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Horizontal Mismatch and Vocational Education

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Horizontal Skills Mismatch and Vocational Education

Juerg Schweri* , Annina Eymann, † , and Manuel Aepli ‡

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Discussion Paper

Abstract

Recent literature suggests that vocational education and training provides individuals with a trade-off between smoother transitions into the labor market, but lower wages in the long-run. We investigate horizontal skills mismatch as a possible mechanism for such findings, which is defined as a mismatch between qualifications acquired and those required for a job. Some studies found that the more specific an education system is, the higher are the wage penalties due to horizontal mismatch. Therefore, we look at the paradigmatic case of Switzerland, the country with the highest share of firm-based vocational education and training in the OECD. We use subjective and objective measures of mismatch from the Swiss Household Panel in the years 1999 to 2016. Controlling for time-invariant heterogeneity in fixed effects regressions, the wage penalty for self-reported horizontal mismatch is 3.6%. Not working in a learned occupation does not lead to significant wage effects. 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. We make several suggestions on improving concept and methods for the analysis of horizontal mismatch.

JEL classification: I21, J24, J31, J62
Keywords: skills mismatch; human capital; Switzerland; overeducation; training; wages; horizontal mismatch

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1 Introduction

The debate about the relative merits of vocational versus general education was recently revived by Hanushek *et al.* (2017). Their core hypothesis is that "the skills generated by vocational education may facilitate the transition in the labor market but may become obsolete at a faster rate." The reason for this supposed trade-off is the specificity of vocational education, which renders workers more vulnerable to changing demands in the labor market due to technological change and offshoring.

An obvious mechanism by which overly specific human capital may harm workers during their labor market career is a mismatch between qualifications acquired and those needed in the current occupation. In his pioneering article, Robst (2007) finds that workers affected by such a horizontal mismatch suffer from substantial wage penalties. He analyzed US workers holding a college degree whose current job is not or is 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 human capital but that the wage penalties for these majors are higher. Following this line of argument, Nordin *et al.* (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. In an overview article, Somers *et al.* (2018) confirm the argument of higher wage penalties for horizontal mismatch with more occupation-specific educations.

Indeed, if education tracks with a higher proportion of more specific human capital increased wage penalties for horizontal mismatch, this would constitute a major challenge for vocational education and training programs. Several countries educate a large proportion of their youngsters in upper-secondary programs that specialize workers in certain occupations, such as Austria, Denmark, Germany, the Netherlands, and Switzerland. Many other countries[1] have considered introducing new or additional vocational tracks and especially apprenticeships to counter youth unemployment. Youth unemployment rose sharply in many countries during the economic crisis from 2007 to 2010 (cf. OECD, 2015). Vocational education is known to ease the transition from school to work in workers' early labor market careers (Ryan, 2001) and could thus decrease youth unemployment. Yet, if vocational education hinders occupational mobility in the long run, introducing more vocational training will exacerbate the effects of horizontal mismatch by allocating skills in the labor market less efficiently. The long-run mismatch cost of vocational education and training may reduce or outweigh the gains from smooth short-term transitions into the labor market, from both individual and social perspectives.

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

Our contribution to the literature on horizontal mismatch is threefold. First, we extend the scope of analyses from university graduates to the vocationally trained workforce and compare effects between workers with vocational educations and those with general educations. Switzerland provides an ideal case for such an analysis because two-thirds of young Swiss attend firm-based apprenticeship programs after compulsory schooling, which is the highest proportion among all OECD countries (OECD, 2018). Secondly, we use both subjective and objective information to measure mismatch. Robst (2007) used a subjective measure, while Nordin *et al.* (2010) used an objective measure. We show that our subjective and objective measures capture different aspects of horizontal mismatch. Thirdly, using longitudinal data in fixed-effect regressions enables us to eliminate estimation bias due to unobserved time-invariant heterogeneity, such as individual differences in ability, motivation and personality. These are major confounding factors for estimating the wage effects of mismatch, a problem that has received substantial attention in the literature on vertical mismatch, i.e. over- and under-education (e.g., Bauer, 2002; Frenette, 2004; Mavromaras *et al.*, 2013; McGuinness and Bennett, 2007).

Our main results are that fixed-effects estimates strongly reduce the wage penalties found by OLS estimates and that remaining penalties are small and mostly insignificant for workers with vocational and general education background alike. These results indicate the high overall adaptability of the Swiss workforce to labor market developments. Yet, the incidence of mismatch and its effects also vary depending on definitions of mismatch and specifications of the estimation models. This highlights the importance of a precise conceptualization and operationalization of horizontal mismatch. We specifically recommend excluding voluntary occupational mobility from the analyses and focusing on horizontal mismatch that is caused by labor demand shocks.

2 Defining Horizontal Mismatch

We apply two definitions of horizontal mismatch in this paper: the first defines horizontal mismatch as a divergence between formal education and current occupation. 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 includes changes between occupations. Accordingly, Nordin *et al.* (2010) compare workers' field of study with their current occupation to identify horizontal mismatch. Robst uses workers' assessment of "the relationship between your work and your education" (Robst, 2007, p. 401). A particularity of this definition is the time lag involved: Because college students typically earn their degree in their twenties, comparing qualifications from formal education and qualifications needed at the current job implies a substantial time lag for middle-

aged and older workers. This definition does not allow for qualifications gained after completing formal education. To escape a situation of horizontal mismatch in this definition, workers have to change back to the occupation or field they first learned. We will use an objective measure of this kind of horizontal mismatch that directly compares learned and current occupations.

