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Horizontal Mismatch in the Labour Market of Graduates: The Role of Signalling

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ABSTRACT

Horizontal Mismatch in the Labour Market of Graduates: The Role of Signalling

We follow Brodaty et al. (2008) and develop a model within the signalling literature where an employer decides whether to hire a worker or not conditionally on the signals she sends – field and length of study and high education (HE) institution. The empirical design of our paper builds on evidence relative to first labour market entry of graduates to identify a signalling effect of individual and institutional quality of study on individual horizontal match quality. First, based on a matched unique employer-employee dataset we report the extent of horizontal mismatch for graduates of different fields of education for a post-transition economy (Slovenia). Second, we test the signal of HE institutions and above average study duration on the likelihood of a horizontal mismatch separately for each field of education. We find that graduates from specific HE institutions experience significantly higher likelihood to get a job that matches the field of study for social sciences, namely business and administration and to a smaller extent education. On the contrary, HE institutions do not signal skills or abilities in the most technical fields of education (engineering, computing, manufacturing). The above average study duration has mixed effects based on the field of education. It can either signal lower innate ability (i.e. for law graduates) or increased skills due to student work (i.e. computing graduates).

JEL Classification: J21, J24, J44, I21

Keywords: horizontal mismatch, signalling, Slovenia

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1. INTRODUCTION

The determinants of the level of education of an individual and the level needed to perform a job have been extensively addressed in the literature and measures of overeducation and undereducation have been widely developed by now (see, for surveys of the literature, Sloane 2003, McGuinnes 2006, Leuven and Oosterbeek 2011, and, for a meta-analysis, Groot & van den Bring, 2000). Recently, an increasing body of literature has been investigating the skill match where the focus of research is not on the match between the level of education and level needed to perform at a job (vertical match) but on the match between an individual's specific field of education (or college major) and the type of skills that are required to do the job an individual actually secures (horizontal match) (Robst, 2007a, Nordin, Perrson and Rooth, 2010). Studies of the horizontal match or the field of education-occupation match find that the effect of the field of education-occupation match is more significant than the effect of the education match.

We further theoretically model the matching mechanism between a graduate endowed with a bundle of abilities and skills that is searching for a job and her potential employer who has incomplete information about the bundle and therefore about her productivity. Based on the signalling literature (Akerlof, 1970 and Spence, 1973) and recent applications (Domadenik, 2007 and Tomić and Domadenik, 2012), we follow Brodaty et al. (2008) and develop a model where an employer decides whether to hire a worker or not conditionally on his/her signals – field and length of study and the high education (HE) institution where she attains her degree. A graduate's productivity is determined by the job (firm-specific component) and a bundle of skills and abilities (worker-specific component) she holds. Skills and abilities are observed by education (individual field of study, type of higher education degree – vocational, professional or academic and HE institution) and duration of study.

Several papers have reported the extent of the horizontal mismatch. but, to our knowledge, none of them investigated the extent of mismatch in the SEE region.[1] Therefore, we attempt to contribute to the existing, yet very limited literature on the horizontal match, by providing evidence of the match for Slovenia, a good representative of countries sharing similar transition and post-transition development of their economic and institutional system. The educational system has some important specificities. The tuition free system, the government dedication for increased higher education enrolment and the emergence of new HE institutions motivated students to continue education on a tertiary level resulting in an increase in the number of graduates (from 6.756 tertiary education graduates in 1981 to 20.461 in 2011) (SORS, 2012). At the same time students enjoy favourable tax conditions when working, which makes employers consider them a flexible and cheap labour force. The extent of student work in Slovenia is higher than that of American or Canadian students (Bartolj, Feldin and Polanec, 2012). Bartolj et al. (2012) further note that student work can generate social and private gains and/or losses (increased duration of studying and probability of dropping out of school, increased earnings and probability of employment) and they find that the effect of student work during full time studying has different effects on the likelihood of a passing the year. However, students often disregard the fact that the increased duration of their studies can serve as a potential signal of their skills to employers. Caroleo and Pastore (2012) and Aina and Pastore (2012), for instance, argue that the length of study increases the probability to experience vertical overeducation; they also find evidence that this is the case in Italy, especially in some fields of education.

[1] Robst (2007a) for United States, Nordin et at. (2010) for Sweeden, Beduwe and Giret (2010) for France, Witte and Kalleberg (1995) for Germany, Allen and Van der Velden (2001) and García-Aracil and Van der Velden (2008) for the Netherlands, Boudarbat and Chernoff (2009) for Canada, Badillo-Amador and Vila-Lladosa (2006) for Spain, Di Pietro and Urwin (2006) for Italy.

Therefore, second, we theoretically model and empirically test the effect of increased study duration on the likelihood of a good horizontal match. Third, we disentangle and test the effect of different HE institutions that might as well serve as a signal about the skills and abilities a graduate possesses. Finally, we also have to stress that our dataset represents the whole population of graduates in the period of 2007-2009 and is based on objective measures of mismatch.

The paper is organised as follows. The next section summarizes the literature review. Section 3 presents the methodology and empirical model, followed by data description (Section 4). Section 5 presents the results and at the end we conclude.

2. LITERATURE REVIEW

Upon completing high secondary education, graduates can choose to continue with schooling on a tertiary level where they can choose among several different fields of education, study programs and HE institutions. The decision about the field of education is, among other reasons, driven by the expectation of acquiring a job where specific knowledge gained during education will be rewarded. When entering the labour market, however, graduates have no guarantee that they will secure a job for which they were educated for and quite often have to face lower than expected wages and job satisfaction and, consequently, are more likely than average to change their jobs (Robst, 2007a; Garcia – Aracil and Van der Velden, 2007; Boudarbat and Chernoff, 2008; Nordin, Perrson and Roth, 2010). The match between the occupation a graduate secures and the previous schooling can be observed either vertically or horizontally (Garcia-Espejo and Ibanez, 2006). Vertical match, the match between the level of education and the level required for the job, has been widely addressed and measures of overeducation and undereducation have been developed (see, for surveys of the literature, Sloane 2003, McGuinnes 2006, Leuven and Oosterbeek 2011, and, for a meta-analysis, Groot & van den Bring, 2000), whereas the horizontal match namely the match between the graduates specific field of education and the knowledge and skills needed to perform a job has been addressed to a much lesser extent (see for example Robst, 2007a or Beduwe and Giret, 2011).[2] The quality of a match is mostly described by three categories: a good match (a graduate has been educated to perform the occupation), weak match (if the occupation poorly matches one's field of education) and a mismatch (the field of education and the occupation are not connected) (Robst, 2007a; Nordin et al. 2010).

