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Jacek Liwiński
University of Warsaw

Francesco Pastore
University of Campania Luigi Vanvitelli, IZA and AISSEC

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IZA – Institute of Labor Economics

Schaumburg-Lippe-Straße 5–9
53113 Bonn, Germany

Phone: +49-228-3894-0
Email: publications@iza.org

www.iza.org

ABSTRACT

Are School-Provided Skills Useful at Work? Results of the Wiles Test

We test for the signalling hypothesis versus human capital theory using the Wiles test (1974) in a country which has experienced a dramatic increase in the supply of skills. For this purpose, we construct a job match index based on the usefulness of the school-provided skills and the relevance of the job performed to the field of study. Then we regress the first earnings of graduates on this index using OLS and Heckit to control for omitted heterogeneity of the employed. The data we use come from a representative tracer survey of Poles who left secondary schools or graduated from HEIs over the period of 1998-2005. We find that only the HEI graduates obtain a wage premium from skills acquired in the course of formal education. This finding is robust to a large number of robustness checks with different indicators of the educational mismatch and instrumental variables.

JEL Classification: I26, J24, J31

Keywords: education, skills, signalling, job matching, wages, Heckman correction

Corresponding author:
Jacek Liwiński
Faculty of Economic Sciences
University of Warsaw
ul. Dluga 44/50
00-241 Warszawa
Poland
E-mail: jliwinski@wne.uw.edu.pl

NON-TECHNICAL SUMMARY

Although it has been over 40 years since labour economists started testing human capital vs. signalling explanation of the wage premium from education, the debate is still going on and authors keep on proposing new methods of testing. The human capital theory postulates that investment in education enhances the productive capacity of individuals, while according to the signalling hypothesis the value of a graduation diploma follows from the fact that it signals innate abilities of its holder.

We apply the approach proposed by Wiles (1974) to test for the signalling hypothesis and, in particular, to find out if there is a positive relation between education and productivity. For this purpose, we construct a job match index based on information if school provided knowledge and skills are useful at work and the job performed is relevant to the field of study. Then we check if the quality of job matching is related to wages of graduates in Poland. To answer this question, we conduct econometric analysis on the basis of data from a representative, nationwide tracer survey of Poles who left secondary schools or graduated from higher education institutions (HEI) over the period of 1998-2005.

We find that only the HEI graduates obtain a wage premium from skills acquired in the course of formal education. They are rewarded for both high usefulness of skills acquired while studying and for high relevance of the job performed to their field of study. We also find that soft and hard skills acquired at HEIs are rewarded by employers differently. Soft skills are rewarded most highly when they are very useful and the job is completely relevant to the field of study, while the hard-applied skills bring a high wage premium when they are very useful but not completely relevant.

Finally, we argue that our results support the weak signalling hypothesis for HEI graduates as this group obtain a positive wage premium from both their degree and the quality of job matching at the same time.

Introduction

For four decades, education economists have been disputing whether formal education provides skills that are useful at work or it is only a tool to signal high innate abilities to employers. The first approach follows the human capital theory (Becker 1964), according to which formal education provides knowledge and skills, thereby enhancing the productive capacity of individuals at work, which translates into higher wages under assumption of perfect competition in the labour market. The second, alternative explanation of the positive wage premium from education is proposed by Spence (1973), who argues that it may result from selection that takes place in the education process, where innate abilities are rewarded. In an extreme case, schooling may provide no skills useful at work whatsoever and be a signalling tool only (Arrow 1973; Stiglitz 1975). This case is termed the *strong signalling hypothesis* (SSH). Yet, it is also possible that education both signals abilities and provides some skills that are useful at work, then the wage premium reflects both these factors. A case like this is referred to as the *weak signalling hypothesis* (WSH) (Blaug 1995; Groot and Hartog 1995; Brown and Sessions 2006).

The signalling hypothesis has been tested empirically in many different ways, with no conclusive results however (see Brown and Sessions 2004 for a review of literature). One of the approaches, known as the Wiles test, verifies whether graduates receive any wage premium from performing a job which is relevant to their field of study, which can be treated as a good job match (Arabsheibani 1989; FengLiang et al. 2009). A positive wage premium from a good job match may be interpreted as evidence of a positive impact of education on employee's productivity at work, which supports the human capital theory, and consequently leads to the rejection of the strong signalling hypothesis. If this coincides with a positive wage premium from education, the weak signalling hypothesis is supported. On the other hand, no wage premium from a good job match coexisting with a positive wage premium from education would validate the signalling theory.

The aim of this study is to test for the signalling hypothesis using the Wiles test as developed in what is considered now a standard format in several recent contributions (see, among others: Dolton (1985) for the UK; Zhu & Zhu (2011) and FengLiang et al. (2009) for China; Miller & Volker (1984) for Australia; Arabsheibani (1989) for Egypt; van der Merwe (2010) for South Africa). In particular, we build a job match index based on the respondents' declaration whether their current occupation was matched with their qualifications in terms of usefulness of the skills acquired in their work and the relevance of their job to the field of study. We estimate an extended Mincer wage equation using OLS and data from a representative, nationwide

tracer survey of Poles who left secondary schools or graduated from higher education institutions over the period of 1998-2005 (Graduate Tracer Survey).

The contributions for Poland most closely related to ours are two studies on vertical overeducation (Kiersztyn 2011; Wincenciak 2016). Although using slightly different methodologies, both of them reach the same conclusion - they identify a wage penalty from a higher level of education than required in a given occupation, as compared to the graduates who are well-matched.[1]

This paper contributes to the existing literature in several ways. First, this is the first study in which the signalling hypothesis is tested by the use of the Wiles approach for Poland. The case of Poland is particularly interesting because the country has recently experienced a dramatic supply push, with an increase in the share of young people holding upper secondary school and tertiary diploma.[2] It is important to understand whether this is going to correspond to an increase in productivity or not. Much will depend also on the ability of the demand side to upgrade to the increased supply of skills by directing towards what is sometimes called the new road to development, which means leaving traditional manufacturing industries in favor of more technologically advanced productions in the secondary and tertiary sector of the economy. The case of Poland is very interesting under this respect, because many South and East EU members are experiencing a similar evolution: increasing supply of skills with the demand which is still lagging behind (Caroleo and Pastore 2017; Ordine and Rose 2017).

Since 1999, when a big education reform was implemented in Poland, pupils aged 13-15 have to attend a lower secondary school, called "gymnasium", after which they have a choice - they can go to a basic vocational school, secondary vocational school or secondary comprehensive school. The first one gives only vocational skills

1 Kiersztyn (2011) used the Polish Social Classification of Occupations (SKZ), ranging from 6 for unskilled service workers to 89 in the highest level managerial and professional occupations, to compute the average educational requirement for each level of education. A respondent was considered overeducated if the educational requirement score attributed to his/her main occupation was lower than one standard deviation below the mean for all respondents in his/her educational category. Wincenciak (2016) computed the dominant level of education for each 3-digit level (ISCO 08) occupation group and assumed that respondents with higher than the dominant level of education are overeducated, while those with a lower level of education than the dominant one are undereducated.

2 The net enrolment ratio in upper secondary schools (comprehensive and vocational) in Poland increased over the first twenty years of economic transformation (1990-2010) from 40,8% to 75,2% (CSO 1992, CSO 2011a). In the same period the net enrolment ratio in higher education increased from 9,8% to 40,8% (CSO 2011b).

and prepares for work, the second gives both vocational and general skills and hence graduates can either start working or study at higher education institutions (HEI), while the third one gives only general knowledge and prepares for studying. As a result of the 1999 reform, enrollment rates in the first type decreased, while in the other two increased (Figure 1). Entering the EU had no impact on this dynamics (after 2004 the rates are quite stable). As for the enrolment rate to the HEI, it increased rapidly in the 1990s and early 2000s - from 9,8% in 1990 to 36,8% in 2004 - while after 2004 there was only a minor increase (Figure 2).

[Figure 1 and 2 about here]

The share of young people holding a high secondary degree and a tertiary degree evolved as in Figure 3.

[Figure 3 about here]

In spite of this evolution in the supply of skills, the structure of GDP in terms of agriculture, industry and services remains remarkably stable. Instead, R&D expenditures has grown relative to GDP (Figure 4) and the share of private firms in these expenditures increases over time (Figure 5).

[Figure 4 and 5 about here]

Our second contribution is to use the Wiles approach to test for signalling hypothesis with respect to not only university graduates, as it was done in all other studies so far, but also with respect to secondary school graduates, which are often neglected in the literature, with few exceptions[3].

Thirdly, and more importantly, from a methodological point of view, ours is among a few studies available to provide estimates of the Wiles test using the Heckman correction for sample selection bias (only Miller and Volker 1984, and Zhu and Zhu 2011 addressed sample selection so far but they did not report the results). However, controlling for omitted heterogeneity of the employed versus the non-employed is necessary in most countries, especially when the graduates' jobless rate is high. We have tried several variables as instruments and finally used three of them (see instrumental variables section below).

Our results support the weak signalling hypothesis in case of university graduates, while at the same time they support the strong signalling hypothesis in case of the graduates of secondary vocational schools. Our explanation is that a large

3 Zhu and Zhu (2011) focus on one type of post-secondary diploma.

increase in the supply of skills in a short period of time is likely not to affect the country's productivity if the country's technological innovation does not react quickly enough.

This paper is structured into six sections. The first section introduces previous studies where the Wiles test was used. The second section presents our methodology of analysis, including the data set used, wage equation and a large experimentation with instrumental variables used for the Heckman correction. The third section provides descriptive statistics of key variables. The fourth section reports the main findings of the study. In the fifth section we test for heterogeneity of the results, while in the sixth one we report some robustness checks. The paper ends with concluding remarks.

1. Overview of empirical literature

So far, the Wiles test has been used in a few studies only, some of which prove a positive effect of education on the graduates' productivity (Arabsheibani, 1989; Zhu and Zhu, 2011), while others show that no such a relation occurs, the role of education being limited to its signalling function (Miller and Volker, 1984; FengLiang et al., 2009; van der Merwe, 2010). Thus, studies are not conclusive so far, whether skills acquired in the course of formal education are useful at work. However, the results of analyses referred to above might have been affected by the fact that the Wiles test is applied slightly differently in each of them.

