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Articles on labour market issues

1|2020 Career paths of PhD graduates in eastern and western Germany: Same qualification, same labor market outcomes?

Andreas Rehs, Michaela Fuchs

Career paths of PhD graduates in eastern and western Germany: Same qualification, same labor market outcomes?

Andreas Rehs (University of Kassel),
Michaela Fuchs (IAB)

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Abstract

This paper investigates the extent to which the returns to gaining a PhD degree depend upon the region of birth, the region where the degree was earned, and the place of work. Eastern Germany serves as an interesting showcase in light of the ongoing debate surrounding the underrepresentation of eastern Germans in top positions in Germany. We examine the career paths of eastern and western German PhD graduates who completed their dissertations between 1995 and 2010. We estimate the returns with regard to obtaining a job suited to their skill level and with high wages. Our data set combines information on PhD graduates and their place of birth collected from data on PhD dissertations in Germany with data from administrative social security records. This record linkage approach provides a unique source of individual employment and wage biographies of eastern and western German PhD graduates. Our findings show that labor market success is affected neither by being born in eastern Germany nor by earning a PhD at an eastern German university. However, the place of work does matter, suggesting that the stark differences between the two parts of Germany with regard to labor market conditions is the main reason for the differences in the labor market prospects of PhD graduates from eastern and western Germany.

Zusammenfassung

Dieses Papier geht der Frage nach, ob die regionale Herkunft ein Hindernis für die Inanspruchnahme der Bildungserträge einer Promotion darstellt. Ostdeutschland bietet hierfür aufgrund der anhaltenden Diskussionen über die Unterrepräsentation von Ostdeutschen in bundesdeutschen Spitzenpositionen ein gutes Beispiel. Wir untersuchen die Erwerbsbiografien ost- und westdeutscher Promovierter, die ihre Dissertationen zwischen 1995 und 2010 beendet haben, um herauszufinden, ob ein ostdeutscher Hintergrund die Bildungserträge reduziert. Diese messen wir anhand einer ausbildungsadäquaten Beschäftigung und hoher Löhne. Unser Datensatz kombiniert Informationen zu Promovierten und ihrem Geburtsort mit administrativen Daten und stellt damit einen einmaligen Datensatz für die Untersuchung der Erwerbbiografien ost- und westdeutscher Promovierter dar. Unsere Ergebnisse weisen weder dem Geburtsort noch dem Standort der Universität, an der die Promotion abgelegt wurde, einen signifikanten Einfluss auf die Bildungserträge zu. Eine zentrale Rolle spielt allerdings der Arbeitsort in Ostdeutschland. Er reduziert die Chancen auf hohe Löhne, was die Bedeutung der Unterschiede in den wirtschaftlichen Bedingungen in Ost- und Westdeutschland für die Arbeitsmarktaussichten der Promovierten betont.

JEL classification

I23, I26, J24, J31, P20

Keywords

Acknowledgments

1 Introduction

Today's knowledge economy strongly depends on capacities for innovation, creating knowledge and solving complex problems. These capacities are associated with PhD graduates, who play a prominent role in fostering economic development and growth (Stephan et al. 2004; Auriol et al. 2013). A crucial issue in this respect is whether they are able to fully exploit their investment in education in their subsequent jobs, or whether they are at risk of mismatch on the labor market. Overeducation in the form of a level of education that exceeds the requirements for the current job has costly consequences for individuals, firms and the economy as a whole (McGuiness 2006). For the PhD graduates themselves, part of their investment in education is unproductive, which translates into lower returns on investment in the form of employment below their skill level and lower wages. There are diverse reasons for PhD graduates not fully reaping the returns to their education and they have not yet been exhaustively investigated (Engelage/Schubert 2009; Van der Steeg/van der Wiel/Wouterse 2014; DiPaolo/Mañé 2016). Findings on the labor market performance of PhD graduates and on the obstacles they face in using their abilities are therefore highly relevant not only for the individuals themselves, when considering their subsequent career paths, but also for policy makers and governments that finance the education of this group and support their integration into the innovation system (Auriol et al. 2013, Auer et al. 2016).

From a sociological perspective, PhD graduates belong to a country's educational and economic elite, holding top positions in academic, economic, political or cultural spheres, while representing certain values and attitudes (Dahrendorf 1965; Hartmann/Kopp 2001; Dee 2004). For Germany, this is even more the case than in other countries, as a PhD is not only a prerequisite for a scientific career, but is also associated with a high reputation and appreciation outside academia. Moreover, in more general terms, a high level of human capital such as that acquired by PhD graduates can generate positive externalities for the general public by strengthening social cohesion and political participation in a democracy (Auer et al. 2016). Hence, any factors that diminish PhD graduates' returns to education may lead not only to adverse consequences for the individuals concerned, such as inadequate jobs and wages, but also to significant societal repercussions.

Focusing on regional background as an inhibiting factor, eastern Germany constitutes an especially intriguing case. Unlike in other Central and Eastern European transformation economies, the incorporation of the former German Democratic Republic into the western democracy and market economy was undertaken very rapidly, with western German institutions being extended to and implemented in the new eastern part of Germany (Salheiser 2012: 123). As a result, a considerable number of the old East German elites were replaced by western Germans, which went hand in hand with the breakdown of the old Socialist elite recruitment regime (Best 2005; Geißler 2014). This profound exchange of elites continues to have an effect today. Bluhm/Jacobs (2016: 30) note that eastern Germans occupy only 2 percent of the top positions in Germany, although eastern Germany accounts for 17 percent of the whole population. In eastern German public discourse, the underrepresentation of eastern Germans in top positions and the consequences for social and political coherence have frequently been the topic of lively discussions (e.g., Lukas/Reinhard 2016; Deutsche Gesellschaft e.V. 2017), indicating that the transformation process in eastern Germany is still in progress. In the light of the ongoing public debates, it is surprising that there is very little

representative empirical evidence on the underrepresentation of eastern Germans in top positions in Germany.

Against this background, this paper investigates whether having an eastern or western German background has an impact on whether or not PhD graduates are able to fully capture the returns on their education. It is unclear whether being from eastern Germany plays an important role for the employment trajectories of highly educated individuals, since the processes of acquiring social and cultural capital changed dramatically for eastern Germans in the course of reunification (Salheiser 2012). We trace the employment trajectories of eastern and western German PhD graduates in order to analyze whether the eastern German graduates fare less well than their western German counterparts and whether this can be explained by their eastern German background. In order to exclude any detrimental effects that might arise from systematic differences between the doctoral education systems in the German Democratic Republic and the Federal Republic of Germany, we only consider individuals who completed their dissertation after 1994. We compare the two groups with respect to two main labor market outcomes, thereby contributing to related findings for PhD graduates (e.g., Auriol et al. 2013; Di Paolo/ Mañé 2016; Koenig 2019). First, we investigate whether an eastern German background is associated with a higher probability of being overeducated for the current job, taking up the conjecture that eastern German PhD graduates might be less likely than their western peers to work in jobs that fully exploit their human capital. Second, we examine whether an eastern German background is associated with a lower probability of achieving high wages as compared to a western German background. To differentiate between an eastern or western German background we use the place of birth as the most straightforward measure. Since the place of birth could be overshadowed by the location of the university where the PhD was completed or by the subsequent place of work, we additionally consider these two measures.

Our analysis is based on a novel data set developed by Heinisch/Koenig/Otto (2019) in order to follow the labor market biographies of German PhD graduates. It combines data on PhD graduates collected in the catalogue of the German National Library with information on their labor market biographies from the Integrated Employment Biographies of the Institute for Employment Research. This data set is then supplemented by information on the PhD graduates' places of birth, as recorded in their dissertations. Our data set comprises individuals who completed their dissertations between 1995 and 2010 and their labor market outcomes for the subsequent five years. We apply logit models to assess whether an eastern German background significantly lowers the PhD graduates' probability of finding employment and earning wages that are in line with their skill level.

The results reveal no significant negative impact on labor market success either for a birthplace in eastern Germany or for a dissertation submitted to an eastern German university. In that respect, the same qualification level results in the same labor market outcomes. It is more the place of work that matters, which indicates the impact of the still divergent economic conditions in the two parts of Germany on PhD graduates' employment prospects. In particular, a place of work in eastern Germany substantially reduces the chances of achieving high wages. This result is confirmed when the different regional differentiations are controlled for.

The remainder of the paper is structured as follows. In section 2, the background on overeducation among PhD graduates and related empirical findings is discussed. Section 3 introduces the data

used for our analysis, along with measurement issues. Descriptive evidence together with the regression results are the focus of section 4. The last section draws conclusions.