The quality of a job match determines the productivity level and earnings in a job (Sattinger, 1993; Robst, 2007a; Nording, Persson and Roth, 2010). A combination of several different theories can be applied when investigating the quality of a match between the graduate's education and the occupation. Based on human capital theory, education in a specific field endows an individual with general and specific knowledge, where the extent of the specific knowledge differs by field of education (Robst, 2007a). Conversely, according to the screening theory, education does not reflect an increase in productivity but is an indicator of innate ability (Arrow, 1973; Spence, 1973) and, similarly, the theory of credentialism (Collins, 1979) considers skills to be acquired on the job and not during education, but education is used as a predictor of the productivity and transferability of employees. Following the job competition model, Thurow (1975) explains education as a screening tool but focuses on it as a signal of an individual's capacity to be trained within a firm (on-the-job

[2] The concern about the specific human capital investments and its match of a job secured was first raised by the labour sociologists (as noted by Witte and Kalleberg, 1995). Among the first papers of economic investigation of the mismatch are Allen and van der Velden (2001), Badillo-Amador and Vila-Lladosa (2006), DiPietro and Urwin (2006), Garcia-Espejo and Ibanez (2006).

training). Based on job-matching theory, mismatches can be the result of incomplete information on the abilities of graduates and the characteristics of jobs offered by employers (Jovanovic, 1979; Wolbers, 2003).

The wage penalty associated with the overeducation has been widely reported, however the wage penalty associated with the horizontal mismatch mostly exceeds the one from the vertical mismatch (Robst, 2007a; Budria and Moro-Egido, 2008)[3]. Both the extent and the penalty also vary for different levels of education (Robst, 2007a; Budrıa & Moro-Egido, 2008; Yakusheva, 2010). However some studies find no significant negative effect of horizontal mismatch on earnings (Beduwe and Giret, 2011, Witte and Kalleberg, 1995) or very small effects (DiPietro and Urwin, 2006). The wage effects are much smaller in magnitude for partially mismatched workers than completely mismatched workers. The more transferable skills are from the field of education to the current job, the smaller the wage effects of being mismatched so the wage effects from mismatch are greater in fields that teach occupation specific skills and the wage effects appear most negative in fields with the least mismatch (Nordin et al., 2010). The wage effects are larger when workers accept the position due to demand-side reasons (unavailibility of a job) compared with supply side reasons such as pay and promotion opportunities, change in career interests, and working conditions (Robst, 2007b; Nordin, et al. 2010; Bender and Heywood, 2009). Apart from the wage penalty the mismatch also affects job satisfaction and the likelihood of changing jobs (Allen and van der Velden, 2001; Badillo-Amador & Vila-Lladosa, 2006; Garcial-Aracil and Van der Velden; 2007; Bender and Heywood, 2009; Beduwe and Giret, 2011). Personal characteristics such as the age, disability, nationality and marital status but not the ability[4] or parents education affect the likelihood of a horizontal match (Robst, 2007a,b; Boudarbat and Chernoff, 2008; Nordin et al., 2010).

3. METHODOLOGY

Further on we provide a simple analytical framework to demonstrate how skills mismatch can originate from the sorting behaviour of potential employers based on incomplete information on workers' productivity. We can identify two main reasons that cause skills mismatch in the case of young graduates when first entering the labour market. The first reason is related with uncertainty, asymmetric information and adverse selection in the labour market that requires to make a distinction between different job-seekers (Akerlof, 1970; Spence, 1973; Gibbons and Katz, 1991).[5] The second reason is related to the labour market conditions that affect employability of graduates holding degrees of different fields. While we control for the second reason by examining the matching process in the same field of education our study mostly concentrates on identifying a possible signalling effects and their source.

[3] Nordin et al. (2010) report an earning penalty of 22 percent for Swedish male graduates and 8 percent for women. Robst (2007a) reports a penalty of about 11% for men and 10% for women and Budria and Moro-Egido (2008) report penalty of 17.6% for men and 26.7% for women in the tertiary level, and 14.1% for men and 12.7% for women in the upper secondary level.

[4] Lacking an ability measure is considered as a limitation of the pioneering Robst (2007a) paper (Nordin et al., 2010), however by adding the measure Nordin et al. (2010) find no significant effect.

[5] Akerlof (1970) and Spence (1973) stress out the importance of *signalling* in the market that the potential seller (job-seeker) sends towards the potential buyer (firm) and *screening* that the 'buyers' need to do before buying the product. Asymmetry in available information appears because the 'sellers' have more knowledge about the quality of their product than the 'buyers' and the purchaser's problem is to identify this quality (Akerlof, 1970). Hence, potential employees confront an offered wage schedule based on their *signals* (Spence, 1973).

The signalling model has been upgraded by Blanchard and Diamond (1994) among others who introduced the ranking among different job applicants while Kugler and Saint-Paul (2004), Domadenik (2007) and Tomić and Domadenik (2012) deal with adverse selection among employed and unemployed job-seekers introducing firing (dismissal) costs. Waldman (1984), on the other hand, uses individual's job assignment as an imprecise signal of the individual's ability for an employed job seeker. Blanchard and Diamond (1994) developed the so-called *ranking model* in order to differentiate among the prospective employees. They assumed that firms have preferences over job applicants based on the time they were searching for employment, that is, if they compete for the same job short-term unemployed always get the job ahead of long-term unemployed. In their model, the duration of unemployment *signals* the productivity of the job applicant.[6] Kugler and Saint Paul (2004) make a similar distinction between more and less productive workers by differentiating between those who are employed and those who are unemployed or inactive. Additionally, they demonstrate that large enough reductions of hiring and firing costs would remove discrimination against unemployed workers completely. This model was adjusted in the work of Domadenik (2007) and Tomić and Domadenik (2012) illustrating that high dismissal costs, created mostly by the adverse selection and rigid legislation, introduce distortions in the labour market that are not similar for all groups of job-seekers.

In our model we assume that firms enter the labour market freely by creating vacant positions. A job seeker meets a vacant job with probability *p* per unit of time while firm decides whether to hire a worker or not conditionally on his/her signals. In the case of graduates seeking their first employment employers don't have lots of signals on which they might assess individual's productivity. We assume that the relevant signals are field of study, delay in graduation and type of HE institutions. We would like to show that these signals serve as proxy for worker's productivity and affect the hiring decision of employers.

