Horizontal Skills Mismatch and Vocational Education

Annina Eymann* and Juerg Schweri†

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Discussion Paper

Abstract

We analyze horizontal mismatch in Switzerland defined as a mismatch between the type of skills acquired by students and the skills required for their job. We investigate the argument in the literature that the more specific an education system is, the higher are the wage penalties due to horizontal mismatch. Switzerland is an ideal case to test this hypothesis because it relies heavily on vocational education and training. The data stems from the longitudinal Swiss Household Panel in the years 1999 to 2012 and contains subjective and objective measures of mismatch. Controlling for time-invariant heterogeneity in fixed effects regressions, the wage penalty for self-reported horizontal mismatch is 3.2% for women, yet not significant for men. Not working in a learned occupation does not lead to significant wage effects, neither for women nor men. The wage effects found are similar for workers with general and vocational education background. Overall, wage penalties for horizontal mismatch are small and do not support the hypothesis of higher penalties for mismatch due to vocational education. We conclude that vocational education is more transferable than often assumed, and that continuous training and on-the-job learning allow workers to update their skills continuously.

*University of Bern, Department of Economics, Schanzeneckstrasse 1, CH-3001 Bern, and Swiss Federal Institute for Vocational Education and Training, P.O. Box, Kirchlindachstrasse 79, CH-3052 Zollikofen. email: annina.eymann@ehb-schweiz.ch

†Swiss Federal Institute for Vocational Education and Training, P.O. Box, Kirchlindachstrasse 79, CH-3052 Zollikofen. email: juerg.schweri@ehb-schweiz.ch

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1 Introduction

In a labor market perspective, education and training are supposed to align the skills acquired by workers with the skills needed by firms. However, recent studies show that many workers experience a horizontal mismatch between their own skills and the skills needed in their current job. In his pioneering article, Robst (2007) finds that this horizontal mismatch is a serious problem for affected workers because they suffer from substantial wage penalties. He analyzed US workers holding a college degree whose current job is not or only weakly related to their field of study. Robst (2007) shows that the incidence of horizontal mismatch is lower in college majors that provide relatively more specific than general human capital, but that the corresponding wage penalties in these majors are higher. Following this line of argument, Nordin, Persson, and Rooth (2010) expected to find higher wage penalties for horizontal mismatch in Sweden because most Swedish fields of higher education are very specialized. They find partial support for this hypothesis: compared to the US, they find higher wage penalties for men, but similar penalties for women.

If the hypothesis were true that education with a higher share of specific human capital increases wage penalties for horizontal mismatch, this would constitute a major challenge for vocational education and training programs. Several countries educate a large part of their youngsters in such programs that specialize workers in certain occupations, e.g., Austria, Denmark, Germany, the Netherlands and Switzerland. Many other countries[1]

[1]Germany has concluded memoranda of understanding with six EU member states with the aim to introduce dual apprenticeships, among them Greece, Italy, Portugal and Spain.

consider introducing new or additional vocational tracks and especially apprenticeships to counter youth unemployment. Youth unemployment has risen in many countries since the beginning of the economic crisis: from 2007 to 2012, youth unemployment rates rose by more than 50 percent in the UK and the US, and even more dramatically in many Southern European countries (cf. OECD, 2013). Vocational education is known to ease the transition from school to work in workers' early labor market career (Ryan, 2001) and could thus provide a solution to high youth unemployment. Yet, if vocational education hinders occupational mobility in the long run, introducing more vocational training will exacerbate the effects of horizontal mismatch due to an inefficient allocation of skills in the labor market. The long-run mismatch cost of vocational education and training may reduce or outweigh the gains from smooth short-run transitions into the labor market, from an individual as well as from a social point of view.

Our aim is to analyze the incidence and wage effects of horizontal mismatch in Switzerland where firm-based apprenticeships are the predominant type of education on upper-secondary level. Two-thirds of a cohort of Swiss youngsters attends a firm-based apprenticeship program after compulsory schooling, only about 20 percent of a cohort attend general school (*Gymnasium*). Similarly, professional education and training is an important track in Swiss higher education, next to universities and universities of applied sciences. We therefore extend the scope of analysis beyond university students and include all types of Swiss workers. This also allows us to compare workers holding degrees from general education with workers holding degrees from vocational education. The aim of this analysis is to see whether voca-

tional education carries a higher risk of skills mismatch, and to test whether it leads to higher mismatch wage penalties in the labor market.

Our contribution to the scant literature on horizontal skills mismatch is threefold. First, we extend the scope of analyses from university students to the entire workforce with a special focus on the comparison between vocational and general education. Second, we use objective as well as subjective information to measure mismatch. Robst (2007) used a subjective, Nordin, Persson, and Rooth (2010) used an objective measure. We show that our subjective and objective measures capture different aspects of horizontal mismatch. Third, using longitudinal data in fixed effect regression, we are able to eliminate estimation bias due to unobserved time-invariant heterogeneity, such as individual differences in ability, motivation or, more generally, personality. These are major confounding factors for estimating the wage effects of mismatch, a problem that has received a lot of attention in the literature on vertical mismatch, i.e., on over- and under-education (e.g., Bauer, 2002; Frenette, 2004; McGuinness and Bennett, 2007).

2 Defining Horizontal Mismatch

The analysis of mismatch asks for careful definitions: what kind of skills, asked and acquired, exactly should we compare to identify horizontal mismatch? We will speak of "skills" to denote all human capital that is useful to successfully master the tasks in a worker's job, i.e., that affects workers' productivity. Skills may thus include personality traits and human capital acquired through schooling, training or experience.

We apply two different definitions of horizontal mismatch in this paper: The first definition defines horizontal mismatch as a divergence between learned and current occupation. In terms of policy relevance, analyzing the wage effect of not working in the learned occupation helps to assess whether the formal education system imparts the skills necessary for a successful labor market career that also allows for changes between occupations. Accordingly, Nordin, Persson, and Rooth (2010) compare workers' field of study with their current occupation to identify horizontal mismatch. Robst (2007) uses workers' assessment of "the relationship between your work and your education" (Robst, 2007, p. 401). A particularity of this definition of horizontal mismatch is the time lag involved: Because college students typically earn their highest degree around age 25, comparing skills from formal education and skills needed at the current job implies a substantial time lag for mid-aged and older workers. This definition does not allow for skills updating after formal education. To escape a situation of horizontal mismatch in this definition, workers have to change back to the occupation they learned in the first place.

The second definition of horizontal mismatch asks whether the total set of skills a worker possesses at a certain point in time matches with the skills needed in his or her current job. We will use workers' self-assessment of this match to identify this kind of horizontal mismatch. The skills currently possessed may not only stem from formal education, but also from life-long learning through courses without formal degree, from informal training and from work experience throughout the career. Conversely, skills learned in schooling or elsewhere may depreciate over time. In terms of policy rele-

vance, this definition allows us to assess whether the combination of schooling, continuing education and training, on-the-job training provided by firms and labor market experience is able to keep workers' skills aligned with labor market needs throughout their career. Institutions like career counseling, privately or firm-financed training, training vouchers and the like can help workers to continuously adjust and update their skills and thus prevent or escape a situation of horizontal mismatch. Our second definition of horizontal mismatch takes these dynamic aspects of skills development into account, while the first definition is static when it comes to workers' skills.

In both definitions, labor market dynamics induced by changes in production technologies, international competition and so forth affect mismatch, because they change workers' tasks. The "task-based" literature directly analyzes the labor market effects of changing tasks (see Acemoglu and Autor, 2011; Autor, 2013), i.e., focuses on the demand-side dynamics of the labor market. Here, we focus on the effects of horizontal mismatch, which is a result of both employees' skills development (supply side) and the tasks to be completed (demand side). Swiss watchmaking provides a good example how technological innovation can create horizontal mismatch: watchmakers faced a disastrous crisis in the seventies when Quartz watches were invented and employment in the traditional mechanical watch industry fell by almost 50 percent from 1970 to 1980 (Young, 1999). Many workers had to change occupation and became thus horizontally mismatched according to the first definition. They would have had to find a job as watchmaker again to escape the situation of mismatch. Those that remained watchmakers are considered well-matched. But for many watchmakers, their learned occupation may

have changed in task content in the meantime, and many of them had to acquire new skills, too. The first definition ignores this, while in the second definition, substantial changes in tasks alone are sufficient to create a mismatch between workers' skills and their (new) tasks. Those that remained watchmakers may thus also have experienced a situation of mismatch. Conversely, former watchmakers that were able to acquire the skills necessary in their new occupation are no longer considered mismatched in the second definition. Our aim is to measure both definitions of horizontal mismatch (as explained in chapter 4) and compare the results on incidence and wage effects.

