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Mit der Reihe „IAB-Discussion Paper“ will das Forschungsinstitut der Bundesagentur für Arbeit den Dialog mit der externen Wissenschaft intensivieren. Durch die rasche Verbreitung von Forschungsergebnissen über das Internet soll noch vor Drucklegung Kritik angeregt und Qualität gesichert werden.

The “IAB-Discussion Paper” is published by the research institute of the German Federal Employment Agency in order to intensify the dialogue with the scientific community. The prompt publication of the latest research results via the internet intends to stimulate criticism and to ensure research quality at an early stage before printing.

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Abstract

We use administrative social security records and event history methods to investigate graduate migration in Germany. The results indicate that most migration events happen up to seven years after graduation. Work experience gathered before and during the studies influences the migration decision, pointing to the importance of labour market contacts and social networks. In contrast to previous studies we do not detect a genuine negative duration dependence for the probability of leaving the region of study. When labour market entry outside the university region is considered there is some indication for cumulative stress.

Zusammenfassung

Jungen Hochschulabsolventen wird wesentliche Bedeutung für die wirtschaftliche Entwicklung von Regionen beigemessen. Die räumliche Mobilität der Absolventen ist daher für regionalpolitische Entscheidungsträger von erheblicher Relevanz. Dieser Aspekt ist vor allem für gering verdichtete und eher ländliche Regionen bedeutsam, die häufig Probleme haben, junge hochqualifizierte Arbeitskräfte anzuziehen. Wir verwenden Verweildaueranalysen, um die Migration von Absolventen nach dem Verlassen der Hochschule zu untersuchen. Die Untersuchung basiert auf einem Datensatz, der erwerbsbiographische Daten des IAB und Absolventendaten mehrerer Hochschulen verknüpft. Die Datengrundlage ermöglicht eine sehr detaillierte Analyse der Abwanderung von Absolventen aus der Hochschulregion – in räumlicher wie in zeitlicher Hinsicht. Die Ergebnisse der Untersuchung zeigen, dass die meisten Wanderungsereignisse während der ersten sieben Jahre nach dem Hochschulabschluss stattfinden. Zudem zeigt sich, dass die Arbeitserfahrung, welche die Absolventen vor ihrem Abschluss sammeln konnte, für die Migrationsentscheidung eine wichtige Rolle spielt. Dieser Befund weist auf den Stellenwert von Arbeitsmarktkontakten und sozialen Netzwerken für den Arbeitsmarkteinstieg und die räumliche Mobilität von Hochschulabsolventen hin.

JEL classification: C41, J61, R23

Keywords: migration, graduates, labour market entry, duration analysis

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1 Introduction

Human capital is a key determinant of regional development, and universities evidently play a crucial role for human capital accumulation in regions (Winters, 2013; Gennaioli et al., 2013). However, graduates of local universities will only increase the human capital endowment if they stay in the university region. Findings by Abel and Deitz (2012) indicate that migration is an important factor for the geographic distribution of human capital. Outward migration might especially be an issue for smaller regions which usually have problems attracting young, highly skilled workers. Instead, graduates tend to move to large urban agglomerations (Krabel and Flöther, 2014; Venhorst, 2013). Therefore, understanding the migration decision of graduates is of particular importance for less developed regions with institutions of higher education (Haapanen and Tervo, 2012).

The extensive literature on student and graduate migration mainly investigates the factors that determine the migration decision. One group of analyses uses information on the aggregate level and aims to explain interregional migration flows. For example, Faggian and McCann (2008) investigate the interdependence between graduate migration and the innovation performance of regions using a simultaneous equation model. Some studies apply gravity models to investigate the determinants of migration flows of students and graduates (e.g. Delisle and Sheamur, 2010; Dotti et al., 2013; Faggian and Franklin, 2014).

A second group of studies, using individual-level information, focuses on the probability of graduates migrating after having finally left university. Probit and logit models are estimated to identify individual, study-related and contextual factors that influence the decision to leave the university region and to belong to different migration types (e.g. Faggian et al., 2006; Faggian et al., 2007; Krabel and Flöther, 2014). Other studies examine the destination choice of graduates based on multinomial logit models (e.g. Gottlieb and Joseph, 2006; Haussen and Uebelmesser, 2015).

In most of these analyses, the time dimension of the migration event has received relatively sparse attention until now. A move is usually identified by comparing the region of study with the region of residence for two dates, frequently on an annual basis. Graduate surveys often provide information on the residence of graduates at specific points in time after having obtained the degree, but the exact date of a move is unknown. For this reason, neither aggregate-level analyses nor micro-econometric models provide information on whether most graduates leave the region of study immediately after graduation, or two, three or five years later after having first entered the labour market in the region of study. Hence, these studies disregard the fact that migration is the termination of a continuous residence spell in the region of study. The duration of the stay may be an additional causal effect on the probability of outward migration (Andrews et al., 2011). Furthermore, survey based analyses face difficulties like non-response, selection bias and measurement errors (Kolek, 2012; Porter, 2011).

In this paper, we apply event history methods to provide new evidence on graduate migration in Germany. We use a unique data set which combines student records of several German universities with administrative social security records. The continuous data enables us to scrutinise the sequence of the migration process in more detail and to examine the role of duration dependence for the likelihood of graduates leaving or staying in the region of study. Furthermore, by using highly reliable administrative data we avoid the above mentioned problems that often come along with the use of survey data. We investigate how the migration behaviour of a sample of 21,000 students who graduated between 1996 and 2011 develops in the long run, with the main focus on moves that are linked to labour market entry outside the region of study. Making use of a micro-level university panel database with biographical information, we are able to identify the exact date of a move as well as to analyse the migration behaviour over a maximum period of 18 years. Studies on graduate migration usually consider much shorter observation periods. As this data encompasses the employment biographies of the graduates on a daily basis, we can investigate changes of the workplaces based on continuous data and in a discrete setting.

We complement the findings of the very few graduate migration studies to have implemented history event methods so far. Busch and Weigert (2010) conducted a duration analysis to study migratory behaviour of German graduates from 1984 to 2004. However, the sample (around 900 persons), coming from an annual household survey, is rather small, and information on the region of residence is only available at the rather aggregate level of federal states and on an annual basis. The latter also applies to an analysis of Finnish university graduates from 1991 to 2003 based on census data (Haapanen and Tervo, 2012). Outward migration from the university region is examined over a period of 13 years after graduation. Two years prior to graduation, the probability of outward migration increases rapidly and starts to decline one year after graduation. Both studies point to a significant negative duration dependence, i.e. the propensity to leave the region of studies declines as the length of the residence spell increases. We apply the same definition of a move based on discrete (annual) residential information in order to be able to compare our results with the findings of these two studies. As we particularly take into account those moves related to labour market entry outside the university region using discrete as well as continuous data, we estimate different specifications of duration models and examine whether the results of the duration analyses vary depending on the given definition of a move.