The second definition of horizontal mismatch considers whether the qualifications a worker needs in his or her current job match with the qualifications he or she possesses at this point in time. The qualifications currently possessed may stem not only from formal education but also from life-long learning through courses without federally recognized certificates, from informal training, and from work experience throughout the career. Conversely, skills learned in school and elsewhere may depreciate over time. This definition allows us to assess whether the combination of schooling, continuing education, on-the-job training, and labor market experience is able to keep workers' skills aligned with labor market needs throughout their careers. Institutions such as career counseling, firm-financed training, and training vouchers may help workers continuously adjust and update their skills and thus prevent or escape a situation of horizontal mismatch. While the first definition treats workers' skills as static, our second definition of horizontal mismatch takes these dynamic aspects of skills development into account. We will use workers' self-assessment of the match between qualifications acquired and needed to identify this kind of horizontal mismatch.

Changes in production technologies and international competition affect mismatch in both definitions, because they change workers' tasks and induce occupational changes. The "task-based" literature directly analyzes the labor market effects of task changes due to demand-side dynamics (see Acemoglu and Autor, 2011; Autor, 2013). Here, we focus on the effects of horizontal mismatch, which is a result of both employees' acquisition of qualifications (supply side) and the tasks to be completed (demand side). Swiss watchmaking provides a good example how technological innovation and international competition can create horizontal mismatch. Watchmakers faced a disastrous crisis in the seventies when foreign quartz watches gained market shares and employment in the traditional mechanical watch industry fell by almost 50 percent between 1970 and 1980 (Young, 1999). Many workers had to change occupation and thus became horizontally mismatched according to the first definition. They would have had to find jobs as watchmakers again to escape the situation of mismatch. Those that remained watchmakers are considered well-matched. But in the meantime, watchmaking may have changed in task content as well, at least in companies with novel production lines. The first definition ignores this, but in the second definition, substantial changes in tasks alone are sufficient to create a mismatch between workers' qualifications and their new tasks. Those that remained watchmakers may thus also have experienced mismatch unless they updated their qualifications. Conversely,

former watchmakers that changed occupation and were able to acquire the qualifications necessary for their new occupations are no longer considered mismatched in the second definition. Our aim is to measure both definitions of horizontal mismatch (see section 4) and to compare the results for incidence and wage effects.

3 Education and Training in Switzerland

The analysis of horizontal mismatch as outlined in section 2 raises two questions about training in Switzerland. First, if specific human capital is a possible cause of horizontal mismatch and associated wage penalties, what is known about the specificity of the human capital acquired in vocational education and training? Second, what possibilities do Swiss workers have to update and extend their skills throughout their working careers? We will shortly discuss the institutions that are relevant in this context.

The Swiss education system consists of two main tracks. Two thirds of those leaving compulsory schooling attend vocational education, usually a firm-based apprenticeship at upper secondary level. Only about a quarter continue in general schooling, mainly *Gymnasium* which prepares for university studies. These two tracks correspond to the levels 3B and 3A of the International Standard Classification of Educations (ISCED). Likewise, there is a vocational track at tertiary level, called professional education and training, and a general track, which consists of various types of universities. These tracks correspond to the ISCED levels 5B and 5A. Our analysis compares mismatch penalties for individuals with highest education corresponding to vocational education and training VET (3B), tertiary-B (5B), and tertiary-A (5A) degrees. We exclude people without upper-secondary education or 3A degree because these groups are small and selective.[2]

Apprenticeships entail several specific elements. Occupational tasks are an important point of reference in the training curricula. Apprentices working in firms several days a week may also acquire a substantial amount of firm-specific skills. However, federal regulations and quality controls by cantons and occupational associations ensure that training is transferable across firms (cf. Hoeckel *et al.*, 2009). National training ordinances specify many general skills, such as communication and general workplace skills, which have to be learned in school and at firms in each of about 250 apprenticeship occupations. In addition, every ordinance defines the duration of training (two, three or four years), the number of lessons in vocational school during this period (one to two days a week), the written, oral, and practical components of the final exams, and the federally recognized degree. A more subtle point is that learning through performing work tasks should not be considered as occupation-specific by

[2]Most students who attended Gymnasium (3A) go on to university and join group 5A.

default. Work tasks allow learning that is embedded in real-world situations as opposed to learning in classrooms. Skills learned in work situations, such as collaborating, solving problems, and working in a precise, efficient, and customer-oriented fashion, may be just as transferable to other work situations as skills learned in classrooms. The same point can be made for subject knowledge: it may be easier to understand mathematical and numerical concepts that are applied in workplace situations, because tasks in the workplace are contextualized and give meaning to concepts that appear entirely abstract in a general math class (e.g. FitzSimons and Boistrup, 2017). In this sense, vocational education and training is not so much about more specific, and thus less transferable, skills but about a different learning technology that is more appealing to many learners.

Empirical evidence supports the view that the human capital imparted through apprenticeships is mostly general. Surveys of the costs and benefits of apprenticeship training show that the benefits to most employers outweigh the costs of training in Switzerland (Wolter and Strupler, 2012; Wolter *et al.*, 2006). This result is consistent with Becker's (1962) model, in which trainees bear the costs and profit from the benefits of general training. Müller and Schweri (2015) evaluate the transferability of apprentices' skills by analyzing wage differentials between apprentices that stay in their training firm directly after completing their apprenticeships, move to another firm in the same occupation, or move to another occupation. Accounting for endogenous changes, they find some evidence for a wage premium for apprentices who work in their learned occupational field (defined by 39 2-digit categories) but not for staying with their training firm. This indicates that apprenticeships impart some skills that are specific to a broad occupational field but that the role of firm-specific skills is very limited on average.

