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Over-education and Mismatch between Occupation and Major Subject among University and College Graduates

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Over-Education and Field-of-Study Mismatch of University and College Graduates

Idan Lipiner, Dror Rosenfeld and Noam Zussman

Abstract

This paper examines the probability of higher-education graduates in Israel to be employed in situations of over-education and mismatch between their occupation and the subject in which they majored, based on types of institutions and subjects of study. We used data on all bachelor-degree graduates born between 1978 and 1985, which include a range of economic, social, and demographic background characteristics in 2008, their Bagrut matriculation exam results, the academic fields they studied, their occupations, and their wage levels. Three common approaches to measuring over-education were adopted—empirical, objective, and subjective (the latter two are based on 2014 PIAAC survey), as well as objective and subjective measures of mismatch (based on social surveys).

Bachelor's degree graduates of public colleges have the greatest probability of being over-educated and mismatched in the first years after graduation, followed by university graduates (3–6 percentage points less) and private colleges (8–9 percentage points less than graduates of public colleges). Highly skilled workers, graduates of subjects with strong labor market affiliation, public sector employees, and those with experience in the labor market, have a lower probability of being over-educated and mismatched than others.

Over-education is correlated with a gross annual wage that is approximately 17 percent less than that of workers whose level of schooling is in line with their occupation, with no gender differences. Mismatch according to the objective/subjective measure is correlated with a wage lower by 5-6 percent/22 percent among both women and men. The negative correlation between over-education and wage is weaker among graduates of private colleges and non-elite universities.

השכלה עודפת ואי-התאמה בין משלח היד למקצוע הלימוד
בקרב בוגרי אוניברסיטאות ומכללות

נעם זוסמן, עידן ליפינר ודרור רוזנפלד

תקציר

המחקר בוחן את ההסתברות של בוגרי מוסדות להשכלה גבוהה בישראל להיות מועסקים במצבים של השכלה עודפת ואי-התאמה בין משלח היד למקצוע שלמדו. זאת על פי סוגי המוסדות ומקצועות הלימוד. נעשה שימוש בנתוני כל בוגרי תואר ראשון ילידי 1978—1985, הכוללים מגוון של מאפיינים דמוגרפיים-חברתיים-כלכליים שלהם ושל משפחותיהם בשנת 2008, הישגיהם בבחינות הבגרות, המקצועות האקדמיים שלמדו, משלחי ידם ורמות שכרם. ננקטו שלוש הגישות המקובלות למדידת השכלה עודפת – האמפירית, האובייקטיבית והסובייקטיבית (שתי האחרונות מבוססות על סקר מיומנויות בוגרים 2014) – וכן שתי הגישות המקובלות למדידת אי-התאמה (על פי הסקרים החברתיים): האובייקטיבית והסובייקטיבית.

בקרב בוגרי תואר ראשון, בעלי הסיכויים הגבוהים ביותר להיות מועסקים בהשכלה עודפת ובאי-התאמה של השכלתם למשלח ידם בשנים הראשונות לאחר תום הלימודים הם בוגרי המכללות הציבוריות, ואחריהם בוגרי האוניברסיטאות (3—6 נקודות אחוז פחות); הסיכויים הנמוכים ביותר לכך הם של בוגרי המכללות הפרטיות (8—9 נקודות אחוז פחות משל בוגרי המכללות הציבוריות). אצל בעלי כישורים גבוהים, בוגרי מקצועות לימוד בעלי זיקה הדוקה לשוק העבודה, עובדי המגזר הציבורי ובעלי ותק בשוק העבודה הסיכויים להשכלה עודפת ולאי-התאמה קטנים יותר מאשר אצל האחרים.

השכלה עודפת מתואמת עם שכר שנתי ברוטו הנמוך בכ-17% מזה של בעלי השכלה ההולמת את משלח ידם, ללא הבדל מגדרי. אי-התאמה לפי הגישה האובייקטיבית/ הסובייקטיבית מתואמת עם שכר הנמוך ב-5%–6%/ 22%, אצל גברים ונשים כאחד. המִתאם השלילי בין תעסוקה בהשכלה עודפת ובאי-התאמה לבין השכר חלש יותר אצל בוגרי המכללות הפרטיות והאוניברסיטאות האחרות (אלה שלא הוגדרו כאוניברסיטאות עילית).

1. Introduction

Over-education exists when an individual's formal education exceeds the education required to perform their job, and is also known as vertical mismatch.[1] A second related phenomenon is a mismatch between one's occupation and one's field of study, which is also known as horizontal mismatch.

Over-education may have adverse effects on the employee, the employer, and the economy through various channels (OECD, 2016). From the employee's perspective, over-education reduces job satisfaction, effort, and wages, and leads to frequent employment transitions. As a result, the employer may reduce their investment in specific human resources, and in addition to the decline in work productivity resulting from decreased effort, the employer's profitability may also decline. From the perspective of the economy, a high rate of over-educated individuals may reflect an inefficient allocation of workers to jobs, which adversely affects work productivity (McGuiness et al., 2018). In addition, frictional unemployment will increase due to frequent employment transitions. Ultimately, over-education may slow the GDP growth rate (also see Adalet-MacGowan & Andrews, 2015). Field-of-study mismatch has adverse effects as over-education, yet they may be more severe because some of the individuals will be forced to undergo occupational retraining, including all this entails (Robst, 2007a). At the same time, previous studies have shown that other factors have a stronger influence on success in the labor market including the field of study and, to a lesser degree, the type of educational institution (Zussman et al., 2007; Krill et al., 2016; Ahdut et al., 2018).

Since the 1990s, the supply of graduates of the higher-education system in Israel has grown considerably following the accelerated expansion of (government-funded) public and (unfunded) private colleges. For example, the number of bachelor-degree graduates increased fourfold and their proportion (in the 20-29 year old age group) increased from approx. 1.6% to approx. 4.2% (CBS, various years). This increase had the potential to intensify the phenomenon of over-education. The expansion of the colleges also created a considerable increase in the supply of graduates in social studies and law, which potentially might increase the number of individuals in mismatched employment.

[1] The opposite phenomenon to over-education is under-education. The current study focuses on tertiary graduates among whom this phenomenon is negligible and therefore was not addressed in this study. A close concept to over-education is over-qualification or over-skilling. For additional information see Flisi et al. (2014, 2017) and McGuiness et al. (2018).

A comparative study of countries that participated in the Survey of Adult Skills (OECD, 2016) found that Israel is one of the leading countries in the rate of over-education: approx. 32% on average, compared to the average of approx. 22% in OECD countries (Appendix Figure A-1). Over-educated workers in Israel earn approx. 27% less than other workers at the same education level, compared to an average of approx. 14% less in OECD countries. In contrast, the rate of horizontal mismatch in Israel is approx. 36%, compared to an average of approx. 40% in OECD countries (Appendix Figure A-2). In general, countries with a high rate of over-education also have a high rate of horizontal mismatch.

Despite the importance of understanding these phenomena for higher-education policy making in Israel — as the vast majority of higher education is publicly funded — and for reducing the potential adverse effects on individual welfare, work productivity, and GDP growth, research on this field in Israel is limited (exceptions are Frenkel & Leck, 2017; Katz, 2017; Romanov et al., 2017), in contrast to the state of research worldwide (see literature review below).

The current study estimates the probability of bachelor-degree graduates in Israel of being employed in over-education and field-of-study mismatch, by tertiary institutions and field of study, using multiple definitions for these phenomena. This study also estimates the adverse effect on graduates' earnings. Notably, to the best of our knowledge, very few studies on over-education have distinguished between graduates of different types of tertiary institutions and fields of study, and none have examined the probability of experiencing over-education by institution type.

In the current study, over-education is defined in three ways: empirically, based on the distribution of number of years of study of individuals working in a specific occupation; objectively; and subjectively, based on responses in an adult skills survey regarding the education required to qualify for their current job and the education required to perform their job at a satisfactory level. Mismatch is defined in two ways: objectively, where the researchers apply discretion to determine the degree of mismatch between an occupation and a field of study in a tertiary institution; and subjectively, based on responses of social survey respondents to a question of whether their job is related to their academic field-of-study. Few studies have used more than a single definition for over-education and mismatch. This is important because the differences between definitions lead to different estimates of the scope of these phenomena and their effect on earnings.