Once a vacant position is filled, production takes place. The firm's output per unit of time is $m+\eta$, where *m* is a firm-specific and η is worker-specific component. The assumption is that firms make higher profits out of 'more productive' workers than out of 'less productive' ones; so they are more willing to hire more productive workers. Following the recent empirical contribution by Brodaty et al. (2008) we assume that an individual's productivity – worker specific component, denoted by η, is given by the relation

$$\eta = a_0 s + b_0 \delta + X c_0 + \theta_1 + \theta_2 \qquad (1)$$

where s is the individual's education, δ is individual's delay in graduation, X is a vector of covariates observed by both the employers and econometrician, $\theta_1$is an ability factor observed by the employer but not by the econometrician, and θ_2 is another ability factor, observed neither by the employer nor by the econometrician. Both ability factors are assumed to have a zero mean, finite variances and a non-negative covariance. The productivity effect of education is denoted a_0 and it is in general nonnegative. Individual's delay is defined as $\delta_i = d_i - E(d_i)$ and measures the deviation of individual's time to graduation if compared with an average student's time to graduation in the same field of study and the same type of study[7]. The direct productivity effect of delay is denoted b_0 and presumably

[6] They indicate several reasons why the assumption that ranking by duration is important, including the fact that the training costs of a new worker increase with unemployment duration as well as the decrease in the searching activities of the long-term unemployed (Blanchard and Diamond, 1994).

[7] Later in the data section we explain that the dataset includes graduates that finished either a professional or academic undergraduate education, where a professional focuses more on the applied knowledge.

positive (or at least zero) because it is a measure of experience if we assume that some students are delayed with formal study completion due to different work obligations (see, for example, Brodaty et al, 2008, for further discussion).[8] Parameters c_0 are the coefficients on control variables. Employers are assumed to observe both- education and delay on study - when deciding on hiring a graduate. Therefore we write this as:

$$s=Xc_1+Zg_1+f_1\,\theta_0+\xi_1 \quad (2)$$

$$\delta=Xc_2+Zg_2+f_2\,\theta_0+\xi_2 \quad (3)$$

Z is a vector of variables that are not included in the productivity equation and uncorrelated with θ but representing exogenous sources of variation in s and δ, θ_0 is a "talent" factor (or innate ability) that is not observed but is being correlated with ability factors θ_1 and θ_2. ξ_1 and ξ_2 are random error terms independent of Z and the θs, while c_1, c_2, g_1, g_2, f_1 and f_2 are parameters.

If new vacancy for a graduate is being posted then we might assume that firm will choose an individual with the highest expected productivity – match (1). If there are no candidates from desired field of education then the graduates from different fields are chosen with lower expected utility and represent a mismatch (0).

$$MATCH = E(\eta \mid X, s, \delta, \theta_1), \quad (4)$$

If we assume our random factors and random error terms are normally distributed, productivity η conditional on X, s, δ and θ_1 is also normal. Using the formula for expectation of a random variable and applying the property on variance being constant we get the equation:

$$\eta = a_0s+b_0\delta+Xc_0+\theta_1+ E(\theta_2|X, s, \delta, \theta_1) \quad (5)$$

Under the assumed normality of the variables, we get the convenient formula

$$E(\theta_2|X, s, \delta, \theta_1)= a_3s+b_3\delta+Xc_3+f_3\theta_1 \quad (6)$$

Applying it into initial model we finally get

$$\eta = (a_0+ a_3)s+(b_0 + b_3)\,\delta+X(c_0 +c_3)+(1+f_3)\theta_1 \quad (7)$$

and the probability of being matched is modelled as follows:

$$\Pr_t(MATCH_i = 1 \mid \eta_i) = F((a_0 + a_3)s + (b_0 + b_3)\,\delta + X(c_0 + c_3) + (1 + f_3)\theta_1) \quad (8)$$

where F is the cumulative distribution function. By rearranging the model of productivity and probability of being matched as it is written above we literally disentangle the effect of education and

[8] Slovenia is a very unique case in which we might assign positive effect of study duration on productivity to well known and widespread phenomena of student work. In the period under study (2007-2009) students were able to work on special contract that were far less expensive for employers if compared with other job seekers (Groot and Oosterbeek, 1994). However the increased duration of studying can be also due to lower innate ability and the delayed graduation signals lower ability (Brodaty et al., 2008; Aina and Pastore, 2012).

delay into the pure effect of education (a_0) and delay (b_0) and into the signalling effect a_3 and b_3 according to Spence. It is not possible to identify a_3 and b_3 separately without making strong additional assumptions, but we can test whether a_3 and b_3 are significantly negative if we can find an efficient estimator of a_0+a_3 and b_0+b_3. The critical assumption is that a_0 and b_0 are strictly nonnegative.

Clear order of the possible labour market outcomes allows us to use ordered logit (Robst, 2007a; Caroleo and Pastore, 2012). Being mismatched (j=0) is worse than being weakly matched (j=1) and better than being weakly matched is if a graduate is completely matched (j=2).[9]

Representing the general version of ordered model with 3 alternatives we can define our empirical model as

$$y_i = j \text{ if } \alpha_{j-1} < y_i^* \leq \alpha_j, \tag{9}$$

where $\alpha_0 = -\infty$. Then

$$\begin{aligned} \Pr[y_i = 1] &= \Pr\left[\alpha_{j-1} < y_i^* \leq \alpha_j\right] \\ &= \Pr\left[\alpha_{j-1} < x_i'\beta + u_i \leq \alpha_j\right] \\ &= \Pr\left[\alpha_{j-1} - x_i'\beta < u_i \leq \alpha_j - x_i'\beta\right] \\ &= F\left(\alpha_j - x_i'\beta\right) - F\left(\alpha_{j-1} - x_i'\beta\right) \end{aligned}$$

where F is the cdf of u. The regression parameters β and the 2 threshold parameters α_1, α_2 are obtained by maximizing the log-likelihood with p_{ij} as defined in (9). u is logistic distributed with $F(z) = e^z/(1+e^z)$. After obtaining the ordered regression results we calculate marginal effects.

Marginal effects are calculated

$$\frac{\partial \Pr[y_i=j]}{\partial x_i} = \left\{F'\left(\alpha_{j-1} - x_i'\beta\right) - F'\left(\alpha_j - x_i'\beta\right)\right\}\beta, \tag{10}$$

where F' denotes the derivative of F.