The second question raised in the introduction to this section was how workers can update and extend their skills once they have entered the labor market. Vocational education and training contribute to "life-long" learning as well: Half of the candidates who obtained a Federal professional education and training (PET) Diploma or an Advanced Federal PET Diploma in 2017 were between the ages of 26 and 37 (FSO, 2019) and had earned labor market experience before. Together with professional colleges, these degrees form vocational higher education in Switzerland. The three extant PET degrees provide ISCED 5B qualifications, which we will call "Tertiary-B" in the analyses. An upper-secondary degree is a minimal entry qualification, but some PET programs are regularly attended by university graduates (e.g. courses for auditors or tax experts). While some of the PET programs expand students' skills to new areas (e.g., business administration skills), others 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 such as computer skills and vocational courses. Both workers and employers pay for these courses. The share of employed people who attended at least one course in one year was 62% in 2016 (FSO, 2017).

In summary, our study evaluates the overall success of the educational system in Switzerland in preparing and updating workers for the labor market by analyzing the incidence and wage effects of horizontal mismatch. This analysis relates to the formal education system and on the combination of predominantly vocational formal education, continuing education, and labor market regulation in Switzerland. It is this system of institutions and markets that determines the quality of matches between employees' qualifications and firms' qualification demands.

4 Data

4.1 Sample Definition

The Swiss Household Panel (SHP)[3] is a longitudinal data set composed of two cohorts of randomly chosen Swiss households, surveyed annually. The first cohort started in 1999, the second in 2004.

We make use of these two cohorts and include observations from 1999 to 2016. Our analyses include working men from age 20 to 65 who are not self-employed.[4] We focus on men to increase the internal validity of the analyses, as women's labor market participation is still highly selective.[5] Observations lacking information on wages, occupation, and mismatch variables are excluded. Moreover, we exclude individuals who work less than 50% or earn full-time wages below 24,000 Swiss francs or above 300,000 Swiss francs a year.[6] The full estimation sample consists of 4,836 individuals (24,373 person-year observations), most of whom were observed in several periods. We also construct a subsample, which we call the bio subsample, that is composed of individuals who also revealed retrospective information on education episodes before the start of the panel. This additional questionnaire was presented to the first cohort in 2001 and 2002 and collected information about the respondents' background: living arrangements, educational trajectory, and work life. The bio subsample consists of 1,221 individuals with 10,193 person-year observations.

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

[4]Excluding self-employed may underestimate the labor-market opportunities for individuals with a 5A degree, but even more so those with a 5B degree, since the Swiss PET system (5B) offers many programs which prepare for self-employment, typically in the crafts sector.

[5]See Bütikofer (2013) for an analysis of female labor supply estimated with SHP data.

[6]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 388 person-year observations due to the lower bound and 277 person-year observations due to the upper bound requirement.

4.2 Variable Definitions

Two mismatch variables relate to the two definitions of mismatch discussed in section 2 and are our key explanatory variables. The first variable identifies a concurrent mismatch between qualifications acquired and needed. It is a "subjective" measure that relies on a survey question that asks for respondents' own assessment of their qualifications. Each year, individuals are asked to rate their qualifications with regard to their current jobs with a set of four possible answers.[7] Individuals who report that their *qualifications correspond to job* are classified as suitably qualified. Respondents who report that their *qualifications do not relate to job* are classified as having a qualification mismatch. Those who report that their *qualifications are superior to job* are classified as overqualified, and those who report *qualifications are not sufficient* are classified as underqualified workers. The categories for over- and underqualification are similar to subjective measures of vertical mismatch in the literature (e.g., Allen and van der Velden, 2001; Diem and Wolter, 2014; Hartog, 2000; McGuinness and Sloane, 2011).

The second horizontal mismatch variable identifies an "objective" deviation between formal education and current occupation, similar to Nordin *et al.* (2010), who compare field of study and current occupation. The SHP data provides a ready-to-use variable containing International Standard Classification of Occupations (ISCO) codes for individuals' learned occupation(s). Thus, we can compare learned and current occupation directly by comparing their ISCO codes. This objective mismatch variable is only available for individuals in the bio subsample. We use information on all educational episodes to create the variable. The current occupation of each individual is matched to a set of up to five previously learned occupations. If there is no match between current and learned occupations, the person is classified as objectively horizontally mismatched. We define mismatch at the 2-digit ISCO level as Bauer (2002) does. Mismatches defined at 3- and 1-digit levels will be used as a sensitivity check.

In the multivariate regressions, the natural logarithm of annual gross wage is used as dependent variable. We deflate wages to 2010 and standardize them to full-time wages (100%) based on information about individuals' employment according to their work contracts.

The set of covariates covers person-specific, occupation-specific, and job-specific characteristics. Personal characteristics include dummies for not being Swiss, being married, having children, and living in one of three linguistic regions. Experience is not directly observed, so potential experience is calculated as $age - schoolyears - 7$. The education variable contains the three groups analyzed: individuals with VET (ISCED 3B), with tertiary-B (5B), or with tertiary-A (5A) degrees. Further

[7] Pecoraro (2016) uses this variable in an ORU-type analysis of overeducation.

dummy variables included in the estimations are having a fixed-term contract, having followed continuing education in the last 12 months, 7 firm-size dummies, and 12 industry dummies.

Finally, we control for current occupation as Robst (2007) and Nordin *et al.* (2010) do; this is available as an ISCO code in the data. Since our mismatch variable is based on the 2-digit ISCO code, we control for 34 2-digit occupation dummies. We also constructed proxy variables for occupational and firm tenure. Occupational tenure measures the years a person has 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 has spent in the same firm and provides a lower bound for the same reason. After each change of firm, the counter is set to zero again. We also control for being a director or being a supervisor in order to account for promotions in the estimations.

5 Empirical Analysis

5.1 Incidence of Mismatch

In the pooled full sample, 81.1% assess their qualification as suitable (see Table 1).[8] The assessment that there is no relation between qualifications acquired and qualifications needed at the current job is rare; only 2.4% report such a subjective horizontal mismatch. Nonetheless, this situation occurs to a substantial number of individuals: 9.2% of all individuals 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 15.1%. Only 1.5% assess themselves as underqualified. Results in the bio subsample are similar (see column percentages in Table 3).

