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Who is overeducated and why? Probit and dynamic mixed multinomial logit analyses of vertical mismatch in East and West Germany

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JEL-Classification: J24; C25; C33; J71

Abstract

Overeducation is an often overlooked facet of untapped human resources. But who is overeducated and why? Relying on SOEP data 1984-2011, we use probit models for estimating the likelihood of entering overeducation and dynamic mixed multinomial logit models with random effects addressing state dependence and unobserved heterogeneity. As further robustness checks we use three specifications of the target variable, i.e. realized matches, self-assessment and two-fold overeducation. We run separate analyses for men and women, East and West Germans and medium and highly educated persons. We find that overeducation is mainly state dependent. Nonetheless, even in the dynamic context staying employed proves to be risk-decreasing. By contrast, scars of past unemployment show up in a higher mismatch risk. Moreover, an employer change does not serve as a suitable exit strategy, and a dual qualification does not show up as a valid insurance against graduates' job mismatch. Overall, effects largely depend on the operationalization of overeducation. We conclude that to combat overeducation, focusing on continuous employment careers and circumventing unintentional withdrawals from the current job is crucial. Moreover, institutional impediments that restrain job match quality for certain groups (migrants, mothers) have to be tackled.

Keywords

overeducation; dynamic mixed multinomial logit; probit model; mismatch; Germany; state dependence

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1 | Introduction

Overeducation occurs if a person attained a higher level of education than is required to perform his or her current job. Vertically inadequate job matches are *economically relevant* since they entail various shortcomings on the macro and on the micro level. On the *macro level*, they reflect untapped resources. Via the inadequate use of human capital and productivity-related skill bottlenecks they reduce GDP growth (Manacorda and Petrongolo 1998) and hinder a country's long-term growth prospects (Sianesi and van Reenen 2003). For societies as a whole, skill mismatch implies a potential waste and misallocation of public funds, particularly those spent on education and training (European Commission 2012). Demographic change further strengthens the necessity for an efficient allocation of scarce resources. In Germany, the replacement need of German academics will increase markedly due to the retirement of baby-boom generations after 2020 (Helmrich et al. 2012). The situation is aggravated by newly generated needs by means of the ongoing economic and occupational change. With younger cohorts being too small to cover the overall need conditional on demographic and structural development, the skill gap is foreseeable (Bundesagentur für Arbeit 2012). Thus, it will become more and more important to have an eye to the full exploitation of resources in terms of a productive use of acquired qualifications in proper job matches. Overeducation is adverse to this aim.

On the *micro level*, overeducation may be linked to de-motivation of workers that shows up in a higher level of absenteeism and turnover of the workforce (Tsang and Levin 1985, Sicherman 1991, Sloane et al. 1999). These adverse outcomes counteract potential positive spill-over effects of excess knowledge in the workplace (Battu et al. 2003) and even then, earnings disadvantages point to the opportunity costs of overeducation compared to correctly matched individuals. Overeducated workers regularly earn more than their correctly matched job colleagues but less than correctly matched workers with similar education (e.g. Daly et al. 2000, Bauer 2002, Boll and Leppin 2014a).² Furthermore, the overeducated are typically found to be less satisfied with

² Our own findings partly support the results from Bauer, indicating that selection accounts for a reasonable part of gendered pay. Adequate education even pays off more for women than for men in both German regions. However, different remunerations, though being less pronounced, are not completely vanishing when unobserved heterogeneity is controlled for. Referring i.e. to a sample of graduates from the

their jobs relative to both their job colleagues and correctly matched workers of the same educational level (Tsang et al. 1991, Battu et al. 2000, Verhaest and Omey 2006, Korpi and Tåhlin 2009). According to our own findings for Germany, required education is positively associated to job satisfaction at the 1%-level of significance for both genders and regions, whereas overeducation is negatively correlated with job satisfaction for women (Boll and Leppin 2014a). As for women, our results correspond to those of Korpi and Tåhlin (2009). To sum up, the status quo of research suggests that overeducation entails considerable disadvantages on the micro and the macro level. In order to address such mismatches in future we investigate the driving factors.

Various *theoretical frameworks* deal with the phenomenon of overeducation and its earnings consequences (for an overview see i. a. Büchel 2001). Search theories (Stigler 1961, Mortensen 1987) postulate that overeducation may temporarily arise due to labor market frictions in the context of incomplete information. Search costs hinder proper matches only in the short term, but as long as the mismatch subsists it goes along with diminished returns to education. Career mobility theory (Sicherman 1991, Albaramirez 1993, Robst 1995) as well considers overeducation to be of limited duration, even though differently motivated. According to this theory, overeducation in the early career stage and associated earnings losses are individually rational from a life course perspective since the mismatch spell entails outstanding upward income mobility later in the career (see e. g. Dekker et al. 2002 for confirming results in internal labor markets). Furthermore, overeducation may arise in the context of labor market distortions. Job competition theory (Thurow 1975) predicts that an excess supply of graduates on the labor market causes persisting overeducation of graduates whereas lower educated persons become unemployed. The privileging of graduates has its origins in lower training costs for employers.

Human capital theory (Shultz 1963, Becker 1964, Ben-Porath 1967), in its earnings aspects commonly specified in a Mincerian wage equation (Mincer 1974), postulates that wages are exclusively determined by supplied human capital. The latter comprises schooling investment as well as job-specific skills derived from training-on-the-job. The focus on attained education grounds on Say's theorem that postulates that each unit of supplied human capital generates its own market demand and is therefore equally remunerated. However, beyond the restrictive assumption of labor demand being perfectly flexible, the supply sided identity of attained education and an individual's productive capacity has also to be questioned. If a person uses his excess education to compensate for deficient human capital in other respects to perform the job, he is less productive than his properly matched colleagues with the same amount of education

German Socio-Economic Panel 1992-2011 (SOEP v28), one year of required education yields a return of 9.64 % (7.07 %) for West (East) German women and of 6.89 % (5.32 %) for West (East) German men. By contrast, one year of excess education comes up with 5.38 % (3.90 %) for West (East) German women and with 4.60 % (3.12 %) for West (East) German men.

(Korpi and Tåhlin 2009 name this the “human capital compensation hypothesis”³). In this case, educational mismatch is not due to labor market imperfections but points to hidden abilities. Returns from overeducation are underestimated in this case. Unobserved heterogeneity not in abilities but in preferences is the issue of Frank’s theory of differential overeducation (Frank 1978). According to this theory, job mismatch is regarded as an outcome of union decisions of couples. Women may prioritize the optimization of the male partners’ job match due to men’s higher earnings capacities and/or traditional gender roles. Hence, female partners willingly refrain from exploiting their earnings capacity. In this case, female partners behave like ‘tied movers’ and ‘tied stayers’ on the labor market (Mincer 1978). Without being the fault of the educational system in this case, returns to overeducation are likewise downward biased. Frank postulates that this behavior is the more likely if partners are married.

International empirical evidence widely confirms the need for a thorough *specification of the underlying model*. As many studies suggest, results on overeducation prevalence and its earnings consequences heavily depend on the applied model specification, particularly with regard to unobserved heterogeneity (e. g. Allen and Van der Velden 2001, Bauer 2002, McGuinness and Bennett 2007, Korpi and Tåhlin 2009, Leuven and Oosterbeek 2011, Blázquez Cuesta and Budría 2011, Andersson Joona et al. 2012, Mavromaras et al. 2012). Furthermore, results differ due to heterogeneous meta-variables like i. a. structure and dynamics of labour markets, business cycle, trade-union density and academic funding systems (Davia et al. 2010, European Commission 2012: 374, Verhaest and van der Velden 2013).⁴ In the international context, country clusters of high-mismatch (comprising countries of the Southern Mediterranean basin), low-mismatch (Eastern and Central Europe) and medium-mismatch (mostly Western and Northern EU member states) arise (European Commission 2012). The composition of the sample also matters. Graduates are typically found to be more affected by vertical mismatch of qualifications than medium educated individuals. In 2009, about 30 % of tertiary education graduates in the EU (ISCED 5A, 6) are found to have been overeducated, whereas this held true only for roughly 12 % of individuals with upper and post-secondary education (medium education; ISCED 3-4, 5B). Furthermore, overeducation frequency varies with the type of graduates and of universities (Davia et al. 2010) and is overall lower if the self-employed are included (Blázquez Cuesta and Budría 2011).

Last but not least, results vary considerably with the chosen *operationalization of the target variable* (Groot and Maassen van den Brink 2000, Mendes de Oliveira et al. 2000, Bauer 2002, Chiswick and Miller 2009, Nielsen 2011). For Germany, a vast majority of empirical studies relies on the Socio-Economic Panel (SOEP; see Wagner et al. 2007). As

³ Korpi and Tåhlin (2009:184).

⁴ Davia et al. (2010) conclude from a multinational analysis that an excess supply of graduates raises the risk of being overeducated whereas higher education fees lower it.

respondents report individually assessed job requirements the construction of the variable “self-assessed overeducation” is quite easily done. Moreover, since a survey person’s knowledge is closest to his or her individual job requirements, the measure is the first best choice from a theoretic point of view. Thus, the method is appealing and widely used (Duncan and Hoffman 1981, Sicherman 1991, Büchel 1996, Vahey 2000, McGuinness and Bennett 2007, Rukwid 2012). However, empirical evidence suggests that self-assessed overeducation is subject to other job features like occupational status and particularly income (Dolton and Vignoles 2000). Survey persons may be inclined to exaggerate educational requirements of their job for various reasons (Borghans and de Grip 2000). Furthermore, the measure exhibits a considerable gender bias (Leuven and Oosterbeek 2011). Also the realized matches (RM) framework as a further common measurement has its virtues and drawbacks. This method more closely refers to markets by setting the prevailing educational standard in the job surroundings of a person as a benchmark for required education. The method has been established by Kiker et al. (1997) referring to the mode and by Verdugo and Verdugo (1989) referring to the mean value. The main challenge of this concept is to continuously adjust the standard to changes in educational requirements. The metric standard in years of education allows a rather fine-grained measure of mismatch. However, results are sensitive to arbitrarily set standard deviations what requires thorough robustness checks.

The majority of studies for Germany report a higher prevalence among women than men (e. g. Büchel 1996, Daly et al. 2000, Büchel 2001, Szillik 1996 for West Germany, Rukwid 2012). Likewise the study by Plicht et al. (1994) relying on German microcensus data and applying a more objective specification report a higher prevalence of overeducation among female than male graduates. This comes as no surprise as i. e. women’s human capital is regarded as being more exposed to depreciation during time out of the labour market. 30-40% of German women who had withdrawn from the workforce for a minimum of three years were formally overeducated in the job they took up at the time of re-entry (Diener et al. 2013). Furthermore, women more often than men cope with restricted labour market options in the context of family tasks. With SOEP data, Büchel and Battu (2002) find partial support for Frank’s theory of ‘tied movers’ and ‘tied stayers’. However, highlighting once more the strong responsiveness of results to the chosen methodological framework, probit regressions relying on Labour Force Survey data 2003-2008 show that males face a higher RM overeducation risk than females in EU-25. Moreover, the risk markedly decreases with age and also firm size and industries turn out to be important (European Commission 2012). Further evidence suggests that migrants born and educated abroad are more frequently hit by overeducation than immigrants educated in the host country (Cedefop 2011b).

However, political inferences as to e.g. gender mainstreaming are not easily to be drawn. If one accounts for the fact that overqualification might mask unmeasured in-

dividual traits as hidden disabilities or preferences for specific job amenities, attention has to be paid (a) to the underlying model specification dealing with measurement error and omitted variable bias. Moreover, (b) the estimation procedure should account for the fact that the German labour market is segmented with respect to gender, education and region. We suggest that beyond shift effects, the named characteristics conceal sizable interaction effects with other covariates. Furthermore, (c) we hypothesize that further workplace, household and even parents' home related factors might impact on the risk of overeducation. Last but not least, (d) the vast empirical evidence of high state dependency has to be taken into account (Mavromaras et al. 2012, Mavromaras and McGuinness 2012).

Thus, the *aim of this paper* is to identify the drivers of overeducation for different subgroups, model specifications and specifications of the target variable. We intend to make full use of the rich SOEP dataset to be able to distinguish employment biography effects from workplace features, household context, parents' home, and migration background. We aim at isolating core drivers of overeducation in a methodological setting that copes with unobserved heterogeneity, measurement error and state dependence. Our findings indicate that overeducation is mainly state dependent. Moreover, biography and workplace related covariates affect the risk of overeducation more significantly than characteristics of the household context and parents' home. An employer change seldom proves to be a suitable exit strategy. Instead, the situation markedly improves with more years in employment whereas scarring effects of past unemployment show up in an increased risk of mismatch across models, regions, education groups and genders. For graduates, a dual qualification does not show up as a valid insurance against job mismatch, Our results contradict search theory and job mobility theory. Finally, results heavily depend on the used operationalization of the target variable. We conclude that focussing on continuous employment and circumventing unintentional withdrawals from the current job is at the core of political strategies combatting overeducation. Moreover, institutional impediments that restrain job match quality for certain groups (migrants, mothers) have to be tackled.

The *outline of the paper* is the following: In Section 2, the data and variables are presented. Section 3 depicts the models, Section 4 reports and discusses the results and Section 5 concludes.