Assume now that the Spence's signalling model as specified in (8) is wrong. In that case the ability factors θ1 and θ2 are fully observable by employers – they have full information on worker's productivity: Employers do not need to use type of HE institution or delay as proxy for something they are supposed to observe directly. In that case we have a Becker version of the model specified as

$$\Pr_t(MATCH_i = 1 \mid \eta_i) = \Phi(a_0 s + b_0 \delta + X c_0 + \theta_1 + \theta_2) \tag{11}$$

If we estimate $\Pr_t(MATCH_i = 1 \mid \eta_i) = \Phi(a_0 s + b_0 \delta + X c_0 + \upsilon)$ where ν is a random error term the estimation of a and b are potentially biased as education and delay are clearly endogenous by assumption (2) and (3). We have to instrument both endogenous variables. The IV estimates $(\hat{a},\hat{b})$ are consistent and we find plim $(\hat{a})=a_0+a_3$ and plim $(\hat{b})=b_0+b_3$. In the case that model (11) is the correctly

[9] Majority of papers investigate the wage penalty associated with being mismatched (Robst, 2007a; Nordin et al., 2010; Beduwe and Giret, 2011; Boudarbat and Chernoff, 2008). This paper investigates the very first labour market outcomes of graduates and due to collective bargaining, especially at the beginning of a professional career wages do not properly reflect the differences in the quality of a match.

specified we strongly expect to find plim $(\hat{a}, \hat{b})$=(a_0,b_0). If we assume that a and be are nonnegative, then the negative and significant coefficients on education and delay in graduation mean that there are signals to the employers being related with unobservable productivity characteristics.

Due to the non-random assignment of students to schools and programmes and a selection bias associated we follow Rosenbaum and Rubin (1983) and apply propensity score matching that define a propensity score as the conditional probability of receiving treatment giving the pre-treatment characteristics:

$$p(X) = \Pr(D = 1|X) = E(D|X) \tag{12}$$

where the treatment is a binary variable described by $D = \{0,1\}$, $D_i = 1$ if unit i is assigned to the treatment (particular higher education institution) and $D_i = 0$ if unit i is assigned to a control treatment (other higher education institutions) and X is a multidimensional vector of pre-treatment characteristics. We calculate the Average Effect of Treatment on the Treated (ATT) can be estimated as follows:

$$\begin{aligned} ATT &= E\{Y_{1i} - Y_{0i}|D_i = 1\} = \\ &= E[E\{Y_{1i} - Y_{0i}|D_i = 1, p(X_i)\}] = \\ &= E[E\{Y_{1i}|D_i = 1, p(X_i)\} - E\{Y_{0i}|D_i = 0, p(X_i)\}|D_i = 1] \end{aligned} \tag{13}$$

where Y_{1i} and Y_{0i} are potential outcomes of two counterfactual situations of treatment and no treatment, respectively. The outcome of interest is the match and the ATT is calculated using Nearest-Neighbour Matching (Becker and Ichino, 2002) with the common support (Heckman, Ichimura and Todd, 1997; Heckman, LaLonde and Smith, 1999).

4. DESCRIPTION OF DATA AND MATCHING PROCEDURE

The study uses micro data on the entire cohort of graduates in three consecutive years from 2007 to 2009 as collected by the Statistical Office of the Republic of Slovenia. The graduation data ("ŠOL-DIPL" for 2007 and 2008 and "ŠOL-DIPL-TERC" for 2009) include the year and month of graduation, the higher education institution, the International Standard Classification of Education (ISCED) field of study, the level of study completed, the type of education achieved, the mode of study (full- or part-time), the year of first enrolment and a number of personal characteristics (gender, year of birth, nationality). Based on an identical individual number assigned to each graduate, graduates are matched with data from the Statistical Register of the Labour-Active Population ("SRDAP") which includes the entire employment history. Based on this matched dataset, we could correctly identify each individual's employment history (date of starting employment or unemployment, job classification, part-time or full-time work, number of shifts in the employment status). The described dataset is truncated at the end of September 2010, which allows us to examine the employment status of the 2009 cohort 9 months after graduation at the latest.

4.1. Matching method

Data from the Statistical Register of the Labour-Active Population ("SRDAP") are used to obtain the first jobs of graduates and to classify a match, a weak match or a mismatch. To define it, the Standard Classification of Occupation 2008 (SKP 2008) prepared by the Statistical Office of the Republic of Slovenia is employed. It is a national standard used to collect, analyse and distribute statistical data

and is in line with the Resolution of the International Labour Organisation (ILO) and update of the International Standard Classification of Occupation 2008 (ISCO-08). Different skills are needed for different occupations. ISCO-08 describes s*kill* as the ability to carry out the tasks and duties of a given job, where two dimensions of skill are used to arrange occupations into groups. These are s*kill level*[10] and s*kill specialisation.* Based on this classification, we can differentiate between four skill levels and for every skill level also the level of formal education of the International Standard Classification of Education (ISCED-97) is defined. The knowledge and skills required at Skill Level 3 are usually obtained when graduating at a higher educational institution's program that lasted for a period of 1 – 3 years. The knowledge and skills required at Skill Level 4 are usually obtained as the result of study at a higher educational institution for a period of 3 – 6 years leading to the award of a first degree or higher qualification. With the combination of the ISCED-97 and ISCO classification first vertical match is assigned.[11]

Horizontal matching is done separately for every field of education based on the ISCED. The definition of the fields of education, together with that of all the other variables used in the estimates, is contained in Appendix 1. The difficulties of investigating horizontal matches originate from the inability to strictly define the knowledge, skills and competences acquired through education and the knowledge needed and rewarded at the labour market (Witte and Kalleberg, 1995; Freeman and Hirsch, 2008). The majority of studies on horizontal mismatch use subjective measures of mismatch (Di Pietro & Urwin, 2006; Badillo-Amador & Vila-Lladosa, 2006; Robst, 2007; Robst (2008); Garcial-Aracil and Van der Velden, 2007; Boudarbat and Chernoff, 2008). However, with a self-reported horizontal match the question of endogeneity arises (Nordin et al., 2010) as the self-reported match might reflect a more general feeling with the job or the working conditions and environment (Garcia – Aracil & Van der Velden, 2007). We follow Nordin et al. (2010) and Yakusheva (2010) and adopt the combination of occupation classification and field of education; it might result in a downward bias and should be hence taken as a lower bound.[12]

4.2. Sample Characteristics

The Slovenian education system is shortly presented in Appendix 2. The sample consists of 27,875 full-time graduates who graduated in the years from 2007 to 2009. In order to investigate the school-to-work transition of graduates who enter the labour market after graduation and not during the time of study we identified 11,438 observations of graduates for further analysis. The number of observations by year; the percentages of graduates in a particular field and type of education, and higher education institution are presented in Table 1 below.

Comparing the sampled individuals by field of study we can observe a high proportion of graduates from business and administration followed by health and education. More than 90 percent of them

[10] The skill level is defined as a function of the complexity and range of tasks and duties to be performed in an occupation. It is measured operationally by considering one or more of: (1) the nature of the work performed in an occupation in relation to the characteristic tasks and duties defined for each ISCO-88 skill level; (2) the level of formal education defined in terms of the International Standard Classification of Education (ISCED-97) required for the competent performance of the tasks and duties involved; and (3) the amount of informal on-the-job training and/or previous experience in a related occupation required for the competent performance of these tasks and duties.