The study population included all bachelor-degree graduates of tertiary institutions in Israel who were born between 1978 and 1985. Extensive information was collected on this population from administrative sources: information on a range of the socio-economic-demographic factors of the graduates and their families in 2008, their matriculation scores, their field of study in higher education, their earnings, and so on. These were first matched to the 2008 Population and Housing Census, which contains information on occupation, and then matched to social surveys for the years 2002 to 2014. The study also used the 2014 Survey of Adult Skills, which was matched with administrative data on matriculation scores, field of study in higher education, and degree.

We classified institutions of higher education into five groups:[2] (a) elite universities (Tel Aviv University, Hebrew University of Jerusalem, Technion, Weizmann Institute of Science); (b) other universities; (c) public colleges; (d) private colleges; (e) colleges of education.

The main findings of the study are as follows: The bachelor-degree graduates with the highest probability of being over-educated for their job and of experiencing a field-of-study mismatch in the first several years after their graduation are the graduates of public colleges, followed by university graduates (3-6 percentage points lower), and by graduates of private colleges (8-9 percentage points lower than the probability of public college graduates). No gender effects were found in the probability of experiencing over-education, although men have a higher probability of experiencing a mismatch. The probabilities of over-education and mismatch are smaller for individuals with high qualifications, graduates of fields of study that are strongly connected to the labor market (such as computer sciences, electrical engineering, accounting, para-medical professions, and social work), public sector employees, and individuals with extensive experience in the labor market. Over-education and field-of-study mismatch show heterogeneous effects by institution.

The gross annual earnings of over-educated workers are approx. 17% lower than others, irrespective of gender. Mismatch, measured objectively / subjectively, is accompanied by earnings that are 5-6% / 22% lower, for both men and women. The negative correlation between the experience of over-education and mismatch, on the one hand, and earnings on

[2] The database available to us does not identify the institutions. For classification of the institutions, see Ahdut et al. (2018).

the other hand, is weaker among graduates of private colleges and other universities compared to graduates of other institutions.

The following chapter presents the approaches applied to measure over-education and field-of-study mismatch. Chapter 3 presents a review of literature, Chapter 4 describes the database and study population, descriptive statistics and the estimated model. Chapter 5 describes the results of the estimations, and Chapter 6 concludes.

2. Defining over-education and field-of-study mismatch

2.1 Defining over-education

In the research literature three approaches are commonly used to define over-education: objective, subjective, and empirical (e.g., Romanov et al., 2017). Each approach leads to different estimates of the scope of the phenomenon (Barone & Ortiz, 2011; European Commission, 2015). Following are the definitions of over-education used in the current study based on these three approaches.

A. The empirical approach

On this approach we look at the distribution of years of education of individuals in a specific occupation. An employee is over-educated when the number of their years of study exceeds the average number of years of study of individuals in that occupation by more than one standard deviation[3] (e.g., Groot & Maasen van den Brink, 1997). The occupation of the study population is known only on the date of the 2008 Census but we did not have access to the number of years of study of the census participants. We therefore took the distribution of years of study by occupation from the labor force surveys for the years 2007-2009.[4] We used only survey participants between age 23 and 30 (approx. 11,000 respondents), similar to the age group of the study population in 2008.

B. The objective approach

In the 2014 Survey of Adult Skills, respondents were asked with reference to their own job, "What certification would be required to be hired for this job?"[5] If the required certification

[3] In rare occasions, the literature uses one half of a standard deviation. Using this definition does not change the results of the estimations presented below. A less accepted definition of an individual in over-education is an individual whose number of years of study exceeds the mode.

[4] We used one occurrence only for each surveyed individuals (according to their weight in the survey) on the date closest to the 2008 Survey date.

[5] The possible responses are : No diploma is necessary; elementary school diploma; junior high school diploma; high school diploma with no matriculation – non-vocational track; high school diploma with no

was lower than a bachelor's degree,[6] then according to the objective approach, the respondent was over-educated. The advantage of this approach is that it refers to the respondents' jobs and not to all the jobs in the respondents' occupations. It does however suffer from reliability concerns, as respondents tend to over-state the qualification conditions of their own job (Hartog, 1997). Use of the objective approach has become common since adult skills surveys are conducted around the world (e.g., Flisi et al., 2017; Nieto & Ramos, 2017; Perry et al., 2014).

C. The subjective approach

In the 2014 Survey of Adult Skills, respondents were asked with respect to the level of education that the employer requires for their job, "Is this level of education required to perform the job satisfactorily? (possible answers are: This level of education is required; a lower level of education is adequate; a higher level of education is required). The response to this question constitutes the individual's subjective assessment of whether their education is in excess, and this response does not necessarily correspond to the employer's assessment. For example, according to the objective approach, a bachelor's degree is required to be hired for a job (and therefore, according to this approach, the respondent is not subject to over-education), but the respondent responded that a lower level of education is sufficient, and therefore, according to the subjective approach, the respondent (who has a bachelor's degree) is over-educated. This approach has similar advantages and shortcomings as the objective approach (Hartog, 1997). Several studies around the world have been based on this approach (e.g., Allen & van der Velden, 2001; Johns, 2019).

2.2 Defining mismatch

In line with conventional practice in the literature, we used two approaches to define field-of-study mismatch: objective and subjective.[7]

A. The objective approach

- *OECD definition*. This definition is mainly based on the classification made by Wolbers (2003). He associated each of the seven fields of study in tertiary institutions with 3-digit-level occupations, based on his judgment. An individual whose occupation is not

matriculation – vocational track; matriculation certificate – non-vocational track; matriculation certificate – vocational track; post-secondary diploma with no academic degree; bachelor's degree; master's degree; PhD.

[6] The study population included graduates who earned a bachelor's degree only.

[7] Individuals who studied professions where occupation in such professions requiring passing certification exams (e.g. accounting and law), and are not employed in those professions because they failed the certification exams, are classified as mismatched.

associated with one of these fields of study is considered to be in mismatch. The OECD (2014, 2016) studies were based on this definition.

- *Mismatch in the amended OECD definition*. The OECD definition of mismatch suffers from numerous distortions. For example, individuals with an engineering degree who worked as photographers were defined as matched, and individuals with degrees in mathematics, computers, and sciences who worked as stock brokers or in water purification and pumping were defined as matched.[8] We therefore amended this definition based on our judgment. Amendments included the attribution of 31 fields of study to occupations.[9]
- *Mismatch based on Bank of Israel definition*. We used our judgment to associate our 31 fields of study to (three-digit-level) occupations of the study population that was sampled in the 2008 Census, and individuals employed in other occupations were defined as mismatched. To confirm these associations, we studied the distribution of fields of study in each occupation, and introduced modifications as necessary.[10] We used this definition in the objective approach, unless stated otherwise.

Examples of studies that used the objective approach include Nordin et al. (2010) and OECD (2014, 2016).

B. <u>The subjective approach</u>

- This approach was based on the following item in the social survey: "Is your work related to your academic field of study?" Possible answers were: 1 – very much, 2 – a lot, 3 – a little, 4 – not at all. Respondent that chose 3 or 4 were defined a mismatched. Examples of studies that were based on the subjective approach and used surveys include Robst (2007a) and Bender et al. (2018).

[8] Use of the OECD definition also required a conversion from 2011 to 1994 job classifications.
[9] An excel file of classification of occupations to 31 fields of study, which is used to identity "mismatch according to the amended OECD definition" is attached to this study.
[10] An excel file of classification of occupations to 31 fields of study, which is used to identity "mismatch according to the Bank of Israel definition" is attached to this study.

