

Sedláček, Jan; Zelenka, Martin

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The effects of education-job (mis)match on the earnings of graduates in the Czech Republic

Jan Sedláček, Martin Zelenka¹

This paper deals with the effects of education-job (mis)match on the earnings of higher education graduates in the context of higher education expansion and different phases of the economic cycle in the Czech Republic in 2006–2018. It aims to contribute to knowledge about the effects of education-job (mis)match on earnings in two ways. First, it concentrates on both the vertical and the horizontal dimensions of education-job (mis)match. Second, it considers the effects of contextual variables: the share of graduates in the population and the unemployment rate of graduates. The paper is based on assumptions derived from assignment theory. The authors use data of graduates' self-evaluation collected in national and international graduate surveys – REFLEX, REFLEX 2010, REFLEX 2013, and Absolvent 2018. The data for contextual variables come from Eurostat and the Czech Statistical Office. The analyses focus on graduates four to five years after graduation. They are examined both as a whole and in groups based on the field of study using the method of weighted least squares. Overeducation usually has significant negative effects on earnings. Horizontal match effects are contradictory. The education-job (mis)match effects are relatively small in comparison with other factors. The role of contextual variables is mostly predictable, however, some exceptions uncover specifics of the labour market in the Czech Republic. There are important differences among groups of graduates in different fields of study.

Keywords: education-job (mis)match, earnings, graduates, higher education, labour market

JEL classification: I23, J20, J21, J23, J24, J30

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Introduction

Many scholars have researched the economic role played by formal education. Higher education systems are expected to produce graduates with the skills to succeed on the labour market. The development of the higher education system both in the quantity and the structure of graduates arises the questions to what extent the outputs of higher education institutions in their education role meet the needs of the labour market and what penalties are for graduates for the imbalance between supply and demand on the labour market.

¹ Centre for Higher Education Studies, Jankovcova 933/63, 170 00 Praha 7, Czech Republic, sedlacek@csvs.cz, martin.zelenka@pedf.cuni.cz

This paper analyses the effects of education–job (mis)match on the earnings of higher education graduates in the early stage of their careers (four to five years after graduation) in the Czech Republic in 2006–2018. It strives to contribute to knowledge about the effects of education–job (mis)match on earnings. First, it considers not only the vertical dimension of education–job (mis)match (level of education) but also the horizontal dimension (field of study) which is in general underestimated in the Czech Republic. Second, it aims to include contextual variables (the share of higher education graduates in the population and the unemployment rate of higher education graduates) whose influence on the earnings and on the effects of education–job (mis)match on the earnings of graduates has scarcely been a subject of previous studies. Third, the results of analyses offer an opportunity to compare the effects of different factors on earnings which are included into analyses in addition to the above mentioned, such as sex, region, level of higher education etc.

The text is structured as follows. First, we conduct a review of the literature on the effects of job (mis)match on graduate earnings, also covering relevant theories. Following the literature review are sections devoted to the research questions, the data and the context in the Czech Republic. The next section contains our main analyses. It covers the methodology, computations and results connected to the research questions. The final section concludes the findings.

A review of literature

In general, the research in the effects of education–job (mis)match on the earnings often naturally emphasizes the over-education and under-education dimension, i.e. the effects of vertical (mis)match on earnings in the sense of time investment in formal education which quantifies the key characteristics of the labour supply. Second, the problem of horizontal (mis)match and its relation to the earnings is solved as another factor connected to the structure of the outputs of education systems.² Taking into consideration frequently quoted publications about this research topic, they try to answer the question about the benefits and penalties of the education–job (mis)match, in other words, they focus on the level of earnings and the return of investment into education in their absolute and relative values.

Examining vertical education–job mismatch, Duncan and Hoffman (1981) find out that “surplus” education of overeducated U.S. workers brings economic benefits. However, the individual return decreases considerably. Verdugo and Verdugo (1989) conclude that overeducated workers have lower earnings than those not overeducated, which was tested at the time of increasing supply of tertiary-educated workers. The findings contradict the idea that relatively higher education means higher productivity and higher earnings. Sloane, Battu and Seaman (1999) find out (for the first time analysing over- and under-education in the UK) that there is a “benefit from the surplus education in terms of a positive return” (Sloane, Battu and Seaman 1999), however, there is a penalty for the overeducated because the return is smaller than in the case of a perfect match. On the background of the arising number of the higher education UK graduates, McGuinness and Sloane (2009) try to answer a relevant question whether the labour market is able to

² The skill (mis)matches are not within the scope of this paper.

absorb them. They find out that the mismatch arises and in general there are considerable wage penalties for over-educated graduates. However, the wages are often traded off with other priorities such as work-family balance etc. Bauer (2002) presents similar results in his panel analysis set in Germany. The education-job mismatch means lower wages for the overeducated and higher wages for the undereducated in comparison to the workers fully utilizing their education. Among some valuable outputs concerning this topic in the context of the Czech Republic can be named Mysíková (2016) providing an estimation of the effect of vertical (mis)match (defined and computed on the basis of three different methodologies) on the wages using two models of Verdugo and Verdugo (1989) and Duncan and Hoffman (1981) which are applied on the data sets of SILC and PIAAC. Some of the findings were that overeducated workers earn more and undereducated workers less than their co-workers with the required education. And overeducated workers earn less and undereducated more than the workers “with the same education whose jobs match their education level” (Mysíková 2016).

Horizontal education-job mismatch is examined e.g. by Robst (2007) who concentrates on the match of the field of study in college with the employment. He states that workers with a mismatched job earn less than those working in a matched job and pays attention to a comparison of different wage effects among the fields of study. For example, the graduates of liberal arts, which emphasize general skills, work more likely in a mismatched occupation but have „relatively low costs to be mismatched.“ (Robst 2007) Montt (2015) focuses both on the demand and supply factors while analysing the field of study mismatch and its impact on wages, risk of being out of work and job satisfaction in cross-country comparisons. He takes into consideration saturation of the labour market with workers of a particular field of study and the level of generic skills of a field of study which predict the occurrence of field of study mismatch. He highlights the wage penalty of field of study mismatch connected to overqualification. Kelly, O’Connell and Smyth (2010) present results that over-educated higher education graduates earn less than their counterparts working in well-matched jobs, which also holds for horizontal mismatch (especially for Education graduates). The effect of over-education is relatively higher. Nordin, Persson and Rooth (2010) set their analysis in Sweden and prove for example that “the rather specialized university/college” probably contributes to the income penalty while working in a field of study mismatched occupation and that work experience partly decreases the income penalty while contributing to overcoming the lack of education-specific skills. Kim, Ahn and Kim (2016) broaden the analyses of the relations of both vertical and horizontal mismatch to the workers (with higher education) divided by the amount of income in the South Korean labour market context. They find the correlation between over-education and horizontal mismatch and conclude that the penalty of over-education is overestimated if horizontal match is ignored. The income penalty of over-education applies almost to all the workers, the income penalty arising from horizontal mismatch is significant for lower income workers. Both horizontal and vertical (mis)match and their influence on the earnings is partly touched by Czech sociologists Katrňák and Doseděl (2019) while examining the education and characteristics of occupation quantified by the International Socio-economic Index of Occupational Status (one of its components is related to the income) in the course of educational expansion. They found out (in analysis including 30 countries), inter alia, that “the role of study field changed during this time of educational expansion, with natural science, computer, and

IT study fields growing stronger than other fields of study” (Katrňák and Doseděl, 2019) and paid attention to the possible role of the context.

To frame the paper into a theoretical concept, the basis of three fundamental or prevailing theories used for the research on the education-job (mis)match in relation to the earnings, as Montt (2015) summarized, deserve attention. The theories are *human capital theory*, *job-competition theory* and *assignment theory*.³ (Hartog 2000 in Montt 2015) *Human capital theory* is based on the assumption that education is a key component of human capital in which people invest time and money which results in improved productivity and higher earnings in future (Becker 1964). Thus, the characteristics of the labour supply are emphasized. The mismatch in terms of not using the level of education means a decrease in the revenue from the investment in human capital. According to Montt (2015) “human capital theories predict that the mismatches are temporary (and firms adapt to labour supply)”. *Job competition theory* (Thurow 1975) in contrast to the human capital theory proposes that the job characteristics determine the productivity and earnings. The workers “line up in a hiring queue” (Montt 2015) according to their education and other criteria which are relevant to the available vacancies. If there are not enough job-seekers with the education required, the employers accept others in the queue and thus the education-job mismatch occurs. Therefore “job-competition theories predict that there are no wage penalties associated with mismatch (and workers adapt to labour demand).” (Montt 2015) *Assignment theory* (Sattinger 1993) is an “intermediate” (Montt 2015) concept which considers both demand and supply factors important for the allocation process and productivity of a job. (Sattinger 1993 in Montt 2015) Workers try to achieve income or utility maximisation and thus they choose particular jobs over others, however, “in equal importance, jobs or groups of occupations available to workers and the mechanism that assigns workers to jobs need to be considered.” (Montt 2015) The productivity and wages “depend on the quality of the match between the job and the worker” (Montt 2015) whose likelihood is a result of the demand and supply of workers.

Since the paper takes into consideration factors of labour demand and supply, *assignment theory* is the basis for the following analyses whose results allow considerations about the relevance of achieving education-job match (both in the level of education and field of study) in connection to earnings in the changing context.

Research questions

As already mentioned, the purpose of the paper is to contribute to knowledge of the effects of education-job (mis)match on earnings in two ways. First, it concentrates not only on the vertical (level of education) but also on the horizontal (field of study) dimension of education-job (mis)match which enables to consider the specifics of graduates in different fields of study in the Czech Republic. Second, it tries to involve contextual variables – the share of tertiary graduates in the population and unemployment rates of higher education graduates. The role of these contextual variables in connection with the effects of education-job (mis)match on earnings deserves more attention, since this topic has not been satisfactorily developed yet. In addition, the results of analyses enable us to compare

³ Other theories explaining education-job (mis)match or its effects on earnings are not included because their principles are not used directly in this paper.

the effects of different factors on the earnings of graduates. The research questions are formulated as follows and are analysed for graduates as a whole and for individual groups based on the field of study:

Education-job (mis)match effects

1. *What are the effects of education-job (mis)match on the earnings of higher education graduates in the Czech Republic?*

Contextual variables effects

2. *What are the effects of unemployment on the earnings of higher education graduates in the Czech Republic?*
3. *What are the effects of graduates' shares in the population on the earnings of higher education graduates in the Czech Republic?*

Effects of the interactions of education-job (mis)match and contextual variables

4. *Do unemployment rates influence the effects of education-job (mis)match on the earnings of higher education graduates in the Czech Republic?*
5. *Do shares of graduates in the population influence the effects of education-job (mis)match on the earnings of higher education graduates in the Czech Republic?*

Comparison of the effects connected with other selected factors

6. *What are the effects of education-job (mis)match on the earnings of higher education graduates in comparison with the other selected factors in the Czech Republic?*

Data and samples

As mentioned above, unlike most of the authors who use data from one field period, we try to cover more periods to follow the differences in the course of time. The data used in this study come from four graduate surveys (REFLEX, REFLEX 10, REFLEX 2013 and Absolvent 2018) which were carried out in the Czech Republic in the frame of national or international projects.

The analyses are based mainly on the self-assessment of graduates⁴. The topic, the focus and the methodology of all these four surveys were very similar, however, some preparations had to be made to secure the comparability of surveys which resulted in a decrease of the number of graduates included in computations in each of the individual surveys. Thus, the final datasets include only graduates meeting all the following criteria:

- were approximately four to five years after graduation (more precisely graduates of 2001 and 2002 for 2006 survey, graduates from 2005 and 2006 for 2010 survey, graduates from 2008 and 2009 for 2013 survey and graduates from 2013 and 2014 for 2018 survey),
- had BA-level and MA-level degrees (level 6 and 7 according to ISCED 2011, excluding higher professional schools),

⁴ The term “graduates” means “higher education graduates” as defined in this section unless otherwise stated.

- graduated from a public higher education institution,
- did not get any additional degree later,
- were no longer enrolled in a degree programme and were working at the time of the surveys,
- had valid answers to all questions used in our analysis,

to stay within the context of the Czech Republic, only the respondents who received their degree from Czech public higher education institutions and were working in the Czech Republic at the time of surveys are included.

Table 1: Basic information on graduate surveys

Name	Target group	Field phase	Number of respondents	Method of questioning	Further information
REFLEX 2006	Higher education graduates of 2001 and 2002	Spring 2006	6794	Paper questionnaire	(Allen, van der Velden 2007) ⁵
REFLEX 2010	Higher education graduates of 2005 and 2006	Spring 2010	8629	Online questionnaire	(Ryška, Zelenka 2011) ⁶
REFLEX 2013	Higher education graduates from 2008 to 2012	Spring 2013	34305	Online questionnaire	(Koucký, Ryška, Zelenka 2014) ⁷
Absolvent 2018	Higher education graduates from 2013 to 2017	Fall 2018	21166	Online questionnaire	(Zelenka, Sedláček, Šmídová, Lounek, Ryška, Koucký 2019) ⁸

The final samples consist of 4392 (REFLEX), 4013 (REFLEX 2010), 4368 (REFLEX 2013) and 5329 (Absolvent 2018) individuals.