2 Overeducation among PhD graduates

Labor market mismatch and its consequences for career mobility and wages have been investigated extensively in education and labor market research (McGuiness 2006; Leuven/Oosterbeek 2011). Due to growing numbers of higher education graduates in many countries, increasing attention has been paid to the educational attainment of PhD graduates as a special subgroup of graduates in recent years (Auriol et al. 2013). While a large body of literature deals with overeducation among graduates and highly qualified labor market participants (see Rossen/Boll/Wolf 2019 for an overview), empirical evidence on the labor market performance of PhD graduates has been expanding in recent years, but still leaves many research questions unanswered.

Several studies investigate the existence and consequences of a labor market mismatch for PhD graduates in specific countries, all reaching similar conclusions. Bender/Heywood (2011) examine the degree of mismatch between education and the current job among a panel of US PhD graduates. Their results show that mismatch is more likely late in careers, which is consistent with mismatch resulting from a certain evolution of the professional employment trajectory. In their study on Swiss PhD graduates, Engelage/Schubert (2009) further emphasize the role of the field of study for obtaining an adequate job. Focusing on overeducation and overskilling among Italian PhD graduates, Gaeta (2015) confirms the importance of the field of study and of job-related characteristics as conditioning factors of both forms of mismatch. Likewise, for a cohort of Spanish PhD students Di Paolo/Mañé (2016) find that many of them face involuntary mismatch accompanied by significant penalties in terms of job satisfaction and earnings. The negative impact of labor market mismatch on wages is corroborated by Bender/Heywood (2009) for PhD graduates in the US. Relatedly, Canal Domínguez/Rodríguez Gutiérrez (2013) study wage differences among Spanish PhD graduates and confirm that working in a job that requires higher education levels is associated with higher earnings. Van der Steeg et al. (2014) investigate the private returns to obtaining a PhD in the Netherlands. They compare wages earned by PhD graduates to those earned by master's graduates over the first 20 years of their careers and find an average annual return to a PhD education of 6 percent over the entire career.

For Germany, empirical findings concerning PhD graduates' wages are provided by Heineck/Matthes (2012). They compare PhD graduates to other university graduates with respect to wages and skill mismatch and find that the monetary returns to holding a PhD are significantly higher than those to just obtaining a university degree. Furthermore, monetary returns are higher in the private sector than in the public sector. Graduates holding a PhD regard their employment as more adequately suited to their skill level than university graduates. Similarly, Falk/Küpper (2013) find that PhD graduates' wages are about 7 percent higher than those of university graduates. However, the wage advantages strongly depend on the field of study, with engineers having the strongest advantages. Mertens/Röbken (2013) confirm the higher monetary returns for PhD graduates compared to master's graduates especially in the fields of economics and law. To investigate the non-academic career prospects of postdocs in German academia, Koenig (2019) uses the same

data set as we do, albeit without information on the individuals' place of birth. His results indicate that a significant number of PhD graduates remain in academia after graduation. However, there is no general wage premium in the non-academic sector for employment as a postdoc.

To our knowledge, no studies on PhD graduates in Germany have so far addressed the origin of the PhD graduates with respect to eastern or western Germany. However, we can embed our analysis in research focusing on university graduates in more general terms. Rukwid (2012) compares the extent of overqualification among university graduates working in eastern and western Germany. As a general picture, in 2010 the risk of being overqualified was higher in eastern Germany, where 23 percent of the graduates were in jobs for which they were overqualified as compared to 18 percent in western Germany. The presentation of the extent of overqualification from 1990 onwards impressively illustrates the problems faced by eastern German graduates when trying to find employment suited to their skill level in the first years after reunification. The corresponding share of overskilled East German graduates rose to almost 32 percent in 2004. At the same time, the share of West German graduates also increased, but only to relatively moderate 20 percent in 2004 (Rukwid 2012: 36). The author puts these large differences down to the severe economic aftermath of German reunification, which led to structural unemployment in eastern Germany. Large numbers of graduates lost their jobs in liquidated stated-owned enterprises and were looking for new employment in the 1990s. In addition, university degrees obtained in the German Democratic Republic were not always accepted as equivalent to degrees obtained from western German universities.

The necessity to examine eastern and western Germany separately with regard to educational mismatch also becomes evident in Boll/Leppin/Schömann (2016). The authors identify the reasons for overeducation according to different measurements and for different subgroups of graduates between 1992 and 2011. For eastern German graduates, the effect of previous unemployment is more pronounced than for their western German counterparts, and they are also more likely to have been exposed to involuntary job changes. This can be put down to the poor labor market prospects in the eastern part of the country during that period. A further central finding is that overeducation exhibits a pronounced path dependency: having been overeducated in the previous year significantly increases the risk of being overeducated at present. Whereas according to individual self-assessment the probability of being currently overeducated increases more for eastern Germans than for western Germans if they exhibited this status in the previous period, the differences between eastern and western German men are quite small when measured in statistical terms. Interestingly, however, state dependency among western German women is found to be more than twice as high as for their eastern German counterparts.

In their paper on the monetary returns to a PhD, Mertens/Röbken (2013) also consider the specific economic situation in eastern Germany by including a dummy variable in the wage regressions for a place of work in western Germany. It is positive and highly significant in most of the fields of study examined, which emphasizes the higher wages earned by both regular university graduates and doctorate graduates in the western part of the country.

Summing up, the empirical evidence on overeducation specifically for eastern and western Germany reveals a higher risk of overqualification and lower wages when working in the eastern part of the country. In the following, we aim to find out whether having an eastern German background

in a broader sense than just the workplace leads to potential lower returns to education in the case of the PhD graduates.

3 Empirical setting

3.1 Data

In order to obtain information on PhD graduates and their employment biographies, we make use of several data sources. Our basic data set comes from the IAB-INCHER project of earned doctorates (IIPED) (see Heinisch/Koenig/Otto 2019 for more details). It combines information on dissertations that are contained in the electronic catalogue of the German National Library (Deutsche Nationalbibliothek or DNB) with the individual labor market history from the Integrated Employment Biographies (IEB) of the Institute for Employment Research (IAB). We further enrich this information by including the PhD graduates' birthplaces, which we obtained from the online dissertations.

As Germany's central archival library, the DNB collects, documents and archives all printed publications and sound recordings issued in Germany together with works that were compiled in the German language or relate to Germany (DNB 2019). Since PhD graduates are required by law to supply a copy of their dissertation, the DNB holds an almost complete set of dissertations submitted to German universities since the 1970s. The electronic catalogue of the DNB features information on the authors, the university name, the year of publication and the subject and therefore constitutes a highly suitable data source for research on PhD graduates in Germany (e.g., Buenstorf/Geissler 2014; Heinisch/Buenstorf 2018).

One drawback of the DNB catalogue, however, is that the PhD graduates' place and date of birth are very rarely reported. In order to retrieve this essential information, we made use of URL links to online dissertations listed in the DNB catalogue. In many faculties, PhD students are required to report their place and date of birth as well as the date of the examination on the front page of their dissertation.[1] However, not all universities have (working) URL links to downloadable dissertations in the DNB database. We therefore resorted to the individual university servers as a second strategy and systematically searched them for online dissertations.[2] These were matched with the dissertations in the DNB catalogue via the author's name, the university name and the year in which the dissertation was submitted.[3] This yielded a total of 79,000 dissertations from the two data sources for which we know the unique identifier in the DNB catalogue.

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[1] Sometimes the dissertations also include a curriculum vitae.

[2] These servers cover the full set of online dissertations (as of August 2017) from the universities of Kassel, Munich (TU and LMU), Braunschweig, Freiburg, Frankfurt/Main, Greifswald, Darmstadt, Düsseldorf, HU Berlin, Halle-Wittenberg, Magdeburg, Regensburg, Rostock, Ulm, all universities in Saxony and Thuringia, and the Karlsruher Institut für Technologie.

[3] We used a fuzzy-string matching procedure based on the Levinstein distance for the author's name and allowed a time window of 2 years before and after the date of the dissertation to compare the year of submission to the DNB with the years stated on the university server website. This is necessary because the two dates do not necessarily coincide. To correct mismatches, in the name matching procedure we additionally checked whether the matched name appears on the front page of the dissertation.

Our variable of interest, a PhD graduate's birthplace, was retrieved by means of a text pattern matching approach. Typical keywords on front pages or curriculum vitae, like "place of birth", indicate the subsequent mention of a birthplace or other information of interest. In English dissertations we systematically searched for the words "born in:", "birthplace" and others. For dissertations in German we repeated this procedure with corresponding German terms.[4] We automatically searched for these keywords on the front pages or in the curriculum vitae of every dissertation from our two first data sources and saved the three subsequent words. In the next step, we cleansed the resulting string manually of frequent errors and entered it into the Google Maps search engine in order to obtain a unique address and more general information such as country, state and zipcode for each birthplace. The Google search engine has the advantage that it takes into account diverse spellings and ambiguous German city names.[5] We were able to identify the birthplaces of 27,321 German PhD graduates with this procedure.