Firstly, the key variable of the model, which shows the relevance of the job to the field of study is not defined in the same way. According to Miller and Volker (1984), the relation exists, if the graduate has embarked on a profession where the skills acquired at school might potentially be useful. Arabsheibani (1989) uses graduates' declaration that their current job is relevant to the field of study as a measure of job matching. FengLiang et al. (2009) use three measures at a time: the relevance of the current job to the field of study, extracurricular courses and test scores. They claim that using the first of these measures only is not enough since the quality of learning should be controlled along with the status of job matching. If follows from the fact that schooling may enhance individual's productivity provided that the individual learns knowledge and skills sufficiently well. Zhu and Zhu (2011), on the other hand, use the job match index developed by Richards (1984), which is based on the respondents' declaration whether their current occupation was matched with their qualifications in terms of status and pay, usefulness of the skills acquired in their academic work, and the relevance of their job to the field of study.

Secondly, in some of the studies, additional variables reflecting the stock of knowledge and skills acquired at school were included in the model, based on the assumption that the greater the stock, the higher the wage premium should be. FengLiang et al. (2009) used two additional variables – participation in extracurricular activities and grade point average, the latter being interacted with the job matching variable Following their approach we used dummy variables on several extracurricular educational activities and the grade point average at the last school or university completed.

Thirdly, the focus of all studies was solely on tertiary education graduates and some of them were even limited to some selected fields of study. The authors substantiate this choice with Rosen's suggestion (1972) that knowledge of the liberal arts should not directly produce the capacity to capture profit in the labour market, at least not during the period of undergraduate study. Hence, Miller and Volker (1984) focused on graduates with training in economics and those with training in science, Arabsheibani (1989) – on graduates of medical sciences, sciences and social sciences, while FengLiang et al. (2009) – on graduates of engineering, sciences and social sciences. Zhu and Zhu (2011), on the other hand, divided fields of study according to the classification developed by Biglan (1973), into four groups: soft-pure (e.g. literature, history), soft-applied (e.g. economics, management), hard-pure (e.g. physics, chemistry) and hard-applied (e.g. computer science, electronics, mechanical engineering). We did our analysis on a pooled sample of HEI graduates and secondary school leavers, irrespective of the field of their study. Besides, we followed the approach used by Zhu and Zhu (2011) - that is we divided the fields of study of HEI graduates into four groups (soft-pure, soft-applied, hard-pure, and hard-applied) and we ran separate wage regressions for each of them.

Fourthly, the studies differed in terms of specification of the wage equation. Arabsheibani (1989), besides the variable reflecting the relationship between the job and the field of study, used only five control variables in the equation, while Zhu and Zhu (2011) estimated a model which contained as many as twenty control variables, including such factors as family origin, cognitive and non-cognitive skills, job search intensity and workplace characteristics.

It is the common feature of most of the studies in this literature that, following the suggestion made by Blaug (1976) and Riley (1979, S242), respondents' first earnings after graduation are the response variable in the model. This enables one to avoid considering how productivity is influenced by such factors as training or learning-by-doing, provided that the sample being analysed consists only of individuals without any professional experience at the time of graduation. Otherwise it would be necessary to control for skills obtained after graduation (with tenure or on-the-job training variables) which obviously cannot be controlled for perfectly.

Finally, it should be noted that the Heckman correction for selection bias was used in two studies. Miller & Volker (1984) used the correction to check if their results are not biased by the fact that they used data on the graduates of two selected fields of study only (economics and science). They conclude that there was no selection bias since the Mill's ratio term was not significant. Zhu & Zhu (2011) applied the Heckman correction as a robustness check. They stated that after correction the results were not changed qualitatively. But they did not provide the results.

2. Methodology

The aim of the study is to find out, based on the Wiles test, whether the knowledge and skills acquired over the years of schooling in Poland are thereafter used productively at work. Unlike previous studies, this one covers not only graduates of tertiary education, but secondary school leavers too. As a productivity measure, we used earnings received at the first job after leaving school or graduating from a higher education institution.

2.1. Data

The analysis is based on data from the nationwide tracer survey of Polish graduates conducted by the Central Statistical Office of Poland (GUS) in the years 2006-2007.[4] The survey was focused on the professional activity of graduates of various school types over the period of the first three years after the completion of formal education, with special attention to the first job after graduation. The nationwide survey comprised a representative sample of 20,251 persons who completed their formal education between 1 January 1998 and 31 December 2005 (at basic vocational schools, secondary vocational schools, secondary comprehensive schools, post-secondary schools, and higher education institutions).[5] The sample was limited to individuals who did not exceed 27 years of age at the time when their schooling ended and whose break between the next-to-last and the last stage of education was not longer than 12 months.

4 The survey was conducted as a part of the project commissioned by the Polish Ministry of Labour entitled: "The analysis of labour market activity of graduates in the context of the implementation of The First Job Program". The aims of the project were: to assess the effects of the nationwide active labour market program "The First Job" addressed to the secondary school leavers and HEI graduates, and to identify the factors causing their unemployment.

5 A description of the system of education in Poland can be found in Eurydice (2006).

The database provides detailed information about the respondent's education process and the first job after the completion of the formal education. Importantly to the context of this study, the respondents were asked two questions referring to the quality of job matching, which we used to design a Job Match Index (JMI). These were the following questions:

Q1. Were the school/university provided knowledge and skills useful at your first job? Answers to be chosen from: (a) very useful, (b) rather useful, (c) not very useful, (d) not useful at all;
Q2. Was your first job relevant to your field of study? Answers to be chosen from: (a) definitely yes, (b) rather yes, (c) rather not, (d) definitely not.

The responses were scored from 0 to 3 points: answer (d) – 0 points, answer (c) – 1 point, answer (b) – 2 points, answer (a) – 3 points. Subsequently, both the scores were totalled, resulting in the Job Match Index. The Index takes seven values – from 0 to 6 – where 0 represents an absolute uselessness of school-provided knowledge and no job-education match at all, while 6 means a very high level of knowledge usefulness at work which is entirely relevant to the field of study.

It is worth noting that the JMI is, in fact, a joint indicator of the reverse of overskilling and overeducation. It captures information on both horizontal and vertical overeducation as it does not distinguish between those whose occupation is relevant to their level of education and those whose occupation is below their level of education.

The database contains also information about the grade point average from the last school completed, which can be considered as an indicator of the amount of knowledge and skills acquired while studying there. Considering the potential endogeneity of the choice of education path, it is important that the database enable identification of each parent's education level, which can be indicative of the respondents innate abilities, to a certain degree.

The focus of empirical analysis is on the factors that influence secondary and tertiary school graduates' first wages earned at the first job after the completion of formal education, provided that the respondent undertook employment in the first year after graduation. Consequently, we have excluded the following respondent categories from the database: 1) individuals who did not work within the first year after ending formal education, 2) the self-employed and the family members helping them at work, since none of these groups was asked about earnings, 3) hired workers who did not disclose their first earnings. Eventually, the sample used for the analysis comprised 5783 observations.

Information on earnings is declarative, therefore the figures are not necessarily consistent with the actual situation, for such reasons as: reluctance to disclose the real earnings, the inability to recollect the actual amount earned, the tendency to round the figures. It is not possible to say, how these measurement errors affect the final result. Yet, the distribution of earnings is – as expected – unimodal and skewed to the right.

2.2. Wage equation

Based on Zhu and Zhu (2011), the following wage equation was designed:

$$\ln(w_i) = M_i\beta_1 + S_i\beta_2 + X_i\beta_3 + \varepsilon_i \quad (1)$$

where the dependent variable ($\boldsymbol{w}_i$) is the school and university graduates' hourly rate of the first net earnings, provided that they undertook employment within the first year after graduation[6], variable $\boldsymbol{M}_i$ reflects the quality of a job match, vector $\boldsymbol{S}_i$ contains variables that reflect the school-provided knowledge and skills, while vector $\boldsymbol{X}_i$ includes other factors that may influence earnings.

Using graduates' first earnings as a dependent variable is consistent with the suggestion made by Blaug (1976) and Riley (1979), as well as with the previous analytical practice. Besides, only those graduates who did not have any job at the time of graduation are included in the sample.

The key independent variable in the model, which reflects the quality of job matching on the first job after graduation ($\boldsymbol{M}_i$) is based on the Job Match Index and takes three values:

1. a good match – when the Index value is 5 or 6,
2. a poor match – when the Index value is 2 to 4,
3. no match – when the Index value is 0 or 1.

This variable was included in the wage equation as a discrete variable, with "no match" being the base category.

The education level and the grade point average from the last school are the next two important variables ($\boldsymbol{S}_i$) included in the model. They reflect the amount of knowledge and skills acquired at school, but at the same time they may signal high innate abilities. Thus, if variable $\boldsymbol{M}_i$ is a good measure of school-provided knowledge and skills that are useful at work, the education level and the grade point average would reflect

6 For the sake of comparability of the initial earnings of graduates who started their first job in different years (1998-2005), initial hourly rates were adjusted by the Consumer Price Index, with 2005 as the base year.

innate abilities only. Hence, their significance in the wage equation would be indicating their signalling function.

There were five education levels distinguished and they represent the type of the last school completed and degree obtained in the process of formal education: 1 – basic vocational, 2 – secondary general, 3 – secondary vocational, 4 - tertiary, bachelor's or engineer's degree; 5 – tertiary, master's degree.

The grade point average in the Polish education system may fall between 2 and 6, where 2 ("mediocre") is the lowest passing grade, while 6 ("excellent") is the highest grade that can be awarded. We divided the variable into three value classes: 1 – low grade (for the interval 2.0-3.5); 2 – average grade (for the interval 3.5-4.5); 3 – high grade (for the interval 4.5-6.0).