[11] A graduate is considered to be overeducated if (s)he secures employment in the group of clerical support workers, service and sales workers, skilled agricultural, forestry and fishery workers, craft and related trades workers, plant and machine operators, and assemblers as well as elementary occupations.

[12] Do to the lack of information on the degree of job satisfaction, we do not distinguish between true and untrue overeducation (Chevalier, 2003; Mavromaras et al., 2008).

studied at two biggest state universities. Almost 95 percent of them were educated based on pre-Bologna curriculum.

Table 1: Characteristics of graduates included in the sample in the period 2007-2009

	2007	2008	2009
Number of observations	4,188	3,738	3,512
Female (in %)	63.71	64.42	64.64
Above average duration of study (in%)	32.81	30.63	28.82
Employment in first 3 months (in %)	62.56	63.80	58.68
Matched individuals (in %)	70.89	70.47	54.95
Vertically overeducated individuals (in %)	35.72	35.23	47.04
Fields of Education (in %)			
Education	10.77	12.57	12.33
Arts	1.41	0.96	1.45
Humanities	4.35	4.28	5.04
Social and behavioural science	7.95	7.09	6.24
Journalism and information	0.91	0.67	0.63
Business and administration	21.28	18.75	16.14
Law	7.52	8.13	6.92
Life sciences	2.10	1.85	2.59
Physical sciences	1.86	1.63	1.71
Mathematics and statistics	0.48	0.56	0.74
Computing	2.39	2.92	3.19
Engineering and engineering trades	9.53	9.42	10.91
Manufacturing and processing	3.01	3.37	3.10
Architecture and building	4.42	4.79	4.04
Agriculture, forestry and fishery	2.91	2.73	2.53
Veterinary	0.74	0.88	1.08
Health	13.42	14.63	15.69
Social services	0.62	0.88	1.40
Services	4.35	3.88	4.27
Type of an higher education degree (in %)			
Higher Vocational	4.68	4.64	4.65
Professional higher (former)	28.52	25.47	23.93
Professional higher (1st Bologna cycle)	0.22	0.56	1.37
Academic higher (former)	66.34	68.95	67.57
Academic higher (1st Bologna cycle)	0.24	0.38	2.48
Higher Education Institutions (in %)			
Public university 1	70.92	70.95	69.19
Public university 2	20.77	20.68	21.70
Public university 3	2.41	2.49	3.10
Private university 1	0.33	0.27	0.20
Upper schools for vocational education	4.68	4.63	4.64
Independent higher education institutions	0.88	0.99	1.17

Source: SORS, 2010; own calculations

Roughly two thirds of the sample is represented by females and slightly lower proportion of graduates found a job in the first three months after graduation. There is a slight decrease in the proportion of those who are employed in the first three months after graduation, which we attribute to the economic crisis. Around one third of graduates exhibit a delay in the time of graduation if compared with other students from the same field and the same year. The work position of more than 70 percent of graduates who were employed in the first nine months after graduation was assigned as matched with their field of study but the percentage deteriorated to 54 percent in 2009. Similarly, the share of overeducated graduates holding a vertically mismatched job (a job implying overschooling) increased substantially from one third in 2007 to almost a half in 2009.

Table 2 looks at the correlation of horizontal match variable (whether an individual secured a job that matched, weakly matched or mismatched his/her field of education) and vertical match variable (whether an individual is overeducated or not). The percentage of all graduates that were matched and overeducated is around 20 percent and almost 40 percent of graduates were mismatched and overeducated. The calculated coefficient of correlation between the horizontal and vertical match is -0.473 and is statistically significant at 1%.

Table 2: Percent of graduates with different combinations of horizontal and vertical match.

	Appropriate level of education	Overeducation	Row percent
Mismatch	5.16	39.29	44.45
Weak match	4.52	2.46	6.98
Match	29.29	19.28	48.57
Column percent	38.98	61.02	100.00

Source: SORS (2010), own calculations.

5. RESULTS

5.1. The effect of the field of study on the likelihood of a match

To test the signalling model we create a dummy variable of above average duration of studying that is calculated for each separate field and type of study (all the variables definitions are explained in Appendix 1). In Table 3 we report the ordered logit estimates of the determinants of the likelihood of experiencing an horizontal mismatch. The base category in our calculations are male Business and administration graduates that finished an academic higher (former) program at Public university 1 and needed average or below average time to graduate and were not employed in the first three months after graduation. Before controlling for different fields of education (Specification 1), we observe a statistically negative effect of above average length of studying on the likelihood of a match, which is in line with Brodaty et al. (2008)[13]. Adding fields of education in Specification 2 significantly improves the model (increase in Pseudo R^2). Interestingly, the majority of the marginal effects for different fields of education are negative with the exception of health graduates which are due to a very high likelihood of a match as compared to business and administration graduates (the reference group). In addition, computing, architecture and building graduates exhibit a high likelihood of a match. Social and behavioural sciences, environmental protection, transport services, security services, humanities, manufacturing and processing, and arts graduates exhibit the lowest likelihood of a match.

[13] We also tested the non-linear effect of above average duration, however the effects are very marginal and non significant and therefore omitted.

Adding also the type of education (as described in the Appendix 1) and higher education institution (Specification 3) marginally improves the model but confirms the robustness of the previously described results. However, despite the fact that all the coefficients relative to the fields of study are reduced a little bit, from specification 3 we can observe that the marginal effects of either different type of study and different higher education institution are not statistically significant[14]. This might be a result of various effects of school quality in different fields of studies and is investigated separately. In all the specifications the negative effect of the above average duration of studying is statistically significant.

Table 3: Marginal effects of the likelihood of experiencing an horizontal mismatch using an ordered logit model

	Specification 1	Specification 2	Specification 3
Probability of horizontal match (y)	0.672	0.704	0.704
	Variables		
	Marg. Eff.	*Marg. Eff.*	*Marg. Eff.*
	(Std. Err.)	*(Std. Err.)*	*(Std. Err.)*
	Personal and Employment Characteristics		
Women	0.023**	-0.015	-0.016
	(0.009)	(0.011)	(0.011)
Overeducation	-0.359***	-0.458***	-0.463***
	(0.008)	(0.010)	(0.010)
	Graduation Characteristics		
Year of graduation	-0.072***	-0.078***	-0.079***
	(0.008)	(0.010)	(0.002)
Above average duration of studying	-0.035***	-0.054***	-0.054***
	(0.010)	(0.010)	(0.010)
	Types of Education		
Higher Vocational			0.029
			(0.022)
Professional higher (former)			0.017
			(0.013)
Professional higher (1st Bologna cycle)			0.060
			(0.050)
Academic higher (1st Bologna cycle)			0.054
			(0.044)
	Higher Education Institutions		
Public University 2			0.007

[14] In an alternative specification where only types of education and higher education institutions are included we in fact find a significant effects of these two groups of variables. However an issue regarding the comparison arises since the Universities essentially differ. For example University 1 is the largest university and offers education in all fields of studies, whereas smaller and newer ones only in some particular fields of study. Therefore we compare graduates from the same field of education and different higher education institution further on in the paper (Table 4).