In the IIPED project, the data on the PhD graduates were merged with information on the graduates' labor market performance from the Integrated Employment Biographies (IEB) of the IAB.[6] The IEB contain information on employment spells, benefit receipt, participation in measures of active labor market policy, and job-search status for every person on a daily basis. Because they are not covered by the social security system, civil servants, self-employed persons, family workers and PhD students financed solely by scholarships are not contained in the IEB. In total, the IEB covers about 80 per cent of the German workforce. The data are available from 1975 onwards for western Germany and from 1993 onwards for eastern Germany. For each individual, the IEB contains a range of sociodemographic characteristics (e.g., sex, date of birth, nationality, qualification level, place of residence) and job features (type of employment, occupation, industry affiliation, place of work). Although the qualification level covers vocational training or bachelor's and master's degrees, there is no information on PhDs. Consequently, it is necessary to match this with the DNB data, which includes that information, in order to trace the labor market biographies of German PhD graduates.

From the matched data set, we select only PhD graduates who were born in Germany and whose dissertation was completed between 1995 and 2010. We set the beginning of our observation period at 1995 because good coverage of online dissertations and thus birthplaces only exists from the middle to the late 1990s onwards. In addition, for most disciplines the starting date of 1995 is justified as it represents the first cohort of PhD graduates who began their dissertation in reunified Germany. Considering earlier cohorts would inevitably also include PhD graduates who began their dissertation in the German Democratic Republic, which is not the focus of our study. We then trace their labor market performance for five years after they earned their PhD. A five-year period has been established as a good predictor of future wages in the literature. Guvenen et al. (2015) find that for US employees the bulk of earnings growth happens between the age of 25 and 35. This is especially the case for lifetime incomes in the upper percentiles of the distribution, where we expect to find doctorate graduates. Since the graduates' mean age at the time when their labor

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[4] The German expressions are "geb. in", "geboren", "aus" and "Geburtsort" and further variations of these terms.

[5] Since some German town names occur more than once in Germany, the nearby river is added to their names in order to avoid confusion. However, the attachment of the river is not used consistently, for example Halle/Saale, Halle a. d. Saale, Halle Saale and so on.

[6] For more detailed information on the IEB see Antoni/Ganzer/vom Berge (2016), who provide a description of the Sample of the Integrated Labour Market Biographies, a 2 percent random sample of the IEB.

market outcome is observed is roughly 37 (see Table A 2 in the Appendix), we should accordingly have a good approximation of the lifetime labor wages in t+5. An additional investigation of other points in time, like t+10 and t+15, would not only add little to the results, but also reduce the number of available cohorts in our data set. An additional argument pertains to the pervasiveness of fixed-term contracts in the early career stage and the postdoc phase that lasts about five years (Auriol et al 2013). Afterwards, PhD graduates should be employed in jobs that are related to their doctoral degree. Since the DNB-IEB matching process is cut after 2015 due to the challenges involved in processing and matching the data as described in Heinisch/Koenig/Otto (2019), 2010 is the last available cohort of PhD graduates. Thus, our final sample only comprises PhD graduates who gained their PhD between 1995 and 2010 and for whom we have labor market information for five years after they obtained their PhD. It includes 2,902 persons in total, 670 of whom were born in eastern Germany, 2,088 in western Germany and 144 in Berlin.

3.2 Main variables

We measure the labor market performance of the eastern and western German PhD graduates on the basis of two outcomes that capture the returns to education. First, we measure the potential formal overeducation due to being eastern German based on the skill level required for the occupation. This indicator is contained in the German Classification of Occupations (KldB 2010) and depicts the various degrees of complexity within those occupations which have a high similarity of occupational expertise (Paulus/Matthes 2013:9).[7] The complexity of an occupation is captured by four requirement levels that range from unskilled, specialist and complex specialist activities to highly complex activities. It is assumed that a certain standard of skills, abilities and knowledge must exist for practicing a certain occupation. In the case of highly complex activities, the required formal qualification encompasses university studies lasting at least four years or relevant professional experience. Corresponding jobs are typically found in research and development, teaching or on the executive boards of medium-sized and large companies. PhD graduates can therefore be regarded as being employed in line with their skill level when they work in jobs involving highly complex activities, i.e. when they are employed as experts. This indicator has regularly been used to measure formal overeducation on the basis of German administrative data (Reichelt/Vicari 2014; Stüber 2016; Kracke/Reichelt/Vicari 2018). We encode the outcome as a dichotomous variable that is equal to one if the individual works in a job that involves highly complex activities five years after earning a PhD, and is equal to zero otherwise.

The second outcome relates to a potential wage penalty among the PhD graduates for being eastern German. To measure this, we use the nominal daily wages reported in the IEB. A general restriction here, however, is that in the IEB wages are only recorded up to the social security contribution assessment ceiling in Germany.[8] Since PhD graduates can be expected to earn wages in excess of this assessment ceiling, we construct a dichotomous variable that is equal to one if the PhD holder earns wages exceeding the inflation-adjusted social security contributions assessment ceiling in year five after earning their PhD.[9] Throughout the analysis, we only consider persons in

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[7] The KldB 2010 is a five-digit classification that contains two dimensions: occupational expertise is encoded in the first four digits, and the requirement level in the fifth digit.

[8] For example, in 2009 this was 157.81 euros/day in eastern Germany and 180.82 euros/day in western Germany.

[9] In 2003, there was an extraordinary sharp increase in the contribution assessment ceiling, which is taken into account in our subsequent procedure.

full-time employment, because the German social security data do not contain information on the exact number of hours worked, which would be necessary to compute hourly wages.

Our central explanatory variable of interest concerns the PhD graduates' regional origin, i.e. eastern or western Germany. The most straightforward differentiation is based on the place of birth. We use a dichotomous variable *birthplace_east*, which takes on the value of one if the individual was born in eastern Germany and zero in the case of western Germany. Since the place of birth may have a different impact on labor market outcomes in the two parts of the country and may be contorted by the individual working in eastern or western Germany, we include the place of work as a second regional distinction. The labor markets in the two parts of the country still differ in many respects due to the ongoing transformation process in eastern Germany, which is characterized by a generally higher extent of overqualification and lower wages (Reichelt/Vicari 2014; Fuchs/Rauscher/Weyh 2014). The dichotomous variable *workplace_east* is equal to 1 when the place of work is in eastern Germany. Because Berlin constitutes a separate regional unit in the dichotomy of eastern/western Germany, PhD graduates born in Berlin are regarded as neither eastern nor western German, but are investigated separately throughout. However, we include a workplace in Berlin (*workplace_berlin*) as a separate regional distinction in order to identify the labor market effects of what is eastern Germany's largest city as well as the capital city of Germany. It is again encoded as a dichotomous variable.

A third dimension of regional origin pertains to the location of the university where the PhD was earned. We include the dichotomous variable *university_east*, that is one if the respective university is located in eastern Germany and zero in the case of western Germany in order to capture potential self-selection mechanisms in the choice of university. Since eastern German universities lag slightly behind their western German counterparts with regard to scientific productivity and recognition (Schmoch/Schulze 2010), promising PhD candidates from both parts of the country may be more likely to take up doctoral studies in western Germany. Furthermore, the different funding structures, especially from industry (Pasternak 2007), as well as differing research field focuses (Schmoch/Schulze 2010) could account for selection effects. However, at the same time, research funding levels and personnel capacities in eastern German universities are similar or even higher than those in their western German counterparts (Pasternack 2007). This would be a reason for selecting eastern German universities.

3.3 Control variables

In order to control for further determinants of adequate employment and wages, we consider additional groups of variables. The first group comprises individual characteristics of the PhD graduates. Age effects are covered by age in years and age squared to take any nonlinearities into account. Gender is included as a dichotomous variable that is equal to one for a female PhD graduate. Since prior work experience also impacts on subsequent labor market success, we construct a continuous variable that cumulates all employment episodes up to one year before the dissertation was published. Another important factor when conducting analysis at the small-scale regional level relates to the individuals' spatial mobility after graduation. If they look for work in regional labor markets rather than global ones, their access to suitable employment might be severely restricted (Büchel/van Ham 2003). This is especially the case in small and rural labor markets, of which there is a disproportionately large number in eastern Germany (Granato et al. 2009). Hence,

mobile PhD graduates have better chances of avoiding skill mismatch if they seek employment elsewhere. We take mobility after graduation into account with a dichotomous variable. A PhD graduate is considered mobile if the location of the university where he or she completed the dissertation is in a different planning region[10] to the place of work five years later.