Furthermore, the model includes a wide range of control variables ($\boldsymbol{X}_i$), that reflect:

- the process of education: field of study, ownership status of the last school or university completed, learning mode (full time, evening/part time), participation in extracurricular activities (foreign language classes, IT classes, sports and tourism, artistic activities, technical activities, scouting), professional practice when at school (paid job, voluntary work),
- the first job characteristics: profession, company ownership sector, company size, company economic sector,
- other individual characteristics of the respondent and of the local labour market: gender, age when first employed, each parent's education level, place of residence, region, year of leaving school.

A complete list of variables included in the wage equation is presented in Table 1. In order to eliminate outliers, we deleted 0.1% of observations with extreme values of the wage hourly rate, half from the lower and half from the upper end of the distribution. The linear regression model was estimated using OLS, by computing heteroscedasticity-resistant variance estimations.

[Table 1 about here]

2.3. Heckman correction

As the wage regression can be estimated for the employed only, our OLS estimates may suffer from a selection to employment bias. To correct for this we apply the approach proposed by Heckman (1979) by using a two-step procedure. In the first step we estimate the probability of a graduate being employed using a probit regression. On this basis the inverse mills ratio is calculated. In the second step we estimate the Mincerian wage equation including this term as an additional explanatory

variable, which allows to correct for sample selection bias. We have tried several variables as exclusion restrictions. The results are provided in table 2.

First, we used regional (NUTS 2) unemployment rate in the year of graduation from the last school or university, that is at the moment the graduates entered the labour market. We tried various definitions of unemployment rate, that is: the LFS unemployment rate, the registered unemployment rate, and also the LFS unemployment rate for individuals aged 17-28 as this was the age range of our sample (see specifications 1-3). Only registered unemployment rate is, as expected, negatively correlated with the probability of being employed, while the LFS unemployment rate for both 15+ and 17-28 population are not significant in the selection equation. The registered unemployment rate cannot be used as an instrument, however, as the main and selection equations are not independent.

Secondly, we tried a couple of variables to identify economic inactivity due to the need to take care of small children:

- having a child child born in the calendar year of graduation from formal education or earlier,
- the regional (NUTS 2) percentage of children aged 0-2 at nurseries,
- the regional (NUTS 2) percentage of children aged 3-4 in kindergartens. [7]

Although only 3% of the sample were parents at the moment of graduating from the last school or university, this first variable is strongly negatively correlated with the probability of finding a job within 12 months after graduation (specification 6). Besides this variable seems to be a good candidate for an instrument as the main and selection equations are independent. The other two variables are not significant in the selection equation, though (specifications 4-5). Probably this is due to rather low shares of children in nurseries and kindergartens in Poland, amounting to 2.2% and 34.2% in 2005, respectively.

Thirdly, we used a variable representing the model of family in which a graduate was brought up. The variable takes value of 1 if one of the graduate's parents was employed while the other was not and did housework only, and 0 otherwise. Thus, the variable captures a sort of cultural capital in the form of being used to a certain lifestyle. The model of family is, as expected, negatively correlated with the probability of finding a job. However, it is not a good instrument.

[7] Although children can attend kindergartens from the age of 3 up to 6, the percentage of those aged 3-4 in kindergartens is much more differentiated by regions than it is in case of those aged 3-6. This is why this narrower age range was chosen.

Fourthly, we used a policy variable associated with the reform of education which was initiated in Poland in 1999. One of the main aims of the reform was to improve the quality of education, so as to achieve an increase in the general competences of secondary school graduates, and thereby increase their readiness to acquire new knowledge and skills in further education (higher education) and / or at work. Several changes in the education system were implemented to achieve these goals, the most important being: 1) the extension of compulsory general education by one year, 2) skill development oriented curricula and 3) an external examination system. The reform affected children born on or after 1 January 1986, while children born until 31 December 1985 continued their education in the old system. The first cohort affected by the reform entered secondary schools in 2002 and completed them in 2005 (secondary comprehensive schools and basic vocational schools) or 2006 (secondary vocational schools). Since our sample includes individuals who completed their last school or university in the years 1998-2005, we can expect to observe an impact of the reform with respect to those only who completed secondary schools in 2005. Drucker and Horn (2016) found that the reform increased the employment rate by 2-3% on average, which was mainly driven by the lowest educated. Thus, we used a dummy variable equal to 1 if a respondent was covered by the reform, that is he/she was born in 1986 or later, or equal to 0 otherwise. Contrary to our expectations, however, the reform variable is negatively correlated with the probability of finding a job within one year after completing formal education (specification 8). Besides, it is not a good instrument as the main and selection equations are not independent.

Fifthly, we tried another education policy variable representing participation in obligatory entrepreneurship course at school or university. Entrepreneurship fundamentals were introduced an obligatory course at secondary schools in 2002. It is widely questioned if this course can deliver any knowledge or skills useful in the labour market, though. It is criticized for being primarily theoretical and not being taught by practitioners, but rather by retrained teachers. If it delivers any useful skills, however, we can expect it to facilitate employment of graduates, and self-employment in particular. Thus, we created a dummy variable equal to 1 in case of participation in an obligatory entrepreneurship course at any school or university. This variable is not correlated, however, with the probability of finding a job. In fact, the estimate is positive, as expected, but it is not significant (specification 9). We have also tried splitting the entrepreneurship variable into theoretical and practice-oriented courses, but both of them were not significant in the selection equation.[8]

[8] Results are not reported but available upon request.

Sixthly, we tried a similar variable to the one proposed by Card (1999), which was the distance from the nearest school. We used for this purpose information from the survey about commuting to the last school or university completed. We created a dummy variable equal to 1 if the last school or university completed was located outside of the place in which the respondent resided before he/she started studying in that school or university. This means that the respondent had either to commute or to move temporarily to the place where his/her last school or university was located. Unfortunately, we do not know the distance or the time necessary to commute to school. The variable is insignificant in the selection equation. However, when interacted with the level of education the commuting variable turned out to be negatively correlated with the probability of finding a job by HEI graduates. It seems that this result may be due to low wages paid to people with tertiary education in small towns. This may discourage the HEI graduates from taking up a job, once they have returned to their home town after graduation.

Seventhly, we tried the delayed graduation as an exclusion restriction. We assume that on average the delayed graduation is a manifestation of relatively low skills with reference to managing one's educational career, which may result in difficulties with managing one's professional career, and finding a job among others. We used a dummy variable equal to 1 for individuals with more years of schooling than necessary to achieve a given educational level. As we do not have information on the number of years spent in each school and breaks on the educational path, we assumed that each individual started education at primary school at the age of 7 (obligatory in Poland) and had to study for: 12 years to achieve basic vocational education (13 years after the 1999 reform), 13 years to achieve secondary comprehensive education, 14 years to achieve secondary vocational education, 17 years to get a BA degree, and 19 years to obtain an MA degree. With these assumptions 28.3% of the sample are regarded the delayed graduates. When included in the selection equation, the delayed graduations is, as expected, negatively correlated with the probability of finding a job. However, it is not a good instrumental variable as the main and selection equations are not independent.

Finally, we tried another policy variable, that is the implementation of "The first job" governmental program, which was aimed to facilitate employment of graduates. The program guaranteed that every graduate registered as unemployed would be offered some active labour market measures within the first six months after graduation. Initially, the program was to be implemented in the years 2002-2003, but then it was extended for the period 2004-2006. We used a dummy variable taking 1 if the respondent eligible for participation in "The first job" program, that is if he/she

graduated in 2002 or later, and 0 otherwise.[9] The variable is positively correlated with the probability of finding a job within 12 months after graduation. Besides, this seems to be a good candidate for an instrument.

We have tried instrumenting the wage equation with several sets of the above mentioned variables - two of these estimations are reported as specifications 14-15 - and it seems that the best solution is to use the following three instruments at the same time:

- having a child when graduating from formal education,
- commuting to the last school or university completed interacted with the level of education,
- "The first job" program.

The value of chi2 in the Wald test of independence of equations is 9.88 and the main and selection equations are independent at 0.17% (specification 15). Thus, we adopted this form of the selection equation in further analysis, the results of which are reported in tables 5-10.

[Table 2 about here]

3. Descriptive statistics

In total, 41% of the sample performed jobs that were well matched to their qualifications, 34% had a poorly matched job, while 25% had an unmatched job (Table 3). To sum it up, three fourths of the sample used at least some of the school-provided knowledge and skills at their first job. The percentage of individuals performing a job which matched their qualifications was highest among vocational school leavers (61%) and among graduates of master degree programs (49%), as well as among graduates with a high grade point average from the last school (54%). A good job matching was least common among secondary comprehensive school leavers (9%), which is quite natural, as they have not acquired any vocational qualifications at school.

[Table 3 about here]

Table 4 shows the average hourly earnings rate paid to graduates at their first job, computed for individual value classes of the key variables in the model. These data show that individuals with a good job match earn ca. 12% more than those whose

qualifications are entirely irrelevant to their job. Yet, this difference may be due to differences between these two groups with respect to other individual characteristics which are conducive to performing a well matched job and to obtaining high earnings at the same time. To find out whether this is really the case, a regression analysis is required.

[Table 4 about here]

4. Main findings

The results of the wage equation estimations are presented in Table 5. The first three specifications are estimated using OLS. Estimation (1) is unconditional in the sense that hourly earnings are regressed on the quality of job matching ($\boldsymbol{M}_i$) only. Both the good and the poor job match are positively correlated with earnings. However, as control variables are added to the model (specifications 2-3), this correlation gradually decreases, which proves that the factors that determine earnings are, in general, positively correlated with the quality of job matching. The estimation (3) – in which the complete set of control variables is used – shows that only a good job match (as compared with no matching) is positively correlated with graduates' earnings but this relationship is observed for a 5% significance level only. Graduates, whose job is well matched to their qualifications, earn by 3.6% more. A poor job match does not show any statistically significant relationship with earnings.

When employment characteristics were being added to the wage equation one by one, it turned out that the inclusion of occupation performed on the first job caused the wage premium decline substantially. Thus, it seems that a good job match is important on some occupations but at the same time it is not so important on others.