Finally, we pay special attention to the impact of the employment biography of the graduates on the decision to leave the region of studies. In particular, we investigate whether work experience before and during the studies influences migration behaviour. The literature on graduate migration has largely neglected this factor so far. Findings by Krabel and Flöther (2014) indicate that graduates' contacts with local employers affect their migration decision. Previous work experience likely reflects the establishment of job-search networks as emphasised by Granovetter (1973). Kramarz and Nordström Skans (2014) point out the significance of networks for labour market entry

of young graduates. Therefore, depending on where the work experience has been gathered, work experience might increase or reduce the probability of outward migration after graduation.

Our analysis shows that the majority of the migration events take place during the first 6 to 7 years after graduation. After this rapid decline of the survival rates, the long-term share of stayers remains more or less constant. The regression analysis provides very robust evidence on significant effects of the work experience gathered inside or outside the university region, pointing to the importance of labour market contacts, local human capital accumulation and social networks. The duration analyses suggest that there is no genuine negative duration dependence when graduate migration is concerned. The negative relationship between the probability of leaving the region of study and the length of a residence spell seems to be entirely driven by observed and unobserved graduate characteristics. In contrast, there is some indication for cumulative stress when labour market entry outside the university region is considered.

The rest of the paper is organised as follows. The following section reviews the literature on graduate migration and briefly discusses the theoretical framework. In sections 3 and 4, we describe the duration models applied in order to investigate graduate migration in Germany and the data set. The results of the duration analysis are discussed in Section 5. Section 6 concludes.

2 Literature and theoretical framework

The literature on graduate migration has largely ignored the time dimension of regional mobility. The majority of studies resort to regional human capital models (e.g. Sjaastad 1962) that consider the individual migration decision as a utility-maximising location choice between destinations that is influenced by individual factors, such as age and gender, and contextual factors, such as regional labour market conditions and amenities. The location decision of graduates is investigated at specific points in time after completion of the studies. But this leaves unresolved the issue of how the migration behaviour develops over time (Haapanen and Tervo 2012).

Instead, the behavioural model of cumulative stress and inertia (Huff and Clark 1978) views the migration decision as a dynamic process. Two conflicting forces determine the likelihood of moving: there is a certain resistance to moving (*cumulative inertia*) on the one hand, and circumstances which accelerate a migration process (*residential stress*) on the other. The longer a person lives in a region, the stronger the personal attachment to that area becomes, due to 'location-specific knowledge' (DaVanzo 1983) through previous experiences leading to knowledge of local circumstances, or through social networks. On the other hand, outward migration can be triggered by residential stress factors such as a lack of adequate jobs and residential opportunities in the region. An individual's probability of moving – as a result of these interacting forces – can thus change over time. In this setting, the migration decision corresponds

to the termination of a continuous spell of residence, and the length of these spells varies between individuals (Haapanen and Tervo 2012).

A small number of migration studies dealing with internal mobility of individuals apply this dynamic model. The corresponding results point to a negative duration dependence in different countries. For the UK, Andrews et al. (2011) show that the probability of outward migration declines as the length of a residence spell increases. Negative duration dependence suggesting a prevalent cumulative inertia is also detected by Gerber (2005) for spatial mobility in Russia and by Detang-Dessendre and Molho (1999, 2000) for long-distance moves of young school leavers in France. Furthermore, studies on international migration indicate that the probability of return migration decreases the longer the migrants reside in the host country (e.g. Van den Berg and Weynandt 2013).

Even fewer studies apply this dynamic approach to graduate migration, although it might be particularly relevant for the decision to stay or leave the region of study after graduation. With final exams approaching, graduates will start to look for an acceptable job in the university region and beyond, with the propensity to outwardly migrate thereby rising. The pressure to migrate may increase in the course of the residence spell if it turns out that there are not enough adequate jobs and residential opportunities available in the university region. Graduates who are eventually dissatisfied with their first job in the region of study could also be increasingly willing to leave. In contrast, graduates who already graduated from school in the university region and studied there are assumed to be strongly embedded in the region through social networks. Hence, cumulative inertia may determine the migratory behaviour of these resident graduates (Haapanen and Tervo 2012).

Empirical evidence on duration dependence among graduates is limited to two studies. A duration analysis for German students shows that the longer a student lives in the study region, the smaller the probability of moving to other German states after graduation is (Busch and Weigert 2010). This evidence of negative duration dependence is corroborated by Haapanen and Tervo (2012), who apply this approach to studying the migratory behaviour of Finnish graduates. Both studies use micro-level panel data and resort to residence information on an annual basis. In both countries, the hazard rates decrease drastically until the fourth year after graduation, and after eight years, the propensity to migrate changes only slightly over time. In the case of the Finnish students, it is also shown that outward migration rates increase rapidly in the two years before graduation. This result indicates that the search process for a job, and thus the migration process, starts even before final exams take place. The highest hazard rate is observed in the graduation year.

There is an extensive empirical literature showing that individual, study-related and regional factors affect the spatial mobility of the young and highly educated. We cannot provide a detailed survey of the corresponding studies. Individual characteristics

such as gender, nationality, age and life-cycle effects[1] (having a partner, children and residential property etc.) evidently determine the length of graduates' residence spells in university regions and are likely to interact with duration dependence. Human capital factors such as the length of study, the degree, the field of study and the final grade may influence the decision to migrate as well. Corresponding evidence on the effects of the final grade is ambiguous, however, showing that better graduates are either more likely to move to other regions or more inclined to stay in the university region (e.g. Haussen and Uebelmesser, 2015; Venhorst et al., 2010). Hence, it is difficult to derive a clear relationship between graduates' propensity to stay in the region of study and their performance.

Another factor that might interact with duration dependence is location-specific work experience. Empirical evidence on this relationship is, however, rather scarce. Some papers address the importance of work experience for finding a job, but ignore the relationship between work experience and mobility behaviour (e.g. Venhorst and Cörvers, 2015). Social capital approaches (Granovetter, 1973) highlight the importance of establishing contacts to employers and colleagues during internships and employment episodes. The information provided via such work-related contacts is supposed to help the young and highly skilled to find a job more easily (e.g. Weiss et al., 2014; Venhorst and Cörvers, 2015). Results by Krabel and Flöther (2014) suggest that graduates' contacts with local employers influence their migration behaviour. Since work experience might be gathered in the university region or elsewhere, it may determine migration behaviour after graduation, since social networks may facilitate labour market entry in the study region or in other areas. For this reason, we might expect a negative relationship between extra-regional work experience and the length of residence spells.

3 Empirical models

To model the mobility of university graduates, we examine the hazard rate of migration. Formally, the hazard rate $h_i(t)$ is the probability of migration given that the graduate i has stayed in the university region up to the period t after graduation:

$$h_i(t) = Pr(T_i < t + 1 | T_i \geq t) \quad (1)$$

where T_i is the length of a residence spell in the university region. In the analysis, we use two different definitions of migration: a change of the region of residence and labour market entry outside the university region. The first definition is based on discrete annual data and refers to the change of the residence (*resid_dis*). For the second definition (*work_cont*), we make use of continuous data that comprises information on the exact starting date of the first (full-time) employment relationship after the graduation date and the corresponding place of work, which coincides with the

[1] We consider the life-cycle aspect to be of minor importance, as most graduates in Germany are presumably still not married and do not have children after graduation.

location of the establishment. In the latter case, we define outward migration as taking up a job outside the university region. Hence, we assume that the graduates do not commute and also change their residence. We can observe, based on this assumption, the exact length of a spell in the university region, namely from the date of graduation to the starting date of the first full-time job outside the region of study. For comparison, we also apply the second definition to annual workplace data (*work_dis*).