Table 1 shows that the proportion of those suitably qualified increases slightly with age. The proportion of people with a subjective horizontal mismatch is highest among young workers. Foreigners more often report being overqualified, underqualified, or horizontally mismatched. Highest education attained has an influence on qualification assessment: VET graduates report more horizontal mismatch, whereas graduates from universities report more overqualification. Higher income is almost uniformly associated with lower mismatch among all categories.

Results for the pooled bio subsample, in Table 2, show that in almost exactly one half of all cases the current occupation matches the learned occupation; the other half is considered as objectively mismatched. [9] The incidence of mismatch is thus much higher when using the objective measure,

[8] In the pooled sample, "81.1%" is a shorthand formulation for "81.1% of all person- year observations". The text is explicit if we consider individuals instead of person-year observations, which include multiple observations for most individuals.

[9] Note that we use differences in 2-digit ISCO code. Using 3-digit ISCO differences, the proportion of the mismatched

a result that confirms earlier findings in the literature (Somers *et al.*, 2018). There are no notable differences between married and unmarried nor between Swiss and foreigners. Unsurprisingly, the proportion of those who no longer work in their learned occupation increases with age. We find the highest proportions of employees working in their learned occupation among university graduates, whereas vocationally trained workers (apprenticeships and tertiary B) are more likely to work in a job outside their learned occupation.

Table 3 shows the bivariate distribution of self-assessed qualification and objective horizontal mismatch in the bio subsample. Among workers who say that their qualifications are not related to their current job, 76.3% do not work in their learned occupation. Yet, among those workers that no longer work in their learned occupations, only 3.0% think they are horizontally mismatched, while 79.9% think that they are suitably 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 idea discussed in section 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 sufficient condition for a current mismatch between qualifications acquired and those 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 qualifications needed in their new occupations. The low incidence of self-assessed mismatch indicates that the Swiss labor market allocates skills and tasks efficiently.

Tables 4 and 5 show the persistence of mismatch. We report the transition probabilities between t and $t+1$. The most stable category in Table 4 is adequate qualification. Yet, even individuals starting with adequate qualifications have a probability of more than 10% of changing their assessment in the next year. Individuals reporting a horizontal mismatch between qualifications acquired and qualifications needed in t have a moderate probability of reporting such a mismatch again in the next year (20.4%), but their highest probability is of reporting suitable qualifications (60.3%). These descriptive results provide evidence that self-assessments are not fixed and are updated each year, probably due to workers' investment in their own skills such as through continuing education and changing tasks on the job. Our results further suggest that overqualification is the most persistent mismatch category among 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; their proportion of those remaining overqualified for more than one year is similar to our results. Unsurprisingly,

increases to 56.0%. Using 1-digit ISCO differences, the proportion of mismatched decreases to 42.7%.

objective mismatch is pretty stable over time (Table 5). For workers who are objectively horizontally mismatched, the probability of moving back to their learned occupations in $t+1$ is slightly lower than for matched workers to move to mismatched situations.

5.2 OLS Mismatch Wage Effects

First, we estimate mismatch wage penalties in Switzerland using pooled OLS Mincer wage regressions. These results allow comparison with the OLS wage penalties estimated in the US and Sweden (Nordin *et al.*, 2010; Robst, 2007). We regress the log of annual gross wage w on a large set X, consisting of personal characteristics, occupation- and job-specific characteristics, and year dummies.

The two mismatch variables enter the wage regressions in all possible 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 other two models can only be estimated for the bio subsample.

Table 6 shows OLS results, in the left three columns without controls for current occupation, and in the right three columns with controls for current occupation. In the full sample (column 1), workers who assess their qualifications as not related to their current jobs suffer from a mean wage penalty of 8.8%. The wage penalty is 5.4% for overqualified workers and 6.1% for underqualified workers.[10] Not working in one's learned occupation (column 2) is associated with a wage premium of 2.7%. Including both types of mismatch in the estimation (column 3) changes the effects only slightly.

The OLS results with control for current occupation differ only slightly for the subjective mismatch measures, but the sign for the coefficient of objective horizontal mismatch changes. Leaving one's learned occupation is associated with a small wage gain on average, if we do not take into account the current occupation. If we do control for current occupation, thus comparing mismatched workers with matched workers in the same occupation, the mismatched earn slightly and insignificantly less.

The huge difference between the results for subjective and objective horizontal mismatch show that the two variables measure different things, as was already evident from their differing incidences (Table 3). The few workers that identify themselves as horizontally mismatched earn substantially less, but not working in one's learned occupation is frequent and barely relevant to one's wage. A likely explanation for this is that workers are mobile on the labor market and often change jobs and occupations voluntarily, not least because they can earn more in new jobs.

How do these results for Switzerland compare to results in the literature? Robst (2007) found wage penalties of more than 10% for subjective horizontal mismatch. Our results on subjective horizontal

[10] Results of the first model are statistically equal when performed in the full sample and the bio subsample.

mismatch are similar in size if we control for objective mismatch as well, and somewhat smaller if not. However, Robst's definition of mismatch is not identical to ours: Robst (2007) uses a subjective measurement of how well earlier education and work fit today, whereas our subjective mismatch variable takes further sources of skills development, such as further education and training, into account. Nordin *et al.* (2010) found wage penalties for not working in an occupation close to one's education in Sweden of 19.5% for men and 12.2% for women. Our estimates are much lower, and there is a penalty only when controlling for current occupation.