The Heckman correction can be applied to the wage equation without job characteristics (specification 2). The OLS estimate of the premium is 8.4% in this case and it does not change after applying the Heckman correction (specification 4). The full results of these two estimations are presented in table 6.

[Table 5 about here]

Table 6 shows that in addition to a wage premium from a good job match graduates obtain a substantial wage premium from formal education. The HEI graduates receive 27% higher hourly earnings than the basic vocational certificate holders, while in case of those with secondary vocational and secondary comprehensive education the Heckman corrected wage premium amounts to 5% and 7%, respectively.

[Table 6 about here]

The findings reported above seem to support the weak signalling hypothesis. This conclusion follows from the coexistence of two findings: the positive correlation of job matching with earnings, which is consistent with human capital view that school-provided skills enhance productivity, and the positive wage premium from education, which, according to the signalling theory, can be attributed to greater innate abilities.

It follows from table 5 that graduates obtain a positive wage premium from a good job match. But the key variable of interest, representing the quality of job matching, is in fact a joint measure of relevance and usefulness of school-provided skills on the first job. One may argue that it is less informative to use the joint measure than the latter two measures separately, since while using the joint measure we are not able to learn whether it is relevance or usefulness of skills or both of them that impact graduates' earnings. To learn this we added the relevance and usefulness variables to the model and interacted them with each other. The results are presented in table 7.

[Table 7 about here]

First, we used the original information from the survey about the relevance and usefulness of skills, that is each of them self-assessed by respondents on a four-level scale, ranging from the lack of up to the very high level. When the two variables, each of them having four categories, were added separately to the model, only high usefulness of skills on the job turned out to be positively correlated with hourly earnings, the OLS and Heckit estimates being the same (specifications 3-4). It seems then that relevance of the job to the field of study does not have any value for employers. What matters is whether the skills developed at school can be used productively at work. The result is, thus, very intuitive.

To confirm this finding, we redefined the relevance and usefulness variables and interacted them. The highest two values of each variable - corresponding to "rather yes" and "very much" answers - were treated as a positive answer, while the lowest two values - corresponding to "rather not" and "not at all" were treated as a negative answer. Thus, each of the two variables was compacted to a dummy variable. In addition, we interacted them. It turned out that graduates obtain a wage premium from skills that are both useful and relevant, while the skills that are useful but irrelevant or useless but relevant are worthless to employers (specifications 5-6).

Finally, we repeated this last exercise with a slightly redefined variables. This time we treated skills as useful if they were self-assessed as very useful, and we

treated skills as relevant if they were self-assessed as definitely relevant. Now very useful skills bring a positive wage premium irrespective of the fact if the job is relevant to the field of study (specifications 7-8). This confirms the previous finding that high usefulness of skills obtained at school is crucial.

5. Heterogeneity

We also checked for heterogeneity of the results by gender, education level and fields of study. First, we find that both men and women receive a wage premium from a good job match only, amounting to 6.4% and 9.8%, respectively, while the poor job match is not correlated with wages (Table 8, specifications 1-4). Men are rewarded for skills which are very useful at work only and, what is interesting, the wage premium is higher if the job is not completely relevant to the field of study than in case of perfect relevance. Women, on the other hand, are rewarded for both usefulness and relevance of the school-provided skills, and not only for complete usefulness and relevance but also for partial ones (specifications 5-12). Thus, it seems that men are relatively effective in looking for jobs in which they are able to utilize their skills well even if it requires inter-occupational mobility.

[Table 8 about here]

Secondly, university graduates enjoy a high wage premium both from a good job match (25.4%) and from a poor one (13.5%), while those who left the basic vocational or secondary schools earn no such premium at all (Table 9, specifications 1-8). Graduates with tertiary education are rewarded both for usefulness and relevance of school-provided skills - the more useful the skills and the more relevant the job to the field of study, the higher their hourly earnings (specifications 15-16, 23-24). Interestingly, the HEI graduates are even paid for skills that are relevant but not useful (however this is significant only at 10%; specification 16).

[Table 9 about here]

The basic vocational school certificate holders obtain a 20.4% wage premium from skills which are very useful although not completely relevant, while perfect relevance gives them no premium at all (specifications 17-18). Surprisingly, the secondary comprehensive school certificate holders earn a wage premium from perfect relevance of their job to the field of study irrespective of the usefulness of their skills (specifications 19-20). This is surprising, as the secondary comprehensive schools do not provide any vocational skills, while in case of secondary vocational school leavers neither relevance nor usefulness of skills are rewarded by employers

(specifications 21-22).The results mentioned above clearly show that these are higher education institutions that provide individuals with skills, which are useful in the labour market. It is not clear, however, for what kinds of skills the HEI graduates are rewarded. To shed some light on this issue, we estimated separate regressions for different fields of study. Although we can identify 22 fields of study in our sample, the number of observations on some of them was too small to run separate regression for each field separately. Therefore, following Zhu & Zhu (2011) we categorised university graduates into four groups of fields of study, using the typology proposed by Biglan (1973). These four groups provide the following types of knowledge and skills:

1) soft-pure, e.g. humanities, social sciences,
2) soft-applied, e.g. pedagogy, business administration and marketing, economics, law, administration,
3) hard-pure, e.g. natural sciences, physical sciences, mathematics,
4) hard-applied, e.g. engineering and technical studies, information technology, architecture and construction, medicine, agriculture.

The results presented in Table 10 show that all the four types of knowledge and skills are rewarded in the labour market, although the soft skills are rewarded much higher than the hard ones. Soft-pure and soft-applied skills acquired in the course of tertiary education provide the wage premium of 39% and 29%, respectively, if the job match is good or 23% and 17%, respectively, if the job match is poor. Whereas hard-pure and hard-applied skills provide the wage premium (21% and 17%, respectively) when the job match is good only and they provide no wage premium in case of a poor job match (specifications 1-8).

[Table 10 about here]

Interestingly, while soft skills are rewarded most highly when very useful and perfectly relevant, the hard skills bring the highest wage premium when very useful but not completely relevant. In particular, the hard-applied skills give a wage premium from their usefulness provided that the job is not relevant to the field of study. Thus, it seems that the hard-applied fields provide some knowledge or skills that are highly rewarded on jobs that are not related to the field of study (specification 17-24).

6. Robustness checks

In order to check for the robustness of results, we estimated the model for two alternative definitions of the variable reflecting the quality of job match ($\boldsymbol{M}_i$). In the first definition, the distance between the Job Match Index (JMI) values showing a good

match and no match at all was increased, while in the second definition the distance was reduced. According to the first definition, ($M1_i$), the match is good when the JMI equals 6, poor – if it ranges from 1 to 5 and none if the value is 0. The second definition - ($M2_i$) – assumes that the match is good when the JMI ranges from 4 to 6, poor – if it equals 3 and none if the value is 1-3. Estimation results for the model based on the alternative job match definitions are presented in Tables 10-12, where the variables reflecting the match according to the first and the second definition are denoted as "Job match 1" and "Job match 2", respectively.

As expected, applying the first definition results in an increase of the wage premium from a good job match, but the results do not change qualitatively. With the second definition used, the effect is the opposite – the estimator of the wage premium from a good job match decreases. To sum it up, if the difference in the JMI value between the group with a good match and that with no match at all is substantial enough, the first group receives a statistically significant wage premium from a good job match.

[Tables 11, 12 and 13 about here]

The only two groups that are exceptions from the above pattern are males and HEI graduates from the hard-applied fields of study. Both these groups receive the highest wage premium if their skills are very useful but their job is not relevant to the field of study. So in terms of the aggregate indicator of job matching that we use they are not well matched. They benefit from high usefulness of skills, which is regarded as good matching, and from low relevance of job to the field of study, which is regarded as poor or no matching. Thus, our aggregate indicator of job matching does not capture these two opposite effects. Only after estimating the model with the separate indicators of usefulness and relevance we were able to identify the two effects.

Conclusions

The aim of this study has been to test for the signalling hypothesis using the Wiles test. We wanted to find out whether the knowledge and skills acquired over the years of schooling in Poland are thereafter used productively at work. We focused on Poland as this economy has experienced a dramatic increase in the supply of skills since 1990. We constructed a job match index based on the usefulness of the school-provided skills and the relevance of the job performed to the field of study. Then we regressed the first earnings of Polish graduates on this index using OLS and also Heckit to control for omitted heterogeneity of the employed.

To the best of our knowledge this study is the first one to test for the signalling hypothesis using the Wiles test in a CEE country, and more specifically in Poland. Unlike previous studies, this one covers not only tertiary education graduates, but secondary school leavers too. Besides, ours is among a few studies available to provide estimates of the Wiles test using the Heckman correction for sample selection bias.

We have reached several findings. Firstly, we argue that the weak signalling hypothesis is supported for HEI graduates since they obtain a positive wage premium from both their degree and the quality of job matching at the same time. What is more, HEI graduates are rewarded for both high usefulness and high relevance of skills acquired while studying.

Secondly, secondary comprehensive schools seem to provide no knowledge or skills that are useful at work. Only the basic vocational and secondary vocational schools seem to provide some skills that are rewarded by employers but these results are not very robust.

Thirdly, soft and hard skills acquired at HEIs are rewarded by employers differently. Soft skills are rewarded most highly when they are very useful and the job is completely relevant to the field of study, while the hard-applied skills bring a high wage premium when they are very useful but not completely relevant.

Fourthly, the Heckman correction for selection to employment bias does not change our results qualitatively.

Obviously, our results are subject to several limitations. Firstly, although we tried to control for innate abilities by adding such explanatory variables like each parent's education, grade point average and extracurricular activities, we acknowledge that the wage premium from a good job match can still be biased due to unobservable heterogeneity. Secondly, information on earnings is declarative, therefore the figures are not necessarily consistent with the actual situation, for such reasons as: reluctance to disclose the real earnings, the inability to recollect the actual amount earned, the tendency to round the figures. Thirdly, our data refer only to the first wage after graduation so we could not analyze how the wage premium from a good job match evolves over time after graduation.