3 Vocational and Continuing Education and Training in Switzerland

The analysis of horizontal mismatch as outlined in chapter 2 raises two questions about the institutional setup of education systems and labor markets. First, if specific human capital is supposed to be a cause for horizontal mismatch and associated wage penalties, how specific is vocational education and training in Switzerland? Second, which possibilities do Swiss workers have to update and extend their skills throughout their working career? We will shortly discuss these questions and the institutions that are relevant in this context.

Becker (1962) introduced the distinction between firm-specific and general human capital, other authors added a medium category of occupation-specific

or industry-specific human capital (e.g., Shaw, 1987; Neal, 1995; Parent, 2000; Kambourov and Manovskii, 2009; Sullivan, 2010). Swiss apprenticeship curricula provide for a mix of general skills and specialized occupational skills which are defined in a national training ordinance for each of about 250 apprenticeship occupations. Every ordinance defines the duration of training (two, three or four years), the amount of lessons in vocational school in this time (one to two days a week), the skills to be acquired in schools and firms and the written, oral and practical parts of the final exams. In their training firms, apprentices work for three to four days a week and acquire skills and experience in occupational tasks. In vocational schools, they attend general classes as well as occupation-specific lessons. If they succeed in the final exam, they receive a federally recognized degree (*Federal VET Diploma*) which identifies them as skilled workers in their occupation.

On the one hand, it appears plausible that vocational education entails many specific elements. Occupational tasks are an important point of reference in the curricula, and with firms training apprentices on-the-job several days a week, they might also train them in firm-specific skills. On the other hand, federal regulations and quality controls by cantons and occupational associations ensure that training is transferable across firms (cf. Hoeckel, Field, and Grubb, 2009). Furthermore, learning in firms by performing work tasks is not occupation-specific by default. Rather, work tasks allow for learning that is embedded in real-world situations, as opposed to learning in class rooms. Skills learned in work situations may be just as transferable to other work situations as skills learned in class rooms. In this view, vocational education and training is about a different learning technology, rather than

about less transferable skills.

Empirical evidence supports the view that the human capital imparted through apprenticeships is mostly general. Surveys of costs and benefits of apprenticeship training show that benefits to most employers outweigh the costs of training (Wolter, Mühlemann, and Schweri, 2006; Strupler and Wolter, 2012). This result is consistent with Becker's (1962) model of general training where trainees bear the cost and profit from the benefits of general training. Mueller and Schweri (2012) evaluate the transferability of apprentices' skills by analyzing wage differentials between apprentices that stay in their training firm directly after graduation, apprentices that move to another firm in the same occupation, and apprentices that move to another occupation. Accounting for endogenous changes, they find some evidence for a wage premium for apprentices that stay in their occupational field, as opposed to apprentices that change the occupational field, defined as 39 2-digit categories. This indicates that apprenticeships impart some skills that are specific to a broad occupational field. Mueller and Schweri (2012) find no evidence for wage differentials between firm stayers and firm movers within the same occupation, which means that the role of firm-specific skills is very limited on average.

The second question raised in the introduction to this chapter was how workers can update and extend their skills once they have entered the labor market. Vocational education and training contributes to "life-long" learning as well: the higher education branch of vocational education, called professional education and training (PET) in Switzerland, provides ISCED 5B qualifications which we will call "Tertiary B" in the analyzes. Students

can enter PET when they have acquired work experience for several years (not counting apprenticeship years). An upper-secondary degree is a minimal entry condition, but some PET programs are even regularly attended by university graduates. Half of the candidates who obtained a Federal PET Diploma or an Advanced Federal PET Diploma in 2007 were between the ages of 27 and 38 (OPET, 2011). The share of employed persons at age 25 to 64 who hold a PET degree was 20 percent in 2008 (OPET, 2011). While some of the PET programs expand students skills to new issues (e.g., business administration skills), other programs serve to specialize students in a vocational domain. Apart from PET, which is part of the formal education system, there is a market for continuing training that does not lead to a federal degree. Private (and partly public) institutes offer general courses (e.g., computer skills) and vocational courses. Either workers or employers pay for these courses. The share of employed persons who attended at least one course in one year's time was 54% in 2008 (FSO, 2010).

Summing up, our study evaluates the success of the educational system in Switzerland in preparing and updating workers for the labor market by looking at incidence and wage effects of skills mismatch. This analysis bears on the formal education system, but also on the combination of formal education (with its predominance of vocational education), continuing education and labor market flexibility and opportunities in Switzerland. It is this set of intertwined institutions and markets as a whole that determines the quality of the concurrent skills matches between employees' skills and firms' skills needs.

4 Data

4.1 Sample Definition

The Swiss Household Panel (SHP)[2] is a longitudinal data set composed of two cohorts of randomly chosen Swiss households, surveyed annually. The first cohort started in 1999 with more than 5'000 households and less than 8'000 individuals. In 2004, a second representative cohort was introduced to enlarge and refresh the sample. The second cohort consists of more than 2'500 households and more than 3'500 individuals.

In this paper, we make use of these two cohorts and include observations from 1999 to 2012. Our analyses include working individuals from age 20 to 60 who are not self-employed. Observations lacking information on wages, occupation and mismatch variables are excluded. Moreover, we exclude individuals with an employment less than 50% and those with full-time wages below 24'000 Swiss francs or above 300'000 Swiss francs a year.[3] The full estimation sample consists of 7'947 individuals (36'462 person-year observations), whereof most respondents are observed in several periods. In the full sample, 16'239 person-year observations concern women and 20'225 person-year observations concern men. We also construct a subsample, referred to here as the bio subsample, which is composed of individuals who also reveal retrospective information on education episodes before the start of the panel.

[2]This study has been realized using the data collected by the Swiss Household Panel, which is based at the Swiss Center of Expertise in the Social Sciences FORS. The project SHP is financed by the Swiss National Science Foundation.

[3]In Switzerland, wages below 2'000 CHF a month are not credible for a full-time job. We consider wages below 24'000 and above 300'000 as outliers. Trimming eliminates 1'500 person-year observations due to the lower bound and 165 person-year observations due to the upper bound requirement.

This additional questionnaire was collected in 2001 and 2002, and collected information about the respondents' background (living arrangements, educational trajectory, work life). This bio subsample consists of 2'475 individuals with 16'252 person-year observations, whereof 6'778 person-year observations concern women and 9'474 concern men.

4.2 Variable Definitions

Two different mismatch variables, which take up the two definitions of mismatch discussed in chapter 2, build our key explanatory variables. The first variable identifies "subjective" horizontal mismatch and relies on a survey question that asks for respondents' own assessment of their qualification with regard to the current job. Respondents indicated whether they are adequately qualified, or whether they experience either a horizontal or a vertical mismatch. Respondents are thus forced to identify a perceived mismatch as a problem of the quality, i.e., the type of skills (horizontal mismatch), or of the quantity of skills (vertical mismatch). Each year, individuals are asked to rate their qualification with regard to the current job with a possible set of four answers. Individuals who report *qualifications correspond to job* are classified as adequately qualified. Respondents who report *qualifications do not relate to job* are assigned to the group of those with no relation between own qualification and current job. Those who report *qualifications are superior to job* belong to the group of overqualified, and those who report *qualifications are not sufficient* belong to the group of underqualified. The categories on over- and underqualification are similar to subjective measures of vertical

mismatch known from the literature (e.g., Hartog, 2000; Allen and van der Velden, 2001; McGuinness and Sloane, 2011; Diem and Wolter, 2014). The four categories of this self-reported qualification variable are available for both the full sample and the bio subsample.