5.3 Fixed Effects Mismatch Wage Effects

Ability, motivation, and personality are major factors influencing the wages of individuals. However, these characteristics are difficult to observe. It is likely that these factors are also correlated with the probability of horizontal mismatch. Not accounting for them will bias the pooled OLS estimates reported above. Nordin *et al.* (2010) use cognitive test scores provided by the military for the subsample of men as a proxy variable for ability. Including these 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), and Mavromaras *et al.* (2013) use the same method to analyze overeducation. We perform the same Mincerian wage regressions as in the pooled OLS version, applying time-demeaning to all variables.

Controlling for time-invariant unobservables has a large impact on the subjective horizontal mismatch estimate, as Table 7 shows: The penalty is small and insignificant in all estimation models. The wage effect of being overqualified is also smaller in fixed-effects regression than in OLS. Being underqualified has no statistically significant wage effect. Finally, the wage effect for objective horizontal mismatch also becomes insignificant when applying fixed effects instead of OLS. We find no evidence that, on average, working in another occupational 2-digit field than that learned has any effect on wages.[11]

The change in effects induced by estimating fixed effects instead of OLS are noteworthy. The decreasing wage effects for overeducation are in line with, for instance, Bauer (2002) and Tsai (2010), who find insignificant wage effects when using fixed-effects regression. The decrease in wage effects for horizontal mismatch are even more pronounced. Our results suggest that OLS estimates suffer from omitted variable bias: mismatched workers differ in relevant yet unobserved personal characteristics from matched workers. We finally check whether FE estimates vary by age, but all horizontal mismatch

[11] According to Tables 8 and 9 the same holds for 1-digit and 3-digit fields, respectively. Moreover, all results are available with an alternative coding scheme, the Swiss Occupation Nomenclature, in Table 10.

estimates are insignificant for workers below and above age 45 alike.

5.4 Wage Effects by Education Groups

The small to insignificant results for wage effects of horizontal mismatch in fixed estimations may mask heterogeneous results for different education groups. Therefore, we test whether the specificity of educational programs has an impact on the wage effects of mismatch. For the three education groups – VET, tertiary B, and tertiary A – we estimated the same wage regressions as in columns (6) of Tables 6 and 7. We present regression results graphically because visual perception allows more efficient comparisons between the different groups.[12]

Figure 1 only shows the wage effects of the fixed-effects regression, since OLS results are likely to suffer from bias. A further advantage of fixed-effects regression is that, if selection into different education groups is driven by time-invariant variables such as ability or personality, it removes bias due to selection. Each point in the graph visualizes the point estimate of the marginal effect of the mismatch variable in the wage regression; the thinner line shows the 95% confidence interval and the thicker line the 90% confidence interval. None of the mismatch variables show a significant effect for any education subgroup.

In sum, the average wage effects for horizontal mismatch, subjective and objective, do not differ significantly between education groups. This finding does not support the hypothesis in the literature that the specificity of an education determines the wage effect of horizontal mismatch. It also indicates that vocational education (apprenticeship and tertiary B) is not overly specific and allows for occupation changes throughout workers' careers.

6 Conclusion

Recent findings suggest that from mid-career, vocational education provides progressively lower earnings than does general education. If this is a general feature of VET, it should harm Switzerland, where two thirds of young people take a firm-based apprenticeship. This study investigated whether horizontal skills mismatch is a mechanism that leads to wage penalties and may thus explain findings of wage gaps between vocational and general education.

We find that subjective horizontal mismatch is rare but associated with sizeable wage penalties in OLS estimations. The wage penalties become small when we account for individual fixed effects, which means that the OLS wage effects are likely caused by unobserved characteristics of the mismatched. Objective mismatch is frequent but has small wage effects in OLS and is insignificant in

[12] Detailed results are available in Table 11.

fixed-effect estimations. Finally, we do not find significant wage penalties for either subjective or objective mismatch for any education group, including workers with vocational education, in fixed-effects estimations.

Thus, we cannot confirm the hypothesis that Switzerland's strongly vocational education system produces horizontal mismatches that lead to large wage penalties. This speaks in favor of an efficient allocation of skills and tasks in the Swiss labor market, at least on average. This result has two likely explanations: First, vocational education seems on average to be sufficiently transferable to allow occupation changes during working careers in Switzerland. Second, many possibilities exist for regular updating of qualifications, for instance through nonformal continuing education and on-the-job training. Our results are also consistent with international studies that find relatively favorable mid- and long-term career outcomes for workers with vocational education backgrounds, such as Malamud and Pop-Eleches (2010) and Brunello and Rocco (2017).

However, several caveats should be mentioned from conceptual and methodological perspectives on horizontal mismatch. Firstly, there are striking contrasts between the two measures of horizontal mismatch. This reflects findings in the literature – Malamud (2011) finds a similarly high proportion of objective mismatch in England, between 44 and 63% depending on the width of the occupational classification used. Studies based on subjective assessment find lower rates (Somers *et al.*, 2018). Secondly, these differences in incidence are a result of conceptual differences: comparing formal education and current occupation is a static concept that does not take into account the heterogeneity of occupations, educations, and skills. Furthermore, it does not account for skills updating by individuals during their working lives. The high incidence of working in an occupation other than that originally learned and the insignificant wage penalties we found suggest that the concept of objective horizontal mismatch is not ideally suited to analyzing the dynamic and widespread phenomenon of occupational mobility. As such mobility is both voluntary and involuntary, our insignificant wage effects may be caused by heterogeneous wage effects that net out to zero. Our subjective measure of horizontal mismatch leads to higher OLS wage penalties, which may indicate that individuals are better able to identify a true qualification mismatch than the rather approximate objective measure. Thirdly, the subjective measure is, however, very sensitive to a change in the estimation method from OLS to fixed effects, which suggests that most of the wage penalty found in OLS reflects the selectivity of the group of mismatched workers.