The second group of control variables concerns job characteristics. Since wages vary significantly between sectors,[11] we control for sectoral affiliation by considering nine economic sectors ranging from agriculture, forestry and horticulture to humanities, culture, arts and media. For analyzing the wage level only, we also include the four skill requirement levels for the job (unskilled, specialist, complex and highly complex activities). Since the regional area can also have an impact on remuneration, we further differentiate between the three broad region types of urban agglomerations, urbanized and rural regions.[12]

The third group of control variables refers to the scientific discipline in which the PhD graduate wrote his or her dissertation. From the subject classification for each dissertation contained in the DNB, we encoded 17 different field dummies. They include natural sciences, literature and linguistics, and economics and business. We excluded dissertations in the field of medicine, because they would account for the majority of observations. Last, we take into account year dummies in order to control for a general time trend.

Table A 1 in the Appendix contains detailed definitions of all variables, and Table A 2 provides descriptive statistics for the dependent and explanatory variables.

4   Results

4.1 Descriptive evidence

Our final sample comprises 2,758 PhD graduates that are traced for five years after earning their PhD. Concerning eastern German backgrounds, we observe 670 PhD graduates born in eastern Germany, 637 graduates working in eastern Germany, and 918 persons who gained their PhD from an eastern German university. Our coverage of PhD cohorts and their labor market outcomes in t+5 improves in the late 2000s. This is due to the improved availability of dissertations online. Regarding our outcomes, 2,016 persons have an expert job status five years after earning their PhD, and 1,051 have an income above the social security contribution assessment ceiling.

Figure 1 depicts the spatial distribution of the birthplaces and university locations of the PhD graduates in our sample. As can be expected from the spatial distribution of the population, many of the birthplaces are located in typical agglomerations, such as the Rhine/Main region in western Germany and Berlin in eastern Germany. When the location of the university is differentiated according to the place of birth, our data suggest that both eastern and western Germans tend to opt for universities in the part of Germany where they were born. Native eastern German graduates

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[10] See https://www.bbsr.bund.de/BBSR/DE/Raumbeobachtung/Raumabgrenzungen/deutschland/regionen/Raumordnungsregionen/raumordnungsregionen-node.html for further details (accessed 30.11.2019).

[11] Wages also vary significantly between occupations. Since many occupations are concentrated in just a few sectors, we only consider sectors in order to avoid multicollinearity.

[12] See https://www.bbsr.bund.de/BBSR/DE/Raumbeobachtung/Raumabgrenzungen/deutschland/kreise/Kreistypen4/kreistypen_node.html (accessed 03.08.2019).

predominantly attended universities in the federal states of Saxony and Thuringia and in Berlin. Some native western German graduates also enrolled in these universities.

Figure 1   **Spatial distribution of the PhD graduates' birthplaces (left) and location of their PhD universities, by birthplace in eastern or western Germany (right)**
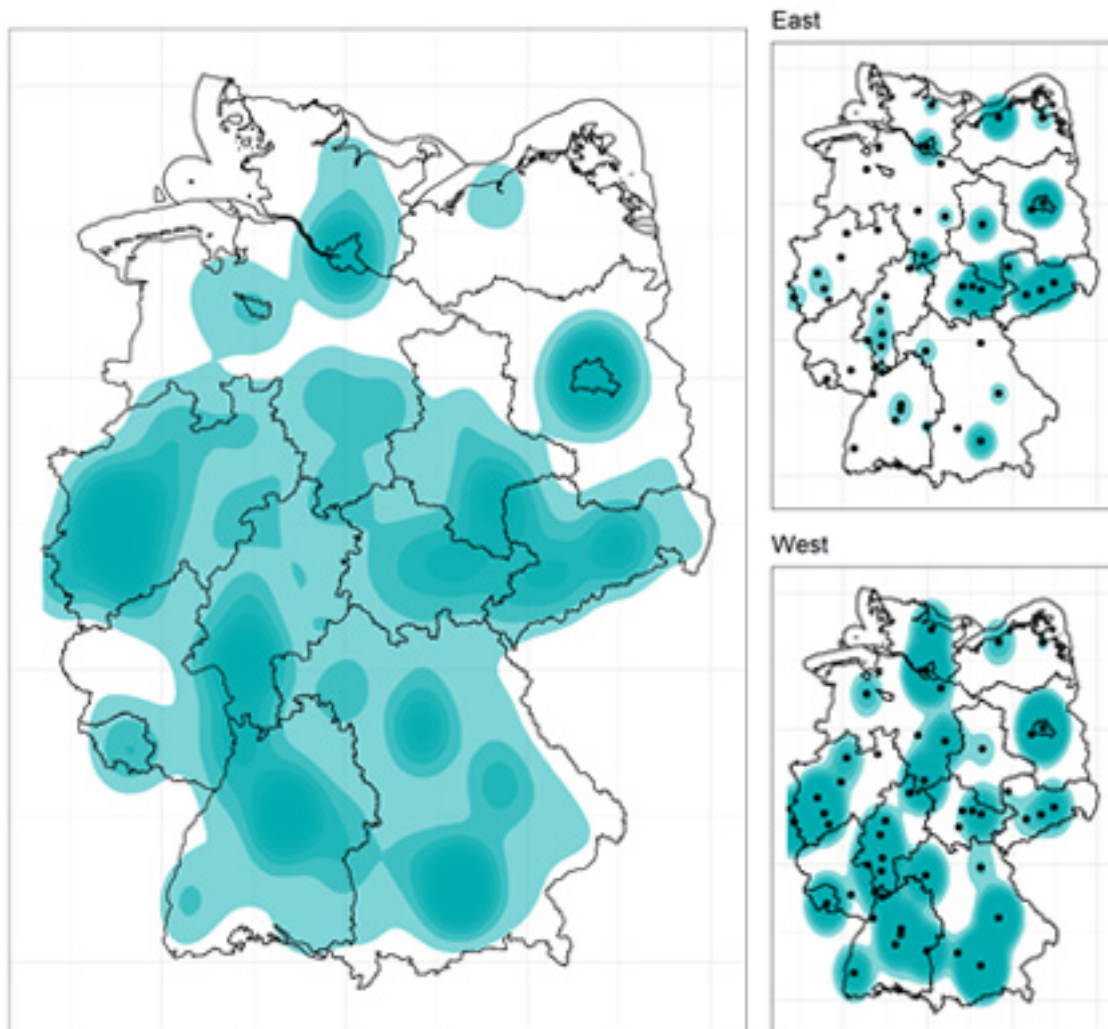
Source: IIPED data set, own birthplace data from online dissertations (geo-referenced by Google maps); own compilation.

Similarly, this also holds for the places of work five years after gaining a PhD, as depicted in Figure 2 – eastern Germans largely remain in eastern German regions and western Germans largely remain in western German regions. This is consistent with empirical evidence on the internal migration of graduates, which finds that the longer the graduates stay in the region of their university, the less likely they are to leave afterwards (Busch/Weigert 2010; see also Teichert et al. 2018). However, some features are noteworthy. The PhD graduates born in western Germany tend to work in the large agglomerations of the Rhine/Main area around Frankfurt, the greater Stuttgart area and the greater Munich area. In slight contrast, the workplaces of the PhD graduates born in eastern Germany tend to be concentrated in the southern parts of Saxony and Thuringia rather than in Berlin, which is eastern Germany's largest agglomeration.