The second type of mismatch variable identifies "objective" horizontal mismatch. We compare the learned occupation with the current occupation, similar to Nordin, Persson, and Rooth (2010) who compare field of study and current occupation. Due to the importance of vocational degrees in Switzerland, learned occupations are coded according to the ISCO classification in the SHP data. Thus, we can compare learned and current occupation directly by comparing their ISCO codes. This mismatch variable is available for individuals in the bio subsample only. We use information on various educational episodes to create the objective horizontal mismatch variable. The current occupation of each individual is matched to a set of at most five previously learned occupations coded according to the ISCO classification. If there is no match between current and learned occupations on the 2-digit level, the person is classified as objectively horizontally mismatched. We define mismatch on the 2-digit ISCO level as done by Bauer (2002). Mismatches based on 3- and 1-digit level comparisons will be used as a sensitivity check.

In the multivariate regressions, the natural logarithm of annual gross wage is used as dependent variable. We standardized wages to full-time wages (100%) based on information about individuals' employment according to their working contract. We also deflated wages to 2010.

The set of covariates covers person-specific, occupation-specific and job-specific characteristics. Personal characteristics include dummies for not be-

ing Swiss, being married, having children, and living in one of three different linguistic regions. Experience is not directly observed, so potential experience is calculated as $age - schoolyears - 7$. The education variable is divided into 15 different categories, where the lowest category stands for individuals without mandatory schooling and the highest refers to university graduates. Further dummy variables included in all models are being a director, being a supervisor, working with a fixed-term work contract, having followed a continuing education in the last 12 months, seven dummies for the firm size, and 12 industry dummies. Information of the current occupation is available in ISCO-codes. Since our mismatch variable is based on the 2-digit ISCO code, we control for 34 2-digit occupation dummies. We constructed proxy variables for occupational and firm tenure. Occupational tenure measures the years a person spent in the same occupation (2-digit ISCO). It is a lower bound of actual occupation tenure since tenure before the first observation in the panel is not accounted for. Firm tenure measures the years a person spent in the same firm and provides a lower bound, too. After each change of firm, the counter is set to zero again.

5 Empirical Analysis

5.1 Incidence of Mismatch

In the pooled full sample, 81% of men and 79% of women assess their qualification as adequate (see table 1).[4] The assessment that there is no relation

[4]In the pooled sample, "81% of men" is a shorthand formulation for "81% of all person-year observations in the group of men". The text is explicit if we talk about individuals

between own qualifications and the qualifications needed at the current job is rare, but shows a notable gender difference: 4.1% of women and 2.7% of men report such a subjective horizontal mismatch. Although the overall number of subjective horizontal mismatches is small, the phenomenon affects a substantial number of individuals: 11.6% of all women and 9.3% of all men in the pooled sample report a subjective horizontal mismatch at least once during the observation period. Table 1 further shows that the share of overqualified workers in the full sample amounts to approximately 15% for women and men. 2.1% of women and 1.8% of men assess themselves as underqualified. Results in the bio subsample are similar (see column percentages in table 3).

Table 1 shows that the share of adequately qualified increases with age. The share of people with a subjective horizontal mismatch is highest among young workers. Compared to Swiss, foreigners report less often to be adequately qualified and the shares of overqualified, underqualified, and those having a qualification with no relation to job is higher. Highest education attained has an influence on qualification assessment: First, the lower the educational degree, the higher the share of horizontally mismatched. Second, the higher the educational degree, the higher the share of overqualified. People in the lowest income group show the highest probability of having a qualification with no relation to the job, whereas people in the highest income group show the highest probability of being adequately qualified.

For the pooled bio subsample, table 2 shows that in 53% of all cases the current occupation equals the learned occupation. Accordingly, almost 47% of employees are objectively mismatched. Men have a higher probability

instead of person-year observations that include multiple observations for most individuals.

of being mismatched.[5] There are no notable differences whether between married and unmarried, nor between Swiss and foreigners. Not surprisingly, the share of those who no longer work in their learned occupation increases with age. Among people in the lowest education group and among university graduates, we find the highest shares of employees working in their learned occupation.. Remarkably, vocationally trained workers (apprenticeships and tertiary B) are more likely to work in a job outside their learned occupation than all other major education groups.

Table 3 presents row and column percentages for the relationship between self-assessed qualification and objective horizontal mismatch. These results come from the bio subsample, therefore the shares of the different subjective mismatch-categories do not match the shares of table 1. The most interesting question is whether self-assessed horizontal mismatch is related to working in an occupation different from the learned. Indeed, among individuals who say that their qualification is not related to their current job, 76.15% of women and 77.66% of men do not work in their learned occupation. Yet, among those women (men) that do not work in their learned occupation anymore, only 6.68% (3.28%) think they are horizontally mismatched, while 76.29% (79.72%) think that they are adequately qualified. In other words, reporting a subjective horizontal mismatch implies an objective horizontal mismatch in most cases, but objective horizontal mismatch does not usually imply a subjective horizontal mismatch. This result is consistent with the

[5]Note that we use differences in 2-digit ISCO code. Using 3-digit ISCO differences, the share of the mismatched increases to 55% for women and almost 56% for men. Using 1-digit ISCO differences, the share of mismatched decreases to 36% for women and less than 42% for men.

ideas discussed in chapter 2 that the two measures capture two different concepts of horizontal mismatch. Not working in the learned occupation is in most cases a necessary, but by no means a sufficient condition for a current mismatch of skills possessed and needed. Most workers that have changed away from their learned occupation do not think they are mismatched, either because they were able to transfer skills to their new occupation, or because they were able to acquire the new skills needed in their new occupation. In this sense, the low incidence of self-assessed mismatch indicates that the Swiss labor market allocates skills and tasks efficiently.

Table 4 analyzes the persistence of subjective mismatch. We report the transition probabilities of the self-assessed qualification between t and $t+1$. The most stable category is adequate qualification. Yet, even individuals starting with an adequate qualification have a probability of more than 12% to change their assessment in the next year. Individuals reporting no relation between own qualification and qualification needed in t have a relatively high probability to report the same qualification in the next year (30% for women and 21% for men), but their highest probability is to report an adequate qualification (47% for women and 57% for men). These descriptive results provide evidence that self-assessments are not fixed and are updated each year, probably due to investment in own skills (e.g., higher and continuing education) and changing tasks on the job. Our results further suggest that overqualification is the most persistent mismatch category within the mismatched. The persistence of overqualification has also been analyzed by Frei and Sousa-Poza (2012). They find that longer spells of overqualification are relatively rare, but the share of those staying overqualified for more than one

year is similar to our results.

For workers who are objectively horizontally mismatched, be it men or women, the probability to move back to their learned occupation in $t+1$ is lower than for matched workers to move to a mismatched situation (see table 5). Mismatched men have a transition probability of 3.8% to be well matched in $t+1$, compared to matched men who have a transition probability of almost 5% to be mismatched in the next year. Mismatched women have a transition probability of 4.3% to be matched again, while matched women have a probability of 4.7% to be mismatched in $t+1$.

5.2 OLS Mismatch Wage Effects

As a first step, we estimate mismatch wage penalties in Switzerland using pooled OLS Mincer wage regressions for both genders separately. We defer the potential problem of unobserved individual differences such as ability and motivation to the next section dedicated to fixed effects analysis. The OLS results allow for a comparison with the OLS wage penalties estimated in the US and Sweden (Robst, 2007; Nordin, Persson, and Rooth, 2010). We regress the log of annual gross wage w on a large set X, consisting of personal characteristics[6], occupation- and job-specific characteristics[7], and

[6]Personal characteristics: foreigner, married, children, education level (15 categories), linguistic region (3 cat.), potential experience, potential experience squared

[7]occupation tenure and its square, firm tenure and its square, director, supervisor, limited work contract, further education, employment, industry (12 cat.), occupation (ISCO 2-digit: 35 cat.), firm size (7 cat.). The estimated coefficients of the mismatch variables are virtually identical if we exclude the occupation- and job-specific characteristics.

year dummies (13 cat.). Finally, we add our two types of mismatch variables.

$$ln(w)_{i,t} = \alpha + \beta X_{i,t} + \gamma \text{mismatch}_{i,t} + \varepsilon_{i,t}$$

The two mismatch variables enter the wage regressions in all different combinations. The first model controls only for the subjective mismatch dummies, the second controls only for objective horizontal mismatch, and the third model combines both types of mismatch. The first model can be estimated for the full sample, whereas the two other models can only be estimated for the bio subsample. All models include occupation-related variables, defined on the 2-digit ISCO aggregation level of occupation.[8]

OLS regression results are reported on the left part of table 6. The upper panel shows the results for women and the lower panel shows the results for men. In the full sample, women who assess their qualification as not related to the current job experience a wage penalty of 11.2%. The wage penalty is 3.7% for overqualified women and 4.5% for underqualified women.[9] Results in the second and the third column refer to the bio subsample. The second column reports the wage effect of not working in the learned occupation. For women, this wage penalty is 4.2%. Including both types of mismatch in the estimation changes the effects only slightly. Having a qualification with no relation to the job leads to a penalty of 10.8%, being overqualified leads to a larger wage penalty of 4.7%, and being underqualified does no longer decrease

[8]This matters for the objective horizontal mismatch variable, occupational tenure, and the control for occupation dummies. Detailed regression results using 1- and 3-digit ISCO aggregation level can be obtained from the authors.