3. Literature Review

3.1 Over-education

The phenomenon of over-education was first addressed by Freeman (1976) and since then has been the subject of numerous studies worldwide (e.g., Adalet-McGowan & Andrews, 2015; Alba-Ramirez, 1993; Chevalier, 2003; Dolton & Vignoles, 2000; Frei & Sousa-Poza, 2012; Sicherman, 1991).[11] The main findings are that the phenomenon is common and persistent at the economy level, yet is temporary at the individual level, until the individual finds a job that matches their level of education, as a result of their accrued experience in the labor market. Over-education is also correlated with relatively low earnings and with relatively high occupational mobility. It is more characteristic of women, young individuals, and individuals lacking higher education. In the low income deciles, women have a higher probability of experiencing over-education than do men, and vice versa in high income deciles (MacGuinneess & Bennett, 2007).

Few researches have studied differences in vulnerability to over-education by type of tertiary institution. Robst (1995) found that the probability of men in the US of being over-educated in their jobs declines as the quality of the tertiary institution increases.[12] Pietro and Cutillo (2006) showed that the probability of being over-educated in Italy declines as the university's research budget (a measure of institutional quality) increases. Berlingieri and Erdsiek (2012) found that in Germany, the probability of graduates of universities of applied science of being over-educated in their job is higher than the probability of graduates of other universities.

To the best of our knowledge, only one study examined the phenomenon of over-education in Israel. Katz (2017) found that the incidence of over-education in Israel, calculated using the objective approach on the basis of an Adult Skills Survey, is 30%, one of the highest rates in the OECD. Among academic graduates this rate is lower (18%), and differences were also found by field of study (graduates of liberal arts and social sciences had a relatively high rate), and no gender or nationality effects were found. Among academic graduates who are over-educated, the return on their education is low and is not significantly different from zero at young ages. This finding indirectly indicates that the

[11] For reviews of literature see Sloane (2003), McGuinness (2006), Quintini (2011), and Berlingieri and Erdsiek (2012).
[12] Graduates of institutions of lower standards who are in over-education are not necessary overqualified for their jobs.

phenomenon of over-education expanded since the 1990s. Katz found support for this finding in analyses of labor force surveys, which show that the proportion of academic graduates whose job is not an academic one increased over time, from slightly over 10% in the early 1990s, to approx. 30% in 2010. Katz did not examine the differences in over-education rates by type of tertiary institution.

3.2 Field-of-study mismatch

Robst (2007b, 2007b) found that the probability of being in a field-of-study mismatch is higher for younger adults, for graduates of liberal arts and social sciences, and for bachelor-degree graduates, compared to holders of advanced degrees; Men have a slightly higher probability of being in a field-of-study mismatch than women (by approx. 2 percentage points), for a variety of reasons: For men, the primary consideration in selecting an employer is wages and advancement potential, irrespective of mismatch, while women mainly act out of family-related considerations. Bender and Heywood (2006) and Craft et al. (2017) found that field-of-study mismatch is negatively correlated with job satisfaction. Wolbers (2003) showed that it is correlated with frequent job transitions. To the best of our knowledge, no studies have examined the probability of graduates of tertiary institutions to be in field-of-study mismatch, by institution type.

Studies from around the world show that individuals who work in a job that does not match their field of study earn less than their peers who completed the same number of years of study and are employed in a job that matches their field of study (Nordin et al., 2010; Robst, 2007a). Nordin et al. (2010), however, show that employees in a field-of-study mismatch have a higher return than others, in terms of wages to work experience. Robst (2007a) show that the wage penalty of field-of-study mismatched workers who are graduates of liberal arts and social sciences is smaller than for graduates of other fields of study.

In Israel, the phenomenon of field-of-study mismatch has attracted limited research attention. Romanov et al. (2017) were the first to study this phenomenon in Israel. These researchers based their work on a survey of bachelor-degree graduates of tertiary institutions, and studied the effect of mismatch, using the objective and subjective approaches.[13] They found that the phenomenon was widespread: Approx. 29% and approx. 37% of bachelor-degree graduates are employed in a job that does not match their field of

[13] Assessing mismatch according to the subjective approach was based on the response to the survey question: "Is your current job related to your field of study?"

study, according to the objective and subjective approach, respectively. Furthermore, wages of mismatched employees were 11% lower than wages of their peers employed in a job that matched their field of study, and mismatched employment is negatively correlated with cognitive abilities (based on scores on sections of the psychometric exam).[14] The authors did not examine differences in the incidence of field-of-study mismatch by type of tertiary institution.

Frenkel and Leck (2017) also studied field-of-study mismatch in Israel, focusing on differences between graduates of tertiary institutions in the country's periphery vs. institutions located in the center of the country. Mismatch was defined according to the subjective approach, based on a survey of bachelor-degree graduates of the above tertiary institutions. The researchers found that graduates of tertiary institutions located in the center of the country have a probability of finding a job in their field of study that is higher by 19 percentage points compared to graduates of institutions located in the country's periphery. They also found that the probability of university graduates to be in a field-of-study mismatch is 33-39 percent higher than graduates of academic colleges. University graduates in the exact sciences and in engineering,[15] and in social sciences had a much lower probability of being in a field-of-study mismatch compared to graduates of liberal arts and education. In contrast, graduates of academic colleges showed the reverse pattern. Notably, these estimations controlled for only three faculties, despite the large differences between the types of institutions in the composition of fields of study in each faculty, and did not take graduates' competencies into account.

4. Database, study population, descriptive statistics, and estimated model

4.1 Database and study population

Multiple databases were used, based on the definitions of over-education and field-of-study mismatch: (1) a follow-up file of individuals born between 1978 and 1985; (2) 2008 population census; (3) social surveys for the years 2002-2014; (4) 2014 Survey of Adult Skills (PIAAC).

[14] The final finding is consistent with the finding of Chevalier (2003), who showed that individuals with a relatively high level of education (which is positively correlated with aptitudes) have a higher frequency of finding work that is strongly matched to their education, while among other individuals, many experience over-education.

[15] This group includes graduates of mathematics, statistics, computer sciences, engineering and architecture, life sciences, agriculture, para-medical professions, and medicine.

The study focused on bachelor-degree graduates only,[16,17] excluding the following: graduates of colleges of education and the Open University, individuals who commenced their undergraduate studies before age 17, individuals in military academic deferment programs, individuals enrolled in medical degree programs, and individuals who were students (for example, graduate students) at the time of the above surveys or census, as their job may be unrelated to the field of their undergraduate studies.

The main database used in this study tracks individuals born between 1978 and 1985. It contains the following main files and fields (for additional information, see Ahdut et al., 2018): the Population Registry — individuals' gender, year of birth, country of birth and parents' country of birth, nationality, place of residence at age 17; continent of origin × education stream in high school,[18] and parents' income; matriculation exam files – subject, number of units, and grade; information on studies in tertiary institutions– fields of study (major and minor), number of years of study, and degrees earned; number of months of employment and annual wages in each of the years between 2008 and 2015 (when graduates were between age 23 and 37), taken from tax authority employer-employee files.

Over-education was measured using the empirical approach, and field-of-study mismatch was measured using the objective approach, based on 2008 census figures, which contain information on individuals' occupations. Therefore, the follow-up file was merged with the 2008 Census data, and included 9,224 surveyed individuals.

Mismatch measured using the subjective approach was based on responses to an item in the annual social surveys conducted between 2002 and 2014, merged with the follow-up file (excluding 2008 census figures). The social survey is a representative sample of the Israeli population of adults aged 20 and over. The merged file contains a total of 1,001 surveyed individuals.

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[16] The reason is that only a very small number of individuals born between 1978 and 1985 completed a master's degree in a college before the 2008 Census, because colleges expanded into graduate programs only at a later stage of the higher education reform.

[17] Omitting master's degree graduates from this study apparently creates an upward bias in the estimated probabilities of university graduates of being in over-education or field-of-study mismatch, because bachelor degree graduates of universities continue to advanced studies at a higher rate than bachelor degree graduates of colleges, and those who continue to advanced degrees are on average more talented than bachelor degree graduates, and the talented graduates have a smaller probability of over-education or field-of-study mismatch. This argument applies even more strongly to graduates of elite universities, which have the highest rate of graduates who continue to more advanced degrees.