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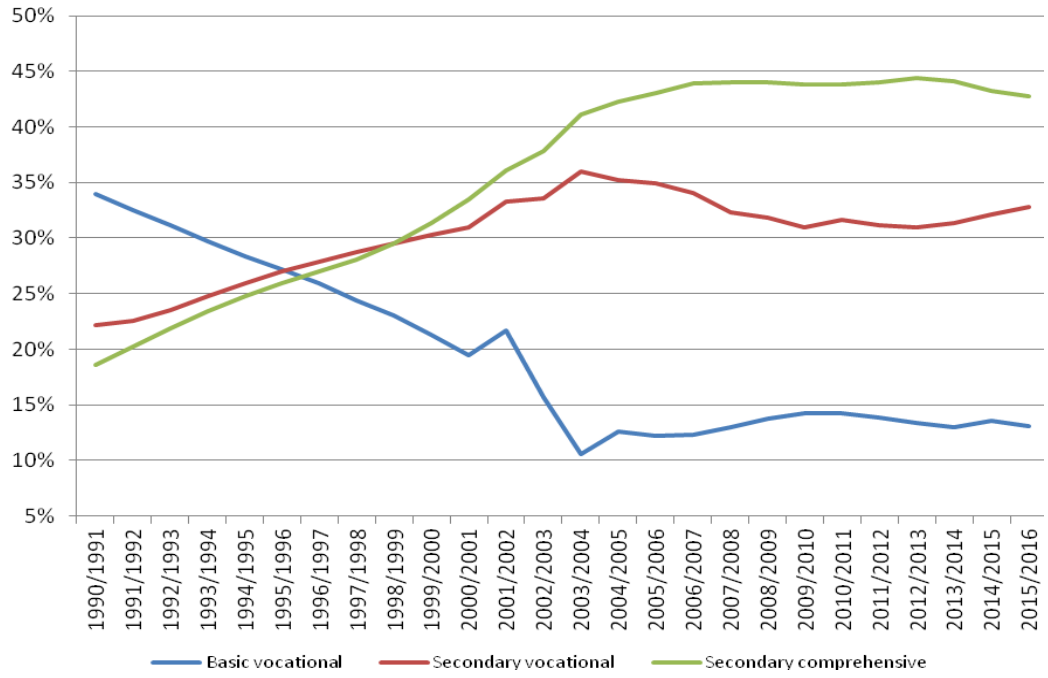
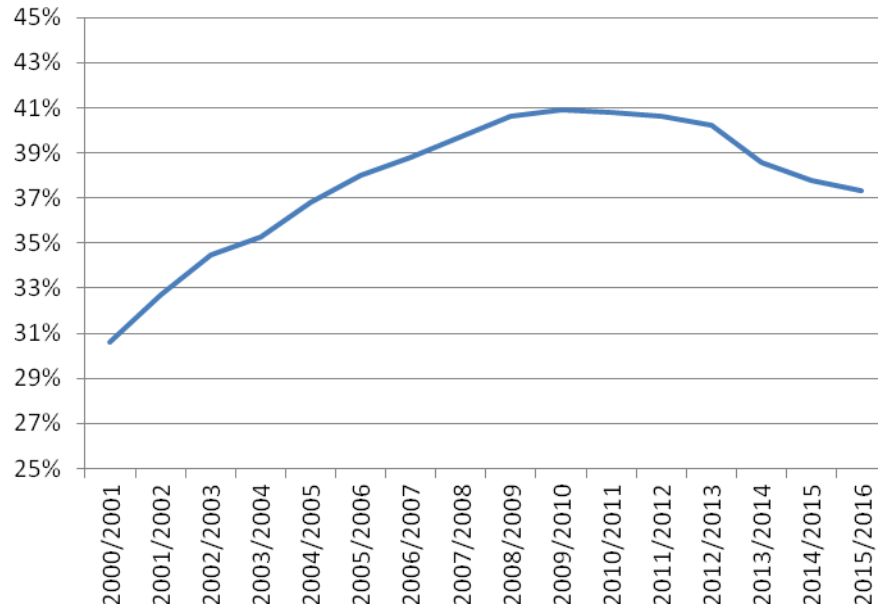
Appendix of Figures and Tables

Figure 1. Net enrolment ratio in post-primary and post-gymnasium schools in Poland in 1990-2015



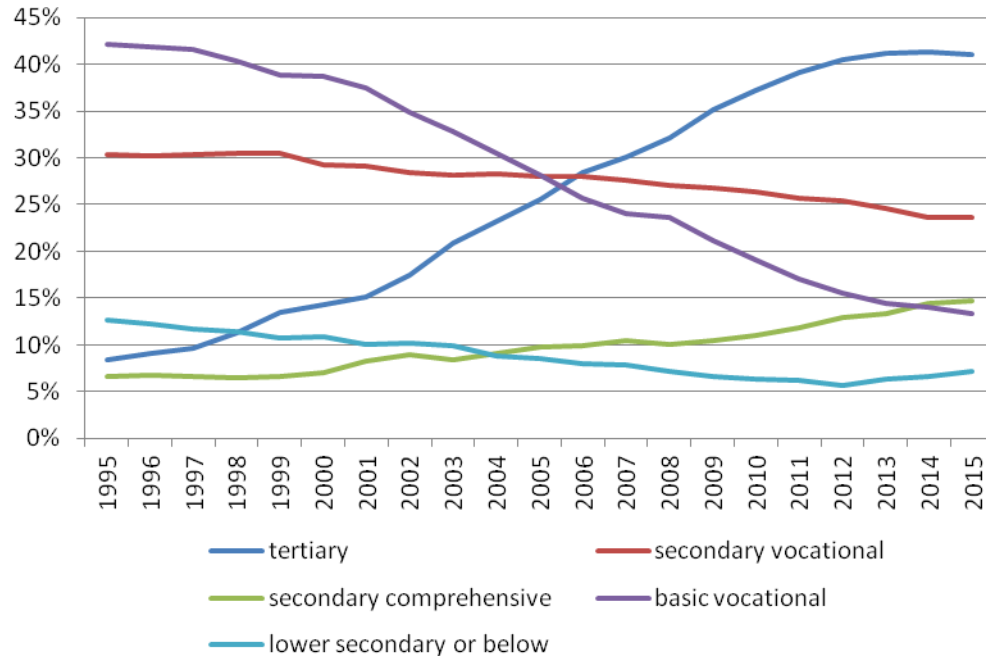
Source: author's analyses based on data from CSO (2016) and previous issues.

Figure 2. The net enrolment ratio in higher education in Poland in 2000-2015



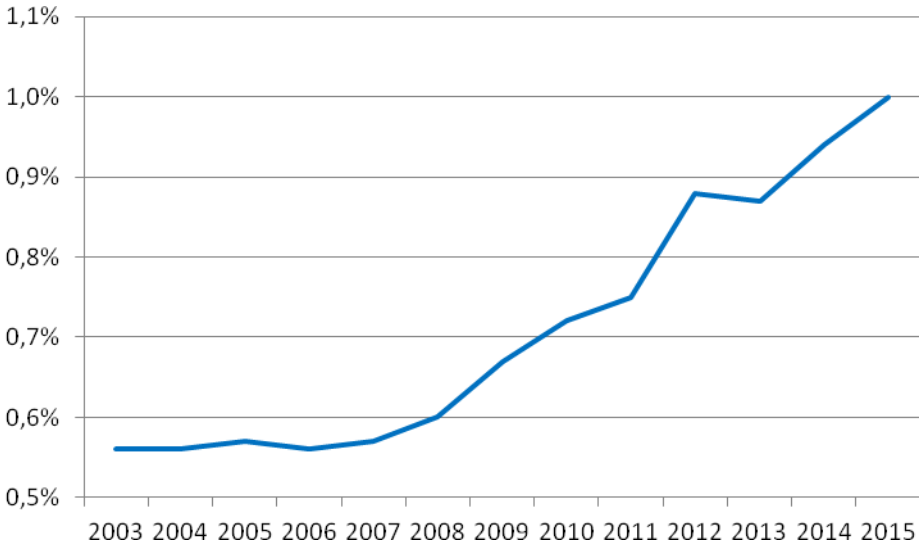
Source: author's analyses based on data from CSO (2016) and previous issues.

Figure 3. Population aged 25-30 by education level in 1995-2015



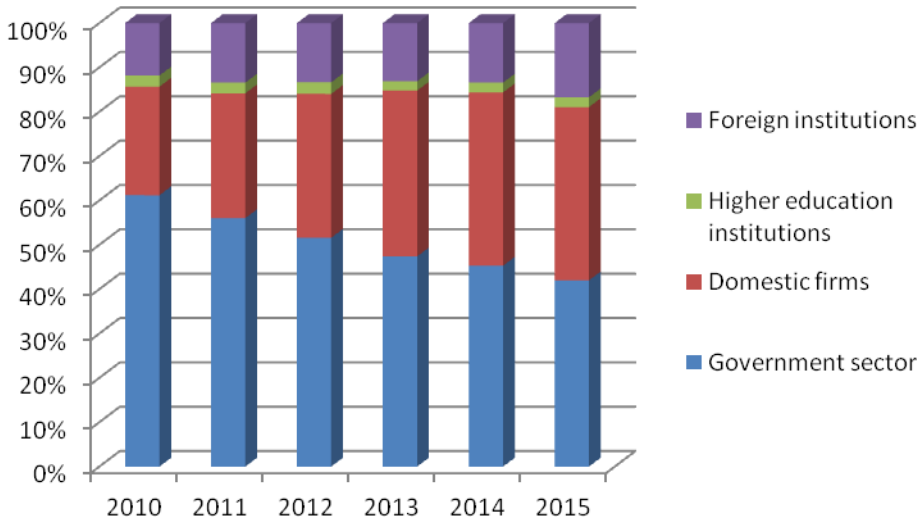
Source: author's analyses based on data from the Polish LFS.