2 | Data

We use data from the German Socio-economic Panel (SOEP) to identify possible determinants of overeducation. The SOEP is a yearly repeated representative panel of households and persons living in Germany that started 1984. The SOEP covers a broad

range of questions addressing socio-economic status and further topics like health or life satisfaction (Wagner et al. 2007). We use data for the waves 1984-2011. The sample is restricted to respondents aged 20 to 55. Persons in education, retirement, civil or military service as well as self-employed persons and women and men with a low educational level (ISCED groups 0-2) are excluded. Information from the latter is solely used to generate the educational benchmark required for the statistical measure of overeducation. We subdivide our sample in subsamples of men and women, East and West Germans and medium and highly educated persons, respectively. West and East Germany (the latter including Berlin) relates to the current residence of the person. Medium educated persons have completed upper secondary or post-secondary education (ISCED 3-4, 5B), and the highly educated have completed tertiary education (ISCED 5A, 6).⁵

We refer to overeducation as a vertical inadequacy (overschooling).⁶ As has been shown in the empirical literature review, both magnitude and pattern of overeducation heavily depend on the used specification of the target variable. To highlight this point, we use three specifications, firstly the realized matches approach (henceforth named “RM overeducation”), secondly the individual self-assessment, and thirdly we control for twofold overeducation referring to observations that are characterized by RM and self-assessed overeducation simultaneously. We code a person as being overeducated by self-assessment if she reports a lower category of required education than she exposes of. From the phrasing of the corresponding question we conclude that it refers to the vertical dimension of required education.⁷ As to the realized matches (RM) framework, we follow the specification established by Verdugo and Verdugo (1989), relying on the arithmetic mean of attained education in years that is to be found in the occupational benchmark group of a person. The occupational affiliation is validated by occupational status information and updated on a regular basis to capture upgrading educational requirements over time.^{8,9} According to our specification, over (under) education is defined as a positive (negative) deviation by more than 1.0 standard devi-

⁵ Graduate education comprises of six degrees, thereof those with a lower amount of years of education are rather dominated by women whereas men have a lead over women in the more prestigious degrees with more years of education. 57.2 % of male but only 47.9 % of female academics graduated from a university or a technical university, respectively. By contrast, only 6.1 % (7.5 %) of male graduates completed an East German professional (technical) college whereas this applies to 19.9 % of female graduates. In the medium education category, years of education are more equally distributed across genders.

⁶ By contrast, overskilling may be interpreted as horizontal inadequacy in terms of a partial non-use of attained occupational skills in the actual job (Quintini 2011).

⁷ The question that is asked SOEP survey persons reads “What type of education or training is usually necessary for this type of work?” The given options change from 1998 to 1999. Before 1999, options differentiated four types of “No particular education or training necessary”. Afterwards, a distinction between “Fachhochschule” and “university or other institution of higher education” has been introduced. For the sake of consistency, we differentiate between the three categories “without completed vocational education”, “with completed vocational education”, and “with completed higher education”.

⁸ In detail, we exploit 28 occupational groups provided by 2-digit international standard classification of occupations (ISCO) and 11 occupational statuses stored in the SOEP data set. The yielded job/status combinations (job cells) are kept if they contain at least 10 observations. The computation of the average education in a distinct job cell is repeated in four years-time intervals to account for an educational upgrading of occupations. The time intervals are 1984-1987, 1988-1991, 1992-1995, 1996-1999, 2000-2003, 2004-2007, 2008-2011.

⁹ Deploying the mean value secures a procedure that is sensitive even to small deviations between demanded and supplied education. One drawback of this method is that it is prone to outliers (Kiker et al. 1997). However, we suggest the mode value being inferior to the mean since it may be located at the outer range of the distribution.

ations from the mean value. Persons whose attained education is within this threshold are coded as correctly matched.

Figure 1 depicts the trend of overeducation by measurement method for East and West German women and men in the time span 1992–2011 and 1984–2011, respectively.¹⁰ The dashed line represents the share of self-assessed overeducated persons on the employed, the solid line depicts the corresponding share of those being overeducated according to the RM framework. The shaded area displays the percentage of twofold overeducated individuals. Five results become apparent. *Firstly*, the importance of self-assessed overeducation by far exceeds the level of RM overeducation among individuals with medium education. The same holds true for East German female graduates, whereas the opposite applies to West German graduates and East German male graduates. As to the higher prevalence of statistical overeducation for graduates our findings are in line with previous studies (even though East German females are a noteworthy exception). However, we do not support the finding from Groot and van den Brink (2000) who claimed an overall higher magnitude of subjective overeducation. Instead, our findings hint to the fact that the magnitude differs by levels of attained education. *Secondly*, self-assessed overeducation decreases over time among the medium educated whereas its relevance remains stable or even increases among graduates. The increase of subjective overeducation among West German male graduates has been confirmed in a study by Rukwid (2012). In a couple of years after reunification, self-assessed overeducation has been more important in the Eastern than in the Western part of Germany. Henceforth the East German figures approached the West German ones.

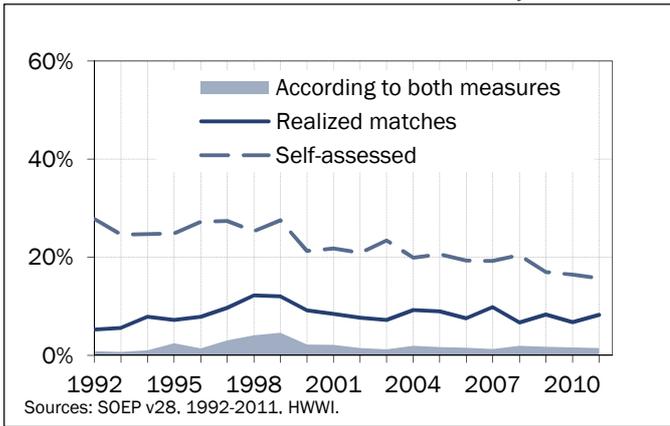
Thirdly, the prevalence of RM overeducation persists at a low level among the medium educated but floats at a rather high level among the highly educated. In a more detailed view, the period from 2003 to 2008 was shaped by an overall improvement of job match quality on the graduate labour market. Simultaneously, graduates' unemployment rate markedly decreased (IAB 2013). Apparently, due to a dynamic and prosperous economy and an increased demand for highly skilled workers the labour market was able to absorb the additional supply accruing from the rapidly increased amount of young persons who graduated from university after 2002 (Statistisches Bundesamt 2012). Obviously, the 'massification' of higher education did not go to the detriment of job match quality, which is in line with findings for the European level for the period 2000-2010 (European Commission 2012). However and in accordance with both job competition theory and the European trend, German graduates' matches worsened in the course of the crisis, resulting in an increase of RM overeducation magnitude in 2009/2010.

¹⁰ Weighting factors have been used to adjust the sample to the basic structure of the overall population.

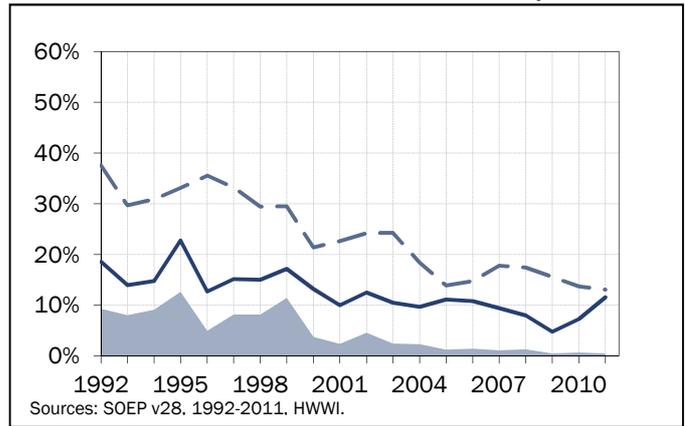
Fourthly, more women than men state themselves being overeducated. Although the gender gap in self-assessed overeducation has been somewhat diminishing over time it perseveres on a noticeable level among graduates, even more so when they live in East Germany. Note that however, this holds true only as long as the subjective measure has been put into focus. Referring to statistical (RM) overeducation, women of both educational groups recently outperformed (West) and almost reached (East) the level of their male counterparts, respectively. *Fifthly*, twofold overeducation is far more a concern for graduates than for individuals with medium education. This applies for both regions and genders. From the rather low overlap of overeducation incidence on the individual level we conclude that different persons are affected. Likewise, in the following causal analyses, the different types of overeducation will be regarded separately.

Figure 1 a)-h): Percentage of overeducated on all employed individuals (%) from 1992 to 2011, by gender, education, region, and measurement method

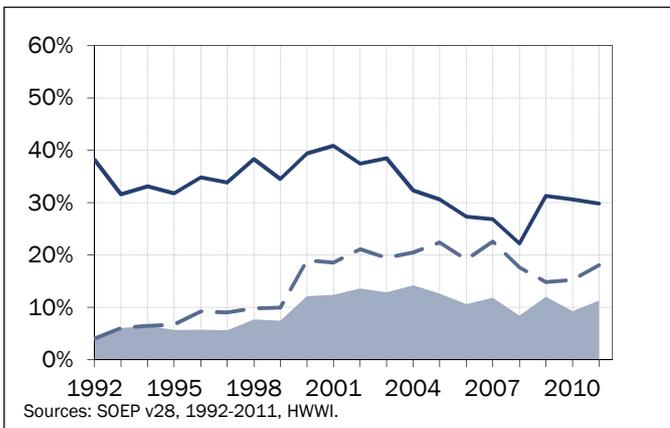
a) Men, medium education, West Germany



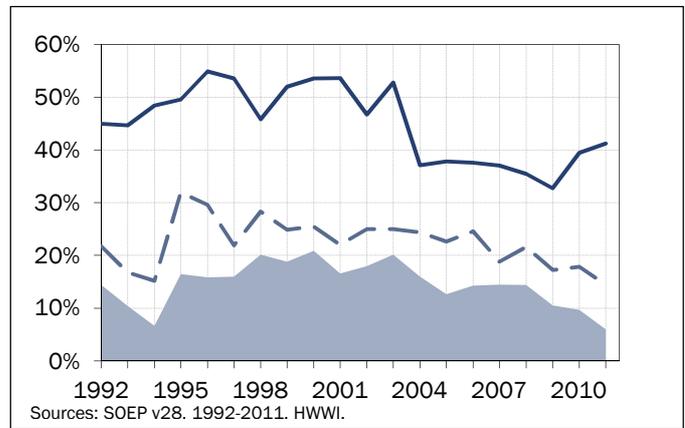
b) Men, medium education, East Germany



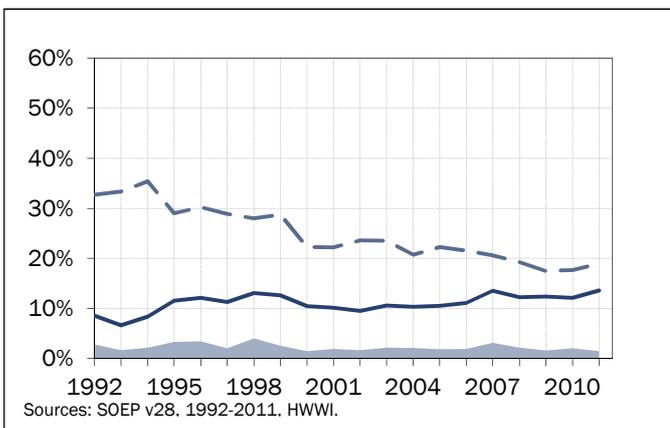
c) Men, high education, West Germany



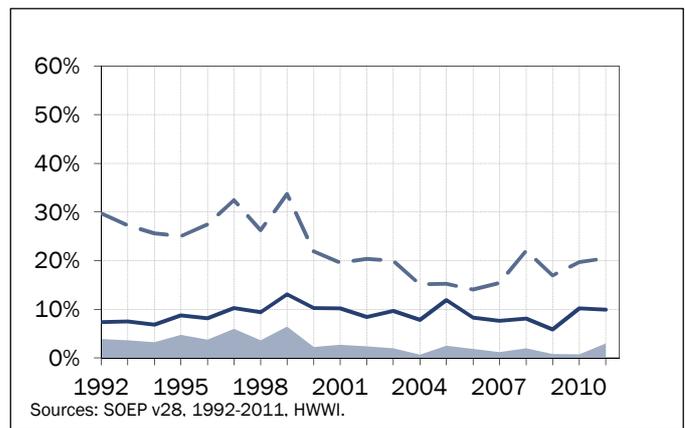
d) Men, high education, East Germany



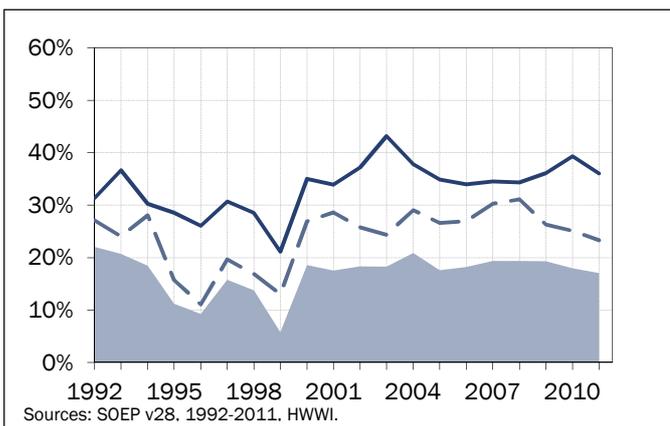
e) Women, medium education, West Germany



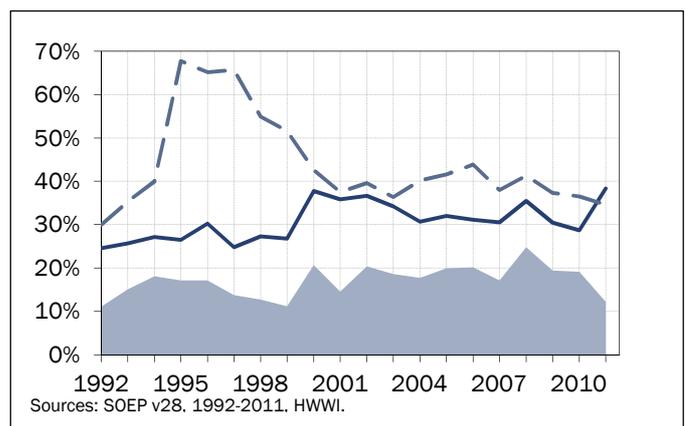
f) Women, med. education, East Germany



g) Women, high education, West Germany



h) Women, high education, East Germany



To investigate the causal factors of overeducation, we use a broad range of explanatory variables. We differentiate between five categories of covariates, namely employment biography, job characteristics, partner and household context, parents' home characteristics and migration background. Detailed summary statistics are provided in tables A1 and A2 in the appendix.