While all the surveys included questions about the field of study, different classifications (which were developing considerably in that era) and different approaches were used. The problem of dividing the graduates into groups according to the fields of study had to be solved. It turned out that the most suitable solution was to group individuals based on the field focus of faculties (which tend to be rather specialized in the Czech Republic) they graduated from.

The contextual variables are based on the data of Eurostat and the Czech Statistical Office.

⁵ For more information see:

<http://www.strediskovzdelavacipolitiky.info/default.asp?page=svp&KID=27>

⁶ For more information see:

<http://www.strediskovzdelavacipolitiky.info/default.asp?page=svp&KID=85>

⁷ For more information see:

<http://www.strediskovzdelavacipolitiky.info/default.asp?page=svp&KID=95>

⁸ For more information see: <https://www.csvs.cz/absolvent-2018/>

Context

Figure 1 shows the development of selected indicators describing the general context concerning the higher education and labour market in the Czech Republic in the era of 2001–2018.

There was a significant increase in the *number of higher education graduates* affecting the competition that graduates had to face when entering the labour market. This trend was particularly pronounced in the first decade of the 21st century. Later, approximately since 2013 (at the time when our last monitored cohort of graduates entered the labour market), the numbers of higher education graduates started to decrease quite significantly, mainly due to the demographically declining cohorts of the corresponding population. This trend can be seen in Figure 1 which also shows the share of tertiary graduates in the population aged 25-34. It can be seen to what extent it increased especially until the year 2013. Since then, the growth slowed down significantly and there was even a decline in the year 2018.

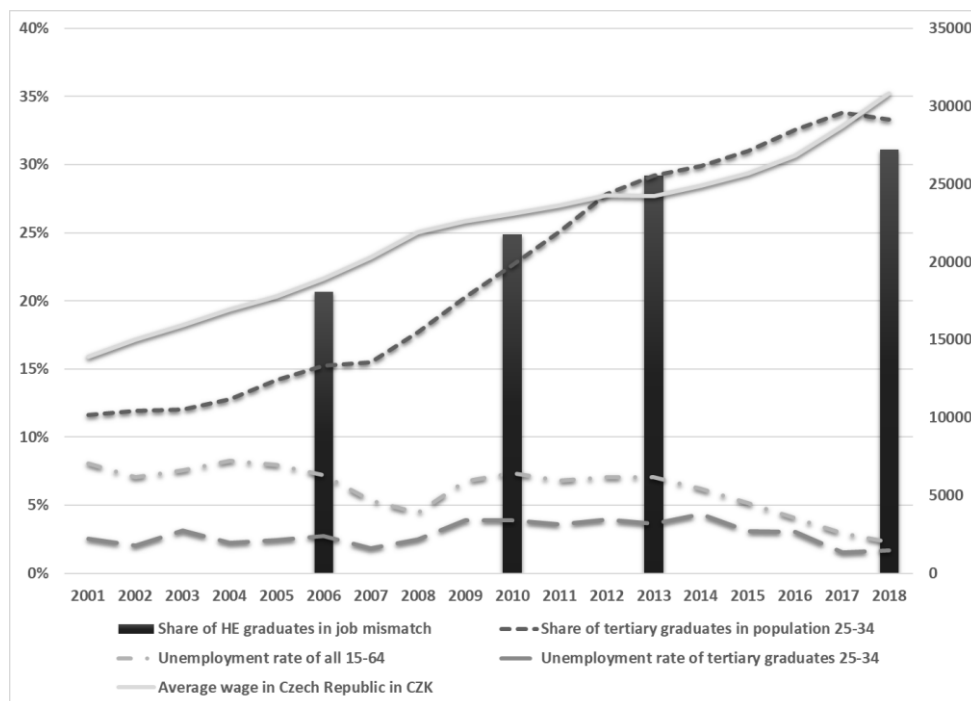
The effects of the *fluctuation of economic cycle* on the conditions on the labour market are visible at the unemployment rates and average earnings. The different cohorts were entering the labour market both at the phase of recession which started in 2008 (increasing the unemployment rates) and expansion which was reaching its peak at the end of the surveyed era causing the lowest unemployment rates in the history of the Czech Republic and the considerable increase of wages.

Each of the monitored cohorts of graduates entered the labour market in different situations. The graduates from the years 2001/2002 graduated before a sharp increase of higher education graduates took place and entered the labour market which still showed a significant shortage of highly skilled labour. The graduates from 2005/2006 started to be affected by increasing numbers of higher education graduates, but at the same time they entered the labour market in a favourable economic situation, which was, however, significantly worse at the time of the survey in 2010. The graduates from 2008/2009 entered the labour market in times when the most numerous cohorts of higher education graduates finished their studies. Moreover, a large part of their four or five years on the labour market took place in a period of a worsened and unstable economic situation. The last cohort, the graduates from 2013/2014 are still a relatively numerically strong group but are followed by significantly smaller cohorts and possibly even more importantly, there is a gradual but significant improvement in the situation on the labour market.

Throughout the era there was a gradual increase in the share of graduates working in education-job mismatch⁹. In a way it copied the growth in a share of tertiary graduates in the population. The trends indicate that the education-job mismatch is more like associated with the characteristics of the supply of the graduates than with the changing conditions on the labour market whose role seems to be overshadowed in this respect.

⁹ It is a share of graduates who are in any type of education-job mismatch, or in other words the share of graduates who are not in full match.

Figure 1: Development of selected indicators in relation to education-job (mis)match in the Czech Republic (2001–2018)



Source: Eurostat, ČSÚ, REFLEX, REFLEX 2010, REFLEX 2013, Absolvent 2018, own calculations

Note: The expression “graduates in education-job mismatch” means graduates who are not in a full match /graduates who are in any type of education-job mismatch.

The selected indicators concerning the graduates in different fields of study¹⁰ are available in appendix 1 and 2. While the absolute numbers have grown immensely, there were not a lot of changes in the field of study structure, which in turn means that the share of tertiary graduates in the population grew in all the fields of study. The fastest growth can be observed in the case of graduates in *Humanities, Social sciences, Theology and Arts*, a change that is driven by the strong feminization of the Czech higher education. A

¹⁰ Differentiation based on the field of study focus of faculties is used. Thus, the seven groups are groups of faculties of the same or similar field of study focus. It was only possible to do it this way as actual fields of study were questioned in different matter throughout the surveys. The division into groups is very much in line with the logic of the ISCED-F 2013 classification. The only differences are that broad fields of Arts and Humanities and Social Sciences, Journalism and Information are merged into one group as well as broad fields of Natural Sciences, Mathematics and Statistics and Information and Communication Technologies (ICTs). The reason for these merges is to make fewer and more robust groups. The ISCED broad group Services is not really used as only very few faculties could be considered to have this focus. Those who could are dispersed into other groups. The names of our groups do not necessarily copy the names of ISCED classification but rather the way the faculties are usually named.

significant increase can be observed in the share of graduates in *Medicine, Pharmacy, Health and Welfare*. It is mostly a result of the number of newly established health and welfare faculties that focus on preparing graduates e.g. for nursing jobs. Compared to other countries, unemployment rates of higher education graduates have always been very low in the Czech Republic basically for all graduates save for the graduates in *Agriculture and Veterinary*. Unemployment rates of these graduates grew the most after the economic crisis in 2008 but improved significantly in the following economic expansion. Also, the average wage has increased greatly in the last years. A similar fact can be said about graduates in *Natural Sciences, ICTs, Electrical Engineering, Chemistry and Technology*. Especially the situation on the labour market of ICTs improved greatly.

A detailed look at the education-job (mis)match shows that while in general there was a decrease of graduates having a full match job, this decrease was larger in some fields of study than in others. Especially a large drop can be observed in the case of graduates of *Agriculture and Veterinary* and *Humanities, Social Sciences, Theology and Arts*. Only a small or no decrease happened in the case of *Natural Sciences, ICTs, Electrical Engineering, Chemistry and Technology, Engineering, Construction and Architecture* and *Medicine, Pharmacy, Health and Welfare*.

Methodology

The decision on the methodology included several steps: discussing the possibilities of making models with regard to data characteristics (a series of cross-sectional data), comparing the methodology with other frequently quoted authors summed up in the literature review with regard to the objectives of this paper, testing basic analytical approaches and checking the assumptions of the methods.

The key question is how to approach the role of the changing context from the methodological point of view. After studying the usual methodology in the publications about this topic, we decided to use regression models. In this sense two options were considered. The first is to create models for each survey's data (general and according to the fields of study) and to interpret the results within the context of the corresponding years. The advantage is that the data set is from one survey and no additional adjustments are needed. The disadvantage is that the context is a too broad category which cannot be clearly interpreted. The comparisons of the β coefficient in models in different years (Sattinger 1993) would help us to follow the results in the changeable context though it would not uncover whether and which factors of the context were significant. At the same time, too many models with the interpretation of their context connected to the specific times or fields of study would have to be presented which might cause confusion.

The second option is to create models which would use merged data of all the surveys and to construct indicators for specified context dimensions (unemployment rates and the share of tertiary graduates) and include them into one model as contextual variables. The disadvantage is that the data from the individual surveys have to be adjusted mainly because of different target groups, different classifications of the field of study etc. At the same time, merging data sets might raise doubts whether it is a correct procedure.¹¹ There

¹¹ Series of cross-sectional data sets are used e.g. by Gangl (2002) focusing on changing labour markets and early career outcomes in the period of one decade.

is also a problem with earnings whose nominal values were rising during the period which we decided to solve by using relative earnings as a dependent variable in the models. The advantages are that the contextual indicators might be clearly interpreted, their interactions with other variables can be included and that a relatively lower number of models allow us to concentrate on the main points.

We tested both the approaches. First, models were created in both ways (models for a corresponding year and models with merged data including contextual variables). Then the results of the education-job (mis)match on the earnings of graduates were compared and it was found that the results were similar, which was one of the reasons to merge the data sets for the purpose of this paper.

In principle, the models (multiple linear regression) compare the mismatched graduates to those with full-matched jobs.¹² The full-matched graduates represent the reference category and the three kinds of mismatches (vertical match and horizontal mismatch, vertical mismatch and horizontal match, vertical and horizontal mismatch) are represented by three dummy-variables in the model. With regard to vertical (mis)match, unlike Verdugo and Verdugo (1989) and Duncan and Hofman (1981) we work with one kind of vertical mismatch – over-education, and do not work with a number of years for studies. The dummy variables for (mis)match are based on Montt (2015) model using variables mismatched horizontally only, overeducated only and mismatched both horizontally and vertically (overqualified). All the variables and their abbreviations used in the models are presented in Table 2 and explained in detail below Table 2. There are three groups of independent variables which are added in the following order: education-job (mis)match, contextual and control variables. The analyses make a basis for answering the research questions from two points of view – all graduates and groups of graduates divided by their field study or rather the field focus of their faculties.

Education-job (mis)match effects

$$\log E_i = \beta_0 + \beta_1 HMIS_i + \beta_2 VMIS_i + \beta_3 FMIS_i + \varepsilon_i \quad (1)$$

Education-job (mis)match and the share of tertiary graduates variables effects

$$\log E_i = \beta_0 + \beta_1 HMIS_i + \beta_2 VMIS_i + \beta_3 FMIS_i + \beta_4 SH_t + \varepsilon_i \quad (2)$$

Education-job (mis)match and the unemployment rate variables effects

$$\log E_i = \beta_0 + \beta_1 HMIS_i + \beta_2 VMIS_i + \beta_3 FMIS_i + \beta_4 U_t + \varepsilon_i \quad (3)$$

Education-job (mis)match, contextual and control variables effects

$$\log E_i = \beta_0 + \beta_1 HMIS_i + \beta_2 VMIS_i + \beta_3 FMIS_i + \beta_4 SH_t + \beta_5 U_t + \beta_6 S_i + \beta_7 L_i + \beta_8 A_i + \beta_9 ES_i + \beta_{10} R_i + \varepsilon_i \quad (4)$$

¹² Interactions between the vertical and the horizontal dimensions are not used.