Seeing the challenges of labor market dynamics and selective mobility in analyzing horizontal mismatch, we suggest that the mechanisms that lead to horizontal mismatch be addressed more explicitly. In a similar vein, Somers *et al.* (2018) recommend using actual measures of workers'

skills. In addition, we propose focusing on mismatch that is caused by labor demand shocks. Such an approach would exclude voluntary labor market mobility, which is conceptually unrelated to the idea of mismatch, and could provide insights into how workers are affected by mismatch when the technological or competitive environment changes in their domain of work.

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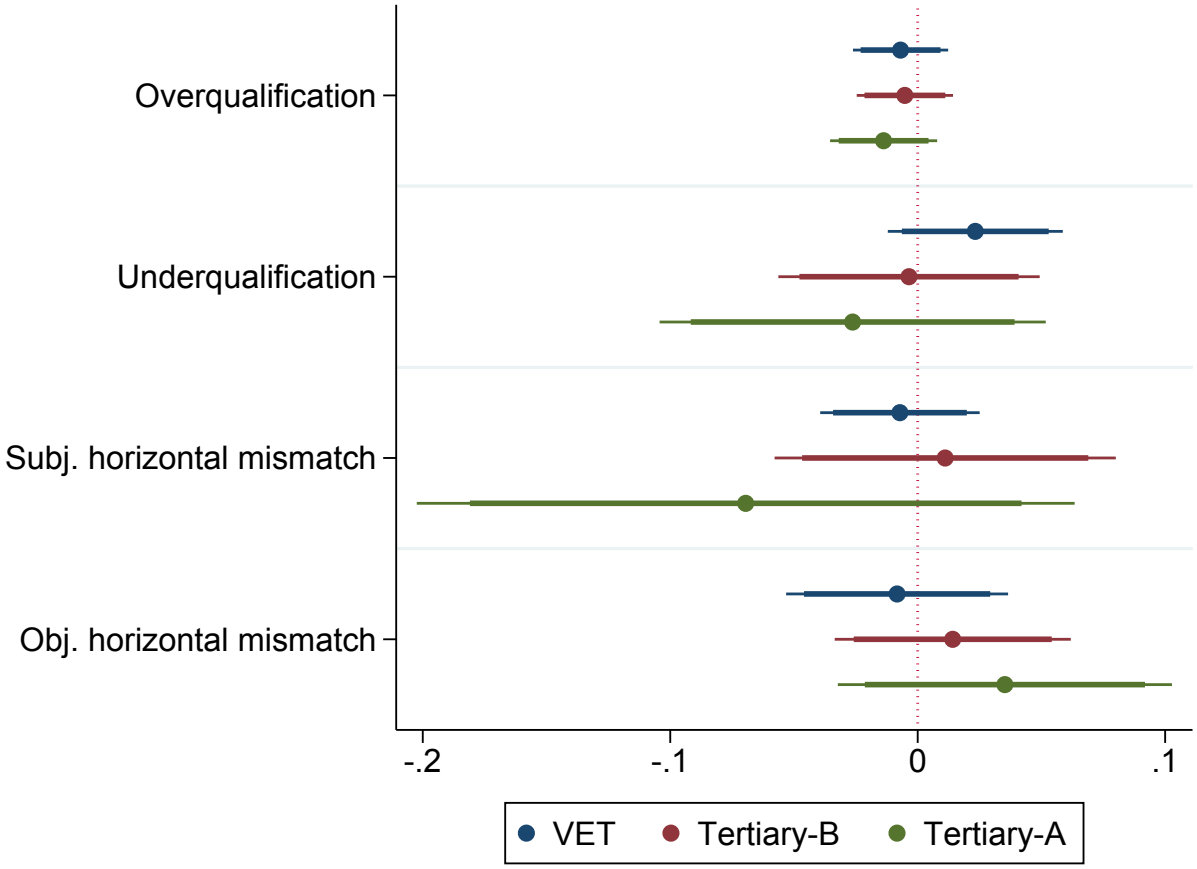
Figures

Figure 1: Estimated coefficient by educational categories



Fixed-effect coefficients estimated separately using the bio subsample. The thin lines indicate the 95% confidence level, the thicker lines the 90% confidence level.

Tables

Table 1: Descriptive statistics for subjective mismatch

	Suitable	Horizontal mismatch	Overqualification	Underqualification	N
Total	81.12	2.37	15.05	1.46	24,373
Age 20-34	78.56	3.57	16.11	1.75	5,542
Age 35-49	81.46	2.21	14.85	1.47	10,859
Age 50-65	82.43	1.74	14.59	1.24	7,972
Married	81.92	2.15	14.59	1.31	15,783
Not married	79.65	2.76	15.92	1.68	8,589
Swiss	81.71	2.19	14.71	1.39	21,905
Foreign	75.91	3.93	18.09	2.07	2,466
VET	81.64	3.32	13.06	1.97	10,648
Tertiary-B	82.75	1.58	14.43	1.23	7,451
Tertiary-A	78.29	1.67	19.17	0.86	6,274
<30,000	70.07	9.49	20.44	0.00	137
30,001-50,000	70.51	7.23	19.00	3.26	1,258
50,001-80,000	78.04	3.34	16.55	2.07	7,135
80,001-100,000	81.14	1.94	15.38	1.54	5,775
100,001-150,000	84.39	1.19	13.66	0.76	7,387
>150,000	85.79	1.31	12.09	0.82	2,681
50-79% employment	72.41	3.37	23.01	1.20	1,334
50-100% employment	81.31	2.01	15.24	1.44	1,942
100% employment	81.65	2.34	14.53	1.48	21,097
N (person-year obs.)	19,771	577	3,669	356	24,373

Notes: Working males aged 20 to 65, sample trimming described in section 4. Source: Swiss Household Panel 1999-2016.