Referring to the individual's employment history, we control for employment experience, unemployment experience and out of labor force (OLF) experience. Beyond registered unemployment, OLF experience measures time spells out of the labor force being they family related or otherwise motivated. The current employment status is coded according to effective weekly working hours and differentiates between marginal employment (15 hours at most), part-time employment (16-25 hours, later on referred to as "small part-time" and 26-35 hours, referred to as "extended part-time"), and full-time employment (36 hours at the minimum). Job changes comprise in-house changes and changes of employers. Re-entry into employment relates to the labour market return after the birth of the first child.¹¹ We expect that a restricted labour market involvement increases the risk of being overeducated. Beyond actual working hours, we furthermore suggest that interrupted employment careers are associated to a higher overeducation risk, due to a lower human capital in terms of training-on-the job that limits the scope for fully exploiting one's formal qualifications.

For graduates only, a dummy variable indicates if a graduate additionally holds a vocational training degree. According to the findings of Büchel und Helberger (1995), dual education increases the risk of self-assessed overeducation. Job characteristics provide categorial variables for industry and firm size as well as public sector and civil servant dummies. Furthermore, the dummy "2005+" indicates if the observation refers to the post-reform period 2005+ since the fourth out of four "Hartz reforms" on the German labour market came into force in January 2005. The partner and household context contains the marital status of a person, the gross wage income of the partner and the partner's educational level.¹² Furthermore, variables on parenthood and the presence of a child younger than 6 years in the household are included. On the household level we control for the number of persons and the nonwage income of the household. We argue that the household context may provide financial disincentives and obstacles to the reconciliation of family and work, e.g. rationed institutional child-care slots. In both cases, we expect overeducation to be more likely. For West Germany we include regional dummies to subdivide the Western part of the country in a north, west and south region. Characteristics of parents' home refer to the situation when the

¹¹ In more detail, the person must have been employed in at least one out of the two years preceding the child's birth.

¹² Partners' gross wages include information on fringe benefits from the corresponding main job. SOEP based analyses for Germany show that fringe benefits like Christmas or vacation allowances are more often granted to men even after controlling for the hourly wage rate (Frick et al. 2007). We prorate fringe benefits according to the previous year's ratio of overall fringe and regular income payments. In case of a job change we exploit the information of most recent months in the new job.

respondent was 15 years old. They contain parents' highest educational degree and employment status. We suggest that a high parental labour market involvement and/or high educational level stimulate a high engagement of the offspring in pursuing his/her career, enhancing his/her job match quality. The migration background differentiates between members of the first and the second generation of migrants, referring to persons who immigrated themselves into Germany and children of immigrants who were born in Germany, respectively. We suppose that migrants are particularly exposed to institutional impediments that hinder a good job match, e. g. the lacking recognition of diplomas and other formal qualifications awarded in the country of origin. We suppose migrants of the second generation being less affected by overeducation than those of the first generation.

3 | Models

The descriptive analysis of overeducation according to the realized matches framework and the subjective self-assessment of individuals revealed only partial accordance of the results on the individual level. Referring to pooled observations from 1992 to 2011, 67.1 % of statistically overeducated persons assess themselves being correctly matched, and vice versa 75 % of those who report being overeducated are properly matched from the realized matches' perspective. Hence, the question arises which covariates determine the occurrence of twofold overeducation, i.e. of subjective and realized matches overeducation at the same time, and which characteristics rather prevail in determining the one or the other form. To shed light on this topic, we construct four disjunct categories of overeducation: subjective overeducation, realized matches overeducation, both definitions at the same time (twofold overeducation) and the residual category of employment without overeducation (comprising undereducation and educationally adequate matches). For the three named statuses of overeducation we henceforth estimate the probability of entering and assuming the respective status in a static and dynamic model setting, respectively. The two different estimators shall be explained in what follows.

The first type of model is a probit model. We use it to estimate the probability of newly entering a distinct overeducation status. The prerequisite for being considered as newly overeducated is that the person has been in any other except this particular status in the preceding period. That is, if a person happens to switch from one overeducation status to another in the course of his/her life course each corresponding observation is coded as a transition to (new) overeducation. The same applies to transitions from undereducation or adequate matches to overeducation. The parameters of the model are estimated by maximum likelihood.

The second type of model is a dynamic mixed multinomial logit model. It serves to jointly estimate the probabilities of being employed in a distinct category of overeducation, with the residual category of non-overeducation as a reference. The model takes state dependence and unobserved heterogeneity into account. The notation of the model closely follows the related estimator in Prowse (2012). We use a dynamic setting to control for the strong state dependence of overeducation over time. Furthermore, cross state dependence is controlled for by using lagged values of all overeducation categories. We define the individual specific vector of lagged overeducation as

$$\Omega_{i,t-1} = [y_{i,s,t-1}, y_{i,rm,t-1}, y_{i,rms,t-1}]$$

where each variable $y_{i,j,t-1}$ denotes one of j different overeducation statuses in the previous time period with $j =$ subjective (s), realized matches (rm) or both (rms). The above specified dynamic structure of our endogenous variables leads to the initial condition problem (Heckman 1981, Blundell und Bond 1998, Arellano und Carrasco 2003). This problem occurs since we do not observe a person's employment history from the very beginning. That is, we may not exclude the possibility that the initial value arising from a person's first observation in the sample is subject to observed or unobserved variables in the unknown past of that person. In particular, we may not assume that the initial value with respect to the overeducation status of a person is unaffected by his or her previously held overeducation status. To prevent estimators from being biased and inconsistent, one of the well-established solutions of Heckman (1981), Orme (1996) or Wooldridge (2005) has to be implemented. Due to the comparable performance of the methods in the context of dynamic probit models (Arulampalam and Stewart 2009) and the simplicity of Wooldridge's approach we chose the latter one. Wooldridge (2005) suggests implementing the individual's overeducation outcome in year $t = 1$ as an additional covariate that captures part of the unobserved heterogeneity between persons. We denote the initial conditions by IC_i which consist of the starting conditions of self-assessed (subjective) overeducation ($y_{i,s,t=1}$), overeducation according to realized matches ($y_{i,rm,t=1}$) and the combination ($y_{i,rms,t=1}$) of both definitions.

We control for individual heterogeneity by using the approach from Mundlak (1978). To this end, we use individual means of all time-variant covariates in the regression that are suggested to be potentially subject to such latent factors. However, we cannot rule out that our time-invariant variables are correlated with individual unobservable traits. The individual heterogeneity, denoted by $\alpha_{i,j}$, is defined by

$$\alpha_{i,j} = IC_i \omega_j + Z_i \delta_j + v_{i,j}$$

where IC_i is the overeducation of person i in $t = 1$. Z_i contains all individual means of time-varying variables alongside with time-invariant variables. $v_{i,j}$ are time-invariant state specific random intercepts which differ between alternatives and are allowed to be correlated.

We use the logistic distribution to model the probability of each employed individual i at time t to be in one of $j = 1, \dots, K$ different overeducation states

$$P(y_{i,t} = j | \Omega_{i,t-1}, X_{i,t}, \alpha_{i,j}) = \frac{\exp(\Omega_{i,t-1}\gamma_j + X_{i,t}\beta_j + \alpha_{i,j})}{1 + \sum_{j=1}^K \exp(\Omega_{i,t-1}\gamma_j + X_{i,t}\beta_j + \alpha_{i,j})}$$

The log-likelihood is given by

$$L = \prod_{i=1}^N \int_{v_s} \int_{v_{rm}} \int_{v_{rms}} \prod_{t=1}^T \prod_{j=1}^K P_{i,j,t}(\Omega_{i,t-1}, X_{i,t}, \alpha_{i,j})^{y_{i,j,t}} f(v_s, v_{rm}, v_{rms}) dv_s dv_{rm} dv_{rms}$$

In order to maximize the likelihood, we have to integrate over the distribution of the time-invariant state specific random intercepts $v_{i,j}$ which involves the solution of higher dimensional integrals. Since an analytical expression of the integral is not possible, we have to resort to approximation methods. Haan and Uhlenborff (2006) suggest using either numerical or simulation methods. Numerical methods are presented in the work of Rabe-Hesketh et al. (2002) who compare different quadrature approaches. To save computation time, we apply maximum simulated likelihood.¹³ In order to approximate the integrals, simulated values of v_j are drawn. But instead of drawing the values randomly we apply simulation based on Halton Sequences since they are found to deliver more accurate results from an even quicker computing procedure (Train 2000, Sándor and Train 2004). We use 100 Halton Sequences to estimate our parameters of interest. The results are presented as average marginal effects.¹⁴

4 | Results

We start with reporting results of the **probit model**. As aforementioned, the model estimates the covariates' impact on the likelihood of newly entering a particular type of overeducation. The model is estimated separately for medium and high education, men and women, East and West Germans. This leaves us with a total of twelve models. Results are grouped by education and marginal effects¹⁵ are presented in tables A3 and

¹³ We use the Stata program "mixlogit" for estimation, provided by Hole (2007). A detailed survey on simulation methods can be found in Train (2003).

¹⁴ Unfortunately, one side effect of the applied estimator is that we are unable to provide standard deviations and significance levels for the marginal effects. The required bootstrapping procedure would be immensely time consuming. Therefore, significance levels of marginal effects refer to those of the estimated parameters.

¹⁵ Estimated coefficients for all models are available upon request.

A4 for medium education and tables A5 and A6 for high education. Results for **medium educated persons** are discussed first.

According to the probit estimation results, *employment experience* lowers the probability to enter overeducation. The finding is more pronounced for West Germany where both genders exhibit a lower risk of entering twofold overeducation and overeducation according to realized matches. Apparently, employment experience does not affect the risk of self-assessed overeducation. In East Germany, employment experience pays off only in terms of a lower RM overeducation risk for women and in terms of twofold overeducation for men. Put differently, persons in an advanced stage of their career regularly face a lower risk of entering overeducation than persons at the very beginning. This result so far¹⁶ corresponds to search theory. *Part-time employment and marginal employment* turn out to be either insignificant or even lowering the risk of overeducation for East German residents. By contrast, for West German women marginal (small part-time) employment increases the risk of entering self-assessed overeducation by 5 % (2 %), compared to full-time employment. Further, marginal employment increases the risk of entering twofold overeducation by 1.6 %. The risk is fairly widespread since one out of eight (12.5 %) medium educated West German female employees is marginally employed, and with 16 % (13.4 %) their share on female employees is above average in the West German trade (other services) sector. In East Germany, a negligible share of 2.6 % of medium educated women work in marginal employment, pointing at the well-known differences in women's labour market involvement in East and West Germany. Effects of *unemployment* further emphasize the importance of continuous employment. Having been unemployed in the past mostly increases the risk of entering subjective overeducation as well as the transition to twofold overeducation for both genders and regions. However, unemployment does either not affect or even alleviate the risk of becoming overeducated according to the realized matches concept. The favorable effect particularly applies to West Germans. Indeed, past unemployment duration is lowest for West (East) Germans who report currently not being (being RM) overeducated and highest for individuals who report excess education.¹⁷

The results for *job changes* are mixed. Whereas *in-house job changes* prove to be riskless, *job changes to a new employer* are problematic and happen more frequently. Among West Germans, we observe job changes to a new employer for 4.5 % (5 %) of male (female) observations. In-house job changes can be observed only for 0.2 % (0.4 %) of observations from men (women). In East Germany, the corresponding shares are 6.5 % (5 %) for job changes to a new employer and 0.2 % (0.3 %) for in-house job changes. A change of the employer is associated to a 3.0 % (3.7 %) higher risk of entering twofold

¹⁶ Later on we find that this holds true only for in-house job mobility.