Education-job (mis)match, contextual and control variables effects (only all graduates)

$$\begin{aligned} \log E_i = \beta_0 + \beta_1 HMIS_i + \beta_2 VMIS_i + \beta_3 FMIS_i + \beta_4 SH_t + \beta_5 U_t + \beta_6 S_i & \quad (5) \\ & + \beta_7 L_i + \beta_8 A_i + \beta_9 ES_i + \beta_{10} R_i + \beta_{11} NIECHT_i \\ & + \beta_{12} ECA_i + \beta_{13} AV_i + \beta_{14} MPHW_i + \beta_{15} HSTA_i \\ & + \beta_{16} EP_i + \varepsilon_i \end{aligned}$$

Effects of the interactions of education-job (mis)match with the share of tertiary graduates

$$\begin{aligned} \log E_i = \beta_0 + \beta_1 HMIS_i + \beta_2 VMIS_i + \beta_3 FMIS_i + \beta_4 SH_t + \beta_5 HMIS_i * SH_t & \quad (6) \\ & + \beta_6 VMIS_i * SH_t + \beta_7 FMIS_i * SH_t + \varepsilon_i \end{aligned}$$

Effects of the interactions of education-job (mis)match with the share of tertiary graduates and control variables (all the graduates)

$$\begin{aligned} \log E_i = \beta_0 + \beta_1 HMIS_i + \beta_2 VMIS_i + \beta_3 FMIS_i + \beta_4 SH_t + \beta_5 HMIS_i * SH_t & \quad (7) \\ & + \beta_6 VMIS_i * SH_t + \beta_7 FMIS_i * SH_t + \beta_8 S_i + \beta_9 L_i + \beta_{10} A_i \\ & + \beta_{11} ES_i + \beta_{12} R_i + \beta_{13} NIECHT_i \\ & + \beta_{14} ECA_i + \beta_{15} AV_i + \beta_{16} MPHW_i + \beta_{17} HSTA_i \\ & + \beta_{18} EP_i + \varepsilon_i \end{aligned}$$

Effects of the interactions of education-job (mis)match with the unemployment rate of higher education graduates

$$\begin{aligned} \log E_i = \beta_0 + \beta_1 HMIS_i + \beta_2 VMIS_i + \beta_3 FMIS_i + \beta_4 U_t + \beta_5 HMIS_i * U_t & \quad (8) \\ & + \beta_6 VMIS_i * U_t + \beta_7 FMIS_i * U_t + \varepsilon_i \end{aligned}$$

Effects of the interactions of education-job (mis)match with the unemployment rate of higher education graduates and control variables (only all the graduates)

$$\begin{aligned} \log E_i = \beta_0 + \beta_1 HMIS_i + \beta_2 VMIS_i + \beta_3 FMIS_i + \beta_4 U_t + \beta_5 HMIS_i * U_t & \quad (9) \\ & + \beta_6 VMIS_i * U_t + \beta_7 FMIS_i * U_t + \beta_8 S_i + \beta_9 L_i + \beta_{10} A_i \\ & + \beta_{11} ES_i + \beta_{12} R_i + \beta_{13} NIECHT_i \\ & + \beta_{14} ECA_i + \beta_{15} AV_i + \beta_{16} MPHW_i + \beta_{17} HSTA_i \\ & + \beta_{18} EP_i + \varepsilon_i \end{aligned}$$

Effects of the interactions of education-job (mis)match with the share of tertiary graduates and control variables (only individual fields of study)

$$\begin{aligned} \log E_i = \beta_0 + \beta_1 HMIS_i + \beta_2 VMIS_i + \beta_3 FMIS_i + \beta_4 SH_t + \beta_5 HMIS_i * SH_t & \quad (10) \\ & + \beta_6 VMIS_i * SH_t + \beta_7 FMIS_i * SH_t + \beta_8 S_i + \beta_9 L_i + \beta_{10} A_i \\ & + \beta_{11} ES_i + \beta_{12} R_i + \varepsilon_i \end{aligned}$$

Effects of the interactions of education-job (mis)match with the unemployment rate of higher education graduates (only individual fields of study)

$$\begin{aligned} \log E_i = \beta_0 + \beta_1 HMIS_i + \beta_2 VMIS_i + \beta_3 FMIS_i + \beta_4 U_t + \beta_5 HMIS_i * U_t & \quad (11) \\ & + \beta_6 VMIS_i * U_t + \beta_7 FMIS_i * U_t + \beta_8 S_i + \beta_9 L_i + \beta_{10} A_i \\ & + \beta_{11} ES_i + \beta_{12} R_i + \varepsilon_i \end{aligned}$$

Table 2: Variables

Abbreviation	Type	Definition
logE	continuous	Relative earnings - logarithm of the ratio between full-time gross monthly earnings in the main employment (including overtime, bonus or extra payments) and average wages.
	binary	Education-job (mis)matches - vertical and horizontal match (full match) – reference category, - vertical match and horizontal mismatch (horizontal mismatch) (1 = yes; 0 = no)
HMIS		- vertical mismatch and horizontal match (vertical mismatch) (1 = yes; 0 = no)
VMIS		- vertical and horizontal mismatch (full mismatch) (1 = yes; 0 = no)
FMIS		
SH	continuous	Share of tertiary graduates in age group 25-34 according to the model (all graduates or graduates in specific fields of study)
U	continuous	Unemployment rate of higher education graduates in the population of 25-34 according to the model (all graduates or graduates in specific fields of study)
S	binary	Sex - female (1 = female; 0 = male)
L	binary	Level of higher education - MA-level (1 = MA-level; 0 = BA level)
A	continuous	Age - age of graduates at the time of graduation
ES	binary	Economic sector - private sector (1 = private sector; 0 = public sector)
R	binary	Region - Prague and Central Bohemia (1 = graduates working in Prague and Central Bohemia; 0 = other regions in the Czech Republic)
	binary	Field of study – focus of groups of faculties (fields of study) - Business and Law – reference category - Natural Sciences, ICTs, Electrical Engineering, Chemistry and Technology (1 = yes; 0 = no)
NIECHT		- Engineering, Construction and Architecture (1 = yes; 0 = no)
ECA		- Agriculture and Veterinary (1 = yes; 0 = no)
AV		- Medicine, Pharmacy, Health and Welfare (1 = yes; 0 = no)
MPHW		- Humanities, Social Sciences, Theology and Arts (1 = yes; 0 = no)
HSTA		
EP		- Education and Physical Education (1 = yes; 0 = no)

Relative earnings – is the dependent variable. It is defined as the natural logarithm of the ratio between full-time gross monthly earnings in the main employment (including overtime, bonus or extra payments) and the average wages.¹³ The respondents were also asked about the number of hours worked per week in the main employment. Based on these data, average full-time earnings were calculated. Then the ratio of full-time earnings

¹³ The questions concerning earnings are usually considered to be a sensitive subject. Therefore, respondents had an option not to answer this question in all four surveys. In spite of this fact the response rate was very high – ranging from 92 to 96%.

to the mean wage was calculated. The ratio is used to enable analyses in the time period. In principle, the use of logarithm is based on the approach of Mincer (1974). The natural logarithm of earnings is used in regression models e. g. by Cohn and Kahn (1995), Nordin, Persson and Rooth (2010), Kim, Ahn and Kim (2016). The advantage is that the logarithm of earnings is usually more normally distributed in comparison to the right-skewed distribution of income and solves extreme values.

There are three kinds of independent variables: education-job (mis)match variables, contextual variables and control variables.

Education-job (mis)match variables are the main independent variables in the analysis. Whether a respondent works in a corresponding job is measured with the help of two self-assessment questions. Vertical (mis)match is measured with an indirect self-assessment approach – respondents were asked what level of education they feel is the most appropriate for their work and then over- and under-education is assessed by comparing this level with the actual educational level of the respondent. It should be noted that for the purpose of this analysis, to be vertically mismatched means that a respondent is overeducated. Horizontal (mis)match is measured with a direct self-assessment approach – respondents were asked what field of study they feel is the most appropriate for their work. If their answer was exclusively “own field” or “own or a related field” they are considered to be horizontally matched. If their answer was a “completely different field” or “no particular field” they are considered horizontally mismatched. Four categories are defined – vertical and horizontal match (hereinafter full match), vertical match and horizontal mismatch (horizontal mismatch), vertical mismatch and horizontal match (vertical mismatch) and vertical and horizontal mismatch (full mismatch).¹⁴

The contextual variables vary only over time. In fact, they replace dummies representing the years of data collection (2016, 2010, 2013, and 2018) and they are *unemployment rate of higher education graduates in the population of 25-34* and *share of tertiary graduates in age group 25-34*.

*Unemployment rate of higher education graduates in the population of 25-34*¹⁵ – is a proxy for the labour market situation of young higher education graduates. Because graduates are not influenced only by the current situation but rather by the situation during their whole employment spell, we use the five-year averages (of years prior to the respective survey) of unemployment rates rather than only the rate at the time of data collection. The mean-centered variable is used (to mitigate collinearity) in models where interaction terms are added.

¹⁴ In addition to *self-assessment* approach, there are also other approaches of measuring education-job (mis) matches e.g. *job analysis* which is “a systematic evaluation by professional job analysts who specify the required level (and type) of education, for the job titles in an occupational classification” (Hartog 2000) or *required education* which “is derived from what workers in the respondent’s job or occupation usually have attained, e.g. the mean or the mode of that distribution.” (Hartog 2000) Their comparison is not within the scope of this paper. For more information about different approaches to the measurement of education-job mismatch, please see e.g. Desjardins and Rubenson (2011), Groot and van den Brink (2000), Hartog (2000).

¹⁵ Source: own calculations of VŠPS (Labour force survey) data.

Share of tertiary graduates¹⁶ in age group 25-34 – is a proxy for the level of competition for young higher education graduates' jobs on the labour market. For the “all graduates” model, the share for each year is calculated using Eurostat data. For all the “types of faculties” models, shares are estimated by the shares of graduates who do not continue in their studies at higher education institutions.¹⁷ The mean-centered variable is used in models where interaction terms are added.

There is a set of independent *control variables* which are used in the calculations whose effects are usually significant and most of them have been proved in the context of the Czech Republic. They include *sex, level of higher education, age, economic sector, region and field of study*.

We checked the Gauss Markov assumptions for the ordinary least squares model and found out that there is a problem with heteroscedasticity (White test) and normality of residuals. No problems with multicollinearity (Variance Inflation Factor) and autocorrelation (Durbin–Watson statistic) were identified. To solve the problem with assumptions, the original method of ordinary least squares (OLS) of linear multiple regression was substituted by the method of weighted least squares (WLS).

The selection bias (Heckman 1979), in this case not including unemployed graduates into the models, has to be noted. The models (Heckit or Tobit models) have not been used because the variables about economic inactivity (student status, maternity leave and unemployment etc.) are not comparable (different analytical categories) between the individual surveys and the data sets cannot be adjusted to be comparable in the case of this variable. Unemployment rates from other data source (Czech Statistical Office) are used as one of the contextual variables in the models.

Results

The results of the WLS regression demonstrate that the effects of education-job mismatch on the relative earnings are statistically significant. However, while vertically mismatched and fully mismatched graduates have a clear disadvantage compared to fully matched graduates, horizontally mismatched graduates tend to earn more. Although horizontally mismatched graduates were found to have a significant advantage in four out of five models, it was always relatively small. Overall, the effect of education-job mismatch on the relative earnings explains about 3% of the variance in the relative earnings. Still, the results prove that education-job (mis)match does affect the relative earnings of higher education graduates in the Czech Republic. The most disadvantaged graduates use neither their higher level of education nor the skills specific to their field of study in their jobs. Their decision of getting or lack of success in finding a matching job leads them to having lower paid employment. We also found that graduates who are overeducated but at least work in their field of study are in a similar situation. They are at a clear disadvantage compared to their fully matched colleagues, but they can use their field-specific skills at work and still hope for a promotion or advancement. The slight

¹⁶ Graduates at level 6, 7 and 8 according to ISCED 2011.

¹⁷ The source is <http://www.strediskovzdelavacipolitiky.info/app/navs2010/>. The shares are calculated using graduates who do not continue in their studies 1-2 years after graduation. The calculations are based on graduates of the last five years prior to the year of survey.

advantage of horizontally mismatched graduates can be attributed (as we will show) to some groups of graduates whose full matched jobs are paid below average.

As for the contextual variables, both of them have a significant negative impact in the models where they are together with only education-job (mis)match variables. However, in the case of the share of tertiary graduates, the significance of the effect disappears once additional control variables are added to the equation. Therefore, it seems that a growing share of tertiary graduates in the population does not lead to a decrease of the relative earnings. We assume that the growing relative number of tertiary graduates is accompanied by increased demand for highly skilled workers.

The unemployment rate of higher education graduates has a somewhat stronger effect, yet it explains only about 1% of the relative earnings variance. This effect remained significant even after we added control variables. Therefore, we have found that the higher the unemployment rate of graduates is, the lower their relative earnings are.

Model 4 adds variables that significantly increase R^2 and adjusted R^2 of the model. The variables with the three strongest effects are region (the graduates working in Prague and Central Bohemia earn much more than graduates in other parts of the Czech Republic), sector (the graduates in the private sector earn much more than those in the public sector), and gender (men earn much more than women). Adding the control variables to Model 4 slightly reduces the effect of education-job mismatch and the effect of the unemployment rate, but the effects of these variables are still significant.