Figure 4. The expenditures on R&D as % of GDP in Poland in 2003-2015



Source: CSO, http://stat.gov.pl/obszary-tematyczne/nauka-i-technika-spoleczenstwo-informacyjne/nauka-i-technika/dzialalnosc-badawcza-i-rozwojowa-w-polsce-w-2015-roku,8,5.html

Figure 5. The expenditures on R&D in Poland by sectors in 2010-2015



Source: CSO, http://stat.gov.pl/obszary-tematyczne/nauka-i-technika-spoleczenstwo-informacyjne/nauka-i-technika/dzialalnosc-badawcza-i-rozwojowa-w-polsce-w-2015-roku,8,5.html

Table 1. Independent variables included in the wage equation

Independent variable	*Value classes*
Main equation	
Job match	1 – good (the Job Match Index equals 5 or 6); 2 – poor (the Job Match Index ranges from 2 to 4); 3* – none (the Job Match Index equals 0 or 1).
Job match 1 (alternative definition)	1 – good (the Job Match Index equals 6); 2 – poor (the Job Match Index ranges from 1 to 5); 3* – none (the Job Match Index equals 0).
Job match 2 (alternative definition)	1 – good (the Job Match Index ranges from 4 to 6); 2 – poor (the Job Match Index equals 3); 3* – none (the Job Match Index ranges from 0 to 2)
Education	1* – basic vocational; 2 –secondary comprehensive; 3 – secondary vocational (secondary technical, profiled secondary, post-secondary); 4 – tertiary
Grade point average (on the diploma or certificate of the last school or university attended)	1* - low (ranging 2.0-3.5); 2 -medium (ranging 3.5-4.5); 3 - high (ranging 4.5-6.0).
Field of study	1* – teacher education, pedagogy; 2 – foreign languages; 3 – humanities; 4 – art; 5 - business administration and marketing; 6 - social sciences; 7 – economics; 8 – law; 9 – administration; 10 – natural sciences; 11 - physical sciences; 12 – mathematics, statistics; 13 – information technology; 14 – engineering and technology; 15 – production and processing; 16 – architecture and construction; 17 – agriculture, forestry, fishery; 18 – services; 19 – healthcare, social services; 20 – military/police; 21 – security and safety; 22 - general programs; 23 – other; 24 – unknown.
Ownership status of the last school or university attended	1* – public; 2 – non-public; 3 – unknown.
Schooling mode	1* – full time; 2 – evening / part time; 3 – unknown.
Internship: paid	1 – yes; 2* – no.
Internship: voluntary	1 – yes; 2* – no.
Occupation on the first job	Binary variables for major groups of occupations according to ISCO-08.
Company ownership sector	1* – public; 2 – private; 3 – public-private.
Company size	1* – up to 9 employees; 2 – 10-49 employees; 3 – 50-249 employees; 4 – 250 employees or more.
Company economic sector	1 – agriculture; 2 – industry; 3* – services.
Gender	1* – woman; 2 – man
Age when graduated [age]	continuous variable
Father's education	1* – primary or less; 2 – basic vocational; 3 –

	secondary (comprehensive, vocational, post-secondary); 4 – tertiary; 5 – unknown
Mother's education	1* – primary or less; 2 – basic vocational; 3 – secondary (comprehensive, vocational, post-secondary); 4 – tertiary; 5 – unknown
Extracurricular activities: language classes	1 – participation in extracurricular organised foreign language classes at the last stage of schooling; 2* – no participation
Extracurricular activities: IT classes	1 – participation in extracurricular organised IT classes at the last stage of schooling; 2* – no participation
Extracurricular activities: sports and tourism	1 – participation in extracurricular organised sports or tourist activities at the last stage of schooling; 2* – no participation
Extracurricular activities: artistic activities	1 – participation in extracurricular organised artistic activities at the last stage of schooling; 2* – no participation
Extracurricular activities: technical activities	1 – participation in extracurricular organised technical classes at the last stage of schooling; 2* – no participation
Extracurricular activities: scouting	1 – participation in scout meetings at the last stage of schooling; 2* – no participation
Place of residence	1* – rural; 2 – town ≤ 100,000 inhabitants; 3 – town >100,000 inhabitants
Region (voivodship)	1* – Dolnośląskie; 2 – Kujawsko-Pomorskie; 3 – Lubelskie; 4 – Lubuskie; 5 – Łódzkie; 6 – Małopolskie; 7 – Mazowieckie; 8 – Opolskie; 9 – Podkarpackie; 10 – Podlaskie; 11 – Pomorskie; 12 – Śląskie; 13 – Świętokrzyskie; 14 – Warmińsko-mazurskie; 15 – Wielkopolskie; 16 – Zachodniopomorskie
Year of graduation	Continuous variable (1998-2005)
Selection equation	
Unemployment rate (LFS)	Continuous variable for each region and year of graduation
Unemployment rate (registered)	Continuous variable for each region and year of graduation
Unemployment rate, 17-28 years (LFS)	Continuous variable for each region and year of graduation
Percentage of children aged 0-2 in nurseries	Continuous variable for each region and year of graduation
Percentage of children aged 3-4 in kindergartens	Continuous variable for each region and year of graduation
Having a child when graduating from formal education	1 – having a child born in the calendar year of graduation from formal education or earlier; 2* – otherwise
Model of family	1 – one of parents was employed while the other was not and did housework only; 2* – otherwise
1999 education reform	1 – respondent covered by the reform (born in 1986 or later); 2* – otherwise

Entrepreneurship course	1 – participation in obligatory entrepreneurship course at school or university; 2* – no participation
Commuting to the last school or university completed	1 – the last school or university completed was located outside the place in which the respondent resided before he/she started studying in that school or university; 2* – otherwise
Delayed graduation	1 - having more years of schooling than the minimum necessary to complete the education path chosen by respondent; 2* – otherwise
"The first job" program	1 – respondent eligible for participation in "The first job" governmental program aimed to facilitate employment of graduates (graduated in 2002 or later); 2* – otherwise

Note: asterisks indicate the base category.

Source: authors' own elaboration.

Table 2. Heckman corrected estimations of the graduate's first wage equation with different exclusion restrictions

Model specification	Heckit	Heckit	Heckit	Heckit	Heckit	Heckit	Heckit
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Main equation							
Job match: good	0.084***	0.084***	0.084***	0.084***	0.084***	0.083***	0.084***
Job match: poor	0.003	0.003	0.003	0.003	0.003	0.003	0.003
Demographic, educational, family background and local labour market characteristics	+	+	+	+	+	+	+
Job characteristics							
Selection equation							
Unemployment rate (LFS)	0.000						
Unemployment rate (registered)		-0.067*					
Unemployment rate, 17-28 years (LFS)			-0.010				
Percentage of children aged 0-2 in nurseries				-0.067			
Percentage of children aged 3-4 in kindergartens					0.001		
Having a child when graduating from formal education						-0.393***	
Model of family							-0.102**
1999 education reform							
Entrepreneurship classes							
Commuting to the last school or university completed							
Delayed graduation							
"The first job" program							
Number of observations	10,994	10,994	10,994	10,994	10,994	10,994	10,994
R2							
chi2	4.648	3.101	3.603	5.263	4.429	6.844	2.979
Prob > chi2	0.0311	0.0782	0.0577	0.0218	0.0353	0.00889	0.0844

Table 2. Continued

Model specification	Heckit	Heckit	Heckit	Heckit	Heckit	Heckit	Heckit	Heckit
	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Main equation								
Job match: good	0.083***	0.084***	0.084***	0.084***	0.084***	0.084***	0.084***	0.084***
Job match: poor	0.003	0.004	0.003	0.003	0.003	0.004	0.003	0.004
Demographic, educational, family background and local labour market characteristics	+	+	+	+	+	+	+	+
Job characteristics								
Selection equation								
Unemployment rate (registered)								
Having a child when graduating from formal education							-0.397***	-0.395***
1999 education reform	-0.124**							
Entrepreneurship classes		0.081						
Commuting to the last school or university completed			-0.029	0.073			0.071	0.071
Commuting x secondary comprehensive education				-0.004			0.003	0.000
Commuting x secondary vocational education				-0.130			-0.133	-0.130
Commuting x tertiary education				-0.236**			-0.236**	-0.235**
Delayed graduation					-0.131**			
"The first job" program						0.216***		0.223***
Number of observations	10,994	10,994	10,994	10,994	10,994	10,994	10,994	10,994
R2								
chi2	4.262	3.419	4.727	5.443	3.949	6.122	8.217	9.883
Prob > chi2	0.0390	0.0644	0.0297	0.0197	0.0469	0.0134	0.0042	0.0017

Notes: All independent variables are listed in Table A1 in the Appendix; ***/**/* stand for 1%, 5% and 10% significance respectively.

Source: Authors' own analyses based on unit data from the Graduate Tracer Study.

Table 3. Distributions of quality of job matching

Model specification	Job match: good	Job match: poor	Job match: none
Total	41.4	33.6	25.0
Females	41.2	34.9	23.9
Males	41.8	31.9	26.3
Education: basic vocational	60.6	21.2	18.2
Education: secondary comprehensive	8.6	46.3	45.1
Education: secondary vocational	34.4	36.6	29.0
Education: tertiary	49.2	33.5	17.2
Average grade: low	40.3	31.3	28.4
Average grade: medium	39.2	35.3	25.5
Average grade: high	53.5	29.1	17.4

Source: Author's own analyses based on unit data from the Graduate Tracer Study.

Table 4. Descriptive statistics of the dependent variable

Model specification	Mean of hourly earnings (PLN)	Standard deviation	N
Total	6.31	4.96	5783
Job match: good	6.71	4.94	2396
Job match: poor	6.06	4.74	1943
Job match: none	5.97	5.25	1444
Females	6.05	4.50	3265
Males	6.65	5.48	2518
Education: basic vocational	5.56	4.47	1214
Education: secondary general	5.78	4.30	743
Education: secondary vocational	5.73	4.76	1936
Education: tertiary	7.59	5.44	1890
Average grade: low	5.91	4.92	1224
Average grade: medium	6.27	5.06	3759
Average grade: high	7.09	4.46	800

Source: Authors' own analyses based on unit data from the Graduate Tracer Study.