Table 2: Descriptive statistics for objective mismatch

	learned = current occupation	learned ≠ current occupation	N
Total	49.94	50.06	10,674
Age 20-34	55.27	44.73	1,547
Age 35-49	51.96	48.04	4,938
Age 50-65	45.93	54.07	3,708
Married	51.28	48.72	7,519
Not married	47.42	52.58	2,674
Swiss	50.11	49.89	9,306
Foreign	51.97	48.03	887
VET	45.47	54.53	4,011
Tertiary-B	46.90	53.10	3,550
Tertiary-A	62.12	37.88	2,632
<30,000	41.03	58.97	39
30,001-50,000	48.87	51.13	399
50,001-80,000	51.80	48.20	2,695
80,001-100,000	50.76	49.24	2,356
100,001-150,000	49.74	50.26	3,406
>150,000	48.31	51.69	1,298
50-79% employment	53.17	46.17	568
50-100% employment	56.24	43.76	713
100% employment	49.61	50.39	8,912
N (person-year obs.)	5,124	5,069	10,193

Notes: Working males aged 20 to 65, sample trimming described in section 4. Source: Swiss Household Panel 1999-2016.

Table 3: Subjective and objective mismatch

	Row percentage			Column percentage		
	learned = current	learned ≠ current	Total	learned = current	learned ≠ current	Total
Suitable	50.61	49.39	100.00	80.99	79.90	80.45
Horizontal mismatch	23.74	76.26	100.00	0.92	2.98	1.94
Overqualification	51.59	48.41	100.00	16.49	15.64	16.07
Underqualification	52.23	47.77	100.00	1.60	1.48	1.54
Total	50.27	49.73	100.00	100.00	100.00	100.00

Notes: Working males aged 20 to 65 in the bio subsample, sample trimming described in section 4. Source: Swiss Household Panel 1999-2016, own calculations.

Table 4: Transition probabilities of subjective mismatch from period$[t]$ to period$[t+1]$

	Suitable $[t+1]$	Horizontal mismatch $[t+1]$	Overqualified $[t+1]$	Underqualified $[t+1]$	Total
Suitable$[t]$	89.65	1.55	7.65	1.15	100.00
Horizontal mismatch$[t]$	60.32	20.41	18.37	0.91	100.00
Overqualification$[t]$	42.82	2.44	53.78	0.96	100.00
Underqualification$[t]$	64.91	4.91	14.04	16.14	100.00
Total	80.47	1.85	16.27	1.40	100.00

Notes: Working males aged 20 to 65, sample trimming described in section 4. $t = 2016$ excluded because we cannot observe any future transition for this year. Moreover, we exclude the last year a person is in the sample because we cannot observe any future transition in this case either. Source: Swiss Household Panel 1999-2016, own calculations.

Table 5: Transition probabilities of ISCO-2d mismatch from period[t] to period[$t+1$]

	learned = current[$t+1$]	learned ≠ current[$t+1$]	Total
learned=current[t]	95.59	4.41	100.00
learned ≠ current[t]	3.06	96.94	100.00
Total	50.03	49.97	100.00

Notes: Working males aged 20 to 65 in the bio sub-sample, sample trimming described in section 4. $t = 2016$ excluded because we cannot observe any future transition for this year. Moreover, we exclude the last year a person is in the sample because we cannot observe any future transition in this case either. Source: Swiss Household Panel 1999-2016, own calculations.

Table 6: OLS estimations

Log annual wage	(1)	(2)	(3)	(4)	(5)	(6)
Subjective mismatch						
Overqualification	-0.054***		-0.045***	-0.042***		-0.033**
	(0.008)		(0.014)	(0.008)		(0.013)
Underqualification	-0.061***		-0.057**	-0.050***		-0.040*
	(0.016)		(0.025)	(0.015)		(0.023)
Horizontal mismatch	-0.088***		-0.131***	-0.070***		-0.105***
	(0.017)		(0.026)	(0.015)		(0.025)
Objective mismatch						
Horizontal mismatch		0.027**	0.030**		-0.024	-0.021
		(0.013)	(0.013)		(0.014)	(0.014)
Constant	8.994***	8.988***	9.017***	9.052***	9.078***	9.100***
	(0.059)	(0.105)	(0.103)	(0.061)	(0.113)	(0.112)
Personal controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Current occupation	No	No	No	Yes	Yes	Yes
R-squared	0.576	0.573	0.577	0.613	0.615	0.617
Observations	24373	10193	10193	24373	10193	10193

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Controls are foreign, children, married, age, age^2, linguistic region, education, director, supervisor, temporary contract, employment in %, industry, and firm size.

Table 7: FE estimations

Log annual wage	(1)	(2)	(3)	(4)	(5)	(6)
Subjective mismatch						
Overqualification	-0.016***		-0.010	-0.014***		-0.008
	(0.005)		(0.006)	(0.005)		(0.006)
Underqualification	-0.003		0.010	-0.004		0.010
	(0.011)		(0.015)	(0.010)		(0.015)
Horizontal mismatch	-0.007		-0.026	-0.008		-0.028
	(0.010)		(0.019)	(0.010)		(0.019)
Objective mismatch						
Horizontal mismatch		0.005	0.006		0.018	0.019
		(0.011)	(0.011)		(0.015)	(0.015)
Constant	9.747***	10.624***	10.636***	9.759***	10.605***	10.622***
	(0.370)	(0.598)	(0.599)	(0.368)	(0.598)	(0.599)
Personal controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Current occupation	No	No	No	Yes	Yes	Yes
R-squared	0.383	0.447	0.448	0.389	0.455	0.456
Observations	24373	10193	10193	24373	10193	10193

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Controls are foreign, children, married, age, age^2, linguistic region, education, director, supervisor, temporary contract, employment in %, industry, and firm size.