¹⁷ As to the latter, the average duration of past unemployment in our sample amounts in case of East German men (women) to 0.75 (0.5) years and in case of West German men (women) to 0.86 (1.73) years whereas the respective figures for their non-overeducated counterparts are 0.23 (0.28) years in the Eastern and 0.42 (0.56) years in the Western part of Germany.

overeducation for men (women) in the Eastern part and to a 0.9 % (1.6 %) higher risk for men (women) in the Western part of Germany. For women of both regions this also applies to self-assessed overeducation, ending up in a respective risk increase of 4.7 % (10.3 %) of East (West) German women. Among men, a change of the employer is associated to a 9.2 % risk increase of entering subjective overeducation for West German men only.

Another risky point in time is the *return to the labour market after a childbirth related break*. At the time of re-entry, medium educated West German women who temporarily quit the labour market face an increased risk of entering overeducation. The risk of becoming overeducated by self-assessment increases by 5.9 %, whereas the risk increase of entering RM overeducation (twofold overeducation) increases by 2.6 % (1.7 %). We do not find a similar effect for East German women. Note that as aforementioned, East German women employees resemble their male counterparts more than this is true for West German women who exhibit more frequent labour market intermittencies, lower work volumes and lower employment rates. West German women pass on average 4.2 years out of the labor force for family reasons whereas East German women accumulate only 1.6 years.¹⁸ Thus, it comes as no surprise that having been *out-of-the-labour force* for some years is associated to a higher risk of entering self-assessed overeducation for West German women (and men). However, East German men who feature OLF spells in their employment biography are more likely to enter RM overeducation. This hints to possible selection effects among East German men. Furthermore, some job related variables are important as well. Working as a civil servant serves as a perfect insurance against the risk of entering overeducation. This applies to our East German sample, where not a single person being employed as a civil servant is overeducated.¹⁹ For West Germany the effect applies only to high or executive level civil servants.

The dummy *2005+* was intended to capture changes in the labor market in the aftermath of the introduction of the fourth Hartz reform in January 2005. In East Germany, men and women have henceforth been portraying a lower risk of entering self-assessed and twofold overeducation. In West Germany, only the transition risk to subjective overeducation has been decreasing after the reform. Being too crude to isolate reform effects, the decade dummy is suggested to incorporate major changes of macroeconomic conditions. For example, the sharply declining unemployment rate of East German medium educated persons since 2004 might have partly answered for the above mentioned effect. Variables relating to the household context and parents' home do not exhibit considerable effects. In West Germany, a direct migration background increases

¹⁸ The same pattern applies, although on a lower level, for men. West (East) German men spend on average 0.1 (0.05) years out of the labor force.

¹⁹ The estimated coefficient would be infinite.

the risk of entering self-assessed and twofold overeducation in the case of men, for women this applies only to self-assessed overeducation.

Graduates differ in some important features from their medium educated counterparts. For West German women, deviations *from full-time employment* increase the probability of entering twofold overeducation. Whereas this now holds true not only for marginal employment but also for “small” part-time, these forms of work do not affect the self-assessed overeducation of female graduates as it was the case for medium educated women. In more detail, carrying out a marginal employment increases the transition risk to twofold overeducation by 8.8 % and exerting a part-time job with 16-25 weekly hours by 5.1 %. Only “extended” part-time with weekly working hours that are close to full-time proves to be riskless among West German female graduates. Their East German counterparts are completely unaffected by restricted working hours. Furthermore, *employment experience* most often loses its risk decreasing effect when graduates are considered. Moreover, having been employed for many years increases the risk of entering twofold (subjective) overeducation among West (East) German men. Obviously, training-on-the-job is less complementary to schooling than for the medium educated and thus is less required to make full use of formal qualifications. Compared to the medium educated, graduates are yet more adequately matched at the very beginning of their career, leaving a lower optimization potential to subsequent stages. As for the medium educated, *unemployment experience* increases the risk of entering twofold overeducation for East German graduates of both genders. This further applies to East German female graduates in the case of self-assessed overeducation but no longer to East German men. In West Germany, only male graduates featuring unemployment episodes are more likely to change over to twofold overeducation. We conclude that for West Germany, scarring effects from unemployment are less pronounced for the highly than for the medium educated and furthermore differ between forms of overeducation. By contrast, disadvantageous effects of previous unemployment are less subject to education and of overall higher magnitude in the Eastern part of Germany.

Like for medium education, *job changes to a new employer* have the tendency to increase the risk of new overeducation. But different from results for medium education, we find significant effects for entering RM overeducation. Regressions for men (women) show an increased risk of 16.9 % (9.6 %) for East Germany and of 3.9 % (7.9 %) for West Germany. The results suggest that East Germans are more exposed to unintentional job changes than their West German counterparts. This view is supported by the far higher layoff rate of East Germans compared to West Germans in the decade after German reunification (Brussig and Erlinghagen 2004).²⁰ The fact that East German men

²⁰ The authors define the layoff rate as the share of layoffs on total employment and figure the rate for East Germany at roughly 21 % in 1991 and still round about 8 % in 2001 whereas the rate was below 5 % throughout this time episode in West Germany.

are more affected than women confirms this view. Even if traditional gender roles are less prevalent in the Eastern part of Germany, men usually have lower options to sidestep unfavorable working conditions than women. In West Germany, the higher risk of women to enter RM overeducation in the course of an employer change might be attributed to more traditional gender roles showing up in a higher tendency to behave as 'tied movers', adapting to altered family needs or partners' preferences. By contrast, likewise the medium educated, graduates seldom take risks of new overeducation in the course of *in-house job changes*.

Contrary to their medium educated counterparts, a *re-entry after a childbirth related break* is not risky for German female graduates. Since a considerable part of highly educated mothers does not return to the labour market at all, the returning women might be more selective than mothers of medium education. Hence, the risk of a worsened job match falls more heavily on the latter ones. Seven years after the birth of their first child, 35.7 % of West German graduate women are still without a job whereas this holds true only for 13.3 % of their East German counterparts. By contrast, the corresponding shares are the same among the medium educated in East (41.9 %) and West (41.3 %) Germany. The riskless experience of *OLF time* in case of graduate women is consistent with this finding and is confirmed by previous results that give evidence for a lower human capital depreciation rate of graduate women compared to medium educated ones (Boll 2011).

Testing for *dual education* shows interesting effects. Graduates who hold a vocational training degree in addition to their graduate education face a higher risk of entering self-assessed overeducation than those who do not. This applies for both regions in case of women and for West German men. Our results are in line with the findings from Büchel und Helberger (1995). However, the subjective assessment is not met by statistics: Effects on RM overeducation are not significant (West German women) or even show a mitigated risk of a dual qualification. For West German graduates only, a higher risk of entering twofold overeducation is found. Exaggerated expectations on the job market to match the attained double qualification might be a reason. Anyway, dual qualification does not show up as a valid insurance against job mismatch. Instead, working as a *civil servant* mostly does, according to the results for the medium educated. Compared to the latter, the dummy *2005+* shows no deviant effects for graduates.

Overeducation exhibits a pronounced path dependency. 83.6% of West German men who are overeducated according to realized matches had already been in this status in the previous period. State dependence of similar magnitude can be found for all regions, educational groups, genders and definitions of overeducation. Moreover, results so far hint to considerable unobserved heterogeneity between persons. To cope with omitted variable bias and state dependence, we run a **dynamic mixed multinomial logit model**. Here, we jointly estimate the probabilities of the three types of overeduca-

tion referred to so far against the reference category of being not overeducated. Following Wooldridge (2005) we control for the initial values problem and referring to Mundlak (1978) we incorporate individual means of all time-variant covariates. This allows us to interpret coefficients of all time-varying variables as within effects. Marginal effects are presented in tables A7-A10 in the appendix.²¹

As expected, having been *overeducated in the previous year* significantly increases the risk of being overeducated at present. This applies to both genders, regions and all types of overeducation with the sole exception of East German medium educated women in terms of RM overeducation.²² The magnitude of state dependence shall be exemplified for medium educated individuals. The probability to be currently overeducated by individual self-assessment increases by 43 % (35 %) for men and 37 % (28.4 %) for women in West (East) Germany if persons yet exhibited this status in the previous period. Overeducation according to realized matches shows up being less state dependent,²³ whereas the path dependency of twofold overeducation is somewhere in the middle.²⁴ For almost all subsamples and types of overeducation, the own lagged variable is highly significant whereas the cross-lagged variables show a lower influence.²⁵ Likewise to medium educated persons, we find a high amount of state dependence in overeducation for highly educated persons.²⁶ Our findings are in line with the aforementioned previous studies exploring longitudinal data which also find a high persistence of overeducation over time.

With respect to other covariates, effects derived from the dynamic model seldom contradict those in the probit model as long as **medium educated persons** are addressed. For instance, *employment experience* keeps its risk alleviating effect. The same holds true for the unfavourable effect of *unemployment experience* on self-assessed overeducation although this variable is less significant in the dynamic context. This result points to the fact that a considerable part of unobservable traits that govern the between-person variation is captured by the initial condition and the job match path of an individual. The effects of an *employer change* mostly vanish in the dynamic model for East Germans and West German men. For West German women however, changing

²¹ The full set of estimated parameters for all models, including means of time variant variables, are available upon request.

²² We do not find any kind of state dependence for this group.

²³ Having been in this status before increases the risk of holding it at present by 17.3 % for East German men and 3.7 % (6.9 %) for West German men (women).

²⁴ The corresponding figures amount to 19.5 % (6.2 %) for men (women) in East Germany and to 5.1 % (11.7 %) for their West German counterparts.

²⁵ The cross-state dependence of overeducation is somewhat weaker than the state dependence within a distinct type of overeducation but it still accounts for a reasonable part of the variation. Which cross-lagged variables increase the probabilities of a current overeducation? The findings indicate that subjective and realized matches overeducation is sensitive to a lagged twofold overeducation and twofold overeducation in turn is subject to RM and subjective overeducation. This pattern holds true for both genders and regions.

²⁶ A previously stated overeducation increases the probability to report a current overeducation by 23.2 % for men and 34.8 % for women in East Germany whereas West Germans report 12.9 % and 7.8 %, respectively. In terms of RM overeducation, men and women in East (West) Germany face a risk increase of 26.9 % and 12.8 % (30.6 % and 28.1 %), respectively. For twofold overeducation, the respective figures are 15.2 % (14.5 %) for men (women) in East Germany and 23.6 % (37.4 %) for men (women) in West Germany. We conclude that path dependence is of even higher importance for graduates. The cross-state dependence of overeducation is again somewhat weaker than self-state dependence but does still account for a reasonable part of the variation. It exhibits the same pattern as for the medium educated.

the employer remains risky in terms of subjective and twofold overeducation even in the dynamic context.

The time of *re-entry* into the labour market *after a childbirth related break* remains risky in terms of self-assessed and twofold overeducation for West German women with medium education. The effect is even more pronounced in the panel model. The more extensive provision of childcare facilities in East Germany presumably mitigates mothers' risk of overeducation in the Eastern part of Germany. *Former OLF time* remains risky for medium educated women. Whereas subjective overeducation keeps its effect in the Western part, East German women happen to suffer RM overeducation in the dynamic model. Furthermore, a *direct migration background* continues to be a risk driving factor in terms of self-assessed overeducation for West German women and men, for West German men and East German women also in terms of twofold overeducation. The few cases of deviating results between model types in the group of medium educated persons refer to *firm size* and the decade dummy "2005+".²⁷

The functional form of the model matters more when **graduates** are addressed. It is noteworthy that "*small*" *part-time work* and *marginal employment* lose their detrimental effects for West German female graduates when unobserved heterogeneity and state dependence is taken into account. Obviously, the effects presented in the probit model have to be attributed rather to cross-person than to cross-time variation. Note that *employment experience* now decreases the risk of RM overeducation for West German female (and – less significant – male) graduates whereas this effect had not been significant in the probit model. The insignificant effect in the probit model of *re-entering the labour market after a childbirth-related break* turns into a very robust negative effect in the panel model. That is, West German highly educated mothers face an increased risk for all three types of overeducation at the time of return to employment. For East German mothers of same education, the risk enhancing effect at the time of re-entry with respect to twofold overeducation persists across models. Furthermore, the higher risk of twofold overeducation in the course of an *employer change* is kept in the panel model for East German graduate females whereas the effect vanished, as aforementioned, for their medium educated counterparts. The opposite holds for West Germany.²⁸ Moreover, also the risk increasing effect of a *dual education* in terms of twofold overeducation that has been displayed by West German graduates in the probit model vanishes in the dynamic model. The same applies to East German female graduates with respect to

²⁷ According to the within-effect in the dynamic panel model, switching to a firm with less than 2000 employees turns out to be risky in terms of self-assessed overeducation for men in both German regions and West German women. Women and men in West Germany are furthermore more prone to RM overeducation after 2004. This effect did not emerge for men in the probit model, and for women it is even more pronounced in the dynamic model. Finally, the detrimental effect on self-assessed overeducation that is related to a direct migration background for West German women with medium education persists even in the panel model framework. However, their highly educated counterparts as well as women and men in East Germany do not face a similar risk. The latter result might be attributed to the fact that in West Germany, 7.4 % of the medium educated dispose of a direct migration background whereas this applies to only 0.8 % of their East German counterparts.