[18] Israeli-born individuals who studied in public-religious education, individuals born in Europe-American who studied in public-religious education, individuals born in Asia-Africa (excluding Ethiopia), individuals of Ethiopian origin, Haredi individuals, Muslims (excluding Bedouins), Bedouins, Christian Arabs, and Druze. The benchmark group is individuals born in Israel who studied in the Hebrew public education system.

Over-education measured by the objective and subjective approaches was calculated on the basis of the 2014 Survey of Adult Skills (PIAAC), which constitutes a representative sample of adults between age 16 and 65. The survey data were merged with the following administrative files: files of graduates of tertiary institutions in Israel (including information on the type of institution, major and minor field of study in each degree program, degree, and date of completion),[19] the population registry (which was the source of information on place of residence at age 17), and matriculation exam files. The merged file contained information on 262 surveyed individuals.

4.2 Descriptive statistics

Table 1 presents raw data on over-educated individuals, based on the empirical approach, by gender and type of tertiary institution. The overall rate of over-education is 14%. The lowest rate is found among graduates of elite universities, followed by graduates of private colleges and other universities. The highest rate is found among graduates of public colleges. This order is more or less retained by gender as well. The rate of over-education, based on the objective and subjective definitions, is lowest among graduates of elite universities, and highest among graduates of public colleges (Figure A-3).

The rate of graduates mismatched by field-of-study, based on the objective approach (according to the 2008 Census), is presented in Table 2. Approx. 40% of all graduates are mismatched by field-of-study; Graduates of elite universities have the lowest rate of mismatch, following by graduates of private colleges and public colleges, and the highest mismatch rate is found among graduates of other universities (also see Figure A-4). Men are mismatched by field of study less than women, in all types of tertiary institutions, and this is also true for Arab vs. Jewish students (excluding graduates of public colleges).

Table A-1 presents mismatch rates based on the objective approach using various definitions. According to the original and amended OECD definitions, mismatch rates are lower than according to Bank of Israel's definition. This is not surprising because the OECD definitions are based on broader occupational categories. The differences in mismatch rates by gender and nationality according to OECD definitions are similar to the differences based on the Bank of Israel's definition.

[19] Information on entitled to a degree and fields of study is also reported in the Survey of Adult Skills, yet since there is only a partial match between the reported survey data and the information in the graduate files, we chose to use only the latter information in our study.

Figure A-4 presents mismatch by type of tertiary institution based on the subjective approach (social surveys for the years 2002-2014). In each type of institution, the mismatch rate of graduates according to the subjective approach is much lower than the mismatch rate based on the objective approach (in 2008). The order of mismatch rates by institution type according to both approaches is similar, with the exception of graduates of private colleges, who are subject to a lower mismatch rate than graduates of other institutions according to the subjective approach.

Table A-3 presents the overlap of objective and subjective mismatch rates. In three-quarters of the cases, the overlap is complete.

As expected, over-education is closely associated with field-of-study mismatch (Table A-4).

Table 1: Over-education of graduates of tertiary institutions[1] based on the empirical approach, by gender and institution type, 2008 (%)

	Total	Female	Male
Elite universities	10.9	11.5	9.5
Other universities	17.3	18.2	14.8
Private colleges	12.3	13.6	10.3
Public colleges	18.9	19.7	17.6
Total	13.6	13.9	13.0
No. of observations	6,823	4,929	1,894

Source: Central Bureau of Statistics and authors' data processing.
(1) Graduates of bachelor-degree programs only.

Table 2: Graduates of tertiary institutions[1] in field-of-study mismatch, based on the objective approach, by gender, nationality, and institution type, 2008 (%)

	Total	Female	Male	Jews	Arabs
Elite universities	34.0	35.1	31.7	35.3	24.4
Other universities	46.5	48.9	39.4	48.6	32.4
Private colleges	37.1	40.8	30.8	38.5	21.1
Public colleges	42.7	48.3	33.0	42.0	54.3
Total	39.9	42.4	33.8	41.5	30.7
No. of observations	9,224	6,620	2,604	7,917	1,307

Source: Central Bureau of Statistics and authors' data processing.
(1) Graduates of bachelor-degree programs only.

4.3 The Estimated Model

We estimated the following model of the probability of experiencing over-education, based on the LMP approach:[20]

$$(1) \quad Y_i = \alpha_0 + \alpha_1 M_i + \alpha_2 X_i + \alpha_3 E_i + \alpha_4 C_i + \alpha_5 S_i + \alpha_6 F_i + \varepsilon_i$$

where:

Y_i – Dummy variable for over-education or field-of-study mismatch, based on various definitions.

M_i – A vector of dummy variables for type of tertiary institution : elite universities, other universities, private colleges, public colleges (the benchmark group)

X_i – A vector of graduates' socio-demographic characteristics: dummy variable for males, dummy variable for married status, and dummy variable for continent of origin × high school educational stream (see Footnote 18). Five dummy variables for residential district at age 17 (Tel Aviv district is the benchmark group). Residential district at age 17 reflects two sources of effects —the environment where the graduate was raised and the job opportunities available to the graduate—because adults tend to live in their district of residence in their childhood.

E_i – A vector of job features: dummy variable for self-employed status and part-time employment, and length of experience in the labor market.

C_i – Dummy variables related to family background: father's and mother's number of years of education—Educated parents have higher cognitive skills on average, and such skills are hereditary; parental education may also indicate the quality of the education that parents give their children. We also includes parents' income percentile when their child is age 24.

S_i – Percentile of average matriculation score—reflects individual-cognitive aptitudes.[21]

F_i – A vector of dummy variables for undergraduate fields of study. For the list of fields, see Ahdut et al. (2018), Table A-1.

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[20] Logistic estimations yielded similar results.
We estimated the same equation in a two-stage estimation, using the auxiliary variable of the log of the minimum geographic distance between each type of tertiary institution to the individual's place of residence at age 17 (similarly to Ahdut et al., 2018). The first-stage equation of the probability to study in each type of institution (compared to the probability of studying in a public college) was successful, but due to the small number of observations, we obtained vary large standard deviations for the estimators in the second-stage equation, and these were not statistically significant. Therefore we were forced to exclude a two-stage estimation.

[21] We chose not to include the psychometric exam scores in the estimations, because that would entail the loss of a considerable share of observations, and especially observations of college graduates, which in any case were very few. Adding the score to the estimations does not change the order of the institution types, or the size of the estimators presented here.

The wage effect of over-education or field-of-study mismatch is estimated using a similar equation, where the dependent variable is the log of the gross annual/hourly wage, and the explanatory variables also include a dummy variable that obtains the value of 1 when the employee is over-education or mismatched and 0 otherwise (thereafter Eq. 2). This is also the commonly used method of estimation.

5. Results of the estimation

5.1 Over-education

Table 3 presents the probability of over-education, according to the empirical approach, by type of tertiary institution. This table shows that in comparison to graduates of public colleges, graduates of private colleges have the lowest probability of over-education (8 percentage points lower), followed by graduates of elite universities (approx. 6 percentage points lower) and graduates of other universities (approx. 4 percentage points lower). The order is also retained when the estimations are performed separately for men and women. The probability of over-education declines as experience in the labor market increases and the percentile of average matriculation score increases.

The proportion of students whose field of study is not linked to the labor market is larger in universities, and a considerable percentage of those students do so for the sake of enrichment and do not plan to work in their field of study. Therefore we also performed an estimation only for graduates of fields of study that are closely linked to the labor market. The results (in the right-hand column) indicate that graduates of public colleges indeed have a larger probability of being in mismatched employment, and the order of the remaining institutions is retained.

Figure 1 presents the probability of over-education by type of educational institution and gender. No statistically significant differences were found by gender within each type of institution, and the order of the institutions appearing in Table 3 is retained within each gender. Figure 2 shows that graduates employed in the public sector have a lower probability of over-education (lower by 7.6 percentage points) compared to graduates employed in the private sector, and the order of the types of institutions appearing in Table 3 is retained in both sectors.