We estimate a proportional hazard specification in order to identify important determinants of migration behaviour. In the continuous-time model, the failure corresponds to the *work_cont* definition of a move, i.e. first full-time employment outside the university region after graduation:

$$h_i(t, x_i) = h_0(t) exp(x_i \beta) \tag{2}$$

where $h_0(t)$ is the baseline hazard and x_i is a vector of influential factors that includes individual characteristics such as gender and age of the graduates, information on the studies and the employment biography, as well as regional labour market characteristics. For a detailed description of all explanatory variables, see Table A1 in the appendix. We apply a parametric model and assume that the baseline hazard can be described by a Weibull distribution[2]:

$$h_i(t, x_i) = p t^{p-1} exp(x_i \beta) \tag{3}$$

The regression analysis provides an estimate of the shape parameter p that indicates whether hazard rates increase or decrease exponentially with time.[3]

To compare our approach with the setting applied in previous duration analyses (Haapanen and Tervo, 2012; Busch and Weigert, 2010), we also consider changes of the region of residence on an annual basis (resid_dis), along with annual changes of the workplace (work_dis). For this purpose, we estimate discrete-time models consistent with the continuous time approach. A complementary log log model is combined with a baseline hazard given by $(\alpha\, ln(t))$, the discrete-time analogue of the continuous time Weibull model[4] with $\alpha = p - 1$:

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[2] We also estimate a semi-parametric Cox model but do not present the estimates of the Cox regressions in the paper. A disadvantage of the Cox model in the present setting is that the baseline hazard is not parametrised and not estimated, i.e. it does not provide explicit information on duration dependence. The corresponding results are available upon request and largely resemble the estimates from the Weibull model. In particular, the findings regarding work experience turn out to be fairly robust. We choose a Weibull distribution because the raw hazards derived from Kaplan-Meyer estimates resemble hazards drawn from a Weibull distribution with $p < 1$ (see Andrews et al. (2011) for a corresponding discussion).

[3] In the case of $p = 1$, the model corresponds to an exponential distribution pointing to a constant hazard rate.

[4] As a robustness check, we also estimate a discrete-time complementary log log model with a third order polynomial in time. Results are available upon request.

$$h_i(t, x_i) = 1 - exp[-exp(x_i\beta + \alpha\, ln(t))] \quad (4)$$

Again, the baseline hazard provides information on the pattern of duration dependence. However, the estimates might be affected by unobserved heterogeneity at the individual level. Therefore, we include a frailty term u_i in the models that captures unobserved heterogeneity. In these models, the hazard of an individual is a function of observed characteristics x_i and a latent random effect u_i that enters multiplicatively on the hazard function. It is assumed that graduates differ randomly in a manner that is not fully accounted for by the observed characteristics and that u_i is independent of x_i (see Cameron and Trivedi, 2005, chapter 18). Applied to the continuous Weibull model in equation (3), the corresponding shared-frailty model is given by[5]:

$$h_i(t, x_i|u_i) = pt^{p-1}u_i\, exp(x_i\beta) = pt^{p-1}exp(x_i\beta + \vartheta_i)\ with\, \vartheta_i = ln(u_i) \quad (5)$$

With the shared-frailty models, we capture within-group correlation and take into account that observations for a given graduate are correlated because they share the same frailty. In other words, the correlation is the result of a latent graduate-level effect. When $u_i > 1$ ($u_i < 1$), the individual risk of outward migration of graduate i is larger (smaller) than for the average graduate. We assume that the young workers have different propensities to migrate, and this approach allows us to distinguish between heterogeneity and duration dependence. Without controlling for heterogeneity, the estimate of duration dependence is likely to be downward biased due to sample selection effects (Cameron and Trivedi, 2005; Andrews et al., 2011).

A drawback of our approach is that we cannot rule out commuting when using the workplace information to detect moves, i.e. the graduates might take up a job at a firm with a location outside the university region, but they may keep their residence. We try to cope with this problem by using functional regions as regional units. Migration is thus defined as a move across the borders of functional regions. These regions consist of several NUTS 3 regions which are linked by intense commuting. Commuting takes place mainly within these regions. Moreover, as a robust check, we only consider moves that involve a working place that is at least 150 kilometres away from the university town (work_dis150). Beyond this threshold, daily commuting is rather unlikely in Germany.

4 Data

Our analysis of graduate mobility rests on a university panel that combines information from student records of five medium-sized German universities and from the Integrated Employment Biographies (IEB) of the Institute for Employment Research (IAB). The advantage of our dataset is that a graduate‘s employment biography includes all

[5] We assume that the heterogeneity can be described by a gamma-distribution.

spells available in German social security records before, during and after studies, which enables us to identify the exact date of a move.

The student records encompass detailed information on students who graduated from three German universities and two universities of applied science. These universities are located in three distinct regions. The student records comprise individual information (e.g. date of birth, gender, nationality) and study-related information such as the duration of study, graduation date, final grade, type of graduation and field of study. The IEB contains starting and ending dates of all spells (i.e. episodes of unemployment, benefit receipt, employment) for all workers covered by the social security system in Germany (see vom Berge et al., 2013). The IEB covers roughly 80 percent of the German workforce and comprises for every worker a set of job characteristics (type of employment, occupation, industry affiliation, region of workplace) and the region of residence. The student records and the IEB are combined via a record linkage using individual identifiers (e.g. first name, surname, date of birth). The majority of graduates were successfully matched with the IEB.

To construct a sample for our analysis, we impose some restrictions on the data. We focus on the last degree from each graduate's higher education. Furthermore, we exclude graduates who are subject to mobility restrictions. For instance, due to specific regulations, it is difficult for teachers to take up employment in a publicly-maintained school in another federal state in Germany. Graduates older than 35 years at the date of graduation are also excluded.[6] We end up with a sample of 20,394 graduates who completed their studies from 1996 to 2011.

Residence and workplace information in the IEB originate from the social security notifications of the corresponding firm. However, the former is updated only annually, while the latter is available on a daily basis. We use the continuous workplace data for the work_cont definition of a move. In this case, we only consider employment of at least one year outside the university region as outward migration. Therefore, short-term temporary migration, linked to an internship for example, is excluded from the analysis. Besides, information on the region of residence is updated for individuals that receive unemployment and social benefits with the exact starting date of the corresponding episode. This also applies to graduates who are registered as searching for a job and those who participate in measures of active labour policies. The IEB reports more frequently and thus consistently about changes of the workplace compared to those of the region of residence. Therefore, we can use only the workplace information to generate continuous mobility data (work_cont). We make use of annual (discrete) data to detect either changes of the region of residence (resid_dis) or of the workplace (work_dis, work_dis150).