Table 5. Estimations of the graduate's first wage equation with Heckman correction

Model specification	OLS	OLS	OLS	Heckit
	(1)	(2)	(3)	(4)
Main equation				
Job match: good	0.143***	0.084***	0.036**	0.084***
Job match: poor	0.046	0.004	-0.016	0.004
Demographic, educational, family background and local labour market characteristics		+	+	+
Job characteristics			+	
Selection equation				
Having a child when graduating from formal education				-0.395***
Commuting to the last school or university completed				0.071
Commuting x secondary comprehensive education				0.000
Commuting x secondary vocational education				-0.130
Commuting x tertiary education				-0.235**
"The first job" program				0.223***
Number of observations	10,994	10,994	10,994	10,994
R2	0.013	0.165	0.190	
chi2				9.883
Prob > chi2				0.0017

Notes: All independent variables are listed in Table A1 in the Appendix; ***/**/* stand for 1%, 5% and 10% significance respectively.

Source: Authors' own analyses based on unit data from the Graduate Tracer Study.

Table 6. Estimations of the graduate's first wage equation (full specification)

Model specification	OLS	Heckit
	(1)	(2)
Main equation		
Job match: good	0.084***	0.084***
Job match: poor	0.004	0.004
Education: secondary comprehensive	0.055	0.067**
Education: secondary vocational	0.045*	0.049**
Education: tertiary	0.276***	0.273***
Average grade: medium	0.005	-0.001
Average grade: high	0.041*	0.032*
Ownership status of the last school or university attended: non-public	0.059	0.055
Ownership status of the last school or university attended: unknown	0.388***	0.381***
Schooling mode: evening / part time	-0.074***	-0.090***
Schooling mode: unknown	-0.433***	-0.432***
Field of study: foreign languages	0.081*	0.072
Field of study: humanities	-0.033	-0.028
Field of study: art	-0.141	-0.121
Field of study: business administration and marketing	-0.051	-0.054
Field of study: social sciences	-0.144**	-0.143**
Field of study: economics	-0.049	-0.054
Field of study: law	-0.041	-0.036
Field of study: administration	-0.091*	-0.083*
Field of study: natural sciences	-0.003	-0.000
Field of study: physical sciences	-0.075	-0.072
Field of study: mathematics, statistics	0.007	0.007
Field of study: information technology	0.056	0.066
Field of study: engineering and technology	-0.047	-0.053*
Field of study: production and processing	-0.120***	-0.127***
Field of study: architecture and construction	-0.043	-0.055
Field of study: agriculture, forestry, fishery	-0.028	-0.015
Field of study: services	-0.096***	-0.103***
Field of study: healthcare, social services	-0.101*	-0.114**
Field of study: military/police	-0.271	-0.261*
Field of study: security and safety	-0.112	-0.102
Field of study: general programs	-0.053	-0.040
Field of study: others	-0.059	-0.058
Field of study: unknown	0.124	0.109
Father's education: basic vocational	0.054	0.042
Father's education: secondary	0.119***	0.105***
Father's education: tertiary	0.192***	0.177***
Mother's education: basic vocational	-0.006	-0.012
Mother's education: secondary	0.011	0.003

Mother's education: tertiary	0.012	0.015
Extracurricular activities: language classes	0.074***	0.070***
Extracurricular activities: IT classes	0.029	0.024
Extracurricular activities: sports and tourism	0.007	-0.005
Extracurricular activities: artistic activities	0.035	0.029
Extracurricular activities: technical activities	0.127**	0.118***
Extracurricular activities: scouting	0.087	0.077
Internship: voluntary	0.095*	0.089*
Internship: paid	0.025	-0.007
Male	0.110***	0.102***
Age when graduated	-0.003	-0.008
Place of residence: rural	-0.040	-0.024
Place of residence: town ≤ 100,000 inhabitants	-0.061**	-0.051*
Region: Kujawsko-Pomorskie	-0.305***	-0.282***
Region: Lubelskie	-0.184***	-0.151***
Region: Lubuskie	-0.188***	-0.176***
Region: Łódzkie	-0.183***	-0.173***
Region: Małopolskie	-0.060***	-0.022
Region: Mazowieckie	-0.017***	0.007
Region: Opolskie	-0.071***	-0.058***
Region: Podkarpackie	-0.207***	-0.175***
Region: Podlaskie	-0.125***	-0.099***
Region: Pomorskie	-0.106***	-0.097***
Region: Śląskie	-0.213***	-0.198***
Region: Świętokrzyskie	-0.274***	-0.230***
Region: Warmińsko-mazurskie	-0.137***	-0.084***
Region: Wielkopolskie	-0.191***	-0.179***
Region: Zachodniopomorskie	-0.126***	-0.103***
Year of graduation	-0.049***	-0.053***
Year of graduation squared	0.003***	0.003***
Selection equation		
Average grade: medium		0.104**
Average grade: high		0.135*
Ownership status of the last school or university attended: non-public		0.076
Ownership status of the last school or university attended: unknown		0.243
Schooling mode: evening / part time		0.319***
Schooling mode: unknown		-0.115
Field of study: foreign languages		0.200**
Field of study: humanities		-0.069
Field of study: art		-0.336
Field of study: business administration and marketing		0.052
Field of study: social sciences		-0.028
Field of study: economics		0.090
Field of study: law		-0.065
Field of study: administration		-0.155

Field of study: natural sciences		-0.048
Field of study: physical sciences		-0.070
Field of study: mathematics, statistics		0.041
Field of study: information technology		-0.166*
Field of study: engineering and technology		0.123
Field of study: production and processing		0.109
Field of study: architecture and construction		0.226*
Field of study: agriculture, forestry, fishery		-0.189**
Field of study: services		0.124*
Field of study: healthcare, social services		0.221***
Field of study: military/police		-0.154
Field of study: security and safety		-0.161
Field of study: general programs		-0.185**
Field of study: others		-0.023
Field of study: unknown		0.262
Father's education: basic vocational		0.191***
Father's education: secondary		0.223***
Father's education: tertiary		0.246***
Mother's education: basic vocational		0.083
Mother's education: secondary		0.128**
Mother's education: tertiary		-0.070
Extracurricular activities: language classes		0.068
Extracurricular activities: IT classes		0.088
Extracurricular activities: sports and tourism		0.201***
Extracurricular activities: artistic activities		0.107
Extracurricular activities: technical activities		0.185
Extracurricular activities: scouting		0.195**
Internship: voluntary		0.126
Internship: paid		0.739***
Male		0.144***
Age when graduated		0.082***
Place of residence: rural		-0.251***
Place of residence: town ≤ 100,000 inhabitants		-0.151**
Region: Kujawsko-Pomorskie		-0.442***
Region: Lubelskie		-0.584***
Region: Lubuskie		-0.254***
Region: Łódzkie		-0.213***
Region: Małopolskie		-0.695***
Region: Mazowieckie		-0.460***
Region: Opolskie		-0.268***
Region: Podkarpackie		-0.595***
Region: Podlaskie		-0.487***
Region: Pomorskie		-0.198***
Region: Śląskie		-0.300***
Region: Świętokrzyskie		-0.776***
Region: Warmińsko-mazurskie		-0.906***
Region: Wielkopolskie		-0.246***

Region: Zachodniopomorskie		-0.446***
Year of graduation		0.000
Year of graduation squared		-0.012**
"The first job" program		0.223***
Education: secondary comprehensive		-0.176**
Education: secondary vocational		-0.007
Education: tertiary		0.204
Commuting to the last school or university completed		0.071
Commuting x secondary comprehensive education		0.000
Commuting x secondary vocational education		-0.130
Commuting x tertiary education		-0.235**
Having a child when graduating from formal education		-0.395***
Number of observations	5,810	10,994
R2	0.164	
chi2		9.883
Prob > chi2		0.0017

Notes: All independent variables are listed in Table A1 in the Appendix; ***/**/* stand for 1%, 5% and 10% significance respectively.

Source: Authors' own analyses based on unit data from the Graduate Tracer Study.

Table 7. Estimations of the graduate's first wage equation with interactions of the matching variable

Model specification	OLS	Heckit	OLS	Heckit	OLS	Heckit	OLS	Heckit
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Main equation								
Job match: good	0.084***	0.084***						
Job match: poor	0.004	0.004						
Relevant: rather not			-0.023	-0.023				
Relevant: rather yes			-0.026	-0.026				
Relevant: definitely yes			-0.003	-0.003				
Useful: rather not			-0.005	-0.005				
Useful: rather yes			0.027	0.027				
Useful: definitely yes			0.101**	0.101**				
Relevant but not useful					-0.008	-0.007		
Not relevant but useful					0.034	0.034		
Relevant and useful					0.065***	0.065***		
Definitely relevant but not entirely useful							0.030	0.030
Not completely relevant but very useful							0.101***	0.101***
Definitely relevant and very useful							0.101***	0.100***
Number of observations	5,810	10,994	5,810	10,994	5,810	10,994	5,810	10,994
R2	0.164		0.166		0.163		0.166	
chi2		9.883		9.704		10.210		9.652
Prob > chi2		0.0017		0.0018		0.0014		0.0019

Notes: The main equation includes also: demographic, educational, family background and local labour market characteristics(all of them are listed in Table A1 in the Appendix); the selection equation includes: having a child while completing formal education, commuting to the last school or university completed x education level, "The first job" program; ***/**/* stand for 1%, 5% and 10% significance respectively.

Source: Authors' own analyses based on unit data from the Graduate Tracer Study.