²⁸ Whereas changing the employer is a risky strategy for medium educated West German women in terms of subjective and twofold overeducation in both models, the risks lose significance or even decrease in the panel model framework for West German female graduates.

self-assessed overeducation. However, the dual education remains risky from West German graduates' self-assessment in the dynamic model.

When it comes to workplace and household related variables, results differ across models for a few covariates only. Being employed in a *firm with less than 2000 employees* is less risky for graduates than for the medium educated and among graduates for women more risky than for men. For the medium educated and West German female graduates, effects are even more pronounced in the dynamic model. A further example is highly educated East German men who are employed in the *High or Executive Level Civil Service*. For them, the dynamic model ends up with an increased risk of statistical overeducation that had not been in place in the probit model. The *household size* that had been a risk driver in terms of RM overeducation for East German female graduates in the probit model does not show a comparable effect in the dynamic model. If economies of scale in household production were dominant they should show up as well in the within-person perspective. As this is not the case we rather assume that the parameter of the household size in the probit model accrues from a selection effect referring to East German women with a lower labour market attachment. Interestingly, net of unobserved heterogeneity, the *household's asset income* turns into a risk increasing factor for RM overeducation for highly educated West German women. This provides evidence for considerable within-person cross-time effects of altered pecuniary incentives on the job match quality. Last but not least, being in line with previous findings on the European level (Cedefop 2011) a *direct migration background* turns out to be more risky for East Germans in the dynamic than in the static model and remains risky for West German medium educated persons.

Overall, the probit model produces more significant effects than the dynamic model. This generally applies to the detrimental effects of past unemployment, restricted working hours, employer change and dual education which lose importance in the dynamic model. Furthermore, employment experience keeps its risk-decreasing effect in the dynamic model in the vast majority of cases. Exceptions for single subgroups in terms of newly arising or reinforced risks in the dynamic context have to be stated for household asset income (West German female graduates), employment experience (West German male graduates), labour market re-entry after a break (West German women), higher or executive level civil servants (East German graduates) and direct migration background (East Germans). Furthermore, the incurred risk in the course of an employer change diminishes more for men than for women, the risk of past unemployment more for medium educated persons than for graduates and the risk accruing from a dual education more for East than for West German academics when the dynamic context is considered.

5 | Conclusion

Educational mismatch on the labour market in terms of overeducation is undoubtedly disadvantageous on the individual level as well as for society as a whole. The presented descriptive statistics show that in Germany, overeducation is of sizeable magnitude. For instance, 1 out of 3 graduates and 1 out of 12 (8-10) medium educated men (women) were overeducated according to realized matches in 2011. Hence, the question how obstacles to proper matches can be removed turns out to be an important political issue. Identifying causal effects is essential in this context. Empirical evidence hints at challenges like omitted variable bias, measurement error and state dependency. In the light of these, we choose a methodological framework that provides robustness checks for the model's functional form as well as for the specification of the target variable. Moreover, running regressions for several subgroups allows us to compare results between different educational groups, regions, and genders.

Four major results stand out from our empirical research. *Firstly*, biography and workplace related covariates mostly affect the risk of overeducation more significantly than characteristics of the household context. We suggest that the latter in a first round affect the employment decision as such, leaving less scope for impacting on job match quality in a second round. *Secondly*, as discussed above, overeducation is highly state dependent. An employer change seldom proves to be a suitable exit strategy. However, the situation markedly improves with more years in employment. *Thirdly*, effects are in total more pronounced in the Western than in the Eastern part of Germany what may relate to a lower total of observations in the new Bundesländer and furthermore to a more homogenous sample. *Fourthly*, results heavily depend on the used operationalization of the target variable.

Our findings, particularly those derived from the sophisticated dynamic model, point to some veritable mismatch beyond selection. We conclude that focusing continuous employment careers and circumventing unintentional withdrawals from the current job is at the core of political strategies combatting overeducation. Moreover, institutional impediments that restrain job match quality for certain groups (migrants, mothers) have to be tackled.

The presented results show various limitations that point to **avenues for further research**. First, due to data restrictions we did not consider fields of study. It would be interesting to investigate the impact of fields of study in a model setting like ours that takes employment biography and the household context into account. This issue has to be left for future research as it is conditional upon suitable data at hand. Secondly, we restricted our analyses to the vertical dimension of skill mismatch, thereby leaving out

any kind of skill underutilization. However, there is a vast empirical evidence on horizontal skill mismatch (e. g. Allen and van der Velden 2001, Chevalier 2003, Green and McIntosh 2007, Mavromaras et al. 2009, Green and Zhu 2010, Desjardins and Rubenson 2011) suggesting manifold associations between the different dimensions of reported mismatch. For instance, among EU-27 only 37 % of employees are matched in terms of both qualifications and skills (European Commission 2012: 363). Hence, a promising issue of further research will be jointly analyzing vertical and horizontal aspects of mismatch based on new data sets like PIACC. Thirdly, in the context of the economic relevance of the overeducation issue earnings effects are crucial to estimate in order to assess the economic impact of overeducation. Own estimation results indicate that overeducated graduates indeed suffer veritable earnings losses compared to their properly matched exam colleagues (Boll and Leppin, 2014a). A corresponding analysis for the medium educated in the same model setting is work in progress.

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Appendix

Table A1: Descriptive statistics, persons with medium education

Variable	West Germany				East Germany			
	Male		Female		Male		Female	
	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.
Endogenous variables								
Overeducation (self-assessed, SA)	0.2000	0.4000	0.2079	0.4058	0.1969	0.3977	0.1810	0.3851
Overeducation (realised matches, 1 Std. dev.)	0.0588	0.2352	0.0817	0.2739	0.0805	0.2721	0.0760	0.2650
Overeducation (RM, 0.75 Std. dev.)	0.1115	0.3148	0.1526	0.3596	0.2521	0.4343	0.1706	0.3762
Overeducation (RM, 1.25 Std. dev.)	0.0436	0.2041	0.0663	0.2488	0.0703	0.2556	0.0704	0.2559
Twofold overeducation (combination of SA and RM 1 Std. dev.)	0.0128	0.1122	0.0228	0.1492	0.0405	0.1970	0.0288	0.1673
Lagged overeducation (RM)	0.0608	0.2391	0.0825	0.2751	0.0852	0.2792	0.0797	0.2709
Lagged overeducation (SA)	0.2019	0.4014	0.2091	0.4067	0.1997	0.3998	0.1808	0.3849
Lagged overeducation (combination)	0.0139	0.1172	0.0263	0.1602	0.0449	0.2072	0.0323	0.1768
Employment biography								
Full-time employment* (<i>Reference</i>)	0.9804	0.1386	0.5108	0.4999	0.9779	0.1472	0.7251	0.4465
Part-time employment (16-25h)*	0.0054	0.0735	0.2376	0.4256	0.0047	0.0683	0.0939	0.2917
Part-time employment (26-35h)*	0.0081	0.0896	0.1264	0.3323	0.0094	0.0963	0.1548	0.3617
Marginal employment	0.0057	0.0754	0.1250	0.3307	0.0081	0.0896	0.0263	0.1599
Employment experience (full-time + part-time, years)	18.9359	9.3332	15.8627	8.5376	18.8997	9.1840	17.5573	9.0727
Unemployment experience (registered UE, years)	0.3476	1.1912	0.3527	0.9785	0.5132	1.1974	0.8025	1.6619
OLF experience (years out of the labor force for family or other reasons)	0.1338	1.0832	4.2469	5.9449	0.0479	0.3233	1.5791	2.4933
Vocational Training*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Job change (new employer)	0.0446	0.2065	0.0503	0.2186	0.0658	0.2479	0.0500	0.2179
Job change (in-house)	0.0020	0.0441	0.0043	0.0656	0.0023	0.0483	0.0033	0.0570
Re-entry after childbirth related break	0.0008	0.0289	0.0139	0.1173	0.0034	0.0583	0.0119	0.1082
Job features								
Primary sector, energy, mining	0.0360	0.1864	0.0114	0.1060	0.0707	0.2563	0.0263	0.1599
Manufacturing* (<i>Reference</i>)	0.3090	0.4621	0.1499	0.3570	0.2342	0.4235	0.1109	0.3140
Construction*	0.2349	0.4239	0.0564	0.2306	0.2589	0.4381	0.0551	0.2282
Trade*	0.1127	0.3162	0.2282	0.4197	0.1324	0.3390	0.2136	0.4099
Transport*	0.0689	0.2534	0.0353	0.1846	0.0967	0.2955	0.0483	0.2145
Banking and insurances*	0.0575	0.2328	0.0689	0.2533	0.0177	0.1318	0.0483	0.2145
Other services* (business services, public administration, social insurance carriers)	0.1809	0.3850	0.4500	0.4975	0.1895	0.3919	0.4976	0.5001
Very small enterprise* (less than 20 employees)	0.1797	0.3839	0.3113	0.4630	0.2749	0.4465	0.2845	0.4512
Small enterprise* (20-199 employees)	0.2786	0.4483	0.2684	0.4432	0.3924	0.4883	0.2933	0.4553
Medium-size enterprise* (200-1999 employees)	0.2553	0.4361	0.2197	0.4141	0.1646	0.3708	0.2291	0.4203
Big enterprise* (2000 or more employees) (<i>Reference</i>)	0.2864	0.4521	0.2006	0.4004	0.1682	0.3741	0.1931	0.3948
Public sector* (<i>Reference: Private sector</i>)	0.1703	0.3760	0.2867	0.4522	0.1648	0.3710	0.3012	0.4588
Middle/Low level civil servant* (<i>Reference: otherwise dependently employed</i>)	0.0210	0.1436	0.0068	0.0825	0.0179	0.1325	0.0060	0.0775
High level civil servant* (<i>Reference: otherwise dependently employed</i>)	0.0093	0.0962	0.0090	0.0943	0.0049	0.0698	0.0033	0.0570
Executive level civil servant* (<i>Reference: otherwise dependently employed</i>)	0.0025	0.0500	0.0000	0.0000	0.0011	0.0326	0.0000	0.0000
Partner and household context								
Partner's gross wage income (per month, Euro)	889.76	1186.20	2716.08	2778.42	1123.99	1296.27	1808.99	1709.17

Table A1 (ctd.): Descriptive statistics, persons with medium education

Variable	West Germany				East Germany			
	Male		Female		Male		Female	
	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.
Cohabiting * (living together but not married)	0.0862	0.2806	0.1133	0.3169	0.1216	0.3268	0.1369	0.3438
Married* (living together with husband/wife)	0.7008	0.4579	0.6403	0.4799	0.6549	0.4755	0.6447	0.4787
Single* (without partner or not living together with a partner)	0.2130	0.4094	0.2464	0.4309	0.2235	0.4167	0.2185	0.4132
Partner is lowly educated* (ISCED <3)	0.1278	0.3339	0.0790	0.2697	0.0292	0.1683	0.0242	0.1536
Partner is medium educated* (ISCED 3-4, 5B)	0.6120	0.4873	0.5523	0.4973	0.5829	0.4931	0.6038	0.4892
Partner is highly educated* (ISCED 5A, 6)	0.0471	0.2119	0.1224	0.3277	0.1644	0.3706	0.1536	0.3606
Parenthood* (referring to births; <i>reference=childlessness</i>)	0.5878	0.4923	0.6472	0.4779	0.6713	0.4698	0.7825	0.4126
Child aged 6 or younger*	0.2180	0.4129	0.1127	0.3163	0.1697	0.3754	0.1106	0.3137
Child aged 7 or older* (<i>Reference</i>)	0.4456	0.4970	0.5737	0.4946	0.5725	0.4948	0.7144	0.4518
Residence in South Germany* (Bavaria, Baden-Wuerttemberg, Hessen)	0.4505	0.4976	0.4622	0.4986	0.0000	0.0000	0.0000	0.0000
Residence in West Germany* (North-Rhine-Westfalia, Rheinland-Pfalz, Saarland)	0.3688	0.4825	0.3481	0.4764	0.0000	0.0000	0.0000	0.0000
Residence in East Germany* (Saxony, Saxony-Anhalt, Thuringia, Brandenburg, Mecklenburg-Vorpommern, Berlin)	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	1.0000	0.0000
Residence in North Germany* (Hamburg, Schleswig-Holstein, Bremen, Lower Saxony)	0.1807	0.3848	0.1897	0.3921	0.0000	0.0000	0.0000	0.0000
Household size (persons)	3.1105	1.3226	2.8337	1.1807	2.9877	1.1735	2.8424	1.0261
Nonwage income of the household (interest, rent, dividend, redistributive income, Euro)	128.53	511.94	207.73	1810.62	58.33	172.33	85.74	347.18
Parents' home characteristics								
Father is employed* (at age 15 of survey person)	0.9090	0.2876	0.9106	0.2853	0.9010	0.2987	0.9068	0.2907
Mother is employed* (at age 15 of survey person)	0.2108	0.4079	0.2116	0.4085	0.2883	0.4530	0.3244	0.4682
Father is highly educated* (ISCED 5A, 6)	0.0429	0.2027	0.0503	0.2186	0.1422	0.3493	0.1290	0.3352
Mother is highly educated* (ISCED 5A, 6)	0.0149	0.1212	0.0166	0.1278	0.0988	0.2984	0.0558	0.2295
Nationality/migration background								
Direct migration background* (survey person born abroad)	0.0934	0.2910	0.0501	0.2182	0.0062	0.0783	0.0070	0.0832
Indirect migration background* (at least one parent born abroad)	0.0384	0.1922	0.0405	0.1971	0.0166	0.1278	0.0139	0.1173
No migration background*	0.8682	0.3383	0.9094	0.2870	0.9772	0.1492	0.9791	0.1431

Sources: SOEP v28, 1984-2011; HWWI.