[9]Results of the first model are statistically equal when performed in the full sample and the bio subsample. Detailed results can be obtained from the authors.

the wage statistically. If learned and current occupation do not match, the wage penalty is 3.8%.

OLS results for men do not differ much from women's results. Two remarks are important: First, men are less penalized for having a qualification that does not relate to the qualification needed. The penalty is 8.7%. Second, being underqualified penalizes men more. The penalty is 6.1%, or 5.7% in model 3 when all types of mismatch are controlled for. This effect is almost twice the effect of being overqualified.

How do these results for Switzerland compare to results in the literature? Robst (2007) found wage penalties of more than 10% for men and women for the subjective horizontal mismatch. For women, our results on subjective horizontal mismatch are almost identical in size. Men experience a slightly lower penalty of less than 9%. However, we have to keep in mind that Robst's definition of mismatch is not identical to ours: Robst (2007) uses a subjective measurement of how well education and work today fit, whereas our subjective mismatch variable takes all possible sources of skills development (e.g., further education, training and learning on the job) into account. Nordin, Persson, and Rooth (2010) found wage penalties for not working in an occupation close to one's education of 19.5% for men and 12.2% for women in Sweden. Our results are much lower. Men experience a penalty of 3.4% and women a penalty of 4.2% if they do not work in their learned occupation. Based on our Swiss sample with a share of 66% of workers with a vocational background , we do not find compelling evidence for the argument that the more specific an education system is, the higher the wage penalties due to horizontal mismatch are. However, we confirm that

horizontal mismatch, be it objective or subjective, leads to significant wage penalties in OLS regressions.

5.3 Fixed Effects Mismatch Wage Effects

Ability, motivation, and personality are major factors influencing the wage of individuals. However, these characteristics are difficult to observe. It is likely that these factors are also correlated with the probability of horizontal mismatch. In that case, not accounting for them will bias the pooled OLS estimates reported above. Nordin, Persson, and Rooth (2010) use cognitive test scores provided by the military for the subsample of men as a proxy variable for ability. Including test scores does not change their results. Since the Swiss Household Panel is a longitudinal data set, we use fixed effects regression to eliminate all time-invariant individual heterogeneity. Allen and van der Velden (2001); Bauer (2002); Frenette (2004); Green and McIntosh (2007) use the same method to analyze overqualification. We perform the same Mincerian wage regressions as in the pooled OLS version, applying time-demeaning to all variables[10]

$$\ddot{ln(w)}_{i,t} = \beta_i \ddot{X}_{i,t} + \gamma_i \ddot{\text{mismatch}}_{i,t} + \ddot{\varepsilon}_{i,t}$$

We use the same covariates X as in the OLS regression.

In the last three columns of table 6, the coefficients of the fixed effects regression are displayed for both genders in the full and the bio subsample. For

[10]We use the same notation for the within estimator as Wooldridge (2006) does where e.g., $\ddot{ln(w)} = ln(w)_{i,t} - \bar{ln(w)}_i$. The time-constant unobserved individual heterogeneity α_i has disappeared, thus the equation can be estimated by pooled OLS.

women, controlling for time-invariant unobservables has a large impact on the subjective horizontal mismatch (qualification no relation). The penalty is 3.2% in the full sample and increases to 4.7% in the bio subsample when we control simultaneously for objective horizontal mismatch. The wage effect of being overqualified is somewhat smaller in fixed effects regression than in OLS. Being underqualified has no statistically significant wage effect. For men, the effects of subjective horizontal mismatch disappear entirely in fixed effects regression, i.e., the effects become small and insignificant. The same happens to the effects of underqualification, whereas the effects of overqualification remain significant, but becomes small (about 1.7%). For both genders, the wage effect for objective horizontal mismatch becomes insignificant when applying fixed effects instead of OLS. We find thus no evidence that working in another occupational 2-digit field than learned has any effect on wages. In the last three columns of table 6, the coefficients of the fixed effects regression are displayed for both genders in the full and the bio subsample. For women, controlling for time-invariant unobservables has a large impact on the subjective horizontal mismatch (qualification no relation). The penalty is 3.2% in the full sample and increases to 4.7% in the bio subsample when we control simultaneously for objective horizontal mismatch. The wage effect of being overqualified is somewhat smaller in fixed effects regression than in OLS. Being underqualified has no statistically significant wage effect. For men, the effects of subjective horizontal mismatch disappear entirely in fixed effects regression, i.e., the effects become small and insignificant. The same happens to the effects of underqualification, whereas the effects of overqualification remain significant, but becomes small (about 1.7%). For both genders, the

wage effect for objective horizontal mismatch becomes insignificant when applying fixed effects instead of OLS. We find thus no evidence that working in another occupational 2-digit field than learned has any effect on wages.

Overall, men and women experience quite similar effects due to mismatch in the fixed-effects models. Two differences are noteworthy: subjective horizontal mismatch leads to a relatively small, but statistically significant wage penalty for women, yet not for men. Second, the penalty for being overqualified is almost twice as large for women than for men. These results hint at differences in labor market experience between women and men that lead to a stronger effect of mismatch among women.

Another important result is that the elimination of time-invariant unobserved individual heterogeneity has a large impact on the results. Compared to OLS results, objective horizontal mismatch does no longer create significant wage effects, the penalties of subjective horizontal mismatch become much smaller for women and insignificant for men. Being overqualified still leads to a statistically significant wage penalty, but the effect is small. These results are in line with Bauer (2002); Tsai (2010), who find insignificant wage effects when using fixed effects regression. Our results suggest that OLS results likely suffer from omitted variable bias.

5.4 Wage Effects for Specific Educational Groups

To shed more light on the wage effects of horizontal mismatch, we differentiate between different educational backgrounds and test whether the specificity of educational programs has an impact on the wage penalties. This is

of utmost importance for a country like Switzerland that relies on a system dominated by vocational education. We look at the three largest educational groups: in the largest group of all, the highest educational level is a firm-based apprenticeship. 13'612 person-year observations are part of the apprenticeship group in the full sample. The second group consists of individuals with a tertiary B education, i.e., persons who completed a professional technical college or hold a federal PET diploma. This group includes a total of 7'793 person-year observations.. The third group consists of individuals with a tertiary A education, i.e. persons who completed a degree at a university, a university of applied sciences or the university of teacher education. It includes a total of 6'932 person-year observations. The share of males is higher in the tertiary B group than in the apprenticeship or the tertiary A group (70.8% versus 54.8% and 58.3%).

For these three groups, we estimated the same wage regressions as in table 6. Each regression is performed separately for each gender. We present regression results graphically because visual perception allows for more efficient comparisons between the different groups.[11] Figure 1 shows the wage effects of the fixed effects regression only, since OLS results are likely to suffer from bias. Note also that fixed effects regression removes bias due to selection into different education groups if selection is driven by time-invariant variables such as ability or personality. The results of the first three variables come from the estimation of the wage regression of the full sample, and the result learned<>current come from the wage regression of the bio subsample. Each point visualizes the coefficient's point estimate in the wage regression;

[11]Detailed results can be obtained from the authors.

the thinner line shows the 95% confidence interval and the thicker line the 90% confidence interval.

Female graduates of a tertiary B education with a qualification that does not relate to their current job experience a wage penalty of approximately 9%. Women with an apprenticeship also experience a significant, though lower penalty of approximately 4%. However, the confidence intervals between education groups overlap and are thus not significantly different from each other. Men do not experience a significant wage penalty for subjective horizontal mismatch in any of the education groups, although in their case the point estimate is lowest for the tertiary A group. Overqualification leads to significant, but relatively small wage penalties for female tertiary B graduates and male apprenticeship graduates. Again, the confidence intervals overlap with those of the other education groups. Underqualification does not have significant wage effect in any of the sex-education groups. Not working in the learned occupation has no significant wage effects, although the effect for female apprenticeship graduates is almost significant at the 10% level. For women, the point estimates are on the negative side for all education groups. For men, on the contrary, the point estimates are on the positive side.