		(0.012)
Public University 3		0.040
		(0.029)
Private University 1		-0.165
		(0.121)
Independent higher education institutions		0.028
		(0.046)
Fields of Education		
Education	-0.271***	-0.259***
	(0.021)	(0.022)
Arts	-0.380***	-0.363***
	(0.043)	(0.045)
Humanities	-0.522***	-0.512***
	(0.018)	(0.021)
Social and behavioural science	-0.612***	-0.604***
	(0.012)	(0.013)
Journalism and information	-0.269***	-0.250***
	(0.069)	(0.070)
Law	-0.295***	-0.281***
	(0.025)	(0.026)
Life sciences	-0.398***	-0.381***
	(0.032)	(0.034)
Physical sciences	-0.369***	-0.353***
	(0.038)	(0.039)
Mathematics and statistics	-0.461***	-0.454***
	(0.045)	(0.046)
Computing	-0.102**	-0.094**
	(0.039)	(0.039)
Engineering and engineering trades	-0.365***	-0.360***
	(0.022)	(0.022)
Manufacturing and processing	-0.501***	-0.498***
	(0.020)	(0.022)
Architecture and building	-0.223***	-0.211***
	(0.032)	(0.033)
Agriculture, forestry and fishery	-0.398***	-0.392***
	(0.029)	(0.029)
Veterinary	-0.380***	-0.363***
	(0.050)	0.052
Health	0.111***	(0.113) ***
	(0.016)	(0.016)
Personal services	-0.056	-0.082

		(0.048)	(0.053)
Transport services		-0.608***	-0.609***
		(0.018)	(0.018)
Environmental protection		-0.581***	-0.533***
		(0.038)	(0.060)
Security services		-0.506***	-0.506***
		(0.032)	(0.033)
Number of observations	11,438	11,438	11,438
Pseudo R^2	0.099	0.211	0.212

y is the likelihood of a match. The baseline are male graduates of Business and Administration who finished the former academic programme at Public University 1, and had an average test score at a matriculation exam and needed average duration to graduate.

** significant at 10%; ** significant at 5%;***a significant at 1%*

Source: SORS, 2010; own calculations

5.2. The signal of duration and university quality

In this section, we test the signalling model proposed in the methodology section, where we disentangle the effect of the education and delay in graduation. From the previous analysis, we conclude that the field of education does affect the likelihood of a match but we also find that the type of education and the higher education institution do not affect the investigated likelihood. This is contrary to what we find in Domadenik et al. (2010) and Farčnik and Domadenik (2012) when investigating the employability of graduates. A possible explanation of our results is that the effect of the higher education institution and type of education is included in the effect of the field of education. Therefore we in particular investigate the signal of different universities on the likelihood of a match using propensity score matching and controlling for field of education and type of education (where possible).

Table 4 reports average treatment effects of graduating from University 1 on the treated for each separate field of education. The signal of the higher education institution is significant for graduates in some social sciences, namely business and administration and, to a lesser extent, for education. On the contrary, the higher education institution does not signal skills or abilities in the technical fields of education (engineering, computing, manufacturing). The rationale behind this might lay in the self selection of students into fields of study indicating that students with higher innate ability as well as higher motivation are more likely to choose a demanding and specific field of study and on the other hand the less able are more likely to choose fields of study that focus more on general skills. Since about a third of the population graduated from social sciences and the supply of institutions offering education in this particular field of study is bigger than for other fields, potential graduates differentiate themselves by choosing the institution that signals higher endowment (both in innate ability as well as skills) and potentially higher productivity to the employers.

Table 4: Propensity score estimates of ATT (treatment=University 1)

	2007		2008		2009	
	NN	Stratification	NN	Stratification	NN	Stratification
Education	-0.055	-0.061	-0.005	0.008	0.128***	0.077**
	(0.032)	(0.027)	(0.040)	(0.027)	(0.037)	(0.031)
Business and Administration (acad.)	0.048	0.071	0.041	0.035	0.059	0.277***
	(0.044)	(0.032)	(0.044)	(0.030)	(0.045)	(0.029)
Business and Administration (prof.)	0.091*	0.079	0.148**	0.108**	0.075	0.195***
	(0.034)	(0.029)	(0.050)	(0.038)	(0.040)	(0.036)
Law	0.045	0.024	0.054	0.097	0.050	0.080
	(0.066)	(0.038)	(0.060)	(0.047)	(0.058)	(0.052)
Computing	0.050	0.020	0.004	0.059	0.151	0.119
	(0.062)	(0.055)	(0.073)	(0.049)	(0.094)	(0.063)
Engineering (acad.)	-0.007	-0.02	0.112	0.085	0.117	0.102
	(0.049)	(0.040)	(0.067)	(0.047)	(0.081)	(0.055)
Engineering (prof.)	0.081	0.061	-0.037	-0.019	0.022	0.013
	(0.092)	(0.065)	(0.084)	(0.062)	(0.078)	(0.061)

Notes: The propensity scores are estimated using a logit model where the treatment is University 1 and average treatment effect on the treated (ATT) is reported for the likelihood of being matched and standard errors are reported in the parenthesis. The ATT is calculated using nearest neighbour (NN) matching and stratification matching with common support. ATT is reported only for fields with sufficient number of observations in both treatment and non-treatment group those are the following fields: Education, Business and Administration, Law, Computing and Engineering. The included fields are the ones that a graduate can obtain a degree at either University 1 or other higher education institutions, whereas in other fields the degree is either obtainable only at University 1 or in all the other higher education institutions.
** significant at 10%; ** significant at 5%;***a significant at 1%*

Source: SORS, 2010; own calculations

In order to investigate the above average duration of studying as a signal of ability for prospective employers, we estimate average treatment effects of above average duration for separate fields of study, as reported in Table 5. We find that the above average duration has a positive effect of the likelihood of a match for such technical fields of studies as computing and engineering, but a negative one for law graduates. The rationale has already been discussed above: graduates from technical fields of study are able to work during their studies and are, hence, able to gain some work experience and build their work-related competences, whereas for instance law graduates are unable to practice in their field before they officially graduate. In the latter case, the increased duration of studying or delay in graduation signals lower skill endowment. The signal of delayed graduation is not statistically significant for Humanities and arts as well as for manufacturing and architecture and building and is mixed for graduates in different fields of services.