Table A2: Descriptive statistics, persons with tertiary education

Variable	West Germany				East Germany			
	Male		Female		Male		Female	
	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.
Endogenous variables								
Overeducation (self-assessed, SA)	0.0472	0.2122	0.0603	0.2380	0.0840	0.2774	0.2809	0.4495
Overeducation (realised matches, 1 Std. dev.)	0.2407	0.4275	0.1578	0.3646	0.2909	0.4543	0.1302	0.3365
Overeducation (RM, 0.75 Std. dev.)	0.4375	0.4961	0.3870	0.4871	0.5577	0.4968	0.3724	0.4835
Overeducation (RM, 1.25 Std. dev.)	0.1789	0.3833	0.2452	0.4303	0.2714	0.4448	0.2214	0.4152
Twofold overeducation (combination of SA and RM 1 Std. dev.)	0.0838	0.2770	0.1595	0.3662	0.1467	0.3539	0.1613	0.3679
Lagged overeducation (RM)	0.2511	0.4337	0.1684	0.3743	0.3045	0.4603	0.1356	0.3424
Lagged overeducation (SA)	0.0461	0.2096	0.0595	0.2366	0.0865	0.2812	0.2696	0.4438
Lagged overeducation (combination)	0.0836	0.2768	0.1633	0.3696	0.1446	0.3518	0.1551	0.3620
Employment biography								
Full-time employment* (<i>Reference</i>)	0.9539	0.2096	0.6085	0.4881	0.9580	0.2006	0.7930	0.4052
Part-time employment (16-25h)*	0.0154	0.1232	0.1882	0.3909	0.0076	0.0871	0.0685	0.2526
Part-time employment (26-35h)*	0.0253	0.1570	0.1358	0.3427	0.0305	0.1721	0.1291	0.3353
Marginal employment	0.0054	0.0730	0.0674	0.2508	0.0038	0.0617	0.0095	0.0969
Employment experience (full-time + part-time, years)	16.4816	7.6171	14.6809	7.8286	19.3186	8.0502	18.6410	7.8409
Unemployment experience (registered UE, years)	0.1754	0.6028	0.2994	0.8075	0.2460	0.6632	0.4002	1.1171
OLF experience (years out of the labor force for family or other reasons)	0.2328	1.5504	2.6057	4.8123	0.1105	0.8910	1.0275	1.9413
Vocational Training*	0.3137	0.4640	0.2314	0.4218	0.4215	0.4939	0.5107	0.5000
Job change (new employer)	0.0379	0.1909	0.0403	0.1966	0.0505	0.2190	0.0355	0.1849
Job change (in-house)	0.0082	0.0902	0.0106	0.1025	0.0051	0.0712	0.0051	0.0715
Re-entry after childbirth related break	0.0005	0.0224	0.0123	0.1105	0.0000	0.0000	0.0084	0.0912
Job features								
Primary sector, energy, mining	0.0245	0.1545	0.0136	0.1158	0.0390	0.1937	0.0203	0.1410
Manufacturing* (<i>Reference</i>)	0.1615	0.3680	0.0714	0.2575	0.1705	0.3761	0.0671	0.2503
Construction*	0.1487	0.3559	0.0432	0.2034	0.1111	0.3143	0.0309	0.1729
Trade*	0.0266	0.1610	0.0519	0.2218	0.0814	0.2735	0.0595	0.2367
Transport*	0.0307	0.1724	0.0311	0.1737	0.0492	0.2163	0.0314	0.1744
Banking and insurances*	0.0665	0.2492	0.0361	0.1865	0.0288	0.1674	0.0406	0.1974
Other services* (business services, public administration, social insurance carriers)	0.5415	0.4983	0.7528	0.4314	0.5199	0.4997	0.7502	0.4330
Very small enterprise* (less than 20 employees)	0.1677	0.3736	0.2309	0.4215	0.1654	0.3716	0.2720	0.4450
Small enterprise* (20-199 employees)	0.2209	0.4149	0.2892	0.4535	0.3571	0.4792	0.2899	0.4538
Medium-size enterprise* (200-1999 employees)	0.2462	0.4309	0.1716	0.3771	0.2443	0.4297	0.2460	0.4307
Big enterprise* (2000 or more employees) (<i>Reference</i>)	0.3652	0.4815	0.3082	0.4618	0.2332	0.4230	0.1922	0.3940
Public sector* (<i>Reference: Private sector</i>)	0.3410	0.4741	0.5500	0.4976	0.3537	0.4782	0.5605	0.4964
Middle/Low level civil servant* (<i>Reference: otherwise dependently employed</i>)	0.0052	0.0719	0.0188	0.1357	0.0093	0.0962	0.0122	0.1097
High level civil servant* (<i>Reference: otherwise dependently employed</i>)	0.0789	0.2696	0.1714	0.3769	0.0606	0.2387	0.0352	0.1843
Executive level civil servant* (<i>Reference: otherwise dependently employed</i>)	0.1405	0.3476	0.1245	0.3302	0.0483	0.2145	0.0165	0.1274
Partner- and household context								
Partner's gross wage income (per month, Euro)	1438.16	2136.15	3753.60	3878.05	1873.02	1720.43	2237.91	2329.52
Cohabiting * (living together but not married)	0.0799	0.2712	0.1173	0.3218	0.1060	0.3079	0.0874	0.2825
Married* (living together with husband/wife)	0.7573	0.4288	0.6105	0.4877	0.7265	0.4459	0.7212	0.4484

Table A2 (ctd.): Descriptive statistics, persons with tertiary education

Variable	West Germany				East Germany			
	Male		Female		Male		Female	
	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.
Single* (without partner or not living together with a partner)	0.1628	0.3692	0.2722	0.4451	0.1675	0.3735	0.1913	0.3934
Partner is lowly educated* (ISCED <3)	0.0320	0.1760	0.0153	0.1228	0.0030	0.0544	0.0325	0.1773
Partner is medium educated* (ISCED 3-4, 5B)	0.4129	0.4924	0.1936	0.3952	0.2629	0.4403	0.4057	0.4911
Partner is highly educated* (ISCED 5A, 6)	0.3923	0.4883	0.5189	0.4997	0.5666	0.4957	0.3705	0.4830
Parenthood* (referring to births; <i>reference=childlessness</i>)	0.6544	0.4756	0.5905	0.4918	0.7091	0.4543	0.8869	0.3168
Child aged 6 or younger*	0.2524	0.4344	0.1383	0.3453	0.1628	0.3693	0.1042	0.3056
Child aged 7 or older* (<i>Reference</i>)	0.5109	0.4999	0.5122	0.4999	0.6128	0.4872	0.8327	0.3733
Residence in South Germany* (Bavaria, Baden-Wuerttemberg, Hessen)	0.4961	0.5000	0.4460	0.4971	0.0000	0.0000	0.0000	0.0000
Residence in West Germany* (North-Rhine-Westfalia, Rheinland-Pfalz, Saarland)	0.3255	0.4686	0.3737	0.4838	0.0000	0.0000	0.0000	0.0000
Residence in East Germany* (Saxony, Saxony-Anhalt, Thuringia, Brandenburg, Mecklenburg-Vorpommern, Berlin)	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	1.0000	0.0000
Residence in North Germany* (Hamburg, Schleswig-Holstein, Bremen, Lower Saxony)	0.1784	0.3829	0.1803	0.3845	0.0000	0.0000	0.0000	0.0000
Household size (persons)	3.2087	1.3875	2.7871	1.2820	3.1213	1.2760	3.0509	1.0971
Nonwage income of the household (interest, rent, dividend, redistributive income, Euro)	360.66	1301.36	362.18	1010.55	135.58	448.98	131.10	461.70
Parents' home characteristics								
Father is employed* (at age 15 of survey person)	0.8946	0.3070	0.9247	0.2640	0.9508	0.2163	0.9169	0.2760
Mother is employed* (at age 15 of survey person)	0.2626	0.4401	0.3221	0.4673	0.2413	0.4280	0.1737	0.3789
Father is highly educated* (ISCED 5A, 6)	0.2618	0.4397	0.3070	0.4613	0.3944	0.4888	0.3142	0.4643
Mother is highly educated* (ISCED 5A, 6)	0.0905	0.2869	0.1022	0.3030	0.1739	0.3791	0.1873	0.3902
Nationality/migration background								
Direct migration background* (survey person born abroad)	0.0595	0.2365	0.0672	0.2504	0.0076	0.0871	0.0181	0.1334
Indirect migration background* (at least one parent born abroad)	0.0214	0.1449	0.0252	0.1567	0.0059	0.0768	0.0024	0.0493
No migration background*	0.9191	0.2727	0.9076	0.2896	0.9864	0.1157	0.9794	0.1420

Sources: SOEP v28, 1984-2011; HWWI.

Table A3: Probit model, East Germany, persons with medium education

Variable	Probability of overeducation: marginal effects					
	Self-assessed		Realized Matches		Twofold	
	Female	Male	Female	Male	Female	Male
Employment biography						
Part-time employment (16-25h)	0.0075	0.0022	-0.0012	0.0202	-0.0055	0.0138
Part-time employment (26-35h)	0.0275	0.1586	-0.0045**	-(i)	-0.0063	-(i)
Marginal emoloyment	0.0382	0.1146		0.0117	-0.0061	0.0040
Employment experience	0.0005	-0.0004	-0.0005*	-0.0003	-0.0002	-0.0007**
Unemployment experience	0.0133***	0.0156***	-0.0142*	0.0014	0.0030***	0.0029**
OLF experience	0.0006	0.0153	0.0004	0.0108**	0.0008	-0.0009
Job change (new employer)	0.0466**	0.0262	-(i)	0.0085	0.0371***	0.0298***
Job change (in-house)	0.1726	-(i)	-(i)	-(i)	-(i)	-(i)
Re-entry after childbirth related break	-0.0044	0.1281	0.0339	-(i)	-(i)	-(i)
Job features						
Public sector	-0.0140	-0.0209**	0.0014	0.0166	-0.0031	-0.0038
Middle/Low level civil servant	0.1013	0.0503	-(i)	-(i)	-(i)	-(i)
High level civil servant	-(i)	-(i)	-(i)	-(i)	-(i)	-(i)
Executive level civil servant	.	-(i)	.	-(i)	.	-(i)
Period 2005+	-0.0235***	-0.0286***	0.0028	-0.0056	-0.0145***	-0.0195***
Partner- and household context						
Partner's gross wage income	0.0000	0.0000	0.0000	0.0000*	0.0000	0.0000
Cohabiting	0.0002	0.0203	-0.0026	0.0021	-0.0049	0.0180
Married	0.0021	0.0075	-0.0005	0.0055	0.0008	0.0049
Partner is medium educated	0.0119	0.0011	0.0000	-0.0068	0.0055	-0.0105*
Partner is lowly educated	0.0301	-0.0290*	-(i)	0.0000	0.0177	0.0014
Parenthood	0.0111	0.0076	0.0031	0.0055	-0.0021	0.0060
Child aged 6 or younger	0.0068	-0.0158	0.0015	-0.0070	0.0018	-0.0070
Household size	-0.0027	0.0024	0.0003	-0.0017	-0.0010	-0.0001
Nonwage income of the household	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Parents' home characteristics						
Father is employed	-0.0187	0.0120	+(i)	0.0088*	0.0032	0.0077*
Mother is employed	-0.0155**	-0.0130	0.0015	-0.0105***	-0.0079**	-0.0079*
Father is highly educated	-0.0055	-0.0172*	0.0015	0.0054	0.0078	-0.0111***
Mother is highly educated	0.0255	0.0017	0.0130	0.0082	0.0165	0.0058
Nationality/migration background						
Direct migration background	0.0212	0.0231	-(i)	-(i)	0.0265	-0.0003
Indirect migration background	-(i)	0.0229	-(i)	0.0044	-(i)	-(i)

Notes: SOEP v28, 1992-2011; HWWI. *, **, *** Statistically significant at the 10-percent, the 5-percent, the 1-percent level. -(i) or +(i) refers to infinite coefficients. Dummies for industry and firm size included.