6 For a comprehensive description of the data preparation, see Appendix.

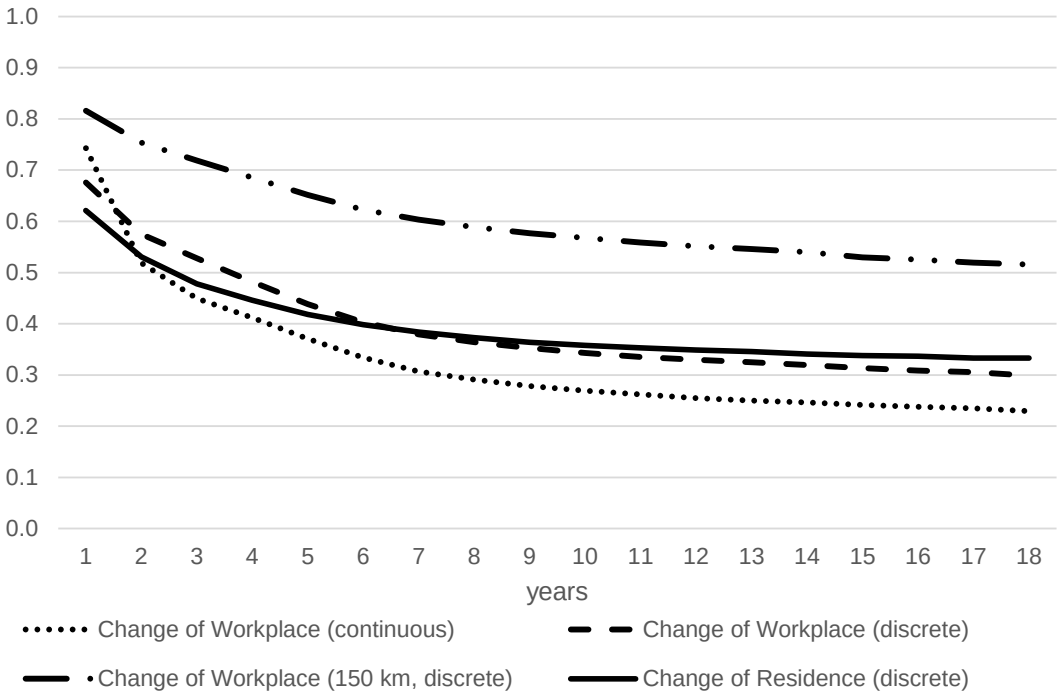
The residence and employment spells are monitored until the graduate moves away from the region of studies, the first (last) year of observation being 1996 (2014). The maximum observed duration thus amounts to 18 years. This implies that the data is possibly right-censored and that some spells are right-censored at shorter duration. However, allowing for a minimum observation period of three years after graduation should reduce the censoring problem compared to previous studies in which the observation ends after only one year after graduation for some workers (see, for example, Haapanen and Tervo, 2012; Busch and Weigert, 2010).

5 Regression results

Figure 1 displays survival functions which are based on non-parametric Kaplan-Meyer estimates for the different definitions of outward migration from the university region (see section 3). The survival rate indicates the probability of staying in the university region until time t after the beginning of the corresponding spell. While there are significant differences in the long-term shares of "stayers", the gradients of the curves are rather similar. All survival functions indicate that the majority of the migration events happen during the first 6 to 7 years after graduation. Afterwards, there are only minor changes in the share of stayers. During the first years after graduation, the hazard rates drop rapidly, pointing to predominant cumulative inertia. In other words, graduates willing to leave for other regions primarily migrate during subsequent years following final exams. The raw hazards look similar to hazards drawn from a Weibull distribution with a shape parameter $p < 1$.

The long-term share of stayers differs significantly depending on the definition of a move (change of residence or first job outside of university region) and whether we use discrete or continuous data. Apart from the first two years after graduation, the range of estimates is determined by estimates that are based on continuous workplace data and discrete data applying a minimum distance of 150 km from the university location. Unsurprisingly, the share of stayers rises if we increase the distance necessary for the event to be considered as a move from leaving a functional region to a distance of 150 kilometres. 18 years after completing their studies, around 23 percent of the graduates had never left the region for an employment relationship that lasted more than a year. If the migration event involves a move of at least 150 kilometres, the corresponding percentage amounts to almost 52 percent. With the latter estimate, we should be able to avoid counting daily commuters as migrants.

Figure 1
Survivor functions (Kaplan-Meyer estimates) for different definitions of migration



Source: university panel linked to the IEB of IAB, own calculations.

Estimates by Busch and Weigert (2010) point to a significantly higher share of stayers among university graduates in Germany. According to their results, 68 percent of the graduates still live in the federal state where they completed their studies 20 years after graduation. The marked variation across estimates is likely caused by different definitions of migration. Busch and Weigert (2010) use information on the residence and rely on federal states, i.e. rather large regional units, to identify migration events. Furthermore, their analysis makes use of discrete data (annual data on the residence). And finally, their data set also covers young workers who finished their studies in large agglomerations, whereas our focus is on medium-sized university towns and their hinterland. Results by Haapanen and Tervo (2012) for Finnish regions indicate that large urban regions are characterised by higher survival rates. For the Helsinki region, survival rates vary between 63 percent and 83 percent 13 years after graduation, whereas for other regions, the percentage of stayers ranges from 34 percent to 56 percent.

A comparison of the results for the continuous and discrete workplace data for functional regions suggests that with continuous data, the observation of exits, i.e. outward migration to another region, becomes more likely. However, the difference in the share of stayers between the two definitions builds up during the first 3 years after graduation. Afterwards, the gap is fairly constant. Interestingly, one year after graduation, the share of stayers is higher for the continuous data than for the discrete-time

model.[7] Between the first and the third year after graduation, a significant difference of approximately 7 percentage points emerges that is more or less constant until the end of the observation period. So it is especially during this early period after graduation that we detect more exits based on the continuous-time model compared to the discrete data.