Graduates' probability of over-education differs by field of study (Figure 3). In most fields, no differences between types of institutions were found. However, the probability of being over-educated for public college graduates of management and industrial engineering, business administration, and economics is higher compared to graduates of the same fields who studied in private colleges and other universities. Figure A-5 shows that in comparison to graduates of economics, graduates of humanities and social sciences (e.g., political science and sociology) and biology have a higher probability of being over-educated, while graduates of fields that are closely related to the labor market (e.g., computer sciences) have a lower probability of over-education.

As experience in the labor market increases, the probability of being over-educated decreases at a diminishing rate, especially for graduates of colleges (Figure 4). Approx. 19% of university graduates and 20% of college graduates were over-educated in the year they graduated.

The probabilities of being over-educated based on the various approaches—empirical, objective, and subjective— are presented in Table 4. According to the empirical approach, the order described in Table 3 is retained.[22] In contrast, according to the objective and subjective approaches, reflected in the Survey of Adult Skills, the probability of over-education for graduates of elite universities is lower than the probability of graduates of all other educational institutions. Caution, however, is required when interpreting findings from the Survey of Adult Skills due to the small number of observations.

Until this stage, graduates of public colleges served as the benchmark group. We also performed estimations in which the benchmark group was defined as holders of non-academic post-secondary diplomas,[23] graduates of technological tracks in high school.[24] We found (findings not shown) that the probability of over-education of public college graduates in the fields of computer sciences and electrical engineering[25] is lower than

[22] Estimates of types of institutions according to the empirical approach in Table 4 differ from the estimates in Table 3 because the control variables in Table 4 were adjusted to those available in the Survey of Adult Skills.
[23] No corresponding estimates were performed i which the benchmark groups is holders of matriculation certificates only, because when using the empirical approach, no jobs were found in which the average number of schools years for employees plus one standard deviation is fewer than 12 years.
[24] Estimations were limited only to graduates of technological high-school tracks because we did not have access to data on post-secondary fields of study. We may assume that a high proportion of graduates of technological high-school tracks studied in a post-secondary technological program (for example, in practical engineering and associate engineering programs).
[25] These two fields are the only fields with at least 30 public college graduates.

holders of non-academic post-secondary diplomas by 15 and 17 percentage points, respectively.

Table 3: Probability of over-education based on the empirical approach, by gender and type of tertiary institution,[1] 2008

	Total	Female	Male	Graduates of fields of study closely linked to the labor market[2]
Elite universities[3]	-0.060*** (0.017)	-0.054** (0.022)	-0.077*** (0.027)	-0.085*** (0.017)
Other universities[3]	-0.038** (0.015)	-0.033* (0.019)	-0.048** (0.024)	-0.078*** (0.016)
Private universities[3]	-0.084*** (0.017)	-0.072*** (0.023)	-0.109*** (0.027)	-0.123*** (0.018)
Male	-0.005 (0.012)			-0.017 (0.012)
Married	0.020* (0.012)	0.020 (0.015)	0.018 (0.018)	0.007 (0.012)
Experience in the labor market[4]	-0.010*** (0.003)	-0.008** (0.004)	-0.018*** (0.006)	-0.005 (0.003)
Self-employed	0.006 (0.039)	-0.034 (0.055)	0.032 (0.054)	0.037 (0.041)
Employed part-time[5]	0.016 (0.014)	0.015 (0.016)	0.072** (0.037)	0.027* (0.016)
Jewish[6]:				
Israeli-born, educated in public religious stream	-0.037*** (0.014)	-0.036** (0.017)	-0.040* (0.024)	-0.029** (0.014)
Born in Europe or America, educated in general public stream	-0.025 (0.017)	-0.010 (0.022)	-0.068** (0.028)	-0.027 (0.017)
Born in Europe or America, educated in public religious stream	-0.015 (0.040)	-0.048 (0.046)	0.129 (0.079)	-0.009 (0.042)
Born in Asia or Africa (excluding Ethiopia)	-0.044 (0.074)	-0.041 (0.081)	-0.102 (0.223)	-0.043 (0.072)
Ethiopian origin[7]	0.042 (0.062)	0.018 (0.070)	0.256 (0.159)	0.082 (0.062)
Haredi	-0.078 (0.065)	-0.085 (0.070)	-0.143 (0.317)	-0.082 (0.058)

Arab[6]:				
Muslim (excluding Bedouin)	0.010 (0.026)	-0.010 (0.036)	0.006 (0.040)	0.051* (0.027)
Bedouin	-0.097 (0.067)	-0.102 (0.092)	-0.081 (0.097)	-0.098 (0.076)
Christian	-0.019 (0.036)	-0.013 (0.047)	-0.040 (0.055)	-0.069* (0.037)
Druze[8]	0.054 (0.058)	0.013 (0.072)	0.156 (0.096)	0.139* (0.072)
Years of education - mother	-0.001 (0.002)	0.000 (0.003)	-0.004 (0.003)	-0.000 (0.002)
Years of education - father	-0.001 (0.002)	-0.002 (0.002)	0.001 (0.003)	0.000 (0.002)
Percentile of parents' income[9]	-0.000 (0.000)	-0.000 (0.000)	-0.001* (0.000)	-0.000* (0.000)
Percentile of average matriculation score[10]	-0.001** (0.000)	-0.001 (0.000)	-0.001* (0.001)	-0.001*** (0.000)
Residential district at age 17	V	V	V	V
Field of study	V	V	V	V
No. of observations	5,065	3,469	1,596	3,559
Adjusted R^2	0.076	0.063	0.114	0.057

Source: Central Bureau of Statistics, and authors' data processing.

*,**,*** - statistically significant at 10%, 5%, and 1%, respectively. Standard errors in parentheses.

(1) Bachelor-degree graduates only.

(2) Graduates of the following fields: education, design, economics, business education, accounting, social work, law, para-medical professions, agriculture, biology, chemistry, earth sciences, physics, mathematics, industrial engineering and management, bio-medical engineering, chemical engineering, civil engineering, mechanical engineering, electrical engineering, computer sciences, and architecture.

(3) Benchmark group: graduates of public colleges.

(4) Number of years elapsed from year of degree award to 2008.

(5) Typically employed fewer than 35 hours a week (not including teachers).

(6) Benchmark group: Jews and others born in Israel, educated in the general public education stream.

(7) Either they or one of their parents immigrated to Israel from Sudan or Horn of Africa countries.

(8) Including Circassians

(9) Gross annual parental income from employed and self-employed sources at the time the graduate was 24 years old. Percentiles were calculated according to the father's age group for each year separately, in order to take into account the development of income over parents' lifecycle.

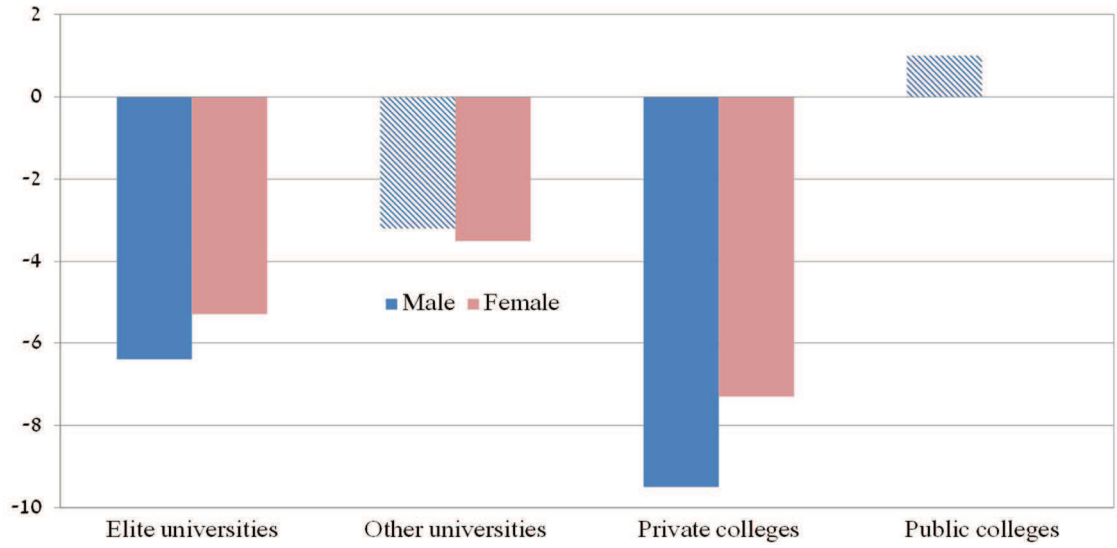
(10) Percentile of average matriculation score for each exam year separately (to take into account that matriculation scores are not calibrated over time), weighted by the number of units of study of each subject.