To sum up, the wage effects for horizontal mismatch, subjective and objective, do not differ between education groups among men. This finding does not support the hypothesis that the specificity of an education determines the wage effect of horizontal mismatch. The finding also suggests that vocational education (apprenticeship and tertiary B) are not overly specific and allow for occupation changes throughout workers' careers. Among women,

the results are not so clear-cut. The wage effects of horizontal mismatch do not differ significantly between education groups, but some point estimates differ significantly from zero for some education groups, even though all the point estimates indicate wage penalties smaller than 10%. It seems plausible that these differences between women and men can be attributed to differences in labor market careers and labor market attachment.

6 Discussion and Conclusion

This paper analyzes the incidence and wage effects of horizontal skills mismatch in Switzerland. The first measure of horizontal mismatch is the share of workers that do not work in a 2-digit occupation they have learned earlier on. This share amounts to roughly 50% on average. The second measure of horizontal mismatch stems from workers' self-assessment of their qualifications: only 4.1% of women and 2.7% of men think that their qualifications bear no relation to the skills needed at their job. The vast majority, roughly 80% of all workers, perceives no mismatch between their qualifications and the skills needed at their current job. About 15% think that they are overqualified and less than 2% think that they are underqualified. Crossing the two measures of horizontal mismatch shows that three quarter of those that perceive a horizontal mismatch in self-assessment do not work in a learned occupation. But the reverse is not true: Of those who do not work in a learned occupation, only 3.3% (men) to 6.7% (women) perceive a horizontal mismatch, the vast majority feels adequately qualified.

OLS wage regressions that control for a large set of covariates show sub-

stantial and significant wage penalties for self-assessed horizontal mismatch of about 11% for women and about 8% for men. These effects are similar in size to the OLS results found by Robst (2007) for the US, keeping in mind that the definition of horizontal mismatch and the estimation specifications are not identical. We find lower wage penalties for not working in the learned occupation of 4% for women and 3% for men. The OLS wage penalties found by Nordin, Persson, and Rooth (2010) for Sweden are much larger, especially for men.

In a next step, we eliminate individual time-invariant heterogeneity by using fixed effects regression. For women, the wage penalty of the perceived mismatch between own qualification and skills needed decreases to 4.7%, but remains significant. For men, the wage effect does no more differ significantly from zero. A mismatch between current occupation and learned occupation does not have a significant wage effect anymore, neither for women nor for men. The differences between OLS and fixed effects estimation are thus stark. This finding suggests that horizontally mismatched workers are a selective group that differs in unobserved time-invariant characteristics from well-matched workers. In this case, the OLS results are biased, as has already been found in the literature that analyzes wage effects of overeducation (Bauer, 2002).

Preferring fixed effects over OLS results for methodological reasons, we thus find no wage effects of horizontal mismatch for men. For women, we find no effect of working in another occupation than learned, but a limited negative effect when they assess their qualification as not related to their current job. Looking at the three major educational groups, we find that

this effect for women is strongest for women with a tertiary B education. As we find no such effect for men with tertiary B education, a likely explanation lies in the differing labor market biographies and labor market attachment of women. Apart from this finding on subjective horizontal mismatch among women, we find no differences in mismatch wage effects between workers with apprenticeship education, tertiary B or tertiary A education.

Thus, we do not find support for the hypothesis that horizontal mismatch will lead to large wage penalties in countries with strong vocational tracks in the education system. In Switzerland, vocational education does not lead to an inefficient allocation of skills and tasks in the labor market. There are two likely explanations for this result: First, vocational education seems to be transferable enough to allow for occupation changes during working careers, on average, at least in Switzerland. Second, there exist many possibilities for regular skills updating through non-formal continuing education and informal on-the-job learning. These results are good news for European countries that have in recent years embarked on extensions and enhancements of vocational education tracks to smooth the transition from education to labor market in an effort to reduce youth unemployment. If these tracks succeed in providing youngsters with relevant skills, and if workers get the opportunity to update their skills throughout working life, workers that choose vocational education will not bear a higher risk to suffer from mismatch than workers that choose general education.

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Tables and Figures

Table 1: Sample Characteristics Full Sample

	Adequate	Quali. no relation	Overqualified	Underqualified	N
Total	79.68	3.32	15.06	1.94	36'462
Women	78.62	4.11	15.16	2.11	16'239
Men	80.53	2.68	14.99	1.79	20'225
Age 20-34	77.97	4.11	15.68	2.23	9'870
Age 35-49	79.14	3.14	15.80	1.92	16'895
Age 50-60	82.37	2.82	13.15	1.67	9'697
Married	81.01	2.96	14.26	1.77	20'529
Not married	77.96	3.78	16.10	2.15	15'933
Swiss	80.30	3.04	14.81	1.85	32'230
Foreigner	75.01	5.39	17.03	2.58	4'229
Compulsory education	82.59	6.25	7.33	3.83	1'488
Upper-secondary: apprenticeship	80.69	3.81	13.40	2.09	13'610
Upper-secondary: general schooling	80.44	4.29	12.60	2.67	2'096
Tertiary B: professional educ.	80.98	1.86	15.66	1.50	7'793
Tertiary A: university	76.31	2.01	20.60	1.08	6'932
<= 30'000 CHF	67.61	12.60	16.20	3.60	389
30'001-50'000 CHF	72.83	8.99	15.16	3.02	3'548
50'001-80'000 CHF	77.76	4.01	15.90	2.33	13'417
80'001-100'000 CHF	80.58	2.09	15.40	1.93	8'043
100'001-150'000 CHF	83.73	1.20	14.01	1.06	8'677
> 150'000 CHF	84.88	1.34	12.73	1.05	2'388
N (person-year obs.)	26'053	1'210	5'493	706	36'462

Notes: Row percentages are presented, e.g., of all individuals aged 20-34, 77.97% report to be adequately qualified, 4.11% do not experience a relation between their qualification and the qualification needed, 15.68% feel over- and 2.23% feel underqualified.

Table 2: Sample Characteristics Bio Subsample

	learned occupation =current occupation	learned occupation <>current occupation	N
Total	53.05	46.95	16'259
Women	56.26	43.74	6'778
Men	50.76	49.24	9'474
Age 20-34	57.74	42.26	3'280
Age 35-49	53.38	46.62	8'304
Age 50-60	49.16	50.84	4'668
Married	53.47	46.53	10'213
Not married	52.34	47.66	6'039
Swiss	52.96	47.04	14'804
Foreigner	54.01	45.99	1'448
Compulsory education	60.62	39.38	226
Upper-secondary: apprenticeship	48.93	51.07	6'007
Upper-secondary: general schooling	50.41	49.59	1'099
Tertiary B: professional	48.88	51.12	3'922
Tertiary A: university	61.18	38.82	3'318
<= 30'000 CHF	41.74	58.26	115
30'001-50'000 CHF	51.25	48.75	1'161
50'001-80'000 CHF	53.87	46.13	5'471
80'001-100'000 CHF	54.65	45.35	3'784
100'001-150'000 CHF	52.36	47.64	4'467
> 150'000 CHF	49.84	50.16	1'254
N (person-year obs.)	8'622	7'63	16'252

Notes: Row percentages are presented, e.g., of all individuals aged 20-34, 57.74% are in the same occupation as learned, and 42.26% have a mismatch between current and learned occupation.

Table 3: Relation Self-Assessed Qualification and Objective Horizontal Mismatch

Row percentages	Women			Men		
	learned=current	learned<>current	Total	learned=current	learned<>current	Total
Adequate	58.02	41.98	100.00	51.30	48.70	100.00
No relation	23.85	76.15	100.00	22.34	77.66	100.00
Overqualification	55.01	44.99	100.00	51.93	48.07	100.00
Underqualification	57.72	42.28	100.00	49.39	50.61	100.00
Total	56.26	43.74	100.00	50.76	49.24	100.00
Column percentages	**Women**			**Men**		
	learned=current	learned<>current	Total	learned=current	learned<>current	Total
Adequate	81.98	76.29	79.49	81.45	79.72	80.60
No relation	1.63	6.68	3.84	0.91	3.28	2.08
Overqualification	14.53	15.28	14.86	15.95	15.22	15.59
Underqualification	1.86	1.75	1.81	1.68	1.78	1.73
Total	100.00	100.00	100.00	100.00	100.00	100.00

Notes: Results from the bio subsample are displayed.