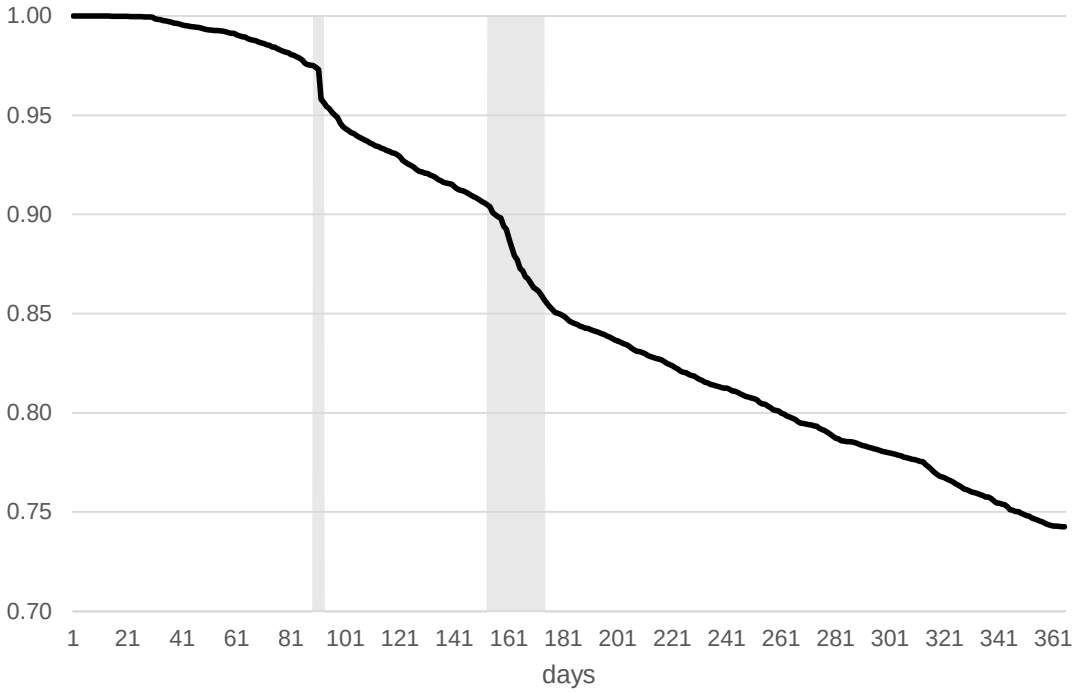
Using the discrete data, we observe for some young workers a change of residence before they take up a full-time job outside the university region. For a period of 6 years after graduation, the share of stayers is higher for the discrete workplace model compared to the residence data. The gap between workplace and residence definition might indicate that some graduates first move to another region in order to search for a job on site. In particular, it seems reasonable that unemployed graduates might return to their home regions and live with their parents until they have found a job. Moreover, graduates may enter the labour market outside the university region via a part-time job or marginal employment. These moves are not considered in the analysis, as our workplace-based definition of migration only considers full-time employment relationships. Commuters may also add to the discrepancy between the curves.

In the long run, the share of stayers is slightly higher if migration refers to a change of residence instead of a workplace outside the university region. Therefore, a certain percentage of the graduates decide to reside permanently in the university region, but at least temporarily work in another region. Altogether, the long-term differences in survival rates between these two definitions are moderate, ranging between 2 and 4 percentage points. Using continuous instead of discrete data and varying the minimum migration distance gives rise to more pronounced changes in the share of stayers.

Figure 2 provides some more detailed information on labour market entry outside the university region based on the continuous workplace data. The Kaplan-Meyer survival function for the first year after graduation indicates that the mobility process starts slowly within the first three months after the final exams. Three months after graduation, we observe a temporary acceleration which recurs after approximately five months. However, apart from these discontinuities, the survival function describes a rather smooth decline of the share of stayers. Despite a slow start, more than 50 percent of the failures that happen up to one year after graduation take place within the first six months.

[7] These differences might result from the corresponding definitions of outward migration. While we consider employment relationships with a minimum tenure of 12 months as labour market entry outside the university region when using the continuous data, this information is not available in the discrete data. In the latter case, therefore, short employment spells of less than one year are also recorded as an outward migration.

Figure 2
Survivor functions (Kaplan-Meyer estimates) – continuous data on workplace location



Source: university panel linked to the IEB of IAB, own calculations.

Table 1 summarises regression results for different continuous and discrete-time models, applying a proportional hazard approach. The models (1) to (3) refer to migration as taking up a job outside the (functional) university region, while model (4) is also based on the workplace location, but demands a move of at least 150 km. Model (5) makes use of annual residence data. All models include individual characteristics of graduates and information on their studies that turned out to be important determinants of the probability of leaving the university region in previous analyses. Moreover, some regional characteristics are considered. Apart from model (1), all specifications take into account frailty.[8]

[8] For regression results for field of study, type of degree and university see Table A3 in the appendix.

Table 1
Regression results: Continuous – and Discrete-Time Duration Models for Change of Workplace/Residence

	Change of Workplace						*Change of Workplace (at least 150 km)*		*Change of Residence*	
	work_cont, without frailty		*work_cont, with frailty*		*work_dis, with frailty*		*work_dis, with frailty*		*resid_dis, with frailty*	
	coef	*se*	coef	*se*	coef	*se*	coef	*se*	coef	*se*
Personal characteristics										
Female	-0.070**	(0.023)	-0.108**	(0.032)	-0.153**	(0.037)	-0.091	(0.047)	0.215**	(0.056)
Age	0.009	(0.040)	0.077	(0.058)	-0.022	(0.041)	0.092	(0.047)	0.441**	(0.067)
Age²	-0.002**	(0.001)	-0.003**	(0.001)	-0.000	(0.001)	-0.001*	(0.001)	-0.008**	(0.001)
Foreigner	0.101	(0.061)	0.125	(0.084)	-0.066	(0.088)	-0.143	(0.112)	-0.121	(0.122)
Mobility before studies	0.493**	(0.024)	0.673**	(0.033)	0.809**	(0.051)	0.834**	(0.057)	2.702**	(0.111)
University entrance qualification abroad	-0.087	(0.068)	-0.061	(0.095)	-0.179	(0.103)	-0.135	(0.130)	-1.164**	(0.151)
Studies										
Exam grade	-0.067**	(0.013)	-0.107**	(0.018)	-0.083**	(0.021)	-0.016	(0.026)	0.048	(0.031)
Study length										
Bachelor degree	0.054**	(0.012)	0.054**	(0.018)	0.028	(0.020)	0.015	(0.026)	0.027	(0.031)
Diploma	0.007	(0.005)	-0.003	(0.007)	-0.007	(0.007)	-0.036**	(0.009)	-0.041**	(0.011)
Master Degree	0.089**	(0.013)	0.084**	(0.019)	0.038	(0.020)	0.054*	(0.026)	0.005	(0.031)
Other degree	-0.034**	(0.007)	-0.050**	(0.009)	-0.067**	(0.011)	-0.090**	(0.014)	-0.108**	(0.017)
Employment biography										
Vocational training	0.049	(0.035)	0.054	(0.050)	0.055	(0.056)	-0.172*	(0.074)	-0.321**	(0.090)
Experience (in 100 days)										
outside univ. region, during studies	0.185**	(0.015)	0.345**	(0.024)	0.396**	(0.033)	0.178**	(0.032)	0.815**	(0.053)
inside univ. region, during studies	-0.113**	(0.010)	-0.154**	(0.013)	-0.164**	(0.017)	-0.145**	(0.021)	-0.291**	(0.025)
outside univ. region, before studies	0.022**	(0.002)	0.029**	(0.003)	0.022**	(0.004)	0.013**	(0.005)	0.058**	(0.006)
inside univ. region, before studies	0.006**	(0.002)	0.004	(0.002)	-0.008**	(0.003)	-0.018**	(0.004)	-0.044**	(0.005)
revious employer	-0.039	(0.037)	-0.151**	(0.051)	-0.018	(0.062)	-0.412**	(0.083)	-0.469**	(0.098)