The field of study variables added in Model 5 explain about 4% of the additional variance of the relative earnings. Graduates of *Business and Law* have the greatest advantage, whereas graduates of *Humanities, Social Sciences, Theology, and Arts* are at the greatest disadvantage. The negative effects of vertical mismatch and full mismatch on the relative earnings decrease slightly but are still significant.

The results of the WLS regression for graduates of different fields of studies show some similar patterns but also some interesting differences. Across all fields of study and all models (whether contextual and/or control variables are included), the negative effects of being vertically and fully mismatched can be observed. In most cases, the graduates who use neither their level of education nor skills specific to their field of study in their jobs earn the least, but in some cases vertically mismatched graduates are the most disadvantaged. This is especially true of graduates of *Agriculture and Veterinary*. In the case of *Education and Physical Education* graduates, the effects of vertical and full mismatch are the smallest and hover on the brink of statistical significance.

Agriculture and Veterinary graduates together with *Business and Law* graduates form a group where being vertically and fully mismatched has the greatest negative effect and in general where the largest effect of education-job mismatch on the relative earnings can be observed. In contrast, we found a rather small effect in the case of graduates of *Natural Sciences, ICT, Electrical Engineering, Chemistry and Technology* and *Engineering, Construction, and Architecture*.

Table 3: The effect of job mismatch on (log) relative gross monthly earnings, all graduates, WLS regression results, β coefficients

	Model 1	Model 2	Model 3	Model 4	Model 5
Horizontal mismatch ⁽¹⁾	0.032***	0.032***	0.033***	0.011	0.026***
Vertical mismatch ⁽¹⁾	-0.099***	-0.097***	-0.098***	-0.087***	-0.084***
Full mismatch ⁽¹⁾	-0.137***	-0.134***	-0.132***	-0.127***	-0.111***
Share of tertiary graduates		-0.041***		-0.01	-0.008
Unemployment rate			-0.096***	-0.068***	-0.072***
Female				-0.205***	-0.207***
Master programme				0.11***	0.109***
Private sector				0.225***	0.204***
Prague and Central Bohemia				0.269***	0.254***
Age				0.081***	0.094***
Natural Sc., ICTs, Electr. Eng., Chem. and Techn. ⁽²⁾					-0.051***
Engineering, Construction and Architecture ⁽²⁾					-0.132***
Agriculture and Veterinary ⁽²⁾					-0.15***
Medicine, Pharmacy, Health and Welfare ⁽²⁾					-0.06***
Humanities, Social Sc., Theology and Arts ⁽²⁾					-0.172***
Education and Physical Education ⁽²⁾					-0.117***
R ²	0.029	0.031	0.039	0.248	0.290
Adjusted R ²	0.029	0.031	0.039	0.247	0.289
N	16319	16319	16319	16319	16319

Notes: (1) Reference category is Full match. (2) Reference category is Business and Law. (3) Significant: *** at the 1% level; ** at the 5% level; * at the 10% level.

In contrast to similarities of effects of being vertically and fully mismatched, the effect of horizontal mismatch differs substantially across the fields of study. First, there are graduates of *Natural Sciences, ICT, Electrical Engineering, Chemistry, and Technology; Medicine, Pharmacy, Health, and Welfare; and Business and Law*. In these fields of study being horizontally mismatched puts graduates at neither a great advantage nor a disadvantage compared to their fully matched peers. In these three groups, the effects are always insignificant when all contextual and control variables are taken into account (Model 4). For graduates of *Engineering, Construction, and Architecture*, we found that having a job mismatched in their field of study has a positive effect, which is significant in all models. The effect, however, is not so strong as it is among graduates of the following three groups. Interestingly, it is strongest in Model 4, whereas in the case of other fields of study it tends to weaken here. In the case of graduates of *Agriculture and Veterinary, Humanities, Social Sciences, Theology, and Arts and Education and Physical Education*, we identified strongly significant positive effects of being horizontally mismatched. Therefore, graduates of these fields who do not work in their field but have

a job commensurate with their education level tend to earn more. This finding comes as no surprise as occupations associated with these fields of study are generally paid below average (again – in the segment of occupations intended for people with higher education).

Table 4: The effect of job mismatch on (log) relative gross monthly earnings, WLS regression results, graduates by fields of faculties, β coefficients

	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4
	Natural Sc., ICTs, Electr. Eng., Chem. and Techn.				Engineering, Construction and Architecture			
Horizontal mismatch ⁽¹⁾	-0,037**	-0,039**	-0,035*	-0,018	0,055**	0,057**	0,056**	0,073***
Vertical mismatch ⁽¹⁾	-0,066***	-0,069***	-0,065***	-0,065***	-0,082***	-0,081***	-0,082***	-0,065***
Full mismatch ⁽¹⁾	-0,139***	-0,143***	-0,137***	-0,099***	-0,071***	-0,073***	-0,073***	-0,059***
Share of tertiary graduates		0,053***		0,047***		0,029		-0,039*
Unemployment rate			-0,057***	-0,062***			0,003	0,009
Adjusted R ²	0,022	0,025	0,025	0,319	0,014	0,014	0,014	0,129
N	3162	3162	3162	3162	1937	1937	1937	1937
	Agriculture and Veterinary				Medicine, Pharmacy, Health and Welfare			
Horizontal mismatch ⁽¹⁾	0,112***	0,123***	0,126***	0,113***	-0,014	-0,012	-0,007	0,028
Vertical mismatch ⁽¹⁾	-0,163***	-0,164***	-0,167***	-0,19***	-0,119***	-0,116***	-0,113***	-0,092***
Full mismatch ⁽¹⁾	-0,138***	-0,127***	-0,123***	-0,132***	-0,132***	-0,131***	-0,125***	-0,104***
Share of tertiary graduates		-0,064**		-0,045		-0,012		0,126***
Unemployment rate			-0,151***	-0,118***			-0,062**	-0,108***
Adjusted R ²	0,062	0,065	0,085	0,199	0,029	0,028	0,031	0,163
N	1052	1052	1052	1052	1600	1600	1600	1600
	Business and Law				Humanities, Social Sc., Theology and Arts			
Horizontal mismatch ⁽¹⁾	0,029*	0,03*	0,031**	0,004	0,115***	0,121***	0,117***	0,069***
Vertical mismatch ⁽¹⁾	-0,151***	-0,149***	-0,149***	-0,118***	-0,074***	-0,071***	-0,075***	-0,068***
Full mismatch ⁽¹⁾	-0,159***	-0,155***	-0,148***	-0,127***	-0,115***	-0,113***	-0,112***	-0,146***
Share of tertiary graduates		-0,062***		0,028		-0,022		-0,025
Unemployment rate			-0,142***	-0,111***			-0,043**	-0,026
Adjusted R ²	0,048	0,051	0,068	0,320	0,036	0,036	0,038	0,160
N	3964	3964	3964	3964	2202	2202	2202	2202

	Education and Physical Education							
Horizontal mismatch ⁽¹⁾	0,145***	0,153***	0,151***	0,097***				
Vertical mismatch ⁽¹⁾	-0,062***	-0,041**	-0,057***	-0,037**				
Full mismatch ⁽¹⁾	-0,06***	-0,032	-0,046**	-0,056***				
Share of tertiary graduates		-0,218***		-0,272***				
Unemployment rate			-0,056***	0,082***				
Adjusted R ²	0,031	0,075	0,033	0,182				
N	2402	2402	2402	2402				

Notes: (1) Reference category is Full match. (2) Significant: *** at the 1% level; ** at the 5% level; * at the 10% level. (3) Model 4 includes the same control variables as Model 4 for all graduates in Table 2. The results for the whole models can be found in appendix.

Contextual variables influence the relationship between education-job mismatch and the relative earnings, but their effect is rather small. When we computed the models for all graduates, we found that a growing share of tertiary graduates leads to a significantly faster decrease in the relative earnings for horizontally and fully mismatched graduates, compared to fully matched graduates. This moderating effect becomes weaker once contextual variables are included. In this case, the increasing share of tertiary graduates leads to a slower decrease in the relative earnings of vertically mismatched graduates compared to fully matched graduates. β coefficients are rather small, and therefore, it is difficult to formulate crucial conclusions. It seems that the growing share of tertiary graduates has a greater negative impact on the relative earnings of horizontally mismatched graduates compared to their vertically mismatched peers.

As for the moderating effect of the unemployment rate, there is only one significant difference between graduates in education-job match and graduates in education-job mismatch. It is the decrease in the relative earnings with a growing unemployment rate which is significantly slower in the case of graduates of vertical mismatch than in the case of graduates in full match. Or in other words, it seems that the disadvantage of vertically mismatched graduates as compared to fully matched graduates is smaller when there are high unemployment rates and higher when there are low unemployment rates, and in the case of other types of mismatches it does not make a difference.

Table 5: The effect of job mismatch on (log) relative gross monthly earnings with interactions, all graduates, WLS regression results, β coefficients

	Model 6	Model 7	Model 8	Model 9
Horizontal mismatch ⁽¹⁾	0,036***	0,027***	0,033***	0,026***
Vertical mismatch ⁽¹⁾	-0,1***	-0,087***	-0,099***	-0,086***
Full mismatch ⁽¹⁾	-0,127***	-0,109***	-0,131***	-0,111***
Share of tertiary graduates (centered)	-0,026***	-0,032***		
Horizontal mismatch * Share of tertiary graduates (centered) ⁽²⁾	-0,035***	-0,018**		
Vertical mismatch * Share of tertiary graduates (centered) ⁽²⁾	0,01	0,014**		
Full mismatch * Share of tertiary graduates (centered) ⁽²⁾	-0,025***	-0,014*		
Unemployment rate (centered)			-0,1***	-0,084***
Horizontal mismatch * Unemployment rate (centered) ⁽³⁾			-0,001	0,004
Vertical mismatch * Unemployment rate (centered) ⁽³⁾			0,019**	0,026***
Full mismatch * Unemployment rate (centered) ⁽³⁾			-0,005	0,005
Female		-0,207***		-0,208***
Master programme		0,109***		0,11***
Private sector		0,209***		0,203***
Prague and Central Bohemia		0,253***		0,254***
Age		0,099***		0,093***
Natural Sc., ICTs, Electr. Eng., Chem. and Techn. ⁽⁴⁾		-0,054***		-0,051***
Engineering, Construction and Architecture ⁽⁴⁾		-0,13***		-0,133***
Agriculture and Veterinary ⁽⁴⁾		-0,15***		-0,15***
Medicine, Pharmacy, Health and Welfare ⁽⁴⁾		-0,063***		-0,06***
Humanities, Social Sc., Theology and Arts ⁽⁴⁾		-0,175***		-0,173***
Education and Physical Education ⁽⁴⁾		-0,118***		-0,118***
R ²	0,033	0,287	0,039	0,291
Adjusted R ²	0,032	0,286	0,039	0,290
N	16319	16319	16319	16319

Notes: (1) Reference category is Full match. (2) Reference category is Full match * Share of tertiary graduates. (3) Reference category is Full match * Unemployment rate. (4) Reference category is Business and Law. (5) Significant: *** at the 1% level; ** at the 5% level; * at the 10% level.

Table 6 shows the results of the moderating effects of contextual variables. In general, the effects are more often insignificant than significant. In the case of graduates of *Natural Sciences, ICT, Electrical Engineering, Chemistry, and Technology*, with a growing unemployment rate, horizontally mismatched graduates' relative earnings decrease significantly more slowly than those of fully matched graduates. For graduates of *Engineering, Construction, and Architecture*, an increasing unemployment rate is

accompanied by a faster decrease in the relative earnings of fully mismatched graduates. In the case of graduates of *Business and Law*, the growing share of tertiary graduates leads to a significantly faster decrease in the relative earnings of horizontally and fully mismatched graduates compared to fully matched ones, but this moderating effect becomes weaker once contextual variables are included. On the other hand, the interaction effect between vertical mismatch and the unemployment rate becomes significant only in the model with control variables.