Table 4: Transition Probabilities of Qualification from Period (t) to Period (t+1)

Women	Adequate[t+1]	No relation[t+1]	Overqualification[t+1]	Underqualification[t+1]	Total
Adequate[t]	87.78	2.16	8.39	1.67	100.00
No relation[t]	46.74	30.32	19.79	3.16	100.00
Overqualification[t]	43.34	4.83	50.37	1.47	100.00
Underqualification[t]	69.29	5.24	10.11	15.36	100.00
Total	79.02	3.71	15.28	1.99	100.00
Men	**Adequate[t+1]**	**No relation[t+1]**	**Overqualification[t+1]**	**Underqualification[t+1]**	**Total**
Adequate[t]	88.74	1.61	8.18	1.48	100.00
No relation[t]	57.35	21.09	19.43	2.13	100.00
Overqualification[t]	44.77	3.01	50.96	1.26	100.00
Underqualification[t]	67.69	5.10	14.97	12.24	100.00
Total	80.98	2.39	14.97	1.66	100.00

Notes: Reported transition probabilities for women and men in the full sample. Example: Women who report being adequately qualified in t have a probability of 87.78% to be adequately qualified in the next year, a probability of 2.16% to report no relation of qualification with job, 8.39% to report being overqualified and a probability of 1.67% to report being underqualified.

Table 5: Transition Probabilities of Objective Mismatch from Period (t) to Period (t+1)

Women	learned=current[t+1]	learned<>current[t+1]	Total
learned=current[t]	95.28	4.72	100.00
learned<>current[t]	4.30	95.70	100.00
Total	56.03	43.97	100.00
Men	**learned=current[t+1]**	**learned<>current[t+1]**	**Total**
learned=current[t]	95.04	4.96	100.00
learned<>current[t]	3.75	96.25	100.00
Total	50.63	49.37	100.00

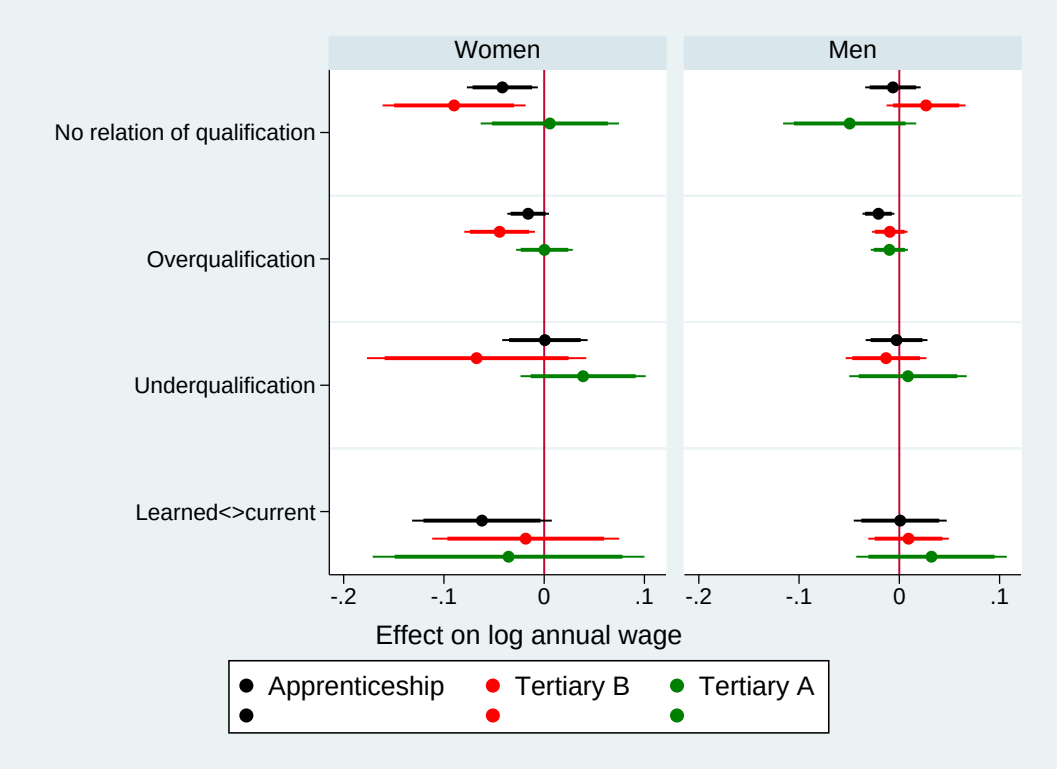
Notes: Reported transition probabilities for women and men in the bio subsample. Example: Women with a formal match on a 2-digit ISCO aggregation level in t have a probability of 95.28% to be formally matched in the next year, and a probability of 4.72% to be formally mismatched.

Table 6: Wage regressions

	OLS			FE		
Women	Full	Bio	Bio	Full	Bio	Bio
Qualification no relation	−0.1120***		−0.1081***	−0.0319*		−0.0470*
	(0.0156)		(0.0243)	(0.0124)		(0.0191)
Overqualification	−0.0372***		−0.0471***	−0.0222**		−0.0328**
	(0.0085)		(0.0139)	(0.0068)		(0.0104)
Underqualification	−0.0453*		−0.0255	−0.0127		−0.0065
	(0.0178)		(0.0272)	(0.0144)		(0.0219)
Learned<>current		−0.0420*	−0.0381*		−0.0266	−0.0253
		(0.0165)	(0.0164)		(0.0206)	(0.0206)
N (person-year obs.)	16'238	6'778	6'778	16'238	6'778	6'778
R^2	0.488	0.478	0.482	0.307	0.342	0.344
	OLS			FE		
Men	Full	Bio	Bio	Full	Bio	Bio
Qualification no relation	−0.0874***		−0.0781**	−0.0152		−0.0228
	(0.0147)		(0.0261)	(0.0105)		(0.0164)
Overqualification	−0.0409***		−0.0345**	−0.0167***		−0.0176**
	(0.0077)		(0.0121)	(0.0050)		(0.0063)
Underqualification	−0.0613***		−0.0566*	0.0002		−0.0077
	(0.0154)		(0.0225)	(0.0112)		(0.0170)
Learned<>current		−0.0336*	−0.0314*		0.0147	0.0158
		(0.0137)	(0.0137)		(0.0134)	(0.0133)
N (person-year obs.)	20'224	9'474	9'474	20'224	9'474	9'474
R^2	0.603	0.592	0.594	0.388	0.446	0.447

Notes: Estimated coefficients from the multivariate regression of the log of annual wages on a set of covariates and mismatch-variables. "Full" refers to the full estimation sample, and "bio" refers to the bio subsample. Robust standard errors are displayed in parentheses. $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Figure 1: Educational Groups FE



Notes: This figure provides a graphical illustration of the results from multivariate regression (fixed effects regression of log of annual wage on covariates and mismatch-variables). Each dot refers to the estimated coefficient, the thinner left- and right-hand line refers to the 95% confidence interval, and the thicker line refers to the 90% confidence interval.