	Change of Workplace						*Change of Workplace (at least 150 km)*		*Change of Residence*	
	work_cont, without frailty		*work_cont, with frailty*		*work_dis, with frailty*		*work_dis, with frailty*		*resid_dis, with frailty*	
	coef	*se*	coef	*se*	coef	*se*	coef	*se*	coef	*se*
Regional characteristics[1]										
Population density	0.012	(0.009)	0.047**	(0.014)	-0.036*	(0.015)	-0.033	(0.018)	0.038	(0.020)
Yearly GDP growth	-0.007	(0.005)	-0.020*	(0.008)	0.015*	(0.007)	0.013	(0.008)	-0.001	(0.008)
Share of people younger than 24 years	0.162	(0.123)	-0.134	(0.203)	1.209**	(0.237)	0.938**	(0.291)	-0.247	(0.311)
Income per capita	-0.048	(0.059)	-0.113	(0.091)	-0.751**	(0.071)	-0.663**	(0.085)	0.332**	(0.086)
Unemployment rate	-0.144**	(0.010)	-0.255**	(0.019)	0.066**	(0.016)	0.069**	(0.020)	0.111**	(0.024)
Ln(*p*)	0.100**	(0.009)	0.433**	(0.021)						
Ln(Θ)			0.190*	(0.078)						
Ln(t)					-0.126	(0.083)	-0.212**	(0.075)	-0.000	(0.068)
Implied *p*	1.106	(0.010)	1.542	(0.032)	0.874		0.788		1.000	
Θ			1.210	(0.095)						
LR test of Θ = 0 (p-value)					211.75 (0.00)		182.28 (0.00)		1379,58 (0.00)	
Log Likelihood	-25,466		-25,234		-27,786		-24,182		-23,222	
Number of students	20,394		20,394		20,394		20,394		20,394	
Observations	125,443		125,443		80,833		108,196		82,451	

Notes: 1: university region; * significance at the 0.05 level, ** significance at the 0.01 level; robust standard errors in parenthesis. All models include time fixed effects and university, field of study and type of degree dummies.

Source: university panel linked to the IEB of IAB, own calculations.

While the shape of the raw hazards is rather similar across alternative definitions of outward migration (see Figure 1), there are significant differences between the regression models. This refers primarily to the comparison of workplace-based versus residence-based definitions. Although we use functional labour market regions to identify moves or demand a distance of at least 150 km between workplace and university location, there are significant differences between the models that are based on the workplace location and the residence of the graduate, even if we assume the workplace data to be discrete. In contrast, the variation across models explaining first employment outside the region of studies is altogether moderate. However, estimates of the model that involve a minimum distance of 150 km seem to be a mixture of workplace-based and residence-based specifications. The variation across the models suggests that the decision to choose a job outside the study region somewhat differs from the choice of a new residence. In contrast, taking into account unobserved heterogeneity, i.e. comparing model (1) and (2), only gives rise to minor changes of most variables. We will discuss some exceptions below.

Female graduates tend to manage labour market entry via a full-time job more often in the region of studies than young males (see e.g., Abreu et al., 2015), but show a higher probability of choosing a residence outside the region. Differences are also evident for age. The variable has a positive but declining impact on the hazard rate of migration if we consider a change of the residence after graduation. This partly confirms results by Haapanen and Tervo (2012), while Busch and Weigert (2010) report a declining probability of outward migration with increasing age of German graduates. In contrast, our results suggest that the probability of job entry outside the university region does not systematically vary with the age of the graduates. The impact of foreign citizenship does not significantly differ from zero.

Findings on the impact of previous migration experience confirm the results of former studies indicating that mobility at entry to university is highly correlated with post-graduation mobility. However, the information at hand allows us to differentiate between international and interregional migration prior to studies. It turns out that this difference is indeed important for subsequent migration behaviour. While interregional migration, in line with previous evidence, enhances the probability of leaving the region of study, graduates who obtained the university entrance qualification abroad show a lower risk of outward migration. For the latter group, however, we detect no important effect on the location of the first full-time job. In contrast, interregional mobility also increases the probability of taking up employment in another region. Graduates who moved to the university region face a hazard 96 percent greater than graduates who study in their home region.

There is some indication that more successful students, in terms of exam grades, face fewer problems finding a full-time job in the local labour market as they enter the labour market more often in the region of study compared to graduates with lower

grades. However, better grades do not impact the probability of changing the residence. The estimates (model (2)) indicate that excellent graduates show, ceteris paribus, a 10.1 percent [1 – exp(–0.107 × 1)] lower risk of taking up a full-time job outside the region of study than very good students. A differentiated effect emerges for the length of study. However, we refrain from a detailed discussion of other study-related factors.

Several characteristics of the university region seem to influence the location of labour market entry and changes of the region of residence. However, we refrain from a detailed discussion of these results because corresponding estimates are not robust across specifications and not always in line with theoretical expectations and previous evidence. We do not pay too much attention to the results, as our focus is not on the role of regional characteristics. Moreover, in our data, the variation of these variables is fairly low because we can only consider graduates in a limited number of university regions. Main results are robust if we use region-year dummies instead of regional context variables.

The employment biography and in particular the work experience gathered prior to and during the studies turn out to be important factors that impact post-graduation mobility. A significant proportion of the young workers have finished a vocational training before starting their studies. These graduates tend to show a lower probability of outward migration than graduates without an apprenticeship. However, the two groups do not significantly differ with respect to the location of labour market entry. If the graduates take up a job with a previous employer, this often coincides with a job inside the university region, and this group of graduates also shows a lower risk of changing residence.

The effects of work experience turn out to be rather robust across the alternative models and definitions of migration. This applies especially to the work experience gathered during the studies. If the experience refers to jobs outside the university region, taking up a job in another region as well as changing the residence becomes more likely. Extending the experience by 100 days give rise to an increase of the hazard of between 41 percent (workplace) and 126 percent (residence). In contrast, a working period of 100 days within the university region reduces the probability of entering full-time employment in another region by more than 14 percent. With respect to outward migration, we detect an effect of 25 percent. Experience gathered before the studies has a significant but smaller influence on the migration behaviour of the graduates, pointing to some kind of depreciation phenomenon, i.e. the importance declines with increasing time lag. Moreover, there is no significant effect of the work experience inside the university region in the continuous workplace model. In contrast, 100 days of work experience before the studies gathered outside the university region increases the likelihood of labour market entry in another region by almost three percent. However, if we consider a change of the residence, again opposing effects show up. These differences suggest that work experience reflects labour market contacts and local

human capital accumulation, but also social networks, in particular when a change of residence is concerned.