Table 4: Probability of over-education, based on empirical, objective, and subjective approaches, by type of tertiary institution[1]

	Empirical approach	Objective approach	Subjective approach
Source of data:	2008 Census	Survey of Adult Skills (2014)	
Elite universities[2]	-0.043*** (0.017)	-0.119** (0.058)	-0.119# (0.080)
Other universities[2]	-0.017 (0.014)	0.012 (0.065)	-0.084 (0.083)
Private universities[2]	-0.065*** (0.017)	0.034 (0.103)	-0.050 (0.118)
Control variables[3]	V	V	V
No. of observations	5,122	262	262
Adjusted R^2	0.038	0.068	0.054

Source: Central Bureau of Statistics, and authors' data processing.
#,*,**,*** - statistically significant at 15%, 10%, 5%, and 1%, respectively. Standard errors in parentheses.
(1) Bachelor-degree graduates only.
(2) Benchmark group: graduates of public colleges.
(3) Male, age, age squared, Arab, educated parents (at least one parent with 12 years of education), residential district in childhood, average matriculation score, field of study in tertiary institution.

Figure 1
Probability of over-education based on the empirical approach, by tertiary institution type and gender,[1,2] **2008**
Compared to female graduates of public colleges (in percentage points)

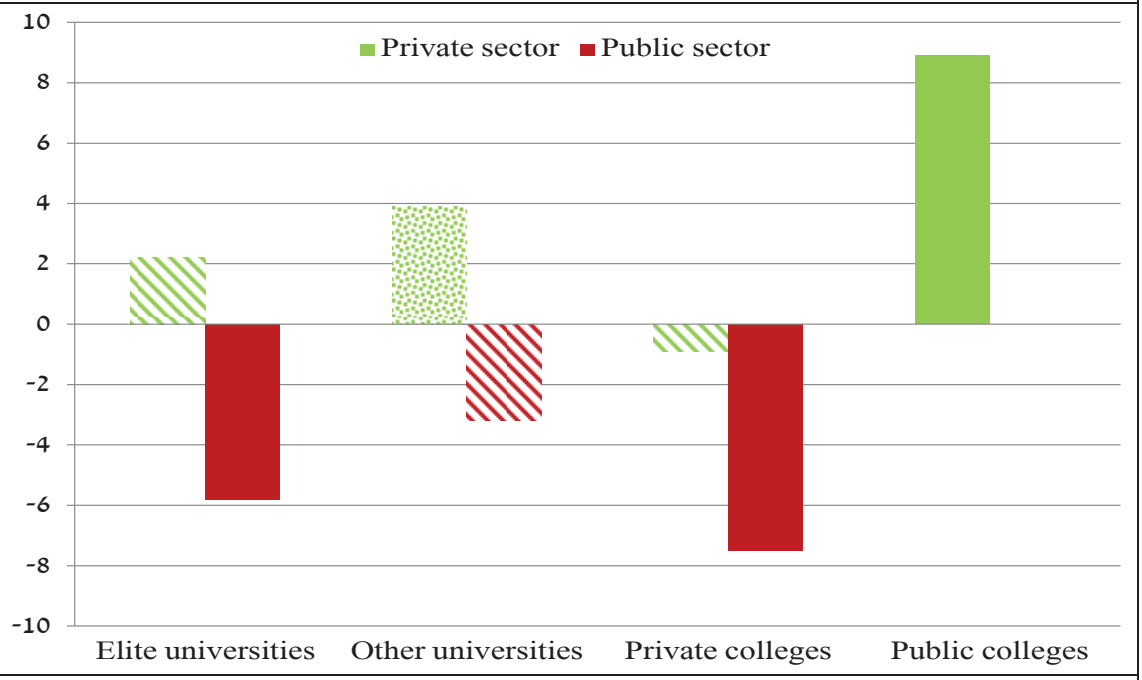


Source: Central Bureau of Statistics, and authors' data processing.
(1) Bachelor-degree graduates only.
(2) Based on estimations of the interaction variables between type of tertiary institution and gender, which were added to the estimation of Eq. 1. Dashed columns represent estimations that did not reach statistical significance of 10%.

Figure 2

Probability of over-education based on the empirical approach, by tertiary institution type and sector,[1,2] 2008

Compared to graduates of public colleges employed in the public sector (in percentage points)



Source: Central Bureau of Statistics, and authors' data processing.

(1) Bachelor-degree graduates only.

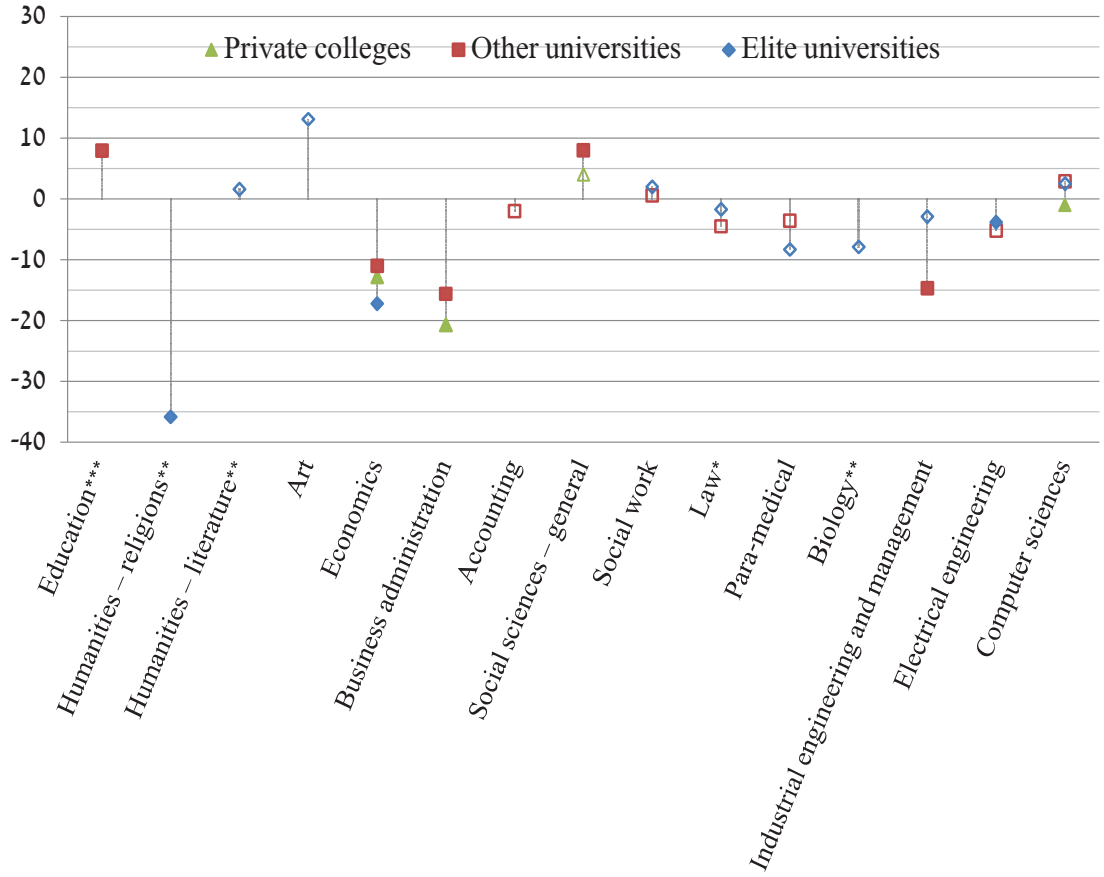
(2) Based on estimations of interaction variables between type of tertiary institution and sector, which were added to the estimation of Eq. 1.