A Appendix

Table A1: Full sample: Summary Statistics (means)

	Adequate qualified	Qualification with no relation	Overqualified	Underqualified
	mean	mean	mean	mean
Age	41.828	39.944	41.169	40.475
Male	0.561	0.449	0.552	0.514
Children	0.394	0.366	0.385	0.402
Foreigner	0.109	0.188	0.131	0.154
Married	0.572	0.502	0.533	0.514
Italian-speaking	0.033	0.033	0.023	0.048
German-speaking	0.709	0.573	0.640	0.494
French-speaking	0.258	0.394	0.337	0.456
Degree of employment	89.637	84.418	87.870	89.109
Work experience in years	21.640	20.496	20.490	20.907
No compulsory school	0.005	0.010	0.003	0.008
Only compulsory school	0.042	0.077	0.020	0.081
Household school	0.019	0.031	0.011	0.014
Vet certificate	0.011	0.028	0.010	0.017
General upper secondary school	0.011	0.023	0.006	0.014
Apprenticeship	0.378	0.429	0.332	0.404
Fulltime vocational school	0.047	0.051	0.042	0.065
Vocational baccalaureate	0.016	0.026	0.018	0.023
Academic baccalaureate	0.072	0.091	0.077	0.102
Federal PET diploma	0.098	0.045	0.090	0.065
technical school	0.042	0.041	0.048	0.035
PET college	0.078	0.034	0.083	0.065
Universities of applied sciences	0.010	0.003	0.017	0.008
University of teacher education	0.004	0.003	0.003	0.003
University	0.168	0.108	0.240	0.095
Occupational tenure	2.744	1.819	2.541	1.904
Firm tenure	2.489	1.776	2.235	1.793
Member of the board	0.082	0.051	0.067	0.091
missing	0.049	0.055	0.043	0.052
Supervisor task	0.552	0.336	0.508	0.537
missing	0.062	0.065	0.057	0.065
Fixed-term work contract	0.049	0.087	0.058	0.072
missing	0.001	0.001	0.002	0.003
Further education	0.432	0.265	0.388	0.364
missing	0.060	0.072	0.097	0.102
Agriculture	0.009	0.012	0.005	0.011
Manufacturing	0.166	0.187	0.159	0.169
Construction	0.044	0.040	0.026	0.048
Wholesale	0.108	0.159	0.129	0.113
Hotel+Restaurant	0.015	0.036	0.023	0.017
Transport+Communication	0.061	0.085	0.061	0.057
Financial+Insurance	0.074	0.046	0.086	0.069
Renting+IT	0.100	0.102	0.088	0.095
Public administration	0.077	0.069	0.086	0.082
Education	0.103	0.026	0.094	0.105
Health+Social	0.125	0.092	0.115	0.123
Other services	0.043	0.038	0.046	0.035
missing	0.074	0.110	0.081	0.075
Gross Annual Wage	90′431.179	67′549.854	86′915.674	77′796.709
N (person-year obs.)	29'053	1'210	5'493	706

Table A2: Women full sample: Summary Statistics (means)

	Adequate qualified mean	Qualification with no relation mean	Overqualified mean	Underqualified mean
Age	41.436	41.135	41.214	40.373
Male	0.000	0.000	0.000	0.000
Children	0.306	0.354	0.344	0.353
Foreigner	0.101	0.190	0.132	0.111
Married	0.469	0.480	0.464	0.397
Italian-speaking	0.032	0.021	0.023	0.035
German-speaking	0.687	0.574	0.653	0.469
French-speaking	0.281	0.405	0.324	0.496
Degree of employment	80.242	75.909	78.716	81.181
Work experience in years	21.580	21.862	20.705	20.965
No compulsory school	0.004	0.009	0.001	0.003
Only compulsory school	0.052	0.084	0.021	0.096
Household school	0.038	0.039	0.020	0.026
Vet certificate	0.010	0.030	0.013	0.017
General upper secondary school	0.016	0.031	0.007	0.015
Apprenticeship	0.385	0.418	0.337	0.373
Fulltime vocational school	0.062	0.072	0.050	0.082
Vocational baccalaureate	0.015	0.021	0.017	0.020
Academic baccalaureate	0.110	0.096	0.111	0.146
Federal PET diploma	0.072	0.043	0.081	0.044
technical school	0.022	0.036	0.028	0.017
PET college	0.045	0.019	0.054	0.047
Universities of applied sciences	0.009	0.001	0.015	0.012
University of teacher education	0.006	0.006	0.004	0.006
University	0.153	0.093	0.239	0.096
Occupational tenure	2.804	1.834	2.432	1.907
Firm tenure	2.495	1.825	2.063	1.761
Member of the board	0.044	0.030	0.039	0.082
missing	0.036	0.060	0.029	0.041
Supervisor task	0.466	0.286	0.426	0.481
missing	0.051	0.070	0.047	0.058
Fixed-term work contract	0.055	0.075	0.055	0.085
missing	0.001	0.001	0.002	0.003
Further education	0.449	0.256	0.383	0.388
missing	0.065	0.072	0.099	0.120
Agriculture	0.006	0.009	0.002	0.003
Manufacturing	0.086	0.162	0.093	0.099
Construction	0.015	0.009	0.005	0.012
Wholesale	0.125	0.175	0.129	0.134
Hotel+Restaurant	0.020	0.039	0.029	0.015
Transport+Communication	0.037	0.067	0.037	0.035
Financial+Insurance	0.067	0.031	0.070	0.079
Renting+IT	0.087	0.102	0.091	0.064
Public administration	0.074	0.063	0.090	0.093
Education	0.147	0.036	0.111	0.157
Health+Social	0.222	0.142	0.204	0.192
Other services	0.047	0.043	0.048	0.047
missing	0.069	0.120	0.091	0.070
Gross Annual Wage	79′062.235	60′714.255	77′745.163	72′204.935
N (person-year obs.)	12'767	667	2'461	343

Table A3: Men full sample: Summary Statistics (means)

	Adequate qualified mean	Qualification with no relation mean	Overqualified mean	Underqualified mean
Age	42.136	38.481	41.133	40.570
Male	1.000	1.000	1.000	1.000
Children	0.463	0.381	0.419	0.449
Foreigner	0.115	0.186	0.130	0.196
Married	0.653	0.529	0.589	0.625
Italian-speaking	0.033	0.048	0.024	0.061
German-speaking	0.727	0.571	0.629	0.518
French-speaking	0.240	0.381	0.347	0.419
Degree of employment	97.002	94.871	95.301	96.601
Work experience in years	21.687	18.818	20.316	20.851
No compulsory school	0.006	0.011	0.004	0.014
Only compulsory school	0.034	0.068	0.019	0.066
Household school	0.004	0.020	0.004	0.003
Vet certificate	0.011	0.026	0.007	0.017
General upper secondary school	0.008	0.013	0.005	0.014
Apprenticeship	0.372	0.442	0.328	0.433
Fulltime vocational school	0.034	0.026	0.036	0.050
Vocational baccalaureate	0.016	0.031	0.018	0.025
Academic baccalaureate	0.043	0.085	0.049	0.061
Federal PET diploma	0.118	0.046	0.098	0.085
technical school	0.057	0.048	0.065	0.052
PET college	0.104	0.052	0.107	0.083
Universities of applied sciences	0.010	0.006	0.019	0.006
University of teacher education	0.002	0.000	0.001	0.000
University	0.180	0.127	0.241	0.094
Occupational tenure	2.697	1.801	2.630	1.901
Firm tenure	2.485	1.716	2.374	1.824
Member of the board	0.111	0.077	0.089	0.099
missing	0.058	0.048	0.055	0.063
Supervisor task	0.619	0.396	0.575	0.590
missing	0.071	0.059	0.065	0.072
Fixed-term work contract	0.045	0.101	0.060	0.061
missing	0.000	0.000	0.001	0.003
Further education	0.419	0.276	0.391	0.342
missing	0.056	0.072	0.096	0.085
Agriculture	0.011	0.015	0.008	0.019
Manufacturing	0.230	0.217	0.213	0.234
Construction	0.068	0.077	0.043	0.083
Wholesale	0.094	0.138	0.130	0.094
Hotel+Restaurant	0.012	0.031	0.018	0.019
Transport+Communication	0.080	0.107	0.080	0.077
Financial+Insurance	0.080	0.064	0.100	0.061
Renting+IT	0.111	0.101	0.086	0.124
Public administration	0.078	0.076	0.082	0.072
Education	0.069	0.015	0.081	0.055
Health+Social	0.049	0.029	0.042	0.058
Other services	0.040	0.031	0.045	0.025
missing	0.078	0.098	0.073	0.080
Gross Annual Wage	99′343.576	75′946.436	94′359.152	83′080.396
N (person-year obs.)	16’286	543	3’032	363

Table A4: Bio subsample: Summary Statistics (means)