Whether we detect cumulative inertia, cumulative stress or neither of the two depends on the definition of outward migration and whether we use discrete or continuous data. With respect to a change of residence, neither cumulative inertia nor cumulative stress clearly dominate. The corresponding shape parameter does not significantly differ from 1, suggesting that the baseline hazard can be described by an exponential distribution which is characterised by a constant hazard rate. This also applies to labour market entry outside the functional region based on discrete data. In contrast, the estimates point to a significant negative duration dependence if we assume a minimum distance of 150 km, probably pointing to the importance of social networks and corresponding migration costs which will increase with the length of the residence spell. The corresponding estimate implies a shape parameter of the Weibull distribution of 0.788, pointing to a moderate negative duration dependence. Andrews et al. (2011) report parameters of similar size for interregional migration in the UK (0.863 for males and 0.857 for females). Haapanen and Tervo (2012) and Busch and Weigert (2010) also provide evidence on a significant duration dependence when residence spells are concerned. It is noteworthy that we detect a positive duration dependence if we use the continuous workplace data. This suggests that the probability of taking up a full-time job outside the university region increases with elapsed time. This result might be driven by graduates who initially search for a job in the region of study, but do not find (adequate) employment and extend their job search area.

Table 2
Duration dependence and the effect of work experience in discrete time models

	Change of Workplace (work_dis)				*Change of Residence (resid_dis)*			
	without frailty		*with frailty*		*without frailty*		*with frailty*	
	coef	*se*	coef	*se*	coef	*se*	coef	*se*
Experience (in 100 days)								
outside univ. region, during studies	0.192**	(0.013)	0.396**	(0.033)	0.215**	(0.013)	0.815**	(0.053)
inside univ. region, during studies	-0.094**	(0.010)	-0.164**	(0.017)	-0.118**	(0.010)	-0.291**	(0.025)
outside univ. region, before studies	0.010**	(0.002)	0.022**	(0.004)	0.017**	(0.002)	0.058**	(0.006)
inside univ. region, before studies	-0.007**	(0.002)	-0.008**	(0.003)	-0.020**	(0.002)	-0.044**	(0.005)
Ln(t)	-0.838**	(0.022)	-0.126	(0.083)	-1.139**	(0.023)	-0.000	(0.068)
Implied *p*	0.162		0.874		-0.139		1.000	
Log Likelihood	-27,892		-27,786		-23,912		-23,222	
Number of students	20,394		20,394		20,394		20,394	
Observations	80,833		80,833		82,451		82,451	

Notes: * significance at the 0.05 level, ** significance at the 0.01 level; robust standard errors in parentheses.
Source: university panel linked to the IEB of IAB, own calculations.

Finally, we discuss the importance of unobserved heterogeneity. In the case of the continuous-time model where the shared frailty is gamma distributed, the estimated frailty variance θ is significant at the 5 percent level, pointing to an important within-group correlation. If we estimate discrete time models with random effects, the likelihood ratio tests also indicate that the intra-group correlation ρ cannot be ignored. Comparing the continuous time models with and without frailty suggests that unobserved heterogeneity affects the results for the baseline hazard. In fact, the positive duration dependence increases once we control for unobserved heterogeneity. In Table 2, we compare the corresponding estimates of the discrete time models with and without frailty. The results confirm the finding that the shape parameter of the Weibull distribution is downward biased if we ignore unobserved heterogeneity. This is in line with evidence provided by Andrews et al. (2011). We also display the coefficients for work experience in Table 2. The majority of these effects are smaller in absolute size if we do not consider unobserved heterogeneity.

6 Conclusion

We apply event history methods to investigate graduate migration in Germany focusing on moves that are linked to labour market entry of young workers. Our unique dataset provides continuous information on the place of residence and the workplace. This data base allows us to identify the exact date of a move and to investigate the migration process in more detail. We observe significant changes in the share of stayers up to 7 years after graduation. Therefore, focusing on a rather short period after graduation, such as one year, will provide an incomplete picture of post-graduation mobility.

Our results partly confirm evidence provided in similar studies by Busch and Weigert (2010) and Haapanen and Tervo (2012). However, compared to these analyses, the share of stayers is rather low among the graduates considered in our analysis. This might be due to our focus on medium-sized university regions which are likely to suffer from an above-average outward migration of young, highly skilled workers. Large urban regions might, in contrast, succeed in retaining a relatively high percentage of their graduates. Corresponding results by Haapanen and Tervo (2012) for Finland are in line with this estimate.

Individual characteristics, study-related factors and regional characteristics impact the location of labour market entry and changes of residence. Moreover, the employment biography influences the decision to leave the region of study. In particular, work experience gathered inside or outside the university regions is significant, pointing to the importance of labour market contacts, local human capital accumulation and social networks. As the work experience is likely to correlate with individual characteristics and study-related factors, estimating the effects of these determinants might result in biased estimates if experience is ignored in the regression model.

This also applies to the duration dependence and unobserved heterogeneity. The hazard becomes flatter if we control for unobserved heterogeneity in the model for

change of residence. More precisely, ignoring different individual propensities to migrate results in overestimating the degree of negative duration dependence, in line with evidence provided by Andrews et al. (2011). Our results suggest that there is no genuine negative duration dependence when graduate migration is concerned. It seems that the negative relationship between the probability of leaving the region of study and the length of the residence spell is entirely driven by observed and unobserved graduate characteristics. In contrast, there is some indication for cumulative stress when labour market entry outside the university region is considered.

The findings differ significantly across alternative specifications, suggesting that the mobility of graduates is a rather complex phenomenon that is characterised by different combinations of changes of residence and workplace. It seems that the estimates for the change of the workplace using discrete data and a minimum distance somehow present a mixture of the findings for the discrete residence model and the continuous workplace approach. So using discrete versus continuous data and applying information on the residence versus the workplace both seem to influence the estimation results. Different combinations of labour market entry outside the university and changes of residence thus seem to be important. Moreover, we suppose that the sequence of these events will vary. This raises important issues for future research and calls for more detailed information on the spatial job search of graduates. With the data at hand, we cannot investigate the precise timing of changes of residence and therefore its interaction with changes of the workplace. High-frequency data on both workplace and residence is required in order to shed some light on these issues and examine the role of commuting and in particular long-distance weekly commuting in this context.

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Appendix

The university panel encompasses detailed information on students who graduated from five medium-sized universities in three distinct regions in Germany: University of Kiel (CAU), Giessen University (JLU), Saarland University (UdS), Kiel University of Applied Sciences (FHK) and University of Applied Sciences Saarland (UdS). Our data set combines individual information from student records with the employment biographies of the graduates. The latter information is available in the Integrated Employment Market Biographies (IEB) of the Institute for Employment Research (IAB). The student records and the IEB are merged via a record linkage using individual identifiers such as first name, surname and date of birth. Using this method, about 85 percent of the students could be linked to the IEB. With the exception of one university, graduates from all fields of study in which students can enrol are covered. For the JLU, we only have information for graduates from natural sciences and economics and business administration.

To construct the sample for our analysis, we impose some restrictions on the data. In our analysis, we only consider the last degree from each graduate's education at the respective university. We can thus make sure that the student has finally left university. We focus on graduates between 20 and 35 years of age and those who manage to finish their studies in fewer than 20 semesters. Since internships of 2 years are obligatory for teachers in Germany after graduation and due to specific mobility restrictions, we exclude these graduates from the analysis. Medical graduates (human and dental) are also excluded, since we do not have reliable information for them from all universities. To be able to compare labour market entry among Bachelor and Master students, spells associated with doctoral degrees are deleted. Furthermore, we only consider graduates for whom we observe a first full or part-time employment or apprenticeship training that lasted at least 7 days within two years after final exams. Graduates who leave the university region but return within a year are not counted as migrants.