Dashed columns represent estimations that did not reach statistical significance of 10%. The effect of other universities × private sector (dashed columns) is significant only at 15%.

Figure 3

Probability of over-education[1] based on the empirical approach, by field of study[2] and institution type,[3] 2008

Compared to graduates of public colleges (in percentage points)



Source: Central Bureau of Statistics, and authors' data processing.

Benchmark group: * private colleges, ** other universities, *** colleges of education.

Empty square, rhombus and triangle – estimate is non-significant at 10%.

(1) Bachelor-degree graduates only.

(2) Major field of study. The figure includes fields of study taught in at least two types of institutions, and at least 30 individuals in each institution completed a degree in these fields.

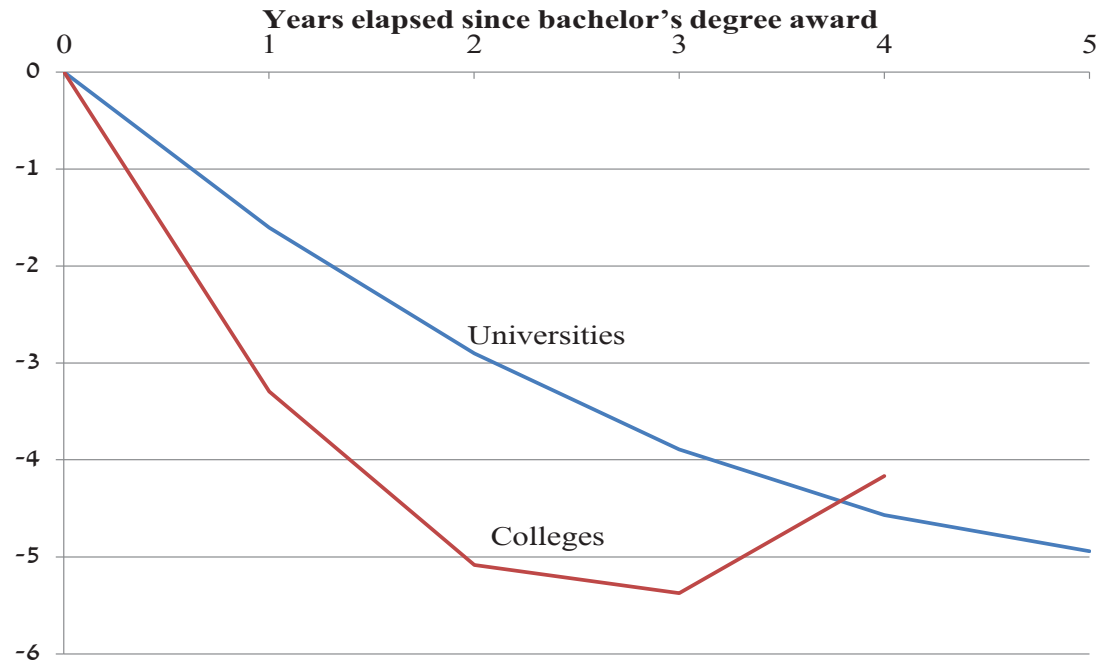
(3) Based on estimates of the dummy variables for tertiary institution type, in estimations such as in Eq. 1, separately for each field of study.

Figure 4

Effect of labor market experience on probability of over-education, based on the empirical approach, by tertiary institution type,[1,2] 2008

Compared to the probability of over-education in the degree award year

(percentage points)



Source: Central Bureau of Statistics, and authors' data processing.

(1) Bachelor-degree graduates only.

(2) Based on estimates of the experience in labor market variables (number of years elapsed from year of bachelor degree award to 2008), and number of years squared, which were added to estimations such as in Eq. 1. Estimations were performed separately for graduates of universities and graduates of colleges. The figure only shows years of experience with at least 100 observations for each year. In estimations for university graduates, the estimate of labor market experience squared is not statistically significant.

5.2 Field-of-Study Mismatch

Table 5 presents the results of the estimations of field-of-study mismatch, based on the objective approach (using the Bank of Israel definition). Compared to graduates of public colleges, graduates of private colleges have the lowest probability of mismatch (approx. 9 percentage points lower), followed by graduates of other universities (approx. 5 percentage points lower) and graduates of elite universities (approx. 3 percentage points lower). This order is retained in estimations for female graduates, while for male graduates, the probability of mismatch for private college graduates is lower than for graduates of other institutions, with no statistically significant differences between graduates of other institutions. Males have a smaller probability of mismatch (by approx. 4 percentage points), and Arabs, and the probability declines as matriculation scores increase. In estimations

limited to graduates of fields of study that are closely related to the labor market, we found (in the right-hand column) larger differences with the largest probability associated with graduates of public colleges, and the order of institution types is retained, similarly to the results obtained for the probability of over-education. In estimates of institution types, no significant differences were found in field-of-study mismatch based on the various definitions of the objective approach— the OECD definition, the amended OECD definition, and the Bank of Israel definition (Table A-5).

Male graduates of all institutions have a smaller risk of mismatch than do female graduates (Figure 5). Graduates in the public sector have a smaller probability of mismatch than graduates employed in the private sector (Figure 6). Among public sector employees, graduates of other universities have a much smaller probability of mismatch than graduates of public colleges. Among private sector employees, graduates of private colleges have the lowest mismatch rate.

Figure 7 presents the probability of mismatch by field of study and type of institution. This figure reflects the extensive heterogeneity in the order of the institutions by field of study. The following insights arise when we look at fields of study that are closely linked to the labor market: In engineering and computer sciences (and law), no significant differences were found between graduates of the different types of tertiary institutions, which is consistent with the findings of the CBS (2019) that the proportion of university graduates who studied high-tech fields[26] and are employed in the high-tech sector (77.5%) is similar to the proportion of graduates of academic colleges who studied the same fields (73.3%). In contrast, in economics and business administration, graduates of private colleges and other universities show a lower mismatch rate than other graduates. Graduates of colleges of education have a lower risk of mismatch than graduates of education in other universities.

Estimated probabilities of mismatch by field of study, without controlling for institution type (Figure A-6) indicate similar results as those obtained for over-education (Figure A-5): the mismatch probability of graduates of fields strongly linked to the labor market such as computer sciences, accounting, para-medical professions, and social work is lower than that of graduates of economics. In contrast, the mismatch probability of several engineering fields and law is similar to the probability of economics graduates, and graduates of several

[26] Fields of study that are oriented to the high-tech sector are computer sciences/engineering (including information systems), mathematics, statistics, physics, electrical engineering, and electronic engineering.

fields in the humanities and social sciences (political science, sociology, and business administration) and biology have a relatively high probability of mismatched employment.

Figure 8 presents the effect of labor market experience on field-of-study mismatch. As experience increases, the probability of mismatch declines at a diminishing rate, especially for university graduates. The mismatch rate in the degree award year is approx. 41% for university graduates and approx. 40% for college graduates.

Finally, the results of mismatch estimated based on the subjective approach show no statistically significance differences between institution type (Table A-6), possibly due to the small number of observations.