Table 6: The effect of job mismatch on (log) relative gross monthly earnings with interactions, WLS regression results, graduates by fields of faculties, β coefficients

	Models 6/8	Models 10/11	Models 6/8	Models 10/11
	Natural Sc., ICTs, Electr. Eng., Chem. and Techn.		Engineering, Construction and Architecture	
Share of tertiary graduates (centered)	0,065***	0,029*	0,034	-0,03
Horizontal mismatch * Share of tertiary graduates(centered) ⁽¹⁾	-0,024	-0,016	-0,024	-0,035
Vertical mismatch * Share of tertiary graduates (centered) ⁽¹⁾	-0,001	0,016	0,021	0,015
Full mismatch * Share of tertiary graduates (centered) ⁽¹⁾	-0,016	-0,014	0,001	0,008
Unemployment rate (centered)	-0,072***	-0,053***	0,007	0,018
Horizontal mismatch * Unemployment rate (centered) ⁽²⁾	0,041**	0,031***	0,023	0,016
Vertical mismatch * Unemployment rate (centered) ⁽²⁾	0	0,009	-0,005	0,007
Full mismatch * Unemployment rate (centered) ⁽²⁾	0,001	-0,014	-0,046*	-0,053**
	Agriculture and Veterinary		Medicine, Pharmacy, Health and Welfare	
Share of tertiary graduates (centered)	-0,064	-0,104***	-0,015	0,045*
Horizontal mismatch * Share of tertiary graduates(centered) ⁽¹⁾	-0,024	-0,026	0,017	0,004
Vertical mismatch * Share of tertiary graduates (centered) ⁽¹⁾	0,015	0,018	0,02	0,018
Full mismatch * Share of tertiary graduates (centered) ⁽¹⁾	0,025	0,016	0,02	-0,004
Unemployment rate (centered)	-0,168***	-0,159***	-0,068***	-0,026
Horizontal mismatch * Unemployment rate (centered) ⁽²⁾	0,011	0,006	0,039	0,037
Vertical mismatch * Unemployment rate (centered) ⁽²⁾	0,051	0,053*	0,031	0,037
Full mismatch * Unemployment rate (centered) ⁽²⁾	-0,017	0,003	-0,074	-0,089

	Business and Law		Humanities, Social Sc., Theology and Arts	
Share of tertiary graduates (centered)	-0,045**	-0,038**	0,013	-0,001
Horizontal mismatch * Share of tertiary graduates(centered) ⁽¹⁾	-0,036**	-0,021	-0,081***	-0,062***
Vertical mismatch * Share of tertiary graduates (centered) ⁽¹⁾	0,006	0,006	-0,022	-0,014
Full mismatch * Share of tertiary graduates (centered) ⁽¹⁾	-0,033**	-0,024*	0,009	0,003
Unemployment rate (centered)	-0,135***	-0,089***	-0,073***	-0,049*
Horizontal mismatch * Unemployment rate (centered) ⁽²⁾	-0,026	-0,016	0,008	-0,003
Vertical mismatch * Unemployment rate (centered) ⁽²⁾	0,027	0,032**	0,032	0,006
Full mismatch * Unemployment rate (centered) ⁽²⁾	-0,022	-0,018	0,052**	0,047**
	Education and Physical Education			
Share of tertiary graduates (centered)	-0,207***	-0,239***		
Horizontal mismatch * Share of tertiary graduates(centered) ⁽¹⁾	0,016	0,036*		
Vertical mismatch * Share of tertiary graduates (centered) ⁽¹⁾	0,013	0,021		
Full mismatch * Share of tertiary graduates (centered) ⁽¹⁾	-0,064***	-0,031		
Unemployment rate (centered)	-0,007	-0,001		
Horizontal mismatch * Unemployment rate (centered) ⁽²⁾	-0,052**	-0,026		
Vertical mismatch * Unemployment rate (centered) ⁽²⁾	-0,019	-0,019		
Full mismatch * Unemployment rate (centered) ⁽²⁾	-0,09***	-0,073***		

Notes: (1) Reference category is Full match * Share of tertiary graduates. (2) Reference category is Full match * Unemployment rate. (3) Significant: *** at the 1% level; ** at the 5% level; * at the 10% level. (3) Models 6 and 8 include the same education-job mismatch variables as Models 6 and 8 for all graduates in Table 5. Models 10 and 11 include the same education-job mismatch and control (except fields of study) variables as Models 7 and 9 for all graduates in Table 4. The results for the whole models can be found in appendix.

For graduates of *Humanities, Social Sciences, Theology, and Arts*, the increasing share of tertiary graduates leads to a decrease in the relative earnings of horizontally mismatched graduates but not of fully matched ones. Also, the relative earnings of fully mismatched graduates decrease less significantly when the unemployment rate grows. And finally, for graduates of *Education and Physical Education*, we found several effects that gain or lose statistical significance depending on whether control variables are included or not. The only significant effect in both models is the effect of a decrease of the relative earnings with increasing unemployment rates for fully mismatched graduates – which is not a case of graduates in full match. Overall, we did not identify any general patterns applicable to

graduates of different fields of study. Most interaction effects are not significant, and those that are significant differ between the fields of study.

Conclusion

In this paper we analysed the effects of education-job (mis)match on the earnings of four cohorts of graduates four to five years after graduation in 2006–2018, examining both graduates as a whole and groups of graduates based on the field of study. We sought to contribute to knowledge about this topic in two ways. We concentrated on both the vertical and the horizontal dimensions of (mis)match; such analyses are rare in the Czech Republic. We also examined the changing context represented by selected variables (unemployment rates and the share of tertiary graduates in the population), which are generally overlooked in relation to the topic of the paper.

Before concluding the main findings, we must consider the limitations of our data and models. We used a series of cross-sectional survey data, which had to be adjusted due to differences in methodology and questionnaires. The method of ordinary least squares in regression analysis had to be replaced by the method of weighted least squares to solve the problems with the econometric assumptions of the original models. We also did not use Tobit and Heckit models to avoid the selection bias because the data did not allow it. However, economic inactivity is partly represented in the models by the independent variable of the unemployment rate as a contextual variable. The impact of the limitations would deserve attention in future. We therefore recommend developing computations using new data sets once they are available for this purpose.

To present the summary of the results in connection to research questions, we use the models with control variables unless otherwise specified.

What are the effects of education-job (mis)match on the earnings of higher education graduates in the Czech Republic?

There are negative statistically significant effects of over-education on the earnings (both in the model for all graduates and graduates' groups based on the field of study). It is evident that the vertical matches play a key role in the effects on the relative earnings. The negative effects of over-education on the relative earnings in comparison with the vertically matched can be found also among other authors using different methodology, e.g., in Verdugo and Verdugo (1989), Bauer (2002), Kim, Ahn and Kim (2016) and Mysíková (2016).

The role of horizontal (mis)match needs a more detailed explanation. In general, the principle of the effects of horizontal dimension on the relative earnings is not the same as that of vertical dimension. Concerning the full mismatch (coincidence of horizontal and vertical mismatch), it has the most negative effect on the relative earnings for all graduates and for most of the groups based on the field of study. In this case, the graduates have a job in which they use neither their level of higher education nor skills specific to their field of study. As for the comparison of horizontal mismatch and full match, there is no generalizable effects on the relative earnings. Although horizontal mismatch (coincidence of vertical match and horizontal mismatch) has a positive significant effect on the relative earnings in the case of all graduates, in the case of the majority of the groups based on the field of study, the effects and statistical significance are sometimes present and

sometimes are not. It means that for most graduates, there is more or less the same situation concerning the effects of full match and horizontal mismatch. However, there are three groups (*Education and Physical Education, Agriculture and Veterinary and Humanities, Social Sciences, Theology and Arts*) with a clear positive effect of being horizontally mismatched. These graduates have lower relative earnings if they have a full-matched job than if they work in horizontally mismatched but vertically matched jobs (horizontal mismatch).

What are the effects of unemployment on the earnings of higher education graduates in the Czech Republic?

Unemployment rates are expected to have clear negative effects on earnings. In the case of all graduates and of the majority of the field of study groups, the unemployment rates have statistically significant negative effects, however, they sometimes become weaker once control variables are included. And there are also groups of graduates where unemployment rates play no or almost no role concerning the effects on the relative earnings: *Engineering, Construction and Architecture* and *Humanities, Social sciences, Theology and Arts*. Again, *Education and Physical Education* graduates are specific, surprisingly, there is a positive effect of unemployment rates on their relative earnings once all control variables are included. We suppose that it is connected to the specifics of the public sector where most of these graduates work.

Do unemployment rates influence the effects of education-job (mis)match on the earnings of higher education graduates in the Czech Republic?

Unemployment rates influence the effects of education-job (mis)match on the relative earnings, however, there is no general pattern. Concerning all students, there is only one significant difference between graduates in full match and vertical mismatch. The disadvantage of vertically mismatched graduates as compared to fully mismatched graduates is smaller when there are high unemployment rates and higher when there are low unemployment rates. With regard to groups of graduates in different fields of study, it has been proved that unemployment rates significantly influence the effects of education-job (mis)match except for the graduates in *Medicine, Pharmacy, Health and Welfare*. The most frequently significantly influenced by unemployment rates are the effects of full mismatch on the relative earnings which are present in *Engineering, Construction and Architecture, Education and Physical Education* and *Humanities, Social Sciences, Theology and Arts*, followed by horizontal mismatch of the graduates in *Natural sciences, ICTs, Electrical Engineering, Chemistry and Technology* and vertical mismatch of the graduates in *Agriculture and Veterinary* and *Business and Law*.

What are the effects of graduates' shares in the population on the earnings of higher education graduates in the Czech Republic?

High shares of tertiary graduates in the population have a significant negative effect concerning the relative earnings in models for all graduates, however, it disappears once the control variables are added. The same applies to graduates of *Agriculture and Veterinary* and *Business and Law*. It is not the case among *Education and Physical Education* graduates where this contextual variable has a statistically significant negative effect in all computed models. On the other hand, there are also positive effects of shares of tertiary graduates on the relative earnings in the groups of *Natural Sciences, ICTs,*

Electrical Engineering, Chemistry and Technology and Medicine, Pharmacy, Health and Welfare. We suppose that it is the result of a strong demand for these graduates that offsets their growing numbers on the labour market.

Do shares of graduates in population influence the effects of education-job (mis)match on the earnings of higher education graduates in the Czech Republic?

Shares of graduates in the population influence the effects of education-job (mis)match on the relative earnings concerning all the graduates. Growing shares of tertiary graduates lead to a significantly faster decrease of the relative earnings in the case of graduates in horizontal and full mismatch, and on the other hand to a slower decrease of the relative earnings in the case of graduates in vertical mismatch as compared to graduates in full match. With regard to the groups of graduates based on the field of study, there are groups of graduates where there is no significant influence of graduate shares on the relative earnings (*Natural Sciences, ICTs, Electrical Engineering, Chemistry and Technology, Engineering, Construction and Architecture, Agriculture and Veterinary, Medicine, Pharmacy, Health and Welfare, Medicine, Pharmacy, Health and Welfare*). Increasing shares of tertiary graduates lead to a decrease in the relative earnings of the graduates in horizontal mismatch in *Humanities, Social Sciences, Theology and Arts* and the graduates in full mismatch in *Business and Law*. Increasing shares of tertiary graduates also lead to an increase of the relative earnings of the graduates in horizontal mismatch in *Education and Physical Education*.

What are the effects of education-job (mis)match on the earnings of higher education graduates in comparison with other selected factors in the Czech Republic?

The comparison of the effects of independent variables on the relative earnings in the models for all graduates shows that education-job (mis)match explains a few percent of the variance in all the models, whereas the group of control variables such as sex, level of education, sector and region are much more influential – even more than the effects of individual fields of study. The effects of contextual variables (unemployment rates and shares of tertiary graduates) belong to the least significant. The magnitude of the effects of education-job (mis)match on the relative earnings is comparable with the magnitude of the effects of control variables only in the case of *Agriculture and Veterinary* graduates.

To sum up the results, the paper broadens the analyses of the effects of education-job (mis)match on the earnings of higher education graduates in the Czech Republic. It concentrates both on vertical and horizontal dimensions and adds the dimension of contextual variables. To have a job in which graduates use the obtained level of higher education is more important than to have a job equalling the field of study. Besides, in some fields of study there is a penalty for working in the field of graduation. The effects of selected contextual factors (unemployment rates and a share of tertiary graduates) on earnings are various. In general (i.e. for all graduates), the unemployment rate has negative but rather modest effects on the earnings, whereas the share of tertiary graduates has a very weak effect and it disappears once additional control variables are considered. The effects of contextual variables on the earnings in the individual groups based on the field of study are inconsistent but the negative significant effects of the unemployment rate can be observed in most cases. The influence of the contextual variables (unemployment rates and shares of graduates) on the effects of education-job (mis)match on the earnings have been proved, however, they are not present and generalizable in all

the groups based on the field of study and cannot be connected to the same types of (mis)match in every model. The comparisons of education-job (mis)match, contextual and control variables show the relatively strongest role of control variables (sex, region, level of higher education). The contextual variables belong to the weakest.