Table 5: Propensity score estimates of ATT (treatment=above average study duration)

	2007		2008		2009	
	NN	Stratification	NN	Stratification	NN	Stratification
Education	-0.034	-0.034	-0.049	-0.049	0.090	0.090
	(0.030)	(0.037)	(0.034)	(0.037)	(0.031)	(0.031)
Humanities and Arts	-0.033	-0.038	0.007	0.006	0.041	0.038
	(0.036)	(0.040)	(0.040)	(0.039)	(0.033)	(0.032)
Social Sci.	-0.1	-0.097	-0.003	-0.004	0.062	0.062
	0.032	0.035	(0.035)	(0.041)	(0.038)	(0.034)
Business and Administration	0.002	0.002	0.140***	0.129***	0.111***	0.108***
	(0.019)	(0.020)	(0.023)	(0.019)	(0.022)	(0.019)
Law	-0.123***	-0.124***	-0.175***	-0.170***	-0.058	-0.053
	0.041	0.04	0.044	0.037	0.049	0.051
Life and Physical sci., Mat, Stat.	-0.222***	-0.230***	-0.131	-0.131	-0.052	-0.052
	(0.054)	(0.050)	(0.063)	(0.069)	(0.061)	(0.058)
Computing	0.019	0.022	0.143*	0.130*	0.248***	0.248***
	(0.062)	(0.053)	(0.064)	(0.062)	(0.059)	(0.068)
Engineering	0.030	0.032	0.128***	0.135***	0.111**	0.116***
	(0.033)	(0.036)	(0.035)	(0.037)	(0.042)	(0.037)
Manufacturing	-0.016	-0.043	0.034	0.024	0.068	0.061
	(0.069)	(0.073)	(0.058)	(0.057)	(0.049)	(0.057)
Architecture and building	-0.12	-0.121	0.086	0.075	0.042	0.04
	(0.057)	(0.053)	(0.048)	(0.058)	(0.058)	(0.061)
Agriculture	-0.048	-0.026	0.002	-0.017	0.008	-0.011
	(0.058)	(0.069)	(0.072)	(0.060)	(0.051)	(0.460)
Health	-0.069	-0.069	-0.037	-0.042	0.018	0.015
	(0.038)	(0.040)	(0.034)	(0.028)	(0.053)	(0.049)
Services	-0.006	-0.005	0.101*	0.094*	0.027	0.027
	(0.040)	(0.048)	(0.045)	(0.041)	(0.032)	(0.033)

Notes: The propensity scores are estimated using a logit model where the treatment is above average study duration and average treatment effect on the treated (ATT) is reported for the likelihood of being matched and standard errors are reported in the parenthesis. The ATT is calculated using nearest neighbour matching (NN) and stratification matching with common support. Graduates of Life sciences, Physical sciences and Mathematics and Statistics are grouped together. The same applies for graduates of Social and behavioural sciences and Journalism and information (Social sciences in the table above) and for graduates of Humanities and arts.
** significant at 10%; ** significant at 5%;***a significant at 1%*

Source: SORS, 2010; own calculations

6. CONCLUSION

The consequences of incomplete information on labour markets have been explored in various ways. Empirical tests of job-market signalling in the sense of Spence (1973) versus human capital theory, inspired by Becker (1964) and Mincer (1974), are difficult to construct as both theories predict the same increasing relationship between education and labour market outcome. However a

decomposition of the productivity-enhancing and signalling effect of education can be obtained with the help of a structural model based on strong restriction. According to employer-learning theory as described by Lange (2007) the impact of job-market signalling effects is limited to the beginning of worker's career because employees learn the unobservable ability characteristics of employees after some time (few years) of being employed. The empirical design of our paper that builds on first labour market evidence of young graduates enables us to study a signalling effect of institutional quality and duration of study on individual employability before it fades out.

Researching the whole dataset of Slovene graduates in the period of 2007-2009 we find out that graduates from specific higher education institutions experienced significantly higher probability to get a job that matches the field of study for social sciences, namely business and administration field of education and to smaller extent for education graduates. On the contrary the higher education institution does not signal skills or abilities in the technical fields of education (engineering, computing, manufacturing). In the period of massive inflow into higher education choosing a technical field of study obviously signal a person with high ability (mechanism of self-selection), whatever the high education institution where the degree was attained. However, on the other hand, in the case of social sciences and humanities we have a mixture of high and low ability individuals and degree itself doesn't provide complete information on productivity. It is also interesting that the signal becomes more effective in the year 2009 when firms faced the severe crisis conditions. Obviously firms became more cautious about who to hire as wrong decisions became relatively more costly than in the booming years of 2007 and 2008.

We also got very interesting results regarding average duration of studying. There are two different effects that should be discussed. Above average duration might originate in above average commitment to get as much practical experience as possible. In this case such students are more likely to be employed on a job that matches his/her field of study. We found out that this is the case of technical fields of studies, such as computing and engineering. Those graduates can get work experience in their fields of study before formal completion. On the other hand we have law graduates who can not accumulate work experience before graduation and our results show significantly negative correlation between delay and probability of match. In this case the increased duration of studying or delay in graduation signals lower endowment. The signal of the delayed graduation is not significant for Humanities and arts as well as for manufacturing and architecture and building and is very mixed for service graduates.