Table A4: Probit model, West Germany, persons with medium education

Variable	Probability of overeducation: marginal effects					
	Self-assessed		Realized Matches		Twofold	
	Female	Male	Female	Male	Female	Male
Employment biography						
Part-time employment (16-25h)	0.0097	0.0296	0.0011	-(i)	0.0027	0.0190
Part-time employment (26-35h)	0.0194***	0.0034	-0.0012	0.0209	-0.0001	0.0222
Marginal emoloyment	0.0505***	0.0288	0.0051	0.0214	0.0135***	-(i)
Employment experience	-0.0001	0.0001	-0.0003**	-0.0005***	-0.0004***	-0.0002**
Unemployment experience	0.0050***	0.0091***	-0.0052**	-0.0039**	0.0013**	0.0006**
OLF experience	0.0009***	0.0030**	-0.0002	0.0004	0.0001	-0.0200
Job change (new employer)	0.1028***	0.0917***	0.0049	0.0058	0.0162***	0.0094**
Job change (in-house)	-0.0026	0.1056	0.0119	-(i)	0.0125	-(i)
Re-entry after childbirth related break	0.0591**	0.1471	0.0260*	-(i)	0.0167*	-(i)
Job features						
Public sector	-0.0071	-0.0224***	0.0025	-0.0048**	-0.0051***	-0.0020
Middle/Low level civil servant	0.0005	0.0000	0.0358	0.0390**	0.0609*	0.0100
High level civil servant	-(i)	-0.0098	-0.0031	-(i)	-(i)	-(i)
Executive level civil servant	.	-(i)	.	-(i)	.	-(i)
Period 2005+	-0.0127***	-0.0113***	0.0030*	-0.0018	-0.0009	-0.0004
Partner- and household context						
Partner's gross wage income	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Cohabiting	-0.0090	-0.0098	0.0081	0.0076	0.0023	-0.0022
Married	-0.0109	-0.0263*	0.0002	0.0038	0.0003	-0.0015
Partner is medium educated	0.0054	0.0129	-0.0049*	-0.0110	-0.0022	0.0039
Partner is lowly educated	0.0131	0.0437**	-0.0021	-0.0083	-0.0041**	0.0029
Parenthood	0.0070	-0.0064	-0.0008	0.0032	-0.0003	0.0007
Child aged 6 or younger	-0.0172***	0.0039	0.0038	0.0014	-0.0002	-0.0020
Residence in South Germany	-0.0017	-0.0088**	0.0021	-0.0051**	0.0002	-0.0014
Residence in West Germany	-0.0029	-0.0066	0.0055*	-0.0013	0.0004	-0.0019
Household size	0.0007	0.0002	-0.0013	-0.0007	0.0002	-0.0009*
Nonwage income of the household	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Parents' home characteristics						
Father is employed	-0.0031	0.0025	0.0008	0.0031	-0.0008	0.0031***
Mother is employed	-0.0061	-0.0009	0.0050**	-0.0027	-0.0055***	-0.0003
Father is highly educated	0.0039	-0.0148*	0.0068	0.0048	0.0090*	0.0074
Mother is highly educated	-0.0196**	-0.0007	-0.0005	-0.0030	-0.0013	0.0057
Nationality/migration background						
Direct migration background	0.0212*	0.0350***	-0.0007	-0.0062***	-0.0006	0.0058**
Indirect migration background	0.0089	-0.0148*	-0.0033	0.0020	-0.0029	-0.0007

Notes: SOEP v28, 1984-2011; HWWI. *, **, *** Statistically significant at the 10-percent, the 5-percent, the 1-percent level. -(i) or +(i) refers to infinite coefficients. Dummies for industry and firm size included.

Table A5: Probit model, East Germany, persons with tertiary education

Variable	Probability of overeducation: marginal effects					
	Self-assessed		Realized Matches		Twofold	
	Female	Male	Female	Male	Female	Male
Employment biography						
Part-time employment (16-25h)	0.0282	-0.0007	-0.0175*	-0.0309	-0.0034	0.0129
Part-time employment (26-35h)	-0.0015	-(i)	0.0064	0.0195	-0.0353***	0.0863
Marginal emoloyment	-(i)	-(i)	0.0528	0.2501	-0.0099	-(i)
Employment experience	0.0012	0.0016**	-0.0005	-0.0008	-0.0012**	0.0006
Unemployment experience	0.0187**	0.0074	-0.0083	-0.0220	0.0165***	0.0153***
OLF experience	0.0019	-(i)	-0.0044	-0.1705	0.0005	-0.0086
Vocational training	0.0369***	0.0122	-0.0336***	-0.0394***	-0.0027	-0.0070
Job change (new employer)	0.0217	0.0523*	0.0956**	0.1694***	0.1274***	-0.0029
Job change (in-house)	0.0786	-(i)	0.0248	0.3161	0.0732	-(i)
Re-entry after childbirth related break	0.1061	.	0.0740	.	0.1876**	.
Job features						
Public sector	0.0221	-0.0130	-0.0006	-0.0031	-0.0324***	-0.0182
Middle/Low level civil servant	-(i)	-(i)	0.0376		0.0765	0.0706
High level civil servant	-(i)	0.0066	-(i)	0.0295	-(i)	0.0173
Executive level civil servant	-(i)	-(i)	0.0195	0.0881*	-(i)	-(i)
Period 2005+	-0.0521***	-0.0155**	-0.0018	-0.0362***	-0.0287***	-0.0285***
Partner- and household context						
Partner's gross wage income	0.0000	0.0000	0.0000	0.0000**	0.0000	0.0000
Cohabiting	-0.0394**	-0.0062	-0.0150	-0.0469***	0.0296	-0.0233*
Married	-0.0245	-0.0068	-0.0313*	-0.0472	0.0221*	-0.0362
Partner is medium educated	0.0501***	-0.0023	-0.0356***	0.0258	-0.0003	0.0278**
Partner is lowly educated	0.0017	-(i)	-(i)	-(i)	-0.0074	-(i)
Parenthood	-0.0273	0.0035	-0.0058	-0.0129	0.0238***	-0.0054
Child aged 6 or younger	0.0238	0.0441	-0.0011	0.0232	-0.0105	-0.0036
Household size	0.0049	0.0016	0.0140***	0.0070	-0.0156***	0.0031
Nonwage income of the household	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Parents' home characteristics						
Father is employed	-0.0115	-0.0061	-0.0022	0.0385**	-0.0036	0.0000
Mother is employed	-0.0538***	-0.0080	0.0315**	0.0059	0.0041	0.0125
Father is highly educated	-0.0285**	-0.0115	0.0035	0.0278*	-0.0135*	-0.0119
Mother is highly educated	0.0100	0.0040	0.0076	-0.0317**	0.0182	-0.0176
Nationality/migration background						
Direct migration background	0.1032	-(i)	-(i)	-(i)	0.0073	0.0573
Indirect migration background	-(i)	-(i)	0.0935	-(i)	-(i)	0.1624

Notes: SOEP v28, 1992-2011; HWWI. *, **, *** Statistically significant at the 10-percent, the 5-percent, the 1-percent level. -(i) or +(i) refers to infinite coefficients. Dummies for industry and firm size included

Table A6: Probit model, West Germany, persons with tertiary education

Variable	Probability of overeducation: marginal effects					
	Self-assessed		Realized Matches		Twofold	
	Female	Male	Female	Male	Female	Male
Employment biography						
Part-time employment (16-25h)	-0.0033	-(i)	-0.0246**	-0.0160	0.0056	0.0136
Part-time employment (26-35h)	0.0058	0.0183	-0.0023	0.0052	0.0508**	0.0048
Marginal emoloyment	0.0091	-(i)	-0.0028	0.0478	0.0877**	0.0986
Employment experience	0.0003	0.0004	0.0000	-0.0009	-0.0010	0.0006*
Unemployment experience	-0.0012	0.0002	0.0010	0.0096	0.0073	0.0054**
OLF experience	-0.0005	-0.0003	-0.0007	-0.0013	0.0013	-0.0089
Vocational training	0.0211***	0.0105***	-0.0162	-0.0332***	0.0198**	0.0079**
Job change (new employer)	0.0296	0.0155	0.0792**	0.0394*	0.0564**	0.0186
Job change (in-house)	0.0458	0.0183	0.0919	0.1649**	0.0132	-(i)
Re-entry after childbirth related break	0.1032	-(i)	0.1143	-(i)	0.0720	-(i)
Job features						
Public sector	-0.0087	-0.0114**	-0.0048	-0.0149	-0.0324***	-0.0108**
Middle/Low level civil servant	-(i)	-(i)	-0.0325**	-(i)	-(i)	-(i)
High level civil servant	-0.0119***	0.0074	-0.048***	-0.0306***	-(i)	-(i)
Executive level civil servant	-(i)	-0.0102**	-0.0298***	-0.0332***	-(i)	-0.0074
Period 2005+	-0.0086*	-0.0012	-0.0224***	-0.0109	-0.0025	-0.0053
Partner- and household context						
Partner's gross wage income	0.0000**	0.0000	0.0000	0.0000	0.0000	0.0000
Cohabiting	-0.0098*	0.0071	0.0095	-0.0053	-0.0134	-0.0028
Married	-0.0300**	-0.0063	0.0016	0.0073	-0.0053	-0.0146
Partner is medium educated	0.0315**	0.0093**	-0.0146	-0.0089	0.0184	0.0042
Partner is lowly educated	-(i)	0.0135	0.0423	-0.0276**	0.0066	0.0029
Parenthood	0.0088	0.0069	-0.0003	-0.0156	-0.0190	-0.0070
Child aged 6 or younger	-0.0031	-0.0039	-0.0152	0.0102	0.0001	0.0119*
Residence in South Germany	-0.0003	0.0019	-0.0053	-0.0067	-0.0094	-0.0094*
Residence in West Germany	-0.0036	-0.0038	0.0042	0.0023	-0.012	-0.0032
Household size	0.0009	-0.0019	0.0057	-0.0001	-0.0016	0.0007
Nonwage income of the household	0.0000	0.0000	0.0000	0.0000**	0.0000	0.0000
Parents' home characteristics						
Father is employed	-0.0061	0.0065	-0.0120	-0.0044	-0.0083	0.0099**
Mother is employed	-0.0069	0.0027	0.0172*	0.0036	-0.0100	0.0039
Father is highly educated	-0.0058	-0.0032	0.0036	0.0027	-0.0028	0.0005
Mother is highly educated	0.0125	-0.0054	-0.0021	0.006	0.0039	-0.0100**
Nationality/migration background						
Direct migration background	-0.0081	0.0153	-0.0169	-0.0275***	0.0180	0.0030
Indirect migration background	0.0113	0.0069	-0.0137	0.0090	0.0113	0.0152

Notes: SOEP v28, 1984-2011; HWWI. *, **, *** Statistically significant at the 10-percent, the 5-percent, the 1-percent level. -(i) or +(i) refers to infinite coefficients. Dummies for industry and firm size included.

Table A7: Dynamic mixed multinomial logit, East Germany, persons with medium education

Variable	Probability of overeducation: marginal effects					
	Self-assessed		Realized Matches		Twofold	
	Female	Male	Female	Male	Female	Male
Employment biography						
Part-time employment (16-25h)	0.0203	-0.096	0.0034	0.1021	0.0079	0.0020
Part-time employment (26-35h)	0.0221	0.0784	-0.0036	-0.0786	-0.0088	-0.0379
Marginal emoloyment	0.0876*	0.1343	-0.0057	-0.0649	-0.0218	-0.0071
Employment experience	0.0005	-0.0018*	-0.003**	0.0001	-0.0017**	-0.0031***
Unemployment experience	0.0007	0.0354***	-0.0174***	0.0089	0.0033	-0.0040
OLF experience	0.0078	0.1941	0.0125*	-0.0699**	-0.0038	-0.0282
Job change (new employer)	-0.0325	-0.041**	-0.0064	-0.0030	0.0092	0.0065
Job change (in-house)	0.2346*	-0.0895	-0.0361	0.0475	-0.0114	-0.0376
Re-entry after childbirth related break	-0.0421	0.1407*	0.0028	0.0031	-0.0244	-0.0376
Job features						
Public sector	-0.0395**	-0.0251	-0.0072	0.0072	-0.0087	-0.0082
Middle/Low level civil servant	0.0627	0.0236	-0.0085	-0.0294	0.0472	0.0149
High level civil servant	-0.1794	-0.1875	-0.0825	-0.0785	0.0452	-0.0376
Executive level civil servant	.	-0.1872	.	-0.0785	.	-0.0376
Period 2005+	0.0014	-0.0138*	0.0118	-0.0086*	-0.0096	-0.0188***
Partner- and household context						
Partner's gross wage income	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Cohabiting	0.0288	-0.0089	0.0369**	0.0321	-0.0135	0.0322*
Married	-0.0222	0.0235	0.0193	0.0166	-0.0157	0.0161
Partner is medium educated	0.0202	0.0141	-0.0156	-0.0218**	0.0102	-0.0072
Partner is lowly educated	0.0561	0.0523	-0.0446*	-0.0182	0.0364	-0.0053
Parenthood	-0.1332**	-0.0448	-0.0178	-0.0211	0.0068	0.0179
Child aged 6 or younger	0.0541**	0.0077	0.0070	0.0124	0.0044	-0.0073
Household size	0.0036	-0.0034	0.0025	0.0024	0.0049	-0.0063
Nonwage income of the household	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Parents' home characteristics						
Father is employed	0.0219	0.0327*	-0.0038	-0.0097	-0.0065	0.0066
Mother is employed	-0.0428***	-0.0266**	0.0108	-0.0128	-0.0112*	-0.0020
Father is highly educated	-0.0216	-0.023	0.0013	0.0126	0.0182	-0.0219**
Mother is highly educated	0.0028	-0.0218	0.0019	0.0271**	0.0109	0.0135
Nationality/migration background						
Direct migration background	0.0329	-0.0836	-0.0825	-0.0402	0.1391***	0.0032
Indirect migration background	-0.0740	0.0724	0.0287	-0.0217	-0.0244	-0.0378
Lagged overeducation						
Lagged overeducation (SA)	0.2843***	0.3497***	-0.0196	-0.0440	0.0192***	0.0499***
Lagged overeducation (RM)	0.0115	-0.0170	0.0053	0.1733***	0.0286**	0.0459***
Lagged overeducation (two-fold)	0.1570***	0.2614***	-0.0052	0.0113***	0.0622***	0.1945***

Notes: SOEP v28, 1992-2011; HWWI. *, **, *** Statistically significant at the 10-percent, the 5-percent, the 1-percent level. Dummies for industry and firm size included.

