0.1406) | 0.4865*** (0.1423) | N.A. |
| Nr. of Obs. | 2,576 | 2,328 | 1,462 | |

Differences are the coefficients of the respective indicator variables for belonging to the group *Early*, *Delayed* or *Failed* in an OLS regression with with weights, generated with the radius matching approach. Covariates on firm and vacancy level are not reported. Interaction dummies between region and year are not reported. 3 digit occupational dummies (based on ISCO-88 classification) are not reported. * indicates $p < 0.1$, ** indicates $p < 0.05$, *** indicates $p < 0.01$.

Data for “Wage bargaining took place”: German Job Vacancy Survey 2011-2013. Data for “Average hourly wage”: German Job Vacancy Survey 2014. Data for “Paid more than intended”: German Job Vacancy Survey 2005-2014.

Table A17: Wage bargaining, hourly wages and paid more than intended - controlled for qualification and experience of hired workers - Radius matching

| | Group <i>In Time</i> (Mean) (1) | Difference between <i>In Time</i> and | | |
|-------------------------------|---------------------------------------|---------------------------------------|-----------------------|----------------------|
| | | <i>Early</i> (2) | <i>Delayed</i> (3) | <i>Failed</i> (4) |
| previously employed workers | | | | |
| Wage bargaining | 0.3242 | 0.0199 | 0.0660*** | N.A. |
| (Standard Error) | | (0.0159) | (0.0167) | |
| Nr. of Obs. | 3,621 | 4,303 | 1,660 | |
| Paid more than intended | 0.0810 | 0.0007 | 0.0545*** | N.A. |
| (Standard Error) | | (0.0054) | (0.0068) | |
| Nr. of Obs. | 11,085 | 13,079 | 4,840 | |
| Hourly wage (Euro) | 13.93 | 0.4139** | 0.3188 | N.A. |
| (Standard Error) | | (0.2053) | (0.2092) | |
| Nr. of Obs. | 1,558 | 1,724 | 792 | |
| previously unemployed workers | | | | |
| Wage bargaining | 0.2674 | -0.0542** | 0.0553** | N.A. |
| (Standard Error) | | (0.0253) | (0.0271) | |
| Nr. of Obs. | 1,440 | 733 | 588 | |
| Paid more than intended | 0.0542 | -0.0081 | 0.0438*** | N.A. |
| (Standard Error) | | (0.0071) | (0.0088) | |
| Nr. of Obs. | 5,660 | 3,243 | 1,995 | |
| Hourly wage (Euro) | 11.88 | 0.3047 | 0.7651*** | N.A. |
| (Standard Error) | | (0.2488) | (0.2738) | |
| Nr. of Obs. | 530 | 300 | 232 | |

Differences are the coefficients of the respective indicator variables for belonging to the group *Early*, *Delayed* or *Failed* in an OLS regression with with weights, generated with the radius matching approach. Covariates on firm and vacancy level are not reported. Interaction dummies between region and year are not reported. 3 digit occupational dummies (based on ISCO-88 classification) are not reported. * indicates $p < 0.1$, ** indicates $p < 0.05$, *** indicates $p < 0.01$.

Data for “Wage bargaining took place”: German Job Vacancy Survey 2011-2013. Data for “Average hourly wage”: German Job Vacancy Survey 2014. Data for “Paid more than intended”: German Job Vacancy Survey 2005-2014.