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Appendix 1: Variables definition

Variable	Description
	Dependent variable
Mismatch	= 0, of the field of education and occupation does not match; = 1, if field of education and occupation weakly match: = 2, if field of education and occupation match.
	Individual characteristics
Gender	=1, if female; = 0 otherwise.
	Graduation characteristics
Field of education	= 14, if Education; = 21, if Arts, = 22, if Humanities; = 31, if Social and behaviour sciences; = 32, if Journalism and information; =34, if Business and administration; = 38, if Law; = 42, if Life sciences; = 44, if Physical sciences; = 46, if Mathematics and statistics; = 48, if Computing; = 52 if Engineering; = 54, if Manufacturing and processing; = 58, if Architecture; = 62, if Agriculture, forestry and fishery; = 64, if Veterinary; = 72, if Health, = 76, if Social services, =81, if Personal services; = 82, if Transport services, = 84, if Environmental protection, = 86, if Security services. Dummy variables are created accordingly for every field of education.
Higher vocational education	= 1, if graduated with diploma at higher vocational program – sublevel 6/1; = 0, otherwise.
Higher professional (former)	= 1, if graduated with diploma at higher professional program (former) – sublevel 6/2; = 0, otherwise.
Professional higher (1st Bologna cycle)	= 1, if graduated with diploma at professional higher (1st Bologna cycle) program – sublevel 6/2; = 0, otherwise.
Academic higher (1st Bologna cycle)	= 1, if graduated with diploma at academic higher (1st Bologna cycle) program – sublevel 6/2; = 0, otherwise.
Academic higher (former)	= 1, if graduated with diploma at academic higher (former) program – sublevel 7; = 0, otherwise.
Public university 1	= 1, if graduated at Public university 1; = 0, otherwise.
Public university 2	= 1, if graduated at Public university 2; = 0, otherwise.
Public university 3	= 1, if graduated at Public university 3; = 0, otherwise.
Private university 1	= 1, if graduated at Private university 1; = 0, otherwise.
Upper schools for vocational education	= 1, if graduated at one of the Upper schools for vocational education; = 0, otherwise.
Independent higher education institutions	= 1, if graduated at one of the Independent higher education institutions; = 0, otherwise.
Above average duration of study	= 1, if the duration of study exceeds the average duration of a study in a specific field of education by at least one standard deviation = 0, otherwise.
	Employment characteristics
Overeducation	= 1, if the occupation is in the group of clerical support workers, service and sales workers, skilled agricultural, forestry and fishery workers, craft and related trades workers, plant and machine operators, and assemblers as well as elementary occupations; = 0, otherwise.
Employment in first three months	= 1, if the graduate secured employment in the first three months after graduation; = 0, otherwise.

Appendix 2: Slovenian higher education system

Along with other Central and Eastern European economies, Slovenia inherited a highly centralised and state-controlled education system from the socialist period. Young people were allocated to the education system in accordance with the economic and social goals of central planning. The transition from school to work was smooth since the first workplace was often assigned by state agencies, supported by employers and secured for all school leavers virtually irrespective of their education level. The period of transition was followed by a two-fold restructuring: on the labour demand side (see for example Domadenik, Prašnikar, Svejnar, 2008) and on the side of educational and training systems.

The Slovenian higher education system is classified according to the national classification system of education and training activities and outcomes ("KLASIUS") and uses a different classification than the International Standard Classification of Education. According to KLASIUS, there are eight levels of education (not six like in the ISCED classification), as presented in Table A1. With the introduction of the Bologna reform a revised classification has been developed. Higher education institutions in Slovenia are public and private universities, faculties, art academies and professional colleges (MVZT, 2011). Faculties and art academies can offer both academic and professional study programmes, while professional colleges offer undergraduate professional study programmes or academic programmes on the graduate level. The difference between university and professional institutions lies in research-based studies and academic research activities. There are three public universities in the country and one private and 26 independent higher education institutions of which one is public and 25 are private.

Table A1: KLASIUS and a description of education levels in the Slovenian higher education system

KLASIUS	Description of type of education
6	Sixth level: First cycle of higher and similar education
6.1	- Sublevel 6/1: Short-term higher education, higher vocational education and similar education
6.2	- Sublevel 6/2: First cycle of higher education (first Bologna cycle), professional higher (former), academic higher education (first Bologna cycle), specialisation after short-term higher education (former)
7	Seventh level: Second cycle of higher and similar education - Specialisation after professional higher education (former), Academic higher education (former), Master's education (second Bologna cycle),
8.	Eighth level: Third cycle of higher and similar education
8.1	- Sublevel 8/1: Education leading to »magisterij« of science (former) and similar education
8.2.	- Sublevel 8/2: Education leading to doctorate of science (former) and doctorate of science (third Bologna cycle) and similar education

Source: SORS, 2011

Appendix 3: Fields of Education description

Field of Education	Description
Education	Teacher training and education science
Arts	Fine arts, performing arts, graphic and audio-visual arts, design, craft skills
Humanities	Native and foreign languages and cultures, interpretation and translation, linguistics, comparative literature, history, archaeology,

	philosophy, ethics, religion and theology.
Social and behavioural science	Economics, economic history, political science, sociology, demography, anthropology (except physical anthropology), ethnology, futurology, psychology, geography (except physical geography), peace and conflict studies, human rights
Journalism and information	Journalism, library technician and science.
Business and administration	Retailing, marketing, sales, public relations, real estate; Finance, banking, insurance, investment analysis; Accounting, auditing, bookkeeping; Management, public administration, institutional administration, personnel administration; Secretarial and office work.
Law	Local magistrates, 'notaries', law (general, international, labour, maritime, etc.), jurisprudence, history of law
Life sciences	Biology, botany, bacteriology, toxicology, microbiology, zoology, entomology, ornithology, genetics, biochemistry, biophysics, other allied sciences, excluding clinical and veterinary sciences
Physical sciences	Astronomy and space sciences, physics, other allied subjects, chemistry, other allied subjects, geology, geophysics, mineralogy, physical anthropology, physical geography and other geosciences, meteorology and other atmospheric sciences including climatic research, marine science, volcanology, paleoecology.
Mathematics and statistics	Mathematics, operations research, numerical analysis, actuarial science, statistics and other allied fields.
Computing	System design, computer programming, data processing, networks, operating systems - software development only (hardware development should be classified with the engineering fields).
Engineering and engineering trades	Engineering drawing, mechanics, metal work, electricity, electronics, telecommunications, energy and chemical engineering, vehicle maintenance, surveying.
Manufacturing and processing	Food and drink processing, textiles, clothes, footwear, leather, materials (wood, paper, plastic, glass, etc.), mining and extraction
Architecture and building	Architecture and town planning, building, construction, civil engineering.
Agriculture, forestry and fishery	Agriculture, agronomy, horticulture and gardening, forestry, fishery science and technology.
Veterinary	Veterinary medicine, veterinary assisting.
Health	Medicine, medical services, nursing, dental services,
Social services	Social care, social work

Personal services	Hotel and catering, travel and tourism, sports and leisure, hairdressing, beauty treatment and other personal services: cleaning, laundry, dry-cleaning, cosmetic services, domestic science.
Transport services	Seamanship, ship's officer, nautical science, air crew, air traffic control, railway operations, road motor vehicle operations, postal service.
Environmental protection	Environmental conservation, control and protection, air and water pollution control, labour protection and security.
Security services	Protection of property and persons: police work and related law enforcement, criminology, fire-protection and fire fighting, civil security; military.

Source: Adopted by UNESCO ISCED 97.