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Appendix

Appendix 1: Development of selected indicators according to the fields of study

Indicator	Year of survey	Natural Sciences and ICTs	Engineering and Construction	Agriculture and Veterinary	Health and Welfare	Business and Law	Humanities, Social Sci. and Arts	Education	Total
Share of tertiary graduates in the population of 25-34	2006	1.9%	2.1%	0.7%	1.1%	4.3%	2.0%	3.2%	15.2%
	2010	2.7%	2.7%	0.9%	1.7%	6.8%	3.1%	4.6%	22.6%
	2013	3.2%	3.0%	1.2%	2.3%	9.2%	4.4%	6.0%	29.2%
	2018	3.6%	3.3%	1.5%	2.8%	10.1%	5.6%	6.4%	33.3%
Unemployment rate of higher education graduates in the population of 25-34	2002-06	2.6%	2.3%	3.7%	0.8%	3.0%	3.4%	2.9%	2.7%
	2006-10	3.3%	3.0%	3.5%	2.2%	2.4%	3.0%	2.6%	2.9%
	2009-13	3.2%	3.5%	5.3%	1.9%	4.1%	4.9%	3.1%	3.8%
	2013-18	2.9%	2.1%	4.3%	2.0%	3.8%	3.3%	3.1%	2.9%
Mean of earnings higher education graduates 4 to 5 years after graduation (in thousands of CZK)	2006	27.1	23.4	20.1	20.4	28.3	21.2	18.6	23.9
	2010	35.2	33.3	24.6	29.7	40.4	26.8	24.9	32.6
	2013	35.8	32.0	23.3	28.4	35.1	25.4	23.4	30.0
	2018	47.7	39.9	29.7	33.8	43.4	32.0	29.6	38.2

Notes:

Share of tertiary graduates in the population of 25-34 – Share of higher education graduates in the population of 25-34 years old. The “Total” share is calculated using Eurostat data. “Fields of study” shares are estimated by numbers of graduates who do not continue in their studies 1-2 years after graduation, in which case the source is <http://www.strediskovzdelavacipolitiky.info/app/navs2010/>.

Unemployment rate of higher education graduates in the population of 25-34 – Unemployment rate of higher education graduates of age 25-34 years – 5 year averages. Source: own calculations of VSPS (Labour force survey) data.

Mean of earnings higher education graduates 4 to 5 years after graduation (in thousands of CZK) – Source: REFLEX, REFLEX 2010, REFLEX 2013, Absolvent 2018

Appendix 2: Development of education-job match of higher education graduates according to the fields of study¹

Year of survey	Type of match	Natural Sciences and ICTs	Engineering and Construction	Agriculture and Veterinary	Health and Welfare	Business and Law	Humanities, Social Sci. and Arts	Education	Total
2006	Full match	80.3%	75.8%	69.9%	93.7%	76.9%	70.0%	81.7%	79.1%
	Horizontal mismatch	12.7%	13.5%	13.6%	1.8%	10.7%	16.5%	10.5%	11.0%
	Vertical mismatch	4.1%	7.0%	9.9%	4.5%	8.1%	5.5%	2.1%	5.7%
	Full mismatch	3.0%	3.7%	6.6%	0.0%	4.4%	8.1%	5.7%	4.2%
2010	Full match	77.7%	78.7%	66.5%	88.5%	76.3%	71.5%	77.0%	76.8%
	Horizontal mismatch	13.0%	12.2%	13.1%	3.1%	13.2%	15.9%	12.2%	12.4%
	Vertical mismatch	4.2%	4.6%	10.7%	6.1%	6.0%	3.1%	6.0%	5.3%
	Full mismatch	5.1%	4.6%	9.7%	2.4%	4.4%	9.5%	4.9%	5.4%
2013	Full match	75.6%	76.8%	57.7%	88.2%	73.0%	57.0%	70.7%	71.7%
	Horizontal mismatch	11.5%	7.4%	19.1%	1.6%	10.7%	20.3%	12.8%	12.0%
	Vertical mismatch	6.5%	8.4%	10.2%	6.8%	9.1%	5.7%	8.4%	7.6%
	Full mismatch	6.3%	7.4%	13.0%	3.3%	7.1%	17.0%	8.0%	8.7%
2018	Full match	74.2%	78.5%	49.7%	85.7%	68.9%	57.9%	69.9%	69.6%
	Horizontal mismatch	12.6%	7.9%	25.5%	2.9%	13.5%	22.5%	12.9%	13.9%
	Vertical mismatch	7.3%	8.4%	5.7%	8.8%	10.1%	7.7%	7.2%	8.2%
	Full mismatch	5.9%	5.2%	19.1%	2.7%	7.5%	11.8%	9.9%	8.3%

Notes: Abbreviated names of fields of study are used.

Source: REFLEX, REFLEX 2010, REFLEX 2013, Absolvent 2018

Appendix 3: Complete results of all models of WLS regression analysis of the effect of job mismatch on (log) relative gross monthly earnings – β coefficients, significance, B coefficients and Standard errors (in parentheses)

Models for all graduates

	Model 1	Model 2	Model 3	Model 4	Model 5
Horizontal mismatch ⁽¹⁾	0,032***	0,032***	0,033***	0,011	0,026***
	0,045 (0,011)	0,045 (0,011)	0,046 (0,011)	0,015 (0,01)	0,035 (0,009)
Vertical mismatch ⁽¹⁾	-0,099***	-0,097***	-0,098***	-0,087***	-0,084***
	-0,202 (0,016)	-0,197 (0,016)	-0,197 (0,016)	-0,173 (0,014)	-0,167 (0,013)
Full mismatch ⁽¹⁾	-0,137***	-0,134***	-0,132***	-0,127***	-0,111***
	-0,256 (0,015)	-0,252 (0,015)	-0,247 (0,015)	-0,235 (0,013)	-0,198 (0,012)
Share of tertiary graduates		-0,041***		-0,01	-0,008
		-0,003 (0,001)		-0,001	-0,001
Unemployment rate			-0,096***	-0,068***	-0,072***
			-0,104 (0,008)	-0,075 (0,008)	-0,079 (0,008)
Female				-0,205***	-0,207***
				-0,19 (0,006)	-0,192 (0,007)
Master programme				0,11***	0,109***
				0,137 (0,009)	0,134 (0,008)
Private sector				0,225***	0,204***
				0,226 (0,007)	0,204 (0,007)
Prague and Central Bohemia				0,269***	0,254***
				0,25 (0,006)	0,237 (0,006)
Age				0,081***	0,094***
				0,007 (0,001)	0,008 (0,001)
Natural Sc., ICTs, Electr. Eng., Chem. and Techn. ⁽²⁾					-0,051***
					-0,056 (0,009)
Engineering, Construction and Architecture ⁽²⁾					-0,132***
					-0,196 (0,012)
Agriculture and Veterinary ⁽²⁾					-0,15***
					-0,313 (0,015)
Medicine, Pharmacy, Health and Welfare ⁽²⁾					-0,06***
					-0,099 (0,012)
Humanities, Social Sc., Theology and Arts ⁽²⁾					-0,172***
					-0,222 (0,01)
Education and Physical Education ⁽²⁾					-0,117***
					-0,163 (0,011)

R ²	0,029	0,031	0,039	0,248	0,290
Adjusted R ²	0,029	0,031	0,039	0,247	0,289
N	16319	16319	16319	16319	16319

Notes: (1) Reference category is Full match. (2) Reference category is Business and Law. (3) Significant: *** at the 1% level; ** at the 5% level; * at the 10% level.

Models for graduates of Natural Sciences, ICTs, Electrical Engineering, Chemistry and Technology

	Model 1	Model 2	Model 3	Model 4
Horizontal mismatch ⁽¹⁾	-0,037** -0,059 (0,029)	-0,039** -0,063 (0,029)	-0,035* -0,056 (0,028)	-0,018 -0,027 (0,022)
Vertical mismatch ⁽¹⁾	-0,066*** -0,141 (0,038)	-0,069*** -0,149 (0,038)	-0,065*** -0,14 (0,038)	-0,065*** -0,139 (0,032)
Full mismatch ⁽¹⁾	-0,139*** -0,295 (0,038)	-0,143*** -0,304 (0,038)	-0,137*** -0,29 (0,038)	-0,099*** -0,199 (0,03)
Share of tertiary graduates		0,053*** 0,043 (0,014)		0,047*** 0,038 (0,013)
Unemployment rate			-0,057*** -0,103 (0,032)	-0,062*** -0,116 (0,03)
Female				-0,232*** -0,248 (0,016)
Master programme				0,078*** 0,11 (0,021)
Private sector				0,33*** 0,378 (0,018)
Prague and Central Bohemia				0,276*** 0,272 (0,015)
Age				0,08*** 0,012 (0,002)
R ²	0,023	0,026	0,026	0,321
Adjusted R ²	0,022	0,025	0,025	0,319
N	3162	3162	3162	3162

Notes: (1) Reference category is Full match. (2) Significant: *** at the 1% level; ** at the 5% level; * at the 10% level.

Models for graduates of Engineering, Construction and Architecture

	Model 1	Model 2	Model 3	Model 4
Horizontal mismatch ⁽¹⁾	0,055** 0,064 (0,026)	0,057** 0,066 (0,027)	0,056** 0,065 (0,026)	0,073*** 0,084 (0,025)
Vertical mismatch ⁽¹⁾	-0,082*** -0,154 (0,043)	-0,081*** -0,152 (0,043)	-0,082*** -0,154 (0,043)	-0,065*** -0,123 (0,04)
Full mismatch ⁽¹⁾	-0,071*** -0,13 (0,041)	-0,073*** -0,132 (0,041)	-0,073*** -0,132 (0,041)	-0,059*** -0,106 (0,039)
Share of tertiary graduates		0,029 0,025 (0,02)		-0,039* -0,035 (0,02)
Unemployment rate			0,003 0,003 (0,018)	0,009 0,007 (0,017)
Female				-0,196*** -0,19 (0,021)
Master programme				0,068*** 0,09 (0,029)
Private sector				0,119*** 0,128 (0,023)
Prague and Central Bohemia				0,225*** 0,182 (0,018)
Age				0,099*** 0,011 (0,002)
R2	0,016	0,016	0,016	0,133
Adjusted R2	0,014	0,014	0,014	0,129
N	1937	1937	1937	1937

Notes: (1) Reference category is Full match. (2) Significant: *** at the 1% level; ** at the 5% level; * at the 10% level.

Models for graduates of Agriculture and Veterinary

	Model 1	Model 2	Model 3	Model 4
Horizontal mismatch ⁽¹⁾	0,112*** 0,105 (0,029)	0,123*** 0,115 (0,029)	0,126*** 0,118 (0,029)	0,113*** 0,11 (0,029)
Vertical mismatch ⁽¹⁾	-0,163*** -0,231 (0,043)	-0,164*** -0,232 (0,043)	-0,167*** -0,227 (0,041)	-0,19*** -0,256 (0,038)
Full mismatch ⁽¹⁾	-0,138*** -0,165 (0,037)	-0,127*** -0,152 (0,037)	-0,123*** -0,151 (0,037)	-0,132*** -0,166 (0,037)
Share of tertiary graduates		-0,064** -0,076 (0,036)		-0,045 -0,056 (0,043)
Unemployment rate			-0,151*** -0,083 (0,016)	-0,118*** -0,066 (0,018)
Female				-0,159*** -0,125 (0,022)
Master programme				0,11*** 0,128 (0,033)
Private sector				0,11*** 0,104 (0,026)
Prague and Central Bohemia				0,224*** 0,219 (0,028)
Age				0,182*** 0,015 (0,002)
R2	0,064	0,069	0,089	0,207
Adjusted R2	0,062	0,065	0,085	0,199
N	1052	1052	1052	1052

Notes: (1) Reference category is Full match. (2) Significant: *** at the 1% level; ** at the 5% level; * at the 10% level.

Models for graduates of Medicine, Pharmacy, Health and Welfare

	Model 1	Model 2	Model 3	Model 4
Horizontal mismatch ⁽¹⁾	-0,014 -0,038 (0,068)	-0,012 -0,033 (0,068)	-0,007 -0,02 (0,067)	0,028 0,093 (0,076)
Vertical mismatch ⁽¹⁾	-0,119*** -0,224 (0,046)	-0,116*** -0,219 (0,046)	-0,113*** -0,212 (0,046)	-0,092*** -0,156 (0,04)
Full mismatch ⁽¹⁾	-0,132*** -0,342 (0,064)	-0,131*** -0,338 (0,064)	-0,125*** -0,327 (0,065)	-0,104*** -0,258 (0,058)
Share of tertiary graduates		-0,012 -0,007 (0,015)		0,126*** 0,082 (0,022)
Unemployment rate			-0,062** -0,047 (0,019)	-0,108*** -0,083 (0,025)
Female				-0,218*** -0,194 (0,021)
Master programme				0,207*** 0,215 (0,026)
Private sector				0,145*** 0,118 (0,019)
Prague and Central Bohemia				0,041* 0,034 (0,019)
Age				0,094*** 0,009 (0,002)
R2	0,031	0,030	0,033	0,168
Adjusted R2	0,029	0,028	0,031	0,163
N	1600	1600	1600	1600

Notes: (1) Reference category is Full match. (2) Significant: *** at the 1% level; ** at the 5% level; * at the 10% level.