	Adequate qualified mean	Qualification with no relation mean	Overqualified mean	Underqualified mean
Age	43.259	42.350	42.794	41.533
Male	0.586	0.431	0.595	0.571
Children	0.433	0.409	0.431	0.460
Foreigner	0.084	0.103	0.106	0.129
Married	0.635	0.562	0.612	0.599
Italian-speaking	0.038	0.031	0.029	0.045
German-speaking	0.682	0.573	0.622	0.436
French-speaking	0.280	0.396	0.349	0.519
Degree of employment	89.484	84.991	87.759	89.059
Work experience in years	22.832	22.589	21.896	21.725
No compulsory school	0.002	0.007	0.000	0.000
Only compulsory school	0.014	0.020	0.008	0.042
Household school	0.017	0.035	0.010	0.017
Vet certificate	0.007	0.031	0.006	0.003
General upper secondary school	0.012	0.024	0.004	0.014
Apprenticeship	0.375	0.475	0.315	0.439
Fulltime vocational school	0.057	0.072	0.050	0.087
Vocational baccalaureate	0.012	0.022	0.018	0.010
Academic baccalaureate	0.066	0.042	0.060	0.094
Federal PET diploma	0.105	0.048	0.105	0.056
technical school	0.056	0.046	0.059	0.059
PET college	0.083	0.048	0.087	0.066
Universities of applied sciences	0.005	0.004	0.012	0.000
University of teacher education	0.002	0.004	0.002	0.000
University	0.188	0.123	0.264	0.111
Occupational tenure	3.446	2.173	3.257	2.446
Firm tenure	3.150	2.081	2.990	2.237
Member of the board	0.091	0.072	0.081	0.087
missing	0.064	0.085	0.056	0.084
Supervisor task	0.578	0.326	0.525	0.544
missing	0.077	0.096	0.074	0.087
Fixed-term work contract	0.039	0.070	0.043	0.045
missing	0.000	0.000	0.002	0.003
Further education	0.466	0.295	0.414	0.383
missing	0.051	0.053	0.080	0.094
Agriculture	0.007	0.007	0.005	0.000
Manufacturing	0.156	0.184	0.157	0.199
Construction	0.036	0.031	0.021	0.031
Wholesale	0.104	0.140	0.126	0.105
Hotel+Restaurant	0.012	0.037	0.020	0.003
Transport+Communication	0.065	0.079	0.061	0.073
Financial+Insurance	0.082	0.059	0.090	0.070
Renting+IT	0.102	0.090	0.085	0.115
Public administration	0.092	0.098	0.083	0.080
Education	0.103	0.026	0.105	0.087
Health+Social	0.118	0.081	0.119	0.105
Other services	0.049	0.048	0.046	0.038
missing	0.074	0.120	0.082	0.094
Gross Annual Wage	95′034.745	73′275.331	91′968.357	82′074.205
N (person-year obs.)	13'024	457	2'484	287

Table A5: Women bio subsample: Summary Statistics (means)

	Adequate qualified mean	Qualification with no relation mean	Overqualified mean	Underqualified mean
Age	42.932	43.188	42.240	41.146
Male	0.000	0.000	0.000	0.000
Children	0.324	0.373	0.369	0.431
Foreigner	0.078	0.092	0.107	0.073
Married	0.500	0.504	0.487	0.496
Italian-speaking	0.040	0.023	0.030	0.016
German-speaking	0.647	0.565	0.650	0.415
French-speaking	0.314	0.412	0.320	0.569
Degree of employment	78.636	77.504	76.516	78.943
Work experience in years	22.930	23.708	21.633	21.805
No compulsory school	0.001	0.008	0.001	0.000
Only compulsory school	0.018	0.023	0.005	0.057
Household school	0.038	0.058	0.022	0.033
Vet certificate	0.008	0.050	0.014	0.008
General upper secondary school	0.015	0.042	0.006	0.024
Apprenticeship	0.402	0.454	0.342	0.423
Fulltime vocational school	0.080	0.085	0.065	0.122
Vocational baccalaureate	0.011	0.019	0.019	0.008
Academic baccalaureate	0.110	0.031	0.098	0.163
Federal PET diploma	0.084	0.062	0.091	0.033
technical school	0.026	0.042	0.022	0.024
PET college	0.036	0.015	0.043	0.016
Universities of applied sciences	0.005	0.004	0.009	0.000
University of teacher education	0.003	0.008	0.006	0.000
University	0.161	0.100	0.258	0.089
Occupational tenure	3.578	2.150	3.118	2.626
Firm tenure	3.213	2.092	2.703	2.407
Member of the board	0.055	0.050	0.039	0.098
missing	0.049	0.100	0.041	0.065
Supervisor task	0.495	0.292	0.432	0.472
missing	0.065	0.108	0.063	0.073
Fixed-term work contract	0.044	0.065	0.043	0.049
missing	0.000	0.000	0.003	0.000
Further education	0.490	0.304	0.408	0.398
missing	0.055	0.050	0.085	0.081
Agriculture	0.005	0.012	0.000	0.000
Manufacturing	0.080	0.165	0.085	0.130
Construction	0.015	0.004	0.007	0.016
Wholesale	0.122	0.162	0.128	0.114
Hotel+Restaurant	0.016	0.023	0.035	0.008
Transport+Communication	0.033	0.069	0.028	0.041
Financial+Insurance	0.072	0.046	0.073	0.065
Renting+IT	0.080	0.100	0.080	0.114
Public administration	0.089	0.081	0.086	0.089
Education	0.148	0.027	0.117	0.138
Health+Social	0.220	0.115	0.216	0.146
Other services	0.057	0.065	0.051	0.057
missing	0.063	0.131	0.092	0.081
Gross Annual Wage	82′063.445	65′877.034	78′568.374	74′580.045
N (person-year obs.)	5'388	260	1'007	123

Table A6: Men bio subsample: Summary Statistics (means)

	Adequate qualified mean	Qualification with no relation mean	Overqualified mean	Underqualified mean
Age	43.489	41.244	43.171	41.823
Male	1.000	1.000	1.000	1.000
Children	0.511	0.457	0.473	0.482
Foreigner	0.089	0.117	0.106	0.171
Married	0.730	0.640	0.697	0.677
Italian-speaking	0.037	0.041	0.028	0.067
German-speaking	0.707	0.584	0.603	0.451
French-speaking	0.257	0.376	0.368	0.482
Degree of employment	97.139	94.873	95.424	96.646
Work experience in years	22.763	21.112	22.075	21.665
No compulsory school	0.002	0.005	0.000	0.000
Only compulsory school	0.012	0.015	0.010	0.030
Household school	0.002	0.005	0.001	0.006
Vet certificate	0.007	0.005	0.001	0.000
General upper secondary school	0.010	0.000	0.002	0.006
Apprenticeship	0.355	0.503	0.297	0.451
Fulltime vocational school	0.040	0.056	0.039	0.061
Vocational baccalaureate	0.012	0.025	0.018	0.012
Academic baccalaureate	0.034	0.056	0.033	0.043
Federal PET diploma	0.120	0.030	0.114	0.073
technical school	0.076	0.051	0.085	0.085
PET college	0.116	0.091	0.116	0.104
Universities of applied sciences	0.005	0.005	0.015	0.000
University of teacher education	0.001	0.000	0.000	0.000
University	0.206	0.152	0.268	0.128
Occupational tenure	3.353	2.203	3.351	2.311
Firm tenure	3.106	2.066	3.185	2.110
Member of the board	0.117	0.102	0.110	0.079
missing	0.075	0.066	0.066	0.098
Supervisor task	0.637	0.371	0.588	0.598
missing	0.086	0.081	0.081	0.098
Fixed-term work contract	0.035	0.076	0.044	0.043
missing	0.001	0.000	0.001	0.006
Further education	0.449	0.284	0.418	0.372
missing	0.049	0.056	0.077	0.104
Agriculture	0.008	0.000	0.009	0.000
Manufacturing	0.211	0.208	0.206	0.250
Construction	0.050	0.066	0.031	0.043
Wholesale	0.092	0.112	0.124	0.098
Hotel+Restaurant	0.009	0.056	0.009	0.000
Transport+Communication	0.087	0.091	0.084	0.098
Financial+Insurance	0.088	0.076	0.101	0.073
Renting+IT	0.117	0.076	0.087	0.116
Public administration	0.095	0.122	0.080	0.073
Education	0.072	0.025	0.097	0.049
Health+Social	0.047	0.036	0.053	0.073
Other services	0.043	0.025	0.043	0.024
missing	0.081	0.107	0.075	0.104
Gross Annual Wage	104′187.359	83′039.581	101′104.297	87′694.826
N (person-year obs.)	7'636	197	1'477	164