Table 8. Estimations of the graduate's first wage equation with interactions by gender

Model specification	Males		Females	
	OLS	Heckit	OLS	Heckit
	(1)	(2)	(3)	(4)
Job match: good	0.064**	0.064**	0.098***	0.098***
Job match: poor	-0.012	-0.013	0.024	0.024
Number of observations	2,532	4,547	3,278	6,447
R2	0.147		0.190	
chi2		6.892		1.982
Prob > chi2		0.00866		0.159
	(5)	(6)	(7)	(8)
Relevant but not useful	-0.048	-0.047	0.040	0.041
Not relevant but useful	0.045	0.044	0.029	0.029
Relevant and useful	0.028	0.028	0.091***	0.090***
Number of observations	2,532	4,547	3,278	6,447
R2	0.145		0.190	
chi2		6.956		2.165
Prob > chi2		0.0084		0.141
	(9)	(10)	(11)	(12)
Definitely relevant but not entirely useful	0.030	0.031	0.031	0.031
Not completely relevant but very useful	0.154**	0.156***	0.062	0.062*
Definitely relevant and very useful	0.087**	0.087***	0.105***	0.104***
Number of observations	2,532	4,547	3,278	6,447
R2	0.150		0.191	
chi2		6.888		1.683
Prob > chi2		0.0087		0.195

Notes: The main equations include: demographic, educational, family background and local labour market characteristics.; the selection equations include: having a child while completing formal education, commuting to the last school or university completed x education level, "The first job" program; ***/**/* stand for 1%, 5% and 10% significance respectively.

Source: Authors' own analyses based on unit data from the Graduate Tracer Study.

Table 9. Estimations of the graduate's first wage equation with interactions by education level

Model specification	Basic vocational		Secondary comprehensive		Secondary vocational		Tertiary	
	OLS	Heckit	OLS	Heckit	OLS	Heckit	OLS	Heckit
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Job match: good	-0.033	-0.033	0.104	0.100	0.020	0.020	0.254***	0.254***
Job match: poor	-0.086	-0.086	-0.048	-0.051	-0.003	-0.003	0.135***	0.135***
Number of observations	1,217	2,496	746	2,028	1,948	3,740	1,899	2,730
R2	0.127		0.162		0.133		0.170	
chi2		2.959		1.570		1.811		2.550
Prob > chi2		0.0854		0.210		0.178		0.110
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Relevant but not useful	-0.058	-0.057	0.092	0.094	-0.091	-0.091*	0.093	0.094*
Not relevant but useful	0.067	0.067	0.047	0.044	0.002	0.002	0.079	0.077
Relevant and useful	-0.044	-0.043	0.055	0.052	0.025	0.025	0.173***	0.173***
Number of observations	1,217	2,496	746	2,028	1,948	3,740	1,899	2,730
R2	0.127		0.159		0.134		0.161	
chi2		2.568		1.369		1.848		3.032
Prob > chi2		0.109		0.242		0.174		0.0817
	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
Definitely relevant but not entirely useful	-0.007	-0.006	0.134*	0.133**	-0.048	-0.048	0.095***	0.095***
Not completely relevant but very useful	0.203*	0.204**	0.100	0.098	-0.024	-0.023	0.176***	0.176***
Definitely relevant and very useful	0.008	0.008	0.166**	0.162**	0.027	0.027	0.224***	0.224***
Number of observations	1,217	2,496	746	2,028	1,948	3,740	1,899	2,730
R2	0.129		0.163		0.134		0.173	
chi2		3.699		1.060		1.705		2.490
Prob > chi2		0.0544		0.303		0.192		0.115

Notes: The main equations include: demographic, educational, family background and local labour market characteristics.; the selection equations include: having a child while completing formal education, commuting to the last school or university completed x education level, "The first job" program; ***/**/* stand for 1%, 5% and 10% significance respectively.

Source: Authors' own analyses based on unit data from the Graduate Tracer Study.

Table 10. Estimations of the HEI graduate's first wage equation with interactions by fields of study

Model specification	Soft-pure		Soft-applied		Hard-pure		Hard-applied	
	OLS	Heckit	OLS	Heckit	OLS	Heckit	OLS	Heckit
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Job match: good	0.391***	0.391***	0.299***	0.292***	0.213**	0.215**	0.174*	0.174*
Job match: poor	0.227*	0.234**	0.174***	0.172***	0.073	0.075	0.116	0.116*
Number of observations	306	433	947	1,363	178	278	377	501
R2	0.286		0.161		0.391		0.285	
chi2		0.271		10.91		1.270		0.00723
Prob > chi2		0.602		0.000954		0.260		0.932
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Relevant but not useful	0.395	0.397	0.169*	0.178*	0.009	0.007	0.038	0.038
Not relevant but useful	0.219*	0.228**	0.037	0.034	0.026	0.024	0.226**	0.226**
Relevant and useful	0.330***	0.334***	0.197***	0.193***	0.143	0.144*	0.128	0.129
Number of observations	306	433	947	1,363	178	278	377	501
R2	0.280		0.151		0.381		0.286	
chi2		0.528		12.69		1.026		0.00718
Prob > chi2		0.467		0.000368		0.311		0.932
	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
Definitely relevant but not entirely useful	0.132	0.129	0.123***	0.119***	0.162	0.166*	0.009	0.009
Not completely relevant but very useful	0.168	0.163	0.146**	0.142**	0.425***	0.425***	0.372**	0.373**
Definitely relevant and very useful	0.451***	0.450***	0.231***	0.226***	0.179**	0.180***	0.115	0.115
Number of observations	306	433	947	1,363	178	278	377	501
R2	0.324		0.157		0.403		0.292	
chi2		0.0287		11.70		1.366		0.0503
Prob > chi2		0.865		0.000624		0.243		0.823

Notes: The main equations include: demographic, educational, family background and local labour market characteristics.; the selection equations include: having a child while completing formal education, commuting to the last school or university completed x education level, "The first job" program; ***/**/* stand for 1%, 5% and 10% significance respectively.

Source: Authors' own analyses based on unit data from the Graduate Tracer Study.

Table 11. Estimations of the graduate's first wage equation for alternative definitions of job matching by gender

Model specification	Total		Male		Female	
	OLS	Heckit	OLS	Heckit	OLS	Heckit
	(1)	(2)	(3)	(4)	(5)	(6)
Job match1: good	0.091***	0.090***	0.045	0.044	0.126***	0.126***
Job match1: poor	0.004	0.003	-0.036	-0.036	0.042	0.041*
Number of observations	5,810	10,994	2,532	4,547	3,278	6,447
R2	0.165		0.148		0.191	
chi2		9.513		6.719		1.691
Prob > chi2		0.0020		0.0095		0.1930
	(7)	(8)	(9)	(10)	(11)	(12)
Job match2: good	0.060***	0.060***	0.028	0.029	0.081***	0.081***
Job match2: poor	-0.007	-0.007	-0.022	-0.023	0.007	0.007
Number of observations	5,810	10,994	2,532	4,547	3,278	6,447
R2	0.162		0.145		0.189	
chi2		10.06		6.913		2.152
Prob > chi2		0.00152		0.00856		0.142

Notes: The main equations include: demographic, educational, family background and local labour market characteristics.; the selection equations include: having a child while completing formal education, commuting to the last school or university completed x education level, "The first job" program; ***/**/* stand for 1%, 5% and 10% significance respectively.

Source: Author's own analyses based on unit data from the Graduate Tracer Study.

Table 12. Estimations of the graduate's first wage equation for alternative definitions of job matching by education level

Model specification	Basic vocational		Secondary comprehensive		Secondary vocational		Tertiary	
	OLS	Heckit	OLS	Heckit	OLS	Heckit	OLS	Heckit
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Job match1: good	-0.052	-0.052	0.123	0.118	0.026	0.026	0.307***	0.307***
Job match1: poor	-0.068	-0.068	-0.051	-0.054	-0.013	-0.013	0.144***	0.145***
Number of observations	1,217	2,496	746	2,028	1,948	3,740	1,899	2,730
R2	0.126		0.162		0.133		0.173	
chi2		2.877		1.249		1.766		2.610
Prob > chi2		0.0898		0.264		0.184		0.106
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Job match2: good	-0.048	-0.047	0.041	0.038	0.019	0.019	0.165***	0.164***
Job match2: poor	-0.041	-0.040	-0.032	-0.034	-0.001	-0.001	0.014	0.013
Number of observations	1,217	2,496	746	2,028	1,948	3,740	1,899	2,730
R2	0.125		0.158		0.133		0.162	
chi2		2.708		1.333		1.831		3.203
Prob > chi2		0.0998		0.248		0.176		0.0735

Notes: The main equations include: demographic, educational, family background and local labour market characteristics.; the selection equations include: having a child while completing formal education, commuting to the last school or university completed x education level, "The first job" program; ***/**/* stand for 1%, 5% and 10% significance respectively.

Source: Author's own analyses based on unit data from the Graduate Tracer Study.

Table 13. Estimations of the HEI graduate's first wage equation for alternative definitions of job matching by fields of study

Model specification	Soft-pure		Soft-applied		Hard-pure		Hard-applied	
	OLS	Heckit	OLS	Heckit	OLS	Heckit	OLS	Heckit
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Job match1: good	0.500***	0.501***	0.374***	0.369***	0.291**	0.294***	0.133	0.133
Job match1: poor	0.128	0.129	0.214***	0.212***	0.253	0.259*	0.047	0.047
Number of observations	306	433	947	1,363	178	278	377	501
R2	0.320		0.162		0.401		0.283	
chi2		0.193		12.89		1.187		0.00341
Prob > chi2		0.660		0.000330		0.276		0.953
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Job match2: good	0.313***	0.314***	0.185***	0.182***	0.140	0.143*	0.130	0.130
Job match2: poor	0.301*	0.304**	-0.046	-0.046	-0.163	-0.160	0.117	0.117
Number of observations	306	433	947	1,363	178	278	377	501
R2	0.281		0.154		0.388		0.284	
chi2		0.327		12.02		1.015		0.0120
Prob > chi2		0.567		0.0005		0.314		0.913

Notes: The main equations include: demographic, educational, family background and local labour market characteristics.; the selection equations include: having a child while completing formal education, commuting to the last school or university completed x education level, "The first job" program; ***/**/* stand for 1%, 5% and 10% significance respectively.

Source: Authors' own analyses based on unit data from the Graduate Tracer Study.