Figure 2: Workplace according to planning regions five years after dissertation, by birthplace in eastern and western Germany
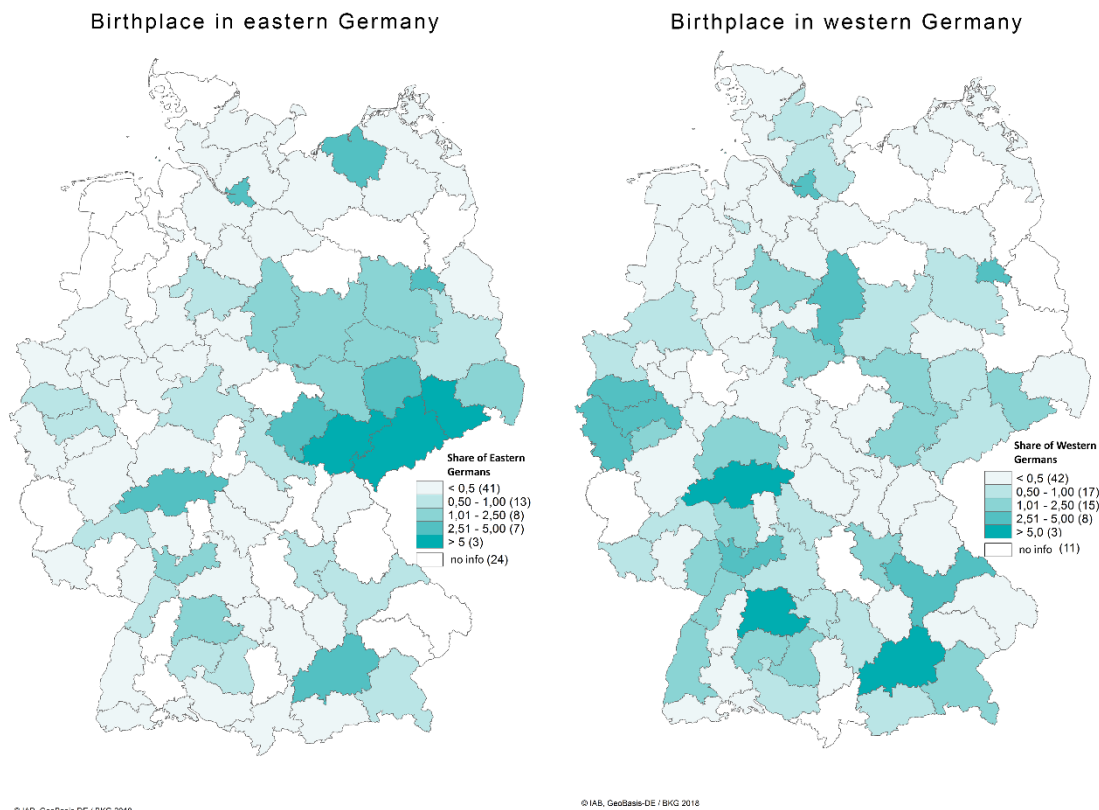
Note: Shares of eastern/western German PhD graduates in relation to all eastern/western German PhD graduates in the sample. Source: IIPED data set, own birthplace data from online dissertations (geo-referenced by Google maps); own compilation.

Regarding our two main labor market outcomes, obtaining an expert job and earning a wage above the social security contribution assessment ceiling, descriptive evidence shows considerable differences between graduates with eastern and western German backgrounds, especially with regard to the second variable. 40.8 percent of the PhD graduates born in western Germany, but only 30.0 percent of those born in eastern Germany earn wages above the contribution assessment ceiling five years after completing their PhD. However, this may be mainly associated with the current workplace and not so much with the birthplace. The PhD graduates in our sample that work in eastern Germany exceed the contribution assessment ceiling in only 23.5 percent of the cases, while in western Germany this is the case for 43.0 percent. This difference can be explained by the profound wage disparities that still exist between the two parts of Germany (see Fuchs/Rauscher/Weyh 2014). Since eastern German PhD graduates generally remain in their own part of Germany rather than moving to western Germany (see Figure 2), they cannot benefit from the higher western German wages to the same extent as their western German counterparts.

The group differences in the first labor market outcome, relating to an expert job status, are not so pronounced. The shares of eastern and western German PhD graduates holding such a job are almost identical (72.5 percent and 73.8 percent respectively). Differentiating by a place of work in eastern or western Germany does not change the picture (72.6 percent and 73.8 percent respectively). A more detailed discussion of the descriptive patterns can be found in Fuchs/Rehs (2019).

Table A 2 in the Appendix provides further information on the distribution of the PhD graduates across age groups, work experience, the sector of the economy, and the discipline in which the PhD was earned.

4.2 Econometric results

We now turn to econometric techniques in order to test our conjectures regarding the labor market outcomes of eastern German PhD graduates in a multivariate setting. Using a logit model, we estimate whether having an eastern German background has a statistically significant negative impact on the probability of (1) obtaining an expert job and (2) achieving wages above the social security contribution assessment ceiling five years after gaining the PhD. The general specification of the logit model is given by:

$$\pi_i = P(Y_i = 1 \,|\, x_{i1}, \dots, x_{ik}) = F(\eta_i) = \frac{\exp(\eta_i)}{1 - \exp(\eta_i)} \tag{1}$$

$$\eta_i = \alpha + \beta birthplace\_east_i + \beta workplace\_east_i + \beta university\_east_i + \beta control_i \tag{2}$$

In this specification, $birthplace\_east_i$ denotes the place of birth, $workplace\_east_i$ denotes the place of work, and $university\_east_i$ denotes the location of the university where individual i gained his or her PhD. All three variables denoting the regional origin are constructed as dichotomous variables with the value of one for eastern Germany. Control variables are contained in $control_i$ and include individual, job-related and scientific characteristics as well as a time trend as described in section 3.3.

Depending on the model, π_i denotes either the probability of currently having a job with the highest skill requirement level (expert) or the likelihood of earning wages that are above the social security contribution assessment ceiling. Robust standard errors are estimated throughout. As the sign, magnitude and significance level of regression coefficients in non-linear models can often be misleading and thus lead to false conclusions, especially concerning interaction terms (Ai/Norton, 2003), we calculate average marginal effects and predicted margins for the covariates of interest.

Table 1 shows the results for the regional background variables when the PhD graduate has an expert job in t+5 (full results can be found in Table A 3 and Table A 4 in the Appendix). Neither in the basic model nor when taking into account interaction effects between *birthplace_east* and *workplace_east* do the marginal effects of an eastern German background show a statistically significant impact on the likelihood of achieving an expert job status. This holds for all three delineations of the regional background as well as for the separate consideration of a place of work in Berlin.

Predictive margins for *birthplace_east* at different levels of *workplace_east* are shown in Table 2. When estimating the average predictive margins, we compute the change in the probability of having an expert job in t+5 when *workplace_east* remains fixed at 0/1 and *birthplace_east* changes for each observation to 0/1. Holding all other variables constant, the results in Table 2 show probabilities for the combinations that are of similar magnitudes to those in Table 1. The probability of native western Germans holding an expert job in t+5 when working in western Germany is 72.8 percent, while the corresponding value for native eastern Germans working in western Germany is 73.5 percent. For western Germans working in the eastern part of the country, the probability is 75.0 percent and for eastern Germans working in eastern Germany is it 75.7 percent. The overlapping confidence intervals indicate that there are no differences between the respective margins at

the levels of *workplace_east*. Therefore, we conclude that an eastern German background in terms of birthplace and place of work has no impact on whether or not the PhD graduate achieves an expert job status in t+5.

Table 1: Selected average marginal effects for holding an expert job in t+5

Variable	dy/dx	std. err.	z-score	p- value	95 % conf. interval
Basic model					
birthplace_east	0.069	0.023	0.30	0.76	-0.039-0.052
workplace_east	0.023	0.025	0.92	0.36	-0.026-0.073
workplace_berlin	-0.007	0.042	-0.16	0.87	-0.090-0.076
university_east	-0.033	0.043	-1.48	0.14	-0.079-0.011
Interaction effects					
birthplace_east	0.002	0.023	0.09	0.93	-0.043-0.047
workplace_east	0.016	0.023	0.02	0.49	-0.095-0.073

Note: Delta method, Model VCE: robust, dy/dx for factor levels is the discrete change from the base level. */**/*** indicates statistical significance at the 10/5/1 % level, respectively.

Sources: IIPED data set, own research; own calculation.

Table 2: Average predictive margins for birthplace_east at different values of workplace_east (holding an expert job in t+5)

	margin	std. error	z-score	p-value	95 % conf. interval
Basic model					
birthplace_east =0 at *workplace_east*=0	0.728***	0.010	72.21	0.00	0.708-0.747
birthplace_east =1 at *workplace_east*=0	0.735***	0.021	35.16	0.00	0.694-0.776
birthplace_east =0 at *workplace_east* =1	0.750***	0.022	34.07	0.00	0.707-0.794
birthplace_east =1 at *workplace_east* =1	0.757***	0.021	34.49	0.00	0.714-0.800
Interaction effects					
workplace_east =0 at *birthplace_east* =0	0.733***	0.009	84.04	0.00	0.716-0.750
workplace_east =0 at *birthplace_east* =1	0.746***	0.027	28.04	0.00	0.694-0.800
workplace_east =1 at *birthplace_east* =0	0.760***	0.028	27.61	0.00	0.707-0.815
workplace_east =1 at *birthplace_east* =1	0.727***	0.020	24.24	0.00	0.690-7.700

Note: Delta method, Model VCE: robust. */**/*** indicates statistical significance at the 10/5/1 % level, respectively.

Sources: IIPED data set, own research; own calculation.

Table 3 shows selected average marginal effects for achieving wages that exceed the social security contribution assessment ceiling in t+5 in the model with and without interaction terms for *birthplace_east* and *workplace_east* (full results can be found in Table A 5 and Table A 6 in the Appendix). The coefficient for an eastern German birthplace is insignificant, which does not suggest any influence of an eastern German origin. However, an eastern German place of work seems to be decisive. It leads to a probability of achieving wages above the contribution assessment ceiling that is 20 percentage points lower than is the case for a place of work in western Germany.[13] This result is in line with Mertens/Röbken (2013), who find that a western German place of work has a positive and significant impact on wages.