Table A8: Dynamic mixed multinomial logit, West Germany, persons with medium education

Variable	Probability of overeducation: marginal effects					
	Self-assessed		Realized Matches		Twofold	
	Female	Male	Female	Male	Female	Male
Employment biography						
Part-time employment (16-25h)	0.0061	0.0225	-0.0115	0.0244***	0.0119	0.0035
Part-time employment (26-35h)	0.0276**	-0.0113	-0.0065	-0.0015	0.0044	0.0227
Marginal emoloyment	0.0574***	-0.0333	0.0049**	0.0439**	0.0257***	0.0149
Employment experience	-0.0021***	-0.0013**	-0.0019***	-0.0016***	-0.0011***	-0.0005**
Unemployment experience	-0.0020	0.0229**	0.0027	-0.0055	-0.0044	0.0034
OLF experience	0.0105**	-0.0263	-0.0043*	-0.0017	-0.0007	-0.0017
Job change (new employer)	0.0263***	0.0205*	-0.0015	-0.0045	0.0093**	0.0030
Job change (in-house)	-0.0978**	0.0735	-0.0133	-0.0285**	0.0039	-0.0115
Re-entry after childbirth related break	0.0490***	0.1393	-0.0037	-0.0168	0.0129**	-0.0115
Job features						
Public sector	0.0061	-0.0264*	-0.0013	-0.0024	-0.0073	-0.0019
Middle/Low level civil servant	-0.0696	-0.0162	0.0189*	0.0523***	0.0628***	0.0028
High level civil servant	-0.1996	-0.0104	0.0057	-0.0616	-0.0235	-0.0115
Executive level civil servant	.	-0.1867	.	-0.0612	.	-0.0115
Period 2005+	-0.0054	-0.0071	0.0095***	0.0076*	0.0024	-0.0031
Partner- and household context						
Partner's gross wage income	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Cohabiting	-0.0120	-0.0285	0.0271**	-0.0071	-0.0035	-0.0054
Married	-0.0152	-0.0150	0.0176	-0.0034	-0.0048	-0.0060
Partner is medium educated	0.0106	0.0128	-0.0074	0.0000	-0.0052	0.0048
Partner is lowly educated	0.0316*	0.0623***	-0.0132	0.0007	-0.0056	0.0036
Parenthood	0.0003	-0.0165	0.0155	-0.0210**	-0.0070	-0.0053
Child aged 6 or younger	-0.0347***	0.0139	-0.0077	-0.0010	0.0025	0.0016
Residence in South Germany	-0.0001	-0.0055	0.0013	-0.0064	0.0010	-0.0011
Residence in West Germany	-0.0028	-0.0045	0.0077	-0.0070	-0.0040	-0.0039*
Household size	-0.0033	-0.0016	0.0049**	0.0007	0.0052***	-0.0009
Nonwage income of the household	0.0000	0.0000**	0.0000	0.0000	0.0000	0.0000
Parents' home characteristics						
Father is employed	-0.0034	-0.0096	-0.0052	0.0045	0.0006	0.0035
Mother is employed	-0.0085	-0.0102	0.0157*	-0.0021	-0.0130***	-0.0001
Father is highly educated	0.0121	-0.0269	0.0080	-0.0075	0.0139***	0.0186**
Mother is highly educated	-0.0438	0.0225	-0.0043	-0.0052	-0.0035	0.0070
Nationality/migration background						
Direct migration background	0.0484***	0.0402***	-0.0042	-0.0088	0.0016	0.0077**
Indirect migration background	0.0039	-0.0009	0.0108	0.0043	-0.0097	0.0020
Lagged overeducation						
Lagged overeducation (SA)	0.3703***	0.4304***	-0.0278	-0.0113	0.0286***	0.0076***
Lagged overeducation (RM)	0.0211	0.0319	0.0687***	0.0369***	0.0128***	0.0215***
Lagged overeducation (twofold)	0.1544***	0.2570***	0.0006***	0.0051***	0.1163***	0.0505***

Notes: SOEP v28, 1984-2011; HWWI. *, **, *** Statistically significant at the 10-percent, the 5-percent, the 1-percent level. Dummies for industry and firm size included.

Table A9: Dynamic mixed multinomial logit, East Germany, persons with tertiary education

Variable	Probability of overeducation: marginal effects					
	Self-assessed		Realized Matches		Twofold	
	Female	Male	Female	Male	Female	Male
Employment biography						
Part-time employment (16-25h)	-0.0308	-0.0024	-0.0175	0.0535	0.0290	0.0003
Part-time employment (26-35h)	0.0573	-0.0877	0.0078	0.1827*	-0.0161	0.0809
Marginal emoloyment	-0.0823	-0.0877	-0.0165	0.1484	0.0526	0.1418
Employment experience	-0.0013	-0.0010	-0.0012	-0.0063***	0.0010	-0.0006
Unemployment experience	-0.0096	0.0250*	0.0460**	-0.1546*	0.0019	0.1750***
OLF experience	-0.0160	-0.0692	-0.0079	-0.0890	0.0365	0.2485
Vocational training	-0.0017	0.0065	-0.0327**	-0.0153	0.0112	-0.0168
Job change (new employer)	-0.0526	0.0428*	0.0116	-0.0042	0.0541**	-0.0154
Job change (in-house)	0.1158*	-0.0078	-0.0557	0.0750	0.0962**	-0.0885*
Re-entry after childbirth related break	0.0124	.	-0.0038	.	0.0574*	.
Job features						
Public sector	-0.0079	0.0323	-0.0060	-0.0518	-0.0077	0.0196
Middle/Low level civil servant	-0.0818	-0.0882	0.0061	0.1924	0.0662	0.3836
High level civil servant	-0.2775	-0.0040	0.0771	0.1160***	-0.1650	0.0154
Executive level civil servant	-0.2762	-0.0883	0.2020*	0.1549***	-0.1632	0.0576
Period 2005+	-0.0176**	0.0053	-0.0058*	-0.0338*	-0.0296***	-0.0136
Partner- and household context						
Partner's gross wage income	0.0000	0.0000	0.0000	0.0000*	0.0000	0.0000
Cohabiting	0.0194	0.1129	-0.0308	0.0065	0.0174	-0.0675
Married	-0.0084	0.0301	-0.0431	-0.1096*	0.0290	-0.0274
Partner is medium educated	0.0473***	0.0086	-0.0390*	0.0077	0.0173	0.0200
Partner is lowly educated	0.0266	-0.0876	-0.0802**	-0.0598	-0.0450	0.1186
Parenthood	-0.1394	0.0070	-0.0314	0.1079	0.0943	-0.1544
Child aged 6 or younger	-0.0003	0.0668**	-0.0182	0.0403	0.0466**	-0.0292
Household size	-0.0079	0.0062	0.0013	-0.0052	-0.0057	0.0042
Nonwage income of the household	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Parents' home characteristics						
Father is employed	-0.0012	-0.0551**	0.0232	0.0412	-0.0193	-0.0246
Mother is employed	-0.0871***	0.0084	0.0403*	0.0280	0.0058	-0.0431*
Father is highly educated	-0.0144	-0.0311*	-0.0115	0.0146	-0.0130	0.0246
Mother is highly educated	-0.0300	0.0323	0.0040	-0.0029	0.0232	-0.0381
Nationality/migration background						
Direct migration background	0.1637**	-0.0876	-0.0290	0.0318	-0.0480	0.4083**
Indirect migration background	-0.2759	-0.0876	0.1021	-0.1415	0.1028	0.3676**
Lagged overeducation						
Lagged overeducation (SA)	0.3480***	0.2319***	-0.0474	-0.0857	0.0711***	0.0676***
Lagged overeducation (RM)	-0.0029	0.0125***	0.1277***	0.2688***	0.0063**	0.0305***
Lagged overeducation (twofold)	0.1378***	0.1150***	0.0336***	0.0570***	0.1454***	0.1520***

Notes: SOEP v28, 1992-2011; HWWI. *, **, *** Statistically significant at the 10-percent, the 5-percent, the 1-percent level. Dummies for industry and firm size included.

Table A10: Dynamic mixed multinomial logit, West Germany, persons with tertiary education

Variable	Probability of overeducation: marginal effects					
	Self-assessed		Realized Matches		Twofold	
	Female	Male	Female	Male	Female	Male
Employment biography						
Part-time employment (16-25h)	0.0358	-0.0452	-0.0089	-0.1145	-0.0128	0.1372
Part-time employment (26-35h)	0.0131	-0.0059***	-0.0041	-0.0272	-0.0283	-0.0154
Marginal emoloyment	0.0034	-0.0160	0.0334	0.1135	-0.0083	-0.0852**
Employment experience	0.0015	-0.0010	-0.0058***	-0.0042*	0.0006	0.0028**
Unemployment experience	-0.0098	0.0025	0.0056	-0.0491	-0.0016	0.0006
OLF experience	-0.0074	-0.0204	-0.0080	0.2593**	0.0008	0.0293
Vocational training	0.0363***	0.0171**	-0.0118	-0.0291	-0.0039	0.0092
Job change (new employer)	-0.0022	0.0446	-0.0057	0.0337*	0.0030*	-0.0333*
Job change (in-house)	0.0134	0.2523	-0.0155	0.0006	0.0083	-0.0638
Re-entry after childbirth related break	0.0457**	.	0.1020***	.	0.0094**	.
Job features						
Public sector	-0.0195***	0.0205	0.0005	0.0263	-0.0614***	-0.0109
Middle/Low level civil servant	-0.0593	-0.0455	0.0625	-0.0385	-0.1554	0.0930
High level civil servant	-0.0188***	0.0232	-0.0387	0.0467	-0.0572***	-0.0853
Executive level civil servant	-0.0605	-0.0233	0.1417***	0.0506*	-0.1566	-0.0020
Period 2005+	-0.0039	0.0121	0.0060	-0.0257***	-0.0131*	-0.0139**
Partner- and household context						
Partner's gross wage income	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Cohabiting	-0.0158	0.0456*	-0.0312	-0.0236	-0.0018	0.0117
Married	-0.0363**	0.0055	-0.0041	0.0306	-0.0044	0.0218
Partner is medium educated	0.0185**	0.0194**	-0.0076	-0.0285	0.0206**	0.0024
Partner is lowly educated	-0.0142	0.0187	0.0678	-0.0387	0.0239	0.0308
Parenthood	0.0049	0.0208	0.0285	0.0033	0.0183	-0.0566**
Child aged 6 or younger	-0.0114	-0.0018	-0.0212	0.0199	-0.0109	0.0160*
Residence in South Germany	-0.0071	0.0065	-0.0027	-0.0054	-0.0145*	-0.0019
Residence in West Germany	-0.0078	-0.0072	0.0059	-0.0242	-0.0179*	0.0138
Household size	0.0115*	-0.0112**	0.0097	0.0020	0.0000	0.0050
Nonwage income of the household	0.0000	0.0000	0.0000**	0.0000	0.0000	0.0000***
Parents' home characteristics						
Father is employed	-0.0026	0.0109	-0.0051	-0.0145	-0.0067	0.0106
Mother is employed	0.0162*	0.0051	-0.0007	-0.0085	-0.0040	0.0010
Father is highly educated	-0.0040	-0.0145	-0.0081	0.0209	0.0042	0.0070
Mother is highly educated	0.0006	-0.0229*	0.0257	-0.0069	-0.0298*	0.0009
Nationality/migration background						
Direct migration background	-0.0055	0.0167	-0.0444	-0.0456	0.0189	0.0200
Indirect migration background	0.0425*	-0.0088	-0.0146	0.0477	-0.0008	0.0047
Lagged overeducation						
Lagged overeducation (SA)	0.0782***	0.1292***	-0.0904	-0.0465	0.1519***	0.0913***
Lagged overeducation (RM)	-0.0172	-0.0050*	0.2811***	0.3063***	0.0492***	-0.0008***
Lagged overeducation (twofold)	0.0322***	0.1209***	0.0208***	0.0253***	0.3739***	0.2363***

Notes: SOEP v28, 1984-2011; HWWI. *, **, *** Statistically significant at the 10-percent, the 5-percent, the 1-percent level. Dummies for industry and firm size included.

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