Models for graduates of Business and Law

	Model 1	Model 2	Model 3	Model 4
Horizontal mismatch ⁽¹⁾	0,029* 0,04 (0,021)	0,03* 0,041 (0,021)	0,031** 0,042 (0,021)	0,004 0,005 (0,019)
Vertical mismatch ⁽¹⁾	-0,151*** -0,302 (0,031)	-0,149*** -0,298 (0,031)	-0,149*** -0,292 (0,03)	-0,118*** -0,232 (0,026)
Full mismatch ⁽¹⁾	-0,159*** -0,361 (0,035)	-0,155*** -0,356 (0,036)	-0,148*** -0,341 (0,036)	-0,127*** -0,29 (0,03)
Share of tertiary graduates		-0,062*** -0,013 (0,003)		0,028 0,006 (0,004)
Unemployment rate			-0,142*** -0,098 (0,011)	-0,111*** -0,077 (0,013)
Female				-0,206*** -0,195 (0,012)
Master programme				0,126*** 0,17 (0,018)
Private sector				0,193*** 0,227 (0,016)
Prague and Central Bohemia				0,355*** 0,333 (0,013)
Age				0,107*** 0,01 (0,001)
R2	0,048	0,052	0,069	0,321
Adjusted R2	0,048	0,051	0,068	0,320
N	3964	3964	3964	3964

Notes: (1) Reference category is Full match. (2) Significant: *** at the 1% level; ** at the 5% level; * at the 10% level.

Models for graduates of Humanities, Social Sciences, Theology and Arts

	Model 1	Model 2	Model 3	Model 4
Horizontal mismatch ⁽¹⁾	0,115*** 0,135 (0,025)	0,121*** 0,141 (0,025)	0,117*** 0,136 (0,025)	0,069*** 0,084 (0,025)
Vertical mismatch ⁽¹⁾	-0,074*** -0,149 (0,043)	-0,071*** -0,144 (0,043)	-0,075*** -0,149 (0,042)	-0,068*** -0,146 (0,043)
Full mismatch ⁽¹⁾	-0,115*** -0,152 (0,028)	-0,113*** -0,15 (0,028)	-0,112*** -0,148 (0,028)	-0,146*** -0,198 (0,028)
Share of tertiary graduates		-0,022 -0,008 (0,007)		-0,025 -0,009 (0,007)
Unemployment rate			-0,043** -0,024 (0,012)	-0,026 -0,016 (0,012)
Female				-0,08*** -0,076 (0,019)
Master programme				0,098*** 0,101 (0,021)
Private sector				0,195*** 0,186 (0,02)
Prague and Central Bohemia				0,24*** 0,223 (0,019)
Age				0,027 0,002 (0,001)
R2	0,037	0,038	0,040	0,163
Adjusted R2	0,036	0,036	0,038	0,160
N	2202	2202	2202	2202

Notes: (1) Reference category is Full match. (2) Significant: *** at the 1% level; ** at the 5% level; * at the 10% level.

Models for graduates of Education and Physical Education

	Model 1	Model 2	Model 3	Model 4
Horizontal mismatch ⁽¹⁾	0,145*** 0,163 (0,023)	0,153*** 0,173 (0,023)	0,151*** 0,17 (0,023)	0,097*** 0,113 (0,023)
Vertical mismatch ⁽¹⁾	-0,062*** -0,11 (0,036)	-0,041** -0,071 (0,035)	-0,057*** -0,101 (0,036)	-0,037** -0,065 (0,033)
Full mismatch ⁽¹⁾	-0,06*** -0,073 (0,025)	-0,032 -0,04 (0,025)	-0,046** -0,057 (0,025)	-0,056*** -0,074 (0,026)
Share of tertiary graduates		-0,218*** -0,061 (0,006)		-0,272*** -0,078 (0,006)
Unemployment rate			-0,056*** -0,119 (0,043)	0,082*** 0,19 (0,05)
Female				-0,209*** -0,18 (0,016)
Master programme				0,083*** 0,078 (0,019)
Private sector				0,096*** 0,079 (0,017)
Prague and Central Bohemia				0,177*** 0,152 (0,016)
Age				0,18*** 0,01 (0,001)
R2	0,032	0,077	0,035	0,186
Adjusted R2	0,031	0,075	0,033	0,182
N	2402	2402	2402	2402

Notes: (1) Reference category is Full match. (2) Significant: *** at the 1% level; ** at the 5% level; * at the 10% level.

Models with interactions, all graduates

	Model 6	Model 7	Model 8	Model 9
Horizontal mismatch ⁽¹⁾	0,036*** 0,05(0,011)	0,027*** 0,037(0,009)	0,033*** 0,046(0,011)	0,026*** 0,035(0,009)
Vertical mismatch ⁽¹⁾	-0,1*** -0,202(0,016)	-0,087*** -0,174(0,014)	-0,099*** -0,2(0,016)	-0,086*** -0,172(0,013)
Full mismatch ⁽¹⁾	-0,127*** -0,24(0,015)	-0,109*** -0,196(0,013)	-0,131*** -0,245(0,015)	-0,111*** -0,199(0,012)
Share of tertiary graduates (centered)	-0,026*** -0,002(0,001)	-0,032*** -0,002(0,001)		
Horizontal mismatch * Share of tertiary graduates (centered) ⁽²⁾	-0,035*** -0,007(0,002)	-0,018** -0,003(0,001)		
Vertical mismatch * Share of tertiary graduates (centered) ⁽²⁾	0,01 0,003(0,002)	0,014** 0,004(0,002)		
Full mismatch * Share of tertiary graduates (centered) ⁽²⁾	-0,025*** -0,007(0,002)	-0,014* -0,004(0,002)		
Unemployment rate (centered)			-0,1*** -0,107(0,009)	-0,084*** -0,093(0,009)
Horizontal mismatch * Unemployment rate (centered) ⁽³⁾			-0,001 -0,003(0,026)	0,004 0,012(0,022)
Vertical mismatch * Unemployment rate (centered) ⁽³⁾			0,019** 0,09(0,037)	0,026*** 0,118(0,032)
Full mismatch * Unemployment rate (centered) ⁽³⁾			-0,005 -0,021(0,033)	0,005 0,019(0,027)
Female		-0,207*** -0,193(0,007)		-0,208*** -0,193(0,007)
Master programme		0,109*** 0,134(0,008)		0,11*** 0,135(0,008)
Private sector		0,209*** 0,209(0,007)		0,203*** 0,203(0,007)
Prague and Central Bohemia		0,253*** 0,236(0,006)		0,254*** 0,237(0,006)
Age		0,099*** 0,009(0,001)		0,093*** 0,008(0,001)

Natural Sc., ICTs, Electr. Eng., Chem. and Techn. ⁽⁴⁾		-0,054*** -0,06(0,009)		-0,051*** -0,057(0,009)
Engineering, Construction and Architecture ⁽⁴⁾		-0,13*** -0,193(0,012)		-0,133*** -0,197(0,012)
Agriculture and Veterinary ⁽⁴⁾		-0,15*** -0,31(0,015)		-0,15*** -0,313(0,015)
Medicine, Pharmacy, Health and Welfare ⁽⁴⁾		-0,063*** -0,103(0,012)		-0,06*** -0,098(0,012)
Humanities, Social Sc., Theology and Arts ⁽⁴⁾		-0,175*** -0,225(0,01)		-0,173*** -0,223(0,01)
Education and Physical Education ⁽⁴⁾		-0,118*** -0,164(0,011)		-0,118*** -0,163(0,011)
R ²	0,033	0,287	0,039	0,291
Adjusted R ²	0,032	0,286	0,039	0,290
N	16319	16319	16319	16319

Notes: (1) Reference category is Full match. (2) Reference category is Full match * Share of tertiary graduates. (3) Reference category is Full match * Unemployment rate. (4) Reference category is Business and Law. (5) Significant: *** at the 1% level; ** at the 5% level; * at the 10% level.

Models with interactions, graduates of Natural Sciences, ICTs, Electrical Engineering, Chemistry and Technology

	Model 6	Model 8	Model 10	Model 11
Horizontal mismatch ⁽¹⁾	-0,037** -0,06(0,029)	-0,016 -0,024(0,022)	-0,036** -0,059(0,029)	-0,018 -0,027(0,022)
Vertical mismatch ⁽¹⁾	-0,07*** -0,15(0,043)	-0,068*** -0,146(0,033)	-0,065*** -0,139(0,038)	-0,065*** -0,137(0,031)
Full mismatch ⁽¹⁾	-0,138*** -0,295(0,04)	-0,096*** -0,194(0,033)	-0,136*** -0,289(0,039)	-0,094*** -0,19(0,031)
Share of tertiary graduates (centered)	0,065*** 0,053(0,016)	0,029* 0,023(0,014)		
Unemployment rate (centered)			-0,072*** -0,13(0,036)	-0,053*** -0,097(0,031)
Horizontal mismatch * Share of tertiary graduates (centered) ⁽²⁾	-0,024 -0,061(0,047)	-0,016 -0,036(0,036)		
Vertical mismatch * Share of tertiary graduates (centered) ⁽²⁾	-0,001 -0,004(0,075)	0,016 0,055(0,057)		
Full mismatch * Share of tertiary graduates (centered) ⁽²⁾	-0,016 -0,062(0,074)	-0,014 -0,053(0,061)		
Horizontal mismatch * Unemployment rate (centered) ⁽³⁾			0,041** 0,224(0,103)	0,031*** 0,155(0,079)
Vertical mismatch * Unemployment rate (centered) ⁽³⁾			0 -0,004(0,151)	0,009 0,076(0,126)
Full mismatch * Unemployment rate (centered) ⁽³⁾			0,001 0,011(0,158)	-0,014 -0,112(0,124)
Female		-0,232*** -0,248(0,017)		-0,225*** -0,241(0,017)
Master programme		0,076*** 0,107(0,021)		0,075*** 0,106(0,021)
Private sector		0,337*** 0,385(0,017)		0,336*** 0,386(0,018)
Prague and Central Bohemia		0,273*** 0,27(0,015)		0,278*** 0,275(0,015)
Age		0,081*** 0,013(0,002)		0,09*** 0,014(0,002)
R2	0,027	0,320	0,027	0,319
Adjusted R2	0,024	0,317	0,025	0,316
N	3162	3162	3162	3162

Notes: (1) Reference category is Full match. (2) Reference category is Full match * Share of tertiary graduates. (3) Reference category is Full match * Unemployment rate. (4) Significant: *** at the 1% level; ** at the 5% level; * at the 10% level.

Models with interactions, graduates of Engineering, Construction and Architecture

	Model 6	Model 8	Model 10	Model 11
Horizontal mismatch ⁽¹⁾	0,053** 0,062(0,027)	0,069*** 0,079(0,025)	0,056** 0,065(0,027)	0,077*** 0,089(0,025)
Vertical mismatch ⁽¹⁾	-0,085*** -0,158(0,042)	-0,069*** -0,13(0,04)	-0,082*** -0,154(0,043)	-0,068*** -0,128(0,041)
Full mismatch ⁽¹⁾	-0,074*** -0,134(0,044)	-0,058*** -0,105(0,04)	-0,066*** -0,121(0,042)	-0,054** -0,096(0,038)
Share of tertiary graduates (centered)	0,034 0,029(0,023)	-0,03 -0,026(0,022)		
Unemployment rate (centered)			0,007 0,005(0,02)	0,018 0,014(0,019)
Horizontal mismatch * Share of tertiary graduates (centered) ⁽²⁾	-0,024 -0,055(0,058)	-0,035 -0,078(0,054)		
Vertical mismatch * Share of tertiary graduates (centered) ⁽²⁾	0,021 0,079(0,086)	0,015 0,055(0,084)		
Full mismatch * Share of tertiary graduates (centered) ⁽²⁾	0,001 0,005(0,101)	0,008 0,031(0,093)		
Horizontal mismatch * Unemployment rate (centered) ⁽³⁾			0,023 0,052(0,056)	0,016 0,036(0,051)
Vertical mismatch * Unemployment rate (centered) ⁽³⁾			-0,005 -0,018(0,084)	0,007 0,025(0,077)
Full mismatch * Unemployment rate (centered) ⁽³⁾			-0,046* -0,145(0,075)	-0,053** -0,162(0,068)
Female		-0,199*** -0,192(0,021)		-0,192*** -0,185(0,021)
Master programme		0,067*** 0,089(0,029)		0,067*** 0,088(0,029)
Private sector		0,117*** 0,125(0,023)		0,118*** 0,128(0,023)
Prague and Central Bohemia		0,223*** 0,18(0,018)		0,223*** 0,18(0,017)
Age		0,102*** 0,011(0,002)		0,098*** 0,01(0,002)
R2	0,018	0,134	0,019	0,138
Adjusted R2	0,015	0,129	0,015	0,132
N	1937	1937	1937	1937

Notes: (1) Reference category is Full match. (2) Reference category is Full match * Share of tertiary graduates. (3) Reference category is Full match * Unemployment rate. (4) Significant: *** at the 1% level; ** at the 5% level; * at the 10% level.