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[13] Note that the substantially lower contribution assessment ceiling in eastern Germany is already taken into account (see section 4.1).

Table 3: Selected average marginal effects for exceeding the contribution assessment ceiling in t+5

	dy/dx	std. err.	z-score	p-value	95 % conf. interval
Basic model					
birthplace_east	-0.001	0.027	-0.04	0.96	-0.055-0.052
workplace_east	-0.203***	0.026	-7.65	0.00	-0.255-0.015
workplace_berlin	-0.069	0.044	-1.58	0.11	0.015-0.017
university_east	-0.021	0.026	-0.82	0.41	-0.073-0.030
Interaction effects					
birthplace_east	-0.016	0.026	-0.62	0.54	-0.067-0.350
workplace_east	-0.221***	0.025	-8.66	0.00	-0.270-0.017

Note: Delta method, Model VCE: robust, dy/dx for factor levels is the discrete change from the base level. */**/*** indicates statistical significance at the 10/5/1 % level, respectively.

Sources: IIPED data set, own research; own calculation.

Just like for the first labor market outcome, Table 4 contains the average predictive margins for *birthplace_east* at different levels of *workplace_east*. In the basic model, the probability of achieving a wage above the contribution assessment ceiling is 42.8 percent for native western Germans working in western Germany and 42.6 percent for native eastern Germans working there. When the place of work is in eastern Germany, the probabilities of earning high wages are much lower. Native eastern and western German PhD graduates have the same probability (22.3 percent) of earning wages above the social security contribution assessment ceiling in t+5. Again, overlapping confidence intervals suggest no statistical differences between the predictive margins at the different levels of *workplace_east*.

Table 4: Average predictive margins for birthplace_east at different levels of workplace_east (exceeding the contribution assessment ceiling in t+5)

	margin	st. error	z-score	p-value	95 % conf. interval
Basic model					
workplace_east =0 at *birthplace_east* =0	0.428***	0.011	35.97	0.00	0.404-0.451
workplace_east =0 at *birthplace_east* =1	0.426***	0.026	15.98	0.00	0.374-0.479
workplace_east =1 at *birthplace_east* =0	0.223***	0.022	9.78	0.00	0.179-0.269
workplace_east =1 at *birthplace_east* =1	0.223***	0.022	9.78	0.00	0.178-0.268
Interaction effects					
workplace_east =0 at *birthplace_east* =0	0.434***	0.011	40.87	0.00	0.413-0.455
workplace_east =0 at *birthplace_east* =1	0.408***	0.030	13.30	0.00	0.348-0.468
workplace_east =1 at *birthplace_east* =0	0.202***	0.029	7.02	0.00	0.147-0.259
workplace_east =1 at *birthplace_east* =1	0.219***	0.019	11.19	0.00	0.180-0.257

Note: Delta method, Model VCE: robust. */**/*** indicates statistical significance at the 10/5/1 % level, respectively.

Sources: IIPED data set, own research; own calculation.

4.3 Robustness checks

Although 1,051 of the 2,758 persons in our sample earn wages above the social security contribution assessment ceiling (see Table A 2 in the Appendix), this threshold might generally be set too high for the majority of PhD graduates. As a consequence, considerable variations between East and West could exist below the threshold, which is not addressed with our approach. We therefore check whether the distribution of individuals within our two groups changes substantially when the contribution assessment ceiling is modified. Figure 3 depicts the results of a reduction by 5 percent and 10 percent respectively. The graph shows an increase in the number of observations occurring in all regional delineations. However, we find no noticeable differences between the ratios

of this increase between the single groups. This implies that a reduction in the social security contribution assessment ceiling affects the two groups in the same manner, regardless of the regional origin. We therefore conclude that the contribution assessment ceiling is a valid measure.

Further robustness checks address the different sectoral composition in eastern and western Germany. As eastern Germany has a more pronounced service sector, we repeated our regression procedure for the manufacturing sector only. Again, the birthplace does not play a role, but the place of work does. It leads to a lower likelihood of obtaining an expert job status and achieving a wage above the contribution assessment ceiling.

Finally, our separate estimate for PhD graduates born in Berlin does not deliver any robust results, since the number of observations is too small. All details on the robustness checks are available from the authors upon request.

Figure 3: Share of PhD graduates with wages above the contribution assessment ceiling (modifications)
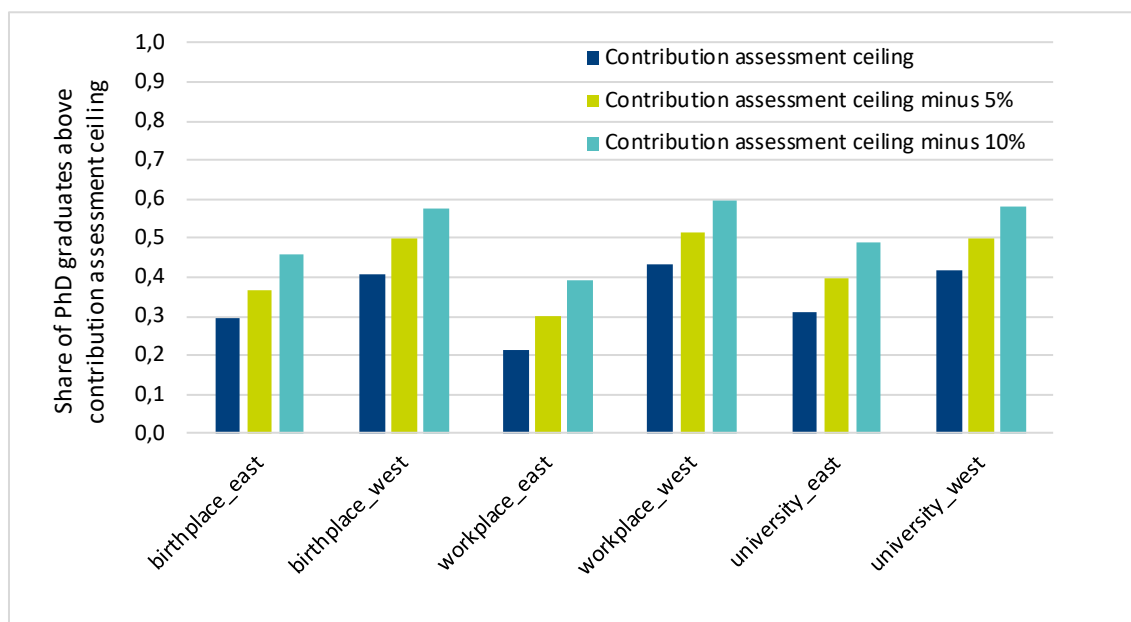
Source: IIPED data set, own birthplace data from online dissertations; own compilation.

5 Conclusions

Are eastern German PhD graduates prevented from fully exploiting their investment in education and thus from getting top positions nationwide because of their regional background? 30 years after the fall of the Berlin wall, the question is discussed at length in the societal reappraisal of German reunification. This paper provides novel findings on this topic by examining the labor market outcomes of PhD graduates with eastern or western German backgrounds. We differentiate between the place of birth, the location of the university at which the PhD was earned, and the subsequent place of work. The analysis uses a novel data set on the employment biographies of PhD graduates, enriched with geo-referenced information about their place of birth.

Our results yield no statistical evidence suggesting that eastern German PhD graduates have poorer labor market outcomes than their western German counterparts as a result of their birthplace when it comes to obtaining a job suited to their qualification level or achieving high wages. Nor does the location of the university in eastern or western Germany have any explanatory power. Hence, the results confirm that equal qualification levels lead to equal labor market outcomes. It is more the place of work that makes a difference. In particular, a place of work in eastern Germany substantially reduces PhD graduates' chances of earning high wages, regardless of which part of the country they were born in. This result suggests that the still divergent economic conditions in the two parts of Germany impact on PhD graduates' labor market prospects.

The results of this paper leave ample scope for further research. One issue is the spatial mobility patterns of eastern and western German PhD graduates. In the regressions, we included an indicator for spatial mobility after gaining a PhD, which is highly significant in the case of PhD graduates with a job that is suited to their qualification level. Obviously, the degree of mobility especially from eastern to western Germany seems to matter for achieving equal labor market opportunities. A deeper investigation of this issue is open to future study. Likewise, we have refrained from considering the profound gender/region disparities among the PhD graduates that arise especially between eastern and western German women. For example, there are fundamental differences concerning labor market attachment among female graduates (Boll/Leppin/Schömann 2016) that might also be of relevance for PhD graduates. Finally, an investigation of earlier cohorts might be of interest. Graduate and/or doctoral education that took place in the German Democratic Republic may have led to a substantial skill mismatch in some disciplines and consequently to poorer labor market outcomes for eastern German doctoral cohorts before 1995.