Table A1
Description of explanatory variables

Personal characteristics	
Female	1 if female, 0 if male
Age	Age
Age²	Age squared divided by 100
Foreigner	1 if foreign graduate, 0 if German graduate
Mobility before studies	1 if not studying in home region, 0 otherwise
University entrance qualification abroad	1 if graduate received university entrance qualification abroad, 0 otherwise
Studies	
Exam grade	From sufficient (1) to excellent (5)
Study length	Number of semesters
Field of study	• Agricultural sciences • Humanities • Geography/Meteorology • Mathematics/computer science • Medicine/Pharmacy • Natural sciences • Psychology • Law • Social sciences • Business and Economics
Type of degree	Bachelor, Master/Diploma, other degrees (dummy variables)
University	CAU, FHK, JLU, UdS, HTW (dummy variables)
Employment biography	
Vocational training	1 if graduate was undergoing vocational training before studying, 0 otherwise
Experience (in 100 working days)	• Work experience outside university region before studies • Work experience within university region before studies • Work experience outside university region during studies • Work experience within university region during studies
Previous employer	• 1 if first job after graduation at former employer, 0 otherwise
Regional characteristics (university region)	
Population density	Population per square metre, in 1,000 inhabitants
Yearly GDP growth	in percent
Share 0-24 years old	Share of persons aged 0 to 24
Income per capita	Primary income of households, in 1,000 Euro
Unemployment rate	Unemployed as percentage of labour force (in per cent)

Table A2
Summary statistics

	Obs.	*Mean*	Std.	*Min.*	Max.
Personal characteristics					
Female	125,443	0.41	0.49	0	1
Age	125,443	30.13	4.35	19	52
Age²	125,443	926.71	282.11	361	2,704
Foreigner	125,443	0.04	0.20	0	1
Mobility before studies	125,443	0.36	0.48	0	1
University entrance qualification abroad	125,443	0.04	0.19	0	1
Studies					
Exam grade	125,443	3.03	0.95	1	5
Study length					
Bachelor degree	125,443	0.53	2.02	0	20
Master degree	125,443	0.23	1.08	0	20
Diploma	125,443	7.95	5.90	0	20
Other degrees	125,443	2.22	4.90	0	20
Field of Study					
Agricultural sciences	125,443	0.05	0.21	0	1
Humanities	125,443	0.15	0.35	0	1
Geography/Meteorology	125,443	0.04	0.20	0	1
Mathematics/computer science	125,443	0.13	0.34	0	1
Pharmacy	125,443	0.04	0.19	0	1
Natural sciences	125,443	0.23	0.42	0	1
Psychology	125,443	0.04	0.19	0	1
Law	125,443	0.05	0.21	0	1
Social Sciences	125,443	0.05	0.22	0	1
Business and Economics	125,443	0.23	0.42	0	1
Type of degree					
Bachelor degree	125,443	0.07	0.26	0	1
Diploma/Master degree	125,443	0.74	0.44	0	1
Other degrees	125,443	0.19	0.39	0	1
Employment biography					
Vocational training	125,443	0.16	0.36	0	1
Experience (in 100 days)					
outside university region, during studies	125,443	0.14	0.57	0	4.47
inside university region, during studies	125,443	1.01	1.27	0	4.52
outside university region, before studies	125,443	2.22	5.04	0	61.58
inside university region, before studies	125,443	6.92	8.12	0	56.73
Previous employer	125,443	0.08	0.27	0	1
Regional characteristics[1]					
Population density	125,443	301.16	97.96	190.13	421.84
Yearly GDP growth	125,443	2.07	3.24	-9.58	5.74
Share of people younger than 24 years	125,443	24.71	1.20	22.06	28.02
Income per capita	125,443	19.05	3.92	12.07	25.79
Unemployment rate	125,443	10.54	1.56	6.6	14.2

Source: university panel linked to the IEB of IAB, own calculations.

Table A3
Regression results for field of study, type of degree and university

	Change of Workplace						*Change of Workplace (at least 150 km)*		*Change of Residence*	
	work_cont, without frailty		*work_cont, with frailty*		*work_dis, with frailty*		*work_dis, with frailty*		*resid_dis, with frailty*	
	coef	*se*	coef	*se*	coef	*se*	coef	*se*	coef	*se*
Field of study (ref: business and economics)										
Agricultural sciences	-0.311**	(0.051)	-0.344**	(0.073)	-0.530**	(0.082)	-0.097	(0.100)	0.167	(0.137)
Humanities	-0.372**	(0.044)	-0.485**	(0.060)	-0.896**	(0.079)	-0.988**	(0.095)	-0.894**	(0.106)
Geography/Meteorology	-0.381**	(0.055)	-0.539**	(0.078)	-0.868**	(0.099)	-0.454**	(0.118)	-0.853**	(0.139)
Mathematics/computer science	-0.314**	(0.039)	-0.368**	(0.057)	-0.455**	(0.062)	-0.412**	(0.079)	-0.778**	(0.096)
Pharmacy	-0.641**	(0.066)	-0.814**	(0.086)	-1.150**	(0.118)	-1.075**	(0.144)	-1.265**	(0.169)
Natural sciences	-0.398**	(0.032)	-0.545**	(0.046)	-0.703**	(0.061)	-0.387**	(0.068)	-0.679**	(0.083)
Psychology	-0.369**	(0.064)	-0.440**	(0.094)	-0.785**	(0.104)	-0.737**	(0.131)	-0.580**	(0.147)
Law	-1.066**	(0.070)	-1.399**	(0.100)	-1.844**	(0.143)	-1.791**	(0.168)	-1.663**	(0.173)
Social Sciences	-0.474**	(0.056)	-0.668**	(0.079)	-1.108**	(0.102)	-0.753**	(0.122)	-1.451**	(0.145)
Type of Degree (ref: Diploma/Master)										
Bachelor	-0.163	(0.112)	-0.236	(0.162)	-0.275	(0.173)	-0.235	(0.228)	-0.177	(0.266)
Other degrees	0.733**	(0.096)	0.797**	(0.130)	0.919**	(0.159)	0.918**	(0.201)	1.375**	(0.244)
University (ref: UdS)										
CAU	2.797	(2.079)	10.699**	(3.431)	-3.887	(3.417)	-3.999	(4.288)	6.079	(4.609)
HTW	-0.349**	(0.044)	-0.475**	(0.063)	-0.517**	(0.069)	-0.665**	(0.088)	-1.168**	(0.107)
FHK	3.017	(2.080)	10.995**	(3.437)	-3.726	(3.419)	-4.409	(4.293)	5.657	(4.611)
JLU	2.665	(2.109)	10.795**	(3.500)	-8.866*	(3.652)	-9.174*	(4.571)	8.764	(4.939)

Notes: ref: reference; * significance at the 0.05 level, ** significance at the 0.01 level; robust standard errors in parenthesis.

Source: university panel linked to the IEB of IAB, own calculations.

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