Models with interactions, graduates of Agriculture and Veterinary

	Model 6	Model 8	Model 10	Model 11
Horizontal mismatch ⁽¹⁾	0,128*** 0,12(0,029)	0,115*** 0,112(0,029)	0,126*** 0,118(0,029)	0,11*** 0,107(0,029)
Vertical mismatch ⁽¹⁾	-0,159*** -0,228(0,044)	-0,186*** -0,258(0,041)	-0,16*** -0,226(0,043)	-0,183*** -0,256(0,04)
Full mismatch ⁽¹⁾	-0,135*** -0,163(0,041)	-0,139*** -0,174(0,042)	-0,118*** -0,145(0,039)	-0,135*** -0,17(0,038)
Share of tertiary graduates (centered)	-0,064 -0,076(0,047)	-0,104*** -0,127(0,047)		
Unemployment rate (centered)			-0,168*** -0,092(0,021)	-0,159*** -0,09(0,021)
Horizontal mismatch * Share of tertiary graduates (centered) ⁽²⁾	-0,024 -0,062(0,09)	-0,026 -0,067(0,088)		
Vertical mismatch * Share of tertiary graduates (centered) ⁽²⁾	0,015 0,069(0,148)	0,018 0,079(0,133)		
Full mismatch * Share of tertiary graduates (centered) ⁽²⁾	0,025 0,083(0,121)	0,016 0,054(0,12)		
Horizontal mismatch * Unemployment rate (centered) ⁽³⁾			0,011 0,014(0,042)	0,006 0,008(0,042)
Vertical mismatch * Unemployment rate (centered) ⁽³⁾			0,051 0,096(0,06)	0,053* 0,099(0,056)
Full mismatch * Unemployment rate (centered) ⁽³⁾			-0,017 -0,028(0,055)	0,003 0,005(0,053)
Female		-0,167*** -0,132(0,022)		-0,157*** -0,125(0,022)
Master programme		0,1*** 0,116(0,034)		0,112*** 0,132(0,034)
Private sector		0,118*** 0,111(0,027)		0,112*** 0,107(0,027)
Prague and Central Bohemia		0,223*** 0,221(0,028)		0,22*** 0,216(0,028)
Age		0,192*** 0,016(0,003)		0,17*** 0,014(0,002)
R2	0,072	0,195	0,092	0,205
Adjusted R2	0,065	0,186	0,086	0,196
N	1052	1052	1052	1052

Notes: (1) Reference category is Full match. (2) Reference category is Full match * Share of tertiary graduates. (3) Reference category is Full match * Unemployment rate. (4) Significant: *** at the 1% level; ** at the 5% level; * at the 10% level.

Models with interactions, graduates of Medicine, Pharmacy, Health and Welfare

	Model 6	Model 8	Model 10	Model 11
Horizontal mismatch ⁽¹⁾	-0,016 -0,043(0,075)	0,022 0,074(0,092)	-0,023 -0,065(0,089)	0,011 0,035(0,093)
Vertical mismatch ⁽¹⁾	-0,121*** -0,23(0,047)	-0,097*** -0,166(0,04)	-0,119*** -0,226(0,047)	-0,096*** -0,166(0,041)
Full mismatch ⁽¹⁾	-0,145*** -0,37(0,07)	-0,101*** -0,253(0,067)	-0,045 -0,118(0,213)	-0,014 -0,037(0,186)
Share of tertiary graduates (centered)	-0,015 -0,009(0,016)	0,045* 0,028(0,016)		
Unemployment rate (centered)			-0,068*** -0,052(0,02)	-0,026 -0,02(0,019)
Horizontal mismatch * Share of tertiary graduates (centered) ⁽²⁾	0,017 0,068(0,112)	0,004 0,018(0,135)		
Vertical mismatch * Share of tertiary graduates (centered) ⁽²⁾	0,02 0,057(0,073)	0,018 0,044(0,06)		
Full mismatch * Share of tertiary graduates (centered) ⁽²⁾	0,02 0,119(0,162)	-0,004 -0,022(0,149)		
Horizontal mismatch * Unemployment rate (centered) ⁽³⁾			0,039 0,243(0,199)	0,037 0,263(0,2)
Vertical mismatch * Unemployment rate (centered) ⁽³⁾			0,031 0,097(0,081)	0,037 0,108(0,07)
Full mismatch * Unemployment rate (centered) ⁽³⁾			-0,074 -0,639(0,698)	-0,089 -0,671(0,545)
Female		-0,211*** -0,188(0,021)		-0,216*** -0,193(0,021)
Master programme		0,212*** 0,22(0,026)		0,202*** 0,212(0,026)
Private sector		0,143*** 0,117(0,019)		0,142*** 0,117(0,019)
Prague and Central Bohemia		0,041* 0,034(0,019)		0,04* 0,033(0,019)
Age		0,102*** 0,01(0,002)		0,106*** 0,01(0,002)
R2	0,033	0,163	0,033	0,164
Adjusted R2	0,029	0,156	0,029	0,158
N	1600	1600	1600	1600

Notes: (1) Reference category is Full match. (2) Reference category is Full match * Share of tertiary graduates. (3) Reference category is Full match * Unemployment rate. (4) Significant: *** at the 1% level; ** at the 5% level; * at the 10% level.

Models with interactions, graduates of Business and Law

	Model 6	Model 8	Model 10	Model 11
Horizontal mismatch ⁽¹⁾	0,032** 0,044(0,021)	0,007 0,01(0,019)	0,029* 0,04(0,021)	0,004 0,006(0,019)
Vertical mismatch ⁽¹⁾	-0,151*** -0,301(0,032)	-0,12*** -0,236(0,028)	-0,151*** -0,299(0,032)	-0,122*** -0,24(0,027)
Full mismatch ⁽¹⁾	-0,145*** -0,338(0,037)	-0,123*** -0,281(0,031)	-0,145*** -0,334(0,036)	-0,124*** -0,279(0,03)
Share of tertiary graduates (centered)	-0,045** -0,009(0,004)	-0,038** -0,008(0,003)		
Unemployment rate (centered)			-0,135*** -0,092(0,012)	-0,089*** -0,062(0,011)
Horizontal mismatch * Share of tertiary graduates (centered) ⁽²⁾	-0,036** -0,021(0,01)	-0,021 -0,013(0,008)		
Vertical mismatch * Share of tertiary graduates (centered) ⁽²⁾	0,006 0,005(0,014)	0,006 0,005(0,013)		
Full mismatch * Share of tertiary graduates (centered) ⁽²⁾	-0,033** -0,033(0,017)	-0,024* -0,024(0,014)		
Horizontal mismatch * Unemployment rate (centered) ⁽³⁾			-0,026 -0,051(0,032)	-0,016 -0,032(0,028)
Vertical mismatch * Unemployment rate (centered) ⁽³⁾			0,027 0,082(0,05)	0,032** 0,097(0,043)
Full mismatch * Unemployment rate (centered) ⁽³⁾			-0,022 -0,073(0,053)	-0,018 -0,058(0,044)
Female		-0,206*** -0,194(0,013)		-0,202*** -0,191(0,012)
Master programme		0,138*** 0,185(0,018)		0,126*** 0,171(0,018)
Private sector		0,194*** 0,228(0,016)		0,191*** 0,224(0,016)
Prague and Central Bohemia		0,361*** 0,337(0,013)		0,359*** 0,336(0,013)
Age		0,111*** 0,01(0,001)		0,113*** 0,01(0,001)
R2	0,052	0,313	0,066	0,317
Adjusted R2	0,050	0,311	0,065	0,315
N	3964	3964	3964	3964

Notes: (1) Reference category is Full match. (2) Reference category is Full match * Share of tertiary graduates. (3) Reference category is Full match * Unemployment rate. (4) Significant: *** at the 1% level; ** at the 5% level; * at the 10% level.

Models with interactions, graduates of Humanities, Social Sciences, Theology and Arts

	Model 6	Model 8	Model 10	Model 11
Horizontal mismatch ⁽¹⁾	0,122*** 0,145(0,025)	0,067*** 0,082(0,025)	0,118*** 0,137(0,025)	0,065*** 0,078(0,025)
Vertical mismatch ⁽¹⁾	-0,07*** -0,142(0,044)	-0,068*** -0,147(0,043)	-0,072*** -0,148(0,044)	-0,071*** -0,151(0,042)
Full mismatch ⁽¹⁾	-0,117*** -0,155(0,029)	-0,149*** -0,202(0,028)	-0,119*** -0,157(0,028)	-0,151*** -0,205(0,028)
Share of tertiary graduates (centered)	0,013 0,005(0,009)	-0,001 0(0,009)		
Unemployment rate (centered)			-0,073*** -0,041(0,015)	-0,049* -0,029(0,015)
Horizontal mismatch * Share of tertiary graduates (centered) ⁽²⁾	-0,081*** -0,07(0,02)	-0,062*** -0,055(0,02)		
Vertical mismatch * Share of tertiary graduates (centered) ⁽²⁾	-0,022 -0,034(0,035)	-0,014 -0,023(0,033)		
Full mismatch * Share of tertiary graduates (centered) ⁽²⁾	0,009 0,01(0,025)	0,003 0,003(0,023)		
Horizontal mismatch * Unemployment rate (centered) ⁽³⁾			0,008 0,011(0,032)	-0,003 -0,005(0,031)
Vertical mismatch * Unemployment rate (centered) ⁽³⁾			0,032 0,083(0,056)	0,006 0,016(0,057)
Full mismatch * Unemployment rate (centered) ⁽³⁾			0,052** 0,079(0,035)	0,047** 0,075(0,034)
Female		-0,08*** -0,076(0,019)		-0,091*** -0,086(0,019)
Master programme		0,095*** 0,098(0,021)		0,104*** 0,106(0,021)
Private sector		0,194*** 0,184(0,02)		0,195*** 0,187(0,02)
Prague and Central Bohemia		0,24*** 0,222(0,019)		0,236*** 0,219(0,019)
Age		0,027 0,002(0,001)		0,023 0,002(0,001)
R2	0,045	0,164	0,042	0,167
Adjusted R2	0,042	0,160	0,039	0,162
N	2202	2202	2202	2202

Notes: (1) Reference category is Full match. (2) Reference category is Full match * Share of tertiary graduates. (3) Reference category is Full match * Unemployment rate. (4) Significant: *** at the 1% level; ** at the 5% level; * at the 10% level.

Models with interactions, graduates of Education and Physical Education

	Model 6	Model 8	Model 10	Model 11
Horizontal mismatch ⁽¹⁾	0,153*** 0,174(0,023)	0,1*** 0,117(0,024)	0,146*** 0,164(0,023)	0,095*** 0,112(0,025)
Vertical mismatch ⁽¹⁾	-0,046** -0,082(0,041)	-0,044** -0,078(0,038)	-0,058*** -0,104(0,036)	-0,053*** -0,096(0,036)
Full mismatch ⁽¹⁾	-0,026 -0,033(0,026)	-0,05** -0,067(0,026)	-0,037* -0,047(0,026)	-0,052** -0,07(0,027)
Share of tertiary graduates (centered)	-0,207*** -0,058(0,006)	-0,239*** -0,068(0,007)		
Unemployment rate (centered)			-0,007 -0,015(0,051)	-0,001 -0,001(0,049)
Horizontal mismatch * Share of tertiary graduates (centered) ⁽²⁾	0,016 0,013(0,017)	0,036* 0,029(0,017)		
Vertical mismatch * Share of tertiary graduates (centered) ⁽²⁾	0,013 0,019(0,035)	0,021 0,03(0,032)		
Full mismatch * Share of tertiary graduates (centered) ⁽²⁾	-0,064*** -0,057(0,019)	-0,031 -0,029(0,018)		
Horizontal mismatch * Unemployment rate (centered) ⁽³⁾			-0,052** -0,287(0,123)	-0,026 -0,147(0,121)
Vertical mismatch * Unemployment rate (centered) ⁽³⁾			-0,019 -0,184(0,202)	-0,019 -0,193(0,209)
Full mismatch * Unemployment rate (centered) ⁽³⁾			-0,09*** -0,658(0,155)	-0,073*** -0,602(0,165)
Female		-0,207*** -0,178(0,016)		-0,207*** -0,178(0,016)
Master programme		0,078*** 0,073(0,019)		0,106*** 0,101(0,019)
Private sector		0,089*** 0,074(0,017)		0,076*** 0,062(0,017)
Prague and Central Bohemia		0,176*** 0,152(0,016)		0,176*** 0,151(0,017)
Age		0,177*** 0,009(0,001)		0,128*** 0,007(0,001)
R2	0,080	0,182	0,044	0,144
Adjusted R2	0,078	0,178	0,041	0,139
N	2402	2402	2402	2402

Notes: (1) Reference category is Full match. (2) Reference category is Full match * Share of tertiary graduates. (3) Reference category is Full match * Unemployment rate. (4) Significant: *** at the 1% level; ** at the 5% level; * at the 10% level.