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Appendix

Table A 1: Definition of the explanatory variables

Variable name	Definition
Regional origin	
birthplace_east	Dummy 1: birthplace in eastern Germany, 0: birthplace in western Germany
workplace_east	Dummy 1: workplace in eastern Germany, 0: workplace in western Germany
workplace_berlin	Dummy 1: workplace in Berlin, 0: workplace elsewhere
university_east	Dummy 1: university in eastern Germany, 0: university elsewhere
Individual characteristics	
Age	Continuous variable
Sex	Dummy 1: female, 0:male
Work experience	Continuous variable, measured in days/100 up until one year before graduation
Move_region	Change between region of university and region of employer in t+5 after obtaining PhD, dummy 1: yes, 0: no
Occupational characteristics	
Sector	9 sectors, dummy 1: yes, 0: no
Requirement level of the job task	According to German classification of occupations (KldB2010); dummy 1: low skills, 2: medium skills, 3: specialist skills, 4: expert skills
Region type	Agglomeration, urbanized region, rural region, dummy 1: yes, 0: no
Scientific characteristics	
Discipline	Scientific disciplines as classified by the German National Library; 1: architecture, 2: history, 3: computer science, 4: engineering, 5: arts and music, 6: mathematics and statistics, 7: sciences, 8: philosophy, 9: political science, 10: psychology, 11: education, 12: law and administration, 13: social sciences, 14: sports, 15: languages and linguistics, 16: theology, 17: economics and business
Other variables	
Year	Dummy 1: yes, 0: no for the years 2000-2015

Source: own compilation.

Table A 2: Descriptive statistics for dependent and explanatory variables

Variable	No. of observations	No. of observations=1	Mean	Std. Dev.	Minimum	Maximum
Dependent variables						
Wage above contribution assessment ceiling in t+5	2,758	1,051	0.38	0.49	0	1
Skill requirement level of the job	2,758		3.62	0.68	1	4
Of which: Low skills	2,758	11				
Medium skills	2,758	287				
Specialist skills	2,578	428				
Expert skills	2,758	2,016	0.73	0.44	0	1
Explanatory variables						
Regional origin						
birthplace_east	2,758	670	0.24	0.42	0	1
workplace_east	2,758	637	0.23	0.42	0	1
workplace_berlin	2,758	91	0.03	0.17	0	1
university_east	2,758	918	0.33	0.47	0	1
Individual characteristics						
Age	2,758		36.79	3.59	22	62

Variable	No. of observa-tions	No. of observa-tions=1	Mean	Std. Dev.	Mini-mum	Maxi-mum
Age^2	2,758		1367.10	289.6	484	3,844
Of which: aged 22-32	2,758	96				
aged 33-35	2,758	1,067				
aged 36-38	2,758	980				
aged 39-42	2,758	430				
aged 43-46	2,758	125				
aged 47-62	2,758	60				
Sex	2,758	682	0.24	0.43	0	1
Work experience			19.04	11.13	0	103.03
Of which: work exp. <=3.91	2,758	219				
work exp. >3.91;<=7.56	2,758	75				
work exp. >7.56;<=10.94	2,758	209				
work exp. >10.94	2,758	2,255				
Move_region	2,758	833	0.66	0.47	0	1
Occupational characteristics						
Sector						
Agriculture, forestry and horticulture	2,758	7				
Production, processing	2,758	555				
Construction, architecture	2,758	24				
Natural science, geography, computer science	2,758	827				
Transport, traffic, security	2,758	20				
Commercial services, wholesale and trade	2,758	71				
Business administration, accounting, law	2,758	589				
Health, social, education	2,758	547				
Humanities, culture, arts, media	2,758	102				
Skill requirement level of the job						
Low skills	2,758	11				
Medium skills	2,758	287				
Specialist skills	2,758	428				
Expert skills	2,758	2,016				
Region type						
Agglomerations	2,758	1673				
Urbanized regions	2,758	801				
Rural regions	2,578	284				
Scientific characteristics						
Discipline (double counts possible)						
Architecture	2,758	12				
History	2,758	16				
Computer science	2,758	97				
Engineering	2,758	400				
Arts and music	2,758	27				
Mathematics and statistics	2,758	108				
Sciences	2,758	1,870				
Philosophy	2,758	30				
Political science	2,758	10				
Psychology	2,758	43				
Education	2,758	20				
Law and administration	2,758	20				
Social sciences	2,758	15				
Sports	2,758	3				
Languages and linguistics	2,758	30				
Theology	2,758	2				
Economics and business	2,758	121				
Other characteristics						
Year of employment spell	2,758		2011.70	3.25	2000	2015
2000-2005	148					
2006-2010	789					
2011-2015	1,895					

Sources: IIPED data set, own research; own calculation.

Table A 3: Average marginal effects for holding an expert job in t+5 (basic model)

Variable	dy/dx	std. error	z-score	p- value
Main independent variables				
birthplace_east	0.069	0.023	0.30	0.764
workplace_east	0.023	0.025	0.92	0.358
workplace_berlin	-0.007	0.042	-0.16	0.870
university_east	-0.033	0.043	-1.48	0.140
Individual characteristics				
Age	0.032	0.022	1.27	0.206
Age^2	-0.000	0.022	-1.23	0.217
Sex	-0.044**	0.018	-2.43	0.015
Work experience	0.000	0.001	-1.09	0.274
Move_region	0.032**	0.016	1.98	0.047
Occupational characteristics				
Sector				
Production, processing	0.056	0.155	0.36	0.717
Construction, architecture	0.111	0.171	0.65	0.517
Natural science, computer science, geography	0.131	0.154	0.85	0.394
Transport, traffic, security	-0.450**	0.183	-2.45	0.014
Commercial services, wholesale and trade, tourism	-0.523**	0.160	-3.25	0.001
Business administration, accounting, law, administration	-0.342**	0.155	-2.21	0.027
Health, social, education	0.214	0.153	1.39	0.165
Humanities, culture, arts, media	-0.235	0.162	-1.45	0.148
Region type				
reference=agglomerations				
rural regions	-0.026	0.026	-0.99	0.322
urbanized regions	0.008	0.016	0.49	0.625
Year of employment spell				
2001	not estimable			
2002	-0.004	0.137	-0.03	0.978
2003	0.156	0.131	1.19	0.233
2004	0.092	0.120	0.77	0.441
2005	0.062	0.121	0.51	0.609
2006	0.089	0.117	0.76	0.447
2007	0.055	0.116	0.47	0.637
2008	0.028	0.117	0.24	0.812
2009	0.051	0.116	0.44	0.660
2010	0.029	0.116	0.26	0.797
2011	0.101	0.116	0.87	0.386
2012	0.139	0.115	1.20	0.230
2013	0.146	0.114	1.26	0.206
2014	0.090	0.115	0.79	0.431
2015	0.096	0.115	0.84	0.403
Discipline characteristics				
Architecture	-0.069	0.114	-0.61	0.542
History	0.026	0.117	0.22	0.823
Computer science	-0.061	0.090	-0.68	0.494
Engineering	0.068	0.079	0.87	0.386
Arts and music	0.023	0.102	0.23	0.816
Mathematics and statistics	0.037	0.089	0.41	0.680
Sciences	0.020	0.079	0.25	0.800
Philosophy	-0.124	0.133	-0.92	0.355
Political science	-0.005	0.133	-0.04	0.968
Psychology	0.256	0.137	1.86	0.062
Education	0.049	0.165	0.30	0.766
Law and administration	0.200	0.113	1.76	0.078
Social sciences	-0.121	0.112	-1.09	0.277
Sports	0.121	0.197	0.61	0.539
Languages and linguistics	0.053	0.111	0.47	0.635
Theology	omitted			
Economics and business	0.037	0.082	0.45	0.651
Number of observations =2,733				

Note: Delta method, Model VCE: robust, dy/dx for factor levels is the discrete change from the base level. */**/*** indicates statistical significance at the 10/5/1 % level, respectively.

Sources: IIPED data set, own research; own calculation.