Table 8: OLS/FE regression results, ISCO 1-digit

	OLS				FE			
Log annual wage	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Subjective mismatch								
Overqualification		-0.045***		-0.033**		-0.009		-0.008
		(0.014)		(0.013)		(0.006)		(0.006)
Underqualification		-0.056**		-0.041*		0.010		0.010
		(0.025)		(0.023)		(0.015)		(0.015)
Horizontal mismatch		-0.130***		-0.106***		-0.026		-0.027
		(0.026)		(0.024)		(0.019)		(0.019)
Objective mismatch								
Horizontal mismatch	0.028**	0.030**	-0.021	-0.019	0.008	0.009	0.018	0.018
	(0.013)	(0.013)	(0.015)	(0.015)	(0.012)	(0.011)	(0.017)	(0.017)
Constant	8.987***	9.016***	9.079***	9.102***	10.614***	10.624***	10.574***	10.589***
	(0.105)	(0.104)	(0.113)	(0.112)	(0.597)	(0.598)	(0.597)	(0.598)
Personal controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Current occupation	No	No	Yes	Yes	No	No	Yes	Yes
R-squared	0.573	0.577	0.615	0.617	0.447	0.448	0.455	0.456
Observations	10193	10193	10193	10193	10193	10193	10193	10193

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Controls are foreign, children, married, age, age^2, linguistic region, education, director, supervisor, temporary contract, employment in %, industry, and firm size.

Table 9: OLS/FE regression results, ISCO 3-digit

	OLS				FE			
Log annual wage	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Subjective mismatch								
Overqualification		-0.045***		-0.033**		-0.010		-0.008
		(0.014)		(0.013)		(0.006)		(0.006)
Underqualification		-0.057**		-0.041*		0.010		0.010
		(0.025)		(0.023)		(0.015)		(0.015)
Horizontal mismatch		-0.132***		-0.106***		-0.027		-0.029
		(0.026)		(0.025)		(0.019)		(0.019)
Objective mismatch								
Horizontal mismatch	0.027**	0.030**	-0.014	-0.011	0.017	0.018	0.036**	0.037**
	(0.013)	(0.013)	(0.014)	(0.014)	(0.013)	(0.013)	(0.016)	(0.016)
Constant	8.991***	9.020***	9.069***	9.092***	10.653***	10.666***	10.644***	10.660***
	(0.105)	(0.103)	(0.113)	(0.112)	(0.600)	(0.601)	(0.600)	(0.601)
Personal controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Current occupation	No	No	Yes	Yes	No	No	Yes	Yes
R-squared	0.573	0.577	0.615	0.617	0.448	0.448	0.456	0.456
Observations	10193	10193	10193	10193	10193	10193	10193	10193

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Controls are foreign, children, married, age, age^2, linguistic region, education, director, supervisor, temporary contract, employment in %, industry, and firm size.

Table 10: OLS/FE regression results, SBN 2-digit

	OLS				FE			
Log annual wage	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Subjective mismatch								
Overqualification		-0.044***		-0.033**		-0.009		-0.008
		(0.014)		(0.013)		(0.006)		(0.006)
Underqualification		-0.056**		-0.041*		0.011		0.010
		(0.025)		(0.023)		(0.015)		(0.015)
Horizontal mismatch		-0.132***		-0.106***		-0.026		-0.027
		(0.025)		(0.024)		(0.019)		(0.019)
Objective mismatch								
Horizontal mismatch	0.035***	0.037***	-0.013	-0.011	-0.001	-0.000	0.006	0.006
	(0.013)	(0.013)	(0.014)	(0.014)	(0.014)	(0.014)	(0.017)	(0.017)
Constant	8.996***	9.025***	9.066***	9.090***	10.613***	10.626***	10.599***	10.615***
	(0.104)	(0.103)	(0.113)	(0.112)	(0.599)	(0.600)	(0.599)	(0.600)
Personal controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Current occupation	No	No	Yes	Yes	No	No	Yes	Yes
R-squared	0.574	0.578	0.615	0.617	0.447	0.448	0.455	0.456
Observations	10193	10193	10193	10193	10193	10193	10193	10193

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Controls are foreign, children, married, age, age^2, linguistic region, education, director, supervisor, temporary contract, employment in %, industry, and firm size.

Table 11: OLS/FE regression results by educational cohorts

	VET		Tertiary-B		Tertiary-A	
	OLS	FE	OLS	FE	OLS	FE
Log annual wage	(1)	(2)	(3)	(4)	(5)	(6)
Subjective mismatch						
Overqualification	-0.020	-0.007	-0.048***	-0.005	-0.037	-0.014
	(0.018)	(0.010)	(0.018)	(0.010)	(0.028)	(0.011)
Underqualification	-0.031	0.023	-0.011	-0.004	-0.111	-0.026
	(0.028)	(0.018)	(0.037)	(0.027)	(0.069)	(0.040)
Horizontal mismatch	-0.084***	-0.007	-0.027	0.011	-0.160*	-0.070
	(0.022)	(0.016)	(0.042)	(0.035)	(0.085)	(0.068)
Objective mismatch						
Horizontal mismatch	-0.025	-0.008	-0.033	0.014	-0.023	0.035
	(0.020)	(0.023)	(0.022)	(0.024)	(0.035)	(0.034)
Constant	9.096***	9.748***	9.435***	11.299***	8.504***	10.095***
	(0.136)	(1.155)	(0.208)	(0.917)	(0.236)	(1.121)
Personal controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Current occupation	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.567	0.405	0.514	0.464	0.573	0.492
Observations	4011	4011	3550	3550	2632	2632

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Controls are foreign, children, married, age, age^2, linguistic region, education, director, supervisor, temporary contract, employment in %, industry, and firm size.