Table A 4: Average marginal effects for holding an expert job in t+5 (interaction effects)

Variable	dy/dx	std. error	z-score	p- value
Main independent variables				
birthplace_east	0.002	0.023	0.090	0.926
workplace_east	0.016	0.023	0.024	0.494
workplace_berlin				
university_east	not estimated			
Individual characteristics				
Age	0.029	0.022	1.29	0.196
Age^2	-0.000	0.000	-1.26	0.206
Sex	-0.044**	0.018	-2.43	0.015
Work experience				
Move_region	0.027***	0.016	1.66	0.096
Occupational characteristics				
Sector				
Production, processing	0.070	0.162	0.43	0.665
Construction, architecture	0.128	0.177	0.72	0.471
Natural science, computer science, geography	0.147	0.161	0.91	0.363
Transport, traffic, security	-0.433**	0.188	-2.29	0.022
Commercial services, wholesale and trade, tourism	-0.502***	0.167	-3.00	0.003
Business administration, accounting, law, administration	-0.325**	0.162	-2.00	0.045
Health, social, education	0.228	0.161	1.42	0.156
Humanities, culture, arts, media	0.221	0.167	-1.31	0.192
Region type				
reference=agglomerations				
rural regions	-0.03	0.02	0.45	0.650
urbanized regions	0.01	0.03	-1.05	0.295
Year of employment spell				
2001	not estimable			
2002	-0.004	0.14	-0.13	0.893
2003	0.157	0.13	1.15	0.249
2004	0.092	0.12	0.72	0.469
2005	0.062	0.12	0.47	0.641
2006	0.089	0.12	0.70	0.482
2007	0.055	0.12	0.44	0.660
2008	0.028	0.12	0.20	0.842
2009	0.051	0.12	0.39	0.696
2010	0.030	0.12	0.22	0.826
2011	0.101	0.12	0.83	0.409
2012	0.013	0.12	1.17	0.241
2013	0.015	0.12	1.25	0.212
2014	0.090	0.11	0.79	0.428
2015	0.960	0.11	0.85	0.398
Discipline characteristics				
Architecture	-0.070	0.11	-0.61	0.543
History	0.032	0.11	0.27	0.785
Computer science	-0.069	0.09	-0.76	0.450
Engineering	0.066	0.08	0.82	0.411
Arts and music	0.027	0.10	0.27	0.789
Mathematics and statistics	0.034	0.09	0.39	0.699
Sciences	0.020	0.81	0.25	0.801
Philosophy	-0.119	0.133	-0.89	0.373
Political science	-0.005	0.131	-0.04	0.968
Psychology	0.246*	0.137	1.79	0.073
Education	0.036	0.161	0.22	0.822
Law and administration	0.201*	0.113	1.76	0.078
Social sciences	-0.127	0.112	-1.13	0.260
Sports	0.126	0.197	0.64	0.523
Languages and linguistics	0.053	0.110	0.48	0.633
Theology	omitted			
Economics and business	0.037	0.016		0.658
Number of observations =2,733				

Note: Delta method, Model VCE: robust, dy/dx for factor levels is the discrete change from the base level. */**/*** indicates statistical significance at the 10/5/1 % level, respectively.

Sources: IIPED data set, own research; own calculation.

Table A 5: Average marginal effects for exceeding the contribution assessment ceiling in t+5 (basic model)

Variable	dy/dx	std. error	z-score	p- value
Main independent variables				
birthplace_east	-0.001	0.027	-0.04	0.966
workplace_east	-0.203***	0.026	-7.65	0.000
workplace_berlin	-0.069	0.044	-1.58	0.115
university_east	-0.021	0.026	-0.82	0.410
Individual characteristics				
Age	-0.092***	0.026	-350	0.000
Age^2	0.001***	0.0003	3.21	0.001
Sex	-0.176***	0.019	-8.89	0.000
Work experience	0.004***	0.001	3.77	0.000
Move_region	0.058	0.019	3.00	0.003
Occupational characteristics				
Sector	not estimable			
Region type				
reference=agglomerations				
rural regions	0.078**	0.030	-1.53	0.012
urbanized regions	-0.029	0.019	2.52	0.125
Skill requirement level of the job				
reference=low skills				
medium skills	0.160**	0.096	1.66	0.097
specialist skills	0.248**	0.095	2.59	0.010
expert skills	0.240**	0.094	2.56	0.010
Year of employment spell				
2001	0.079	0.23	0.23	0.820
2002	0.175	0.75	0.75	0.453
2003	-0.279	-1.24	-1.24	0.215
2004	-0.139	-0.63	-0.63	0.528
2005	-0.118	-0.55	-0.55	0.582
2006	-0.082	-0.39	-0.39	0.697
2007	-0.167	-0.79	-0.79	0.428
2008	-0.083	-0.39	-0.39	0.694
2009	-0.145	-0.69	-0.69	0.492
2010	-0.089	-0.43	-0.43	0.670
2011	-0.153	-0.73	-0.73	0.467
2012	-0.169	-0.81	-0.81	0.420
2013	-0.019	0.93	-0.93	0.351
2014	-0.245	-1.17	-1.17	0.241
2015	0.075	-0.36	-0.36	0.720
Discipline characteristics				
Architecture	-0.240	0.171	-1.41	0.160
History	-0.358**	0.177	-2.02	0.044
Computer science	-0.001	0.102	-0.01	0.991
Engineering	-0.007	0.092	-0.08	0.936
Arts and music	-0.107	0.132	-0.81	0.418
Mathematics and statistics	-0.115	0.102	-1.12	0.261
Sciences	-0.101	0.093	-1.08	0.279
Philosophy	0.053	0.133	0.40	0.687
Political science	-0.188	0.166	-1.13	0.258
Psychology	-0.150	0.139	-1.07	0.282
Education	-0.122	0.162	-0.75	0.452
Law and administration	-0.120	0.130	-0.92	0.358
Social sciences	-0.392*	0.226	-1.73	0.083
Sports	-0.048	0.254	-0.19	0.847
Languages and linguistics	-0.047**	0.225	-2.13	0.034
Theology	omitted			
Economics and business	0.012	0.099	0.13	0.899
Number of observations =2,733				

Note: Delta method, Model VCE: robust, dy/dx for factor levels is the discrete change from the base level. */**/*** indicates statistical significance at the 10/5/1 % level, respectively.

Sources: IIPED data set, own research; own calculation.

Table A 6: Average marginal effects for exceeding the contribution assessment ceiling in t+5 (interaction effects)

Variable	dy/dx	std. error	z-score	p- value
Main independent variables				
birthplace_east	-0.016	0.026	-0.62	0.535
workplace_east	-0.221***	0.025	-8.66	0.000
workplace_berlin	-0.070	0.044	-1.59	0.113
university_east	not estimated			
Individual characteristics				
Age	-0.091***	0.026	-3.46	0.001
Age^2	0.001***	0.003	3.17	0.002
Sex	-0.176***	0.019	-8.85	0.000
Move_region	0.057**	0.019	2.98	0.019
Occupational characteristics				
Sector	not estimable			
Region type				
reference=agglomerations				
rural regions	0.080	0.031	2.59	0.010
urbanized regions	-0.030	0.019	-1.57	0.117
Work experience	0.004	0.001	3.79	0.000
skill requirement level of the job				
reference=low skills				
medium skills	0.159	0.097	1.64	0.101
specialist skills	0.246**	0.096	2.56	0.010
expert skills	0.240**	0.094	2.54	0.011
Year of employment spell				
2001	0.085	0.351	0.24	0.807
2002	0.170	0.234	0.73	0.468
2003	0.170	0.225	-1.24	0.214
2004	-0.139	0.220	-0.63	0.526
2005	-0.120	0.214	-0.56	0.574
2006	-0.085	0.212	-0.40	0.687
2007	-0.168	0.211	-0.80	0.427
2008	-0.086	0.211	-0.41	0.682
2009	-0.147	0.211	-0.70	0.485
2010	-0.092	0.210	-0.44	0.661
2011	-0.155	0.211	-0.73	0.463
2012	-0.171	0.210	-0.82	0.413
2013	-0.197	0.210	-0.94	0.348
2014	-0.245	0.209	-1.17	0.240
2015	-0.074	0.209	-0.36	0.722
Discipline characteristics				
Architecture	-0.244	0.171	-1.42	0.101
History	-0.362**	0.178	-2.03	0.010
Computer science	-0.010**	0.102	-0.10	0.011
Engineering	-0.014	0.092	-0.16	0.155
Arts and music	-0.110**	0.132	-0.83	0.042
Mathematics and statistics	-0.122	0.102	-1.19	0.917
Sciences	-0.106	0.093	-1.14	0.876
Philosophy	0.050	0.133	0.38	0.406
Political science	-0.195	0.166	-1.17	0.233
Psychology	-0.155	0.140	-1.11	0.255
Education	-0.135	0.162	-0.83	0.406
Law and administration	-0.125	0.130	-0.96	0.339
Social sciences	-0.400*	0.226	-1.77	0.077
Sports	-0.055	0.253	-0.22	0.828
Languages and linguistics	-0.48**	0.224	-2.14	0.032
Theology	omitted			
Economics and business	0.225	0.099	0.94	0.942
Number of observations =2,733				

Note: Delta method, Model VCE: robust, dy/dx for factor levels is the discrete change from the base level. */**/*** indicates statistical significance at the 10/5/1 % level, respectively.

Sources: IIPED data set, own research; own calculation.

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For further inquiries contact the author

Michaela Fuchs
Phone +49 345 1332-232
E-Mail Michaela.Fuchs@iab.de