Table 5: Probability of field-of-study mismatch based on the objective approach, by tertiary institution type[1] and gender, 2008

	Total	Female	Male	Graduates of fields of study closely linked to the labor market[2]
Elite universities[3]	-0.034* (0.018)	-0.054** (0.022)	0.007 (0.030)	-0.096*** (0.020)
Other universities[3]	-0.050*** (0.015)	-0.058*** (0.019)	-0.024 (0.027)	-0.110*** (0.019)
Private universities[3]	-0.094*** (0.018)	-0.101*** (0.023)	-0.090*** (0.030)	-0.149*** (0.022)
Male	-0.036*** (0.013)			-0.041*** (0.014)
Married	0.007 (0.012)	0.016 (0.015)	-0.022 (0.021)	0.012 (0.014)
Experience in the labor market[4]	-0.005 (0.003)	-0.005 (0.004)	-0.003 (0.007)	-0.001 (0.004)
Self-employed	0.027 (0.041)	-0.019 (0.057)	0.071 (0.060)	0.038 (0.050)
Employed part-time[5]	-0.005 (0.015)	-0.009 (0.017)	0.060 (0.039)	0.057*** (0.020)
Jewish[6]:				
Israeli-born, educated in public religious stream	-0.042*** (0.015)	-0.054*** (0.018)	-0.014 (0.027)	-0.034* (0.018)
Born in Europe or America, educated in general public stream	-0.018 (0.018)	-0.009 (0.022)	-0.041 (0.031)	-0.036* (0.020)
Born in Europe or America, educated in public religious stream	-0.067 (0.041)	-0.112** (0.047)	0.101 (0.087)	-0.049 (0.051)

Born in Asia or Africa (excluding Ethiopia)	-0.193** (0.076)	-0.215*** (0.082)	-0.066 (0.208)	-0.203** (0.087)
Of Ethiopian origin[7]	0.102 (0.069)	0.102 (0.075)	-0.010 (0.185)	0.132* (0.078)
Haredi	-0.053 (0.077)	-0.059 (0.080)	-0.195 (0.412)	-0.065 (0.077)
Arab[6]:				
Muslim (excluding Bedouin)	-0.095*** (0.027)	-0.144*** (0.036)	-0.056 (0.043)	0.004 (0.031)
Bedouin	-0.159** (0.069)	-0.091 (0.095)	-0.213** (0.103)	0.033 (0.095)
Christian	-0.050 (0.036)	-0.090** (0.046)	0.020 (0.060)	-0.007 (0.043)
Druze[8]	-0.096 (0.059)	-0.222*** (0.071)	0.234** (0.108)	0.051 (0.087)
Years of education - mother	-0.001 (0.002)	-0.001 (0.003)	-0.001 (0.004)	0.002 (0.003)
Years of education - father	0.000 (0.002)	-0.002 (0.002)	0.007* (0.004)	0.001 (0.002)
Percentile of parents' income[9]	-0.000 (0.000)	-0.000 (0.000)	-0.001 (0.000)	-0.000 (0.000)
Percentile of average matriculation score[10]	-0.002*** (0.000)	-0.002*** (0.000)	-0.002*** (0.001)	-0.001*** (0.000)
Residential district at age 17	V	V	V	V
Field of study	V	V	V	V
No. of observations	6,859	4,690	2,169	4,625
Adjusted R^2	0.264	0.271	0.228	0.138

Source: Central Bureau of Statistics, and authors' data processing.

*,**,*** - statistically significant at 10%, 5%, and 1%, respectively. Standard errors in parentheses.

(1) Bachelor-degree graduates only.

(2) Graduates of the following fields: education, design, economics, business education, accounting, social work, law, para-medical professions, agriculture, biology, chemistry, earth sciences, physics, mathematics, industrial engineering and management, bio-medical engineering, chemical engineering, civil engineering, mechanical engineering, electrical engineering, computer sciences, and architecture.

(3) Benchmark group: graduates of public colleges.

(4) Number of years elapsed from year of degree award to 2008.

(5) Typically employed fewer than 35 hours a week (not including teachers).

(6) Benchmark group: Jews and other graduates born in Israel, educated in the general public education stream.

(7) Either they or at least one of their parents immigrated to Israel from Sudan or Horn of Africa countries.

(8) Including Circassians.

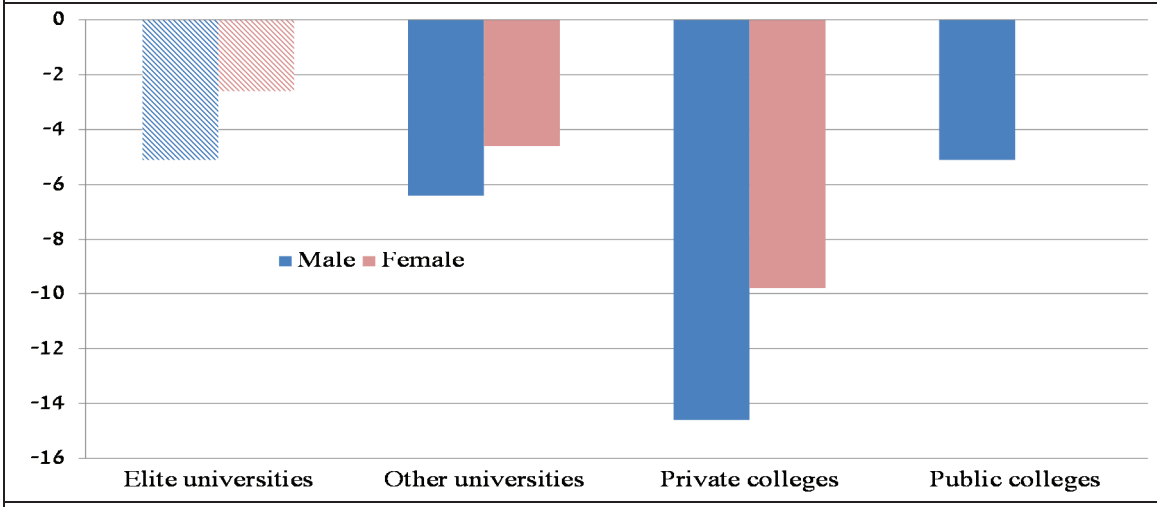
(9) Gross annual parental income from employed and self-employed sources at the time the graduate was 24 years old. Percentiles were calculated according to the father's age group for each year separately, in order to take into account the development of income over parents' lifecycle.

(10) Average score percentiles in matriculation subjects for each exam year separately (to take into account that matriculation scores are not calibrated over time), weighted by the number of units of study in each subject.

Figure 5

Probability of field-of-study mismatch,[1] based on the objective approach, by institution type and gender, 2008

Compared to female graduates of public colleges[2] (in percentage points)



Source: Central Bureau of Statistics, and authors' data processing.

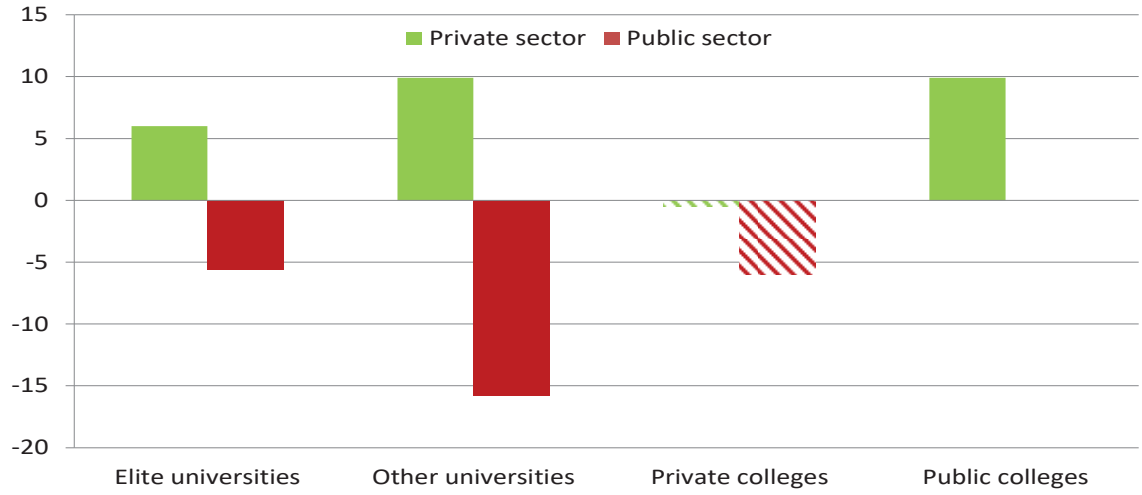
(1) Bachelor-degree graduates only.

(2) Based on estimations of interaction variables between type of tertiary institution and gender, which were added to the estimation of Eq. 1. Dashed columns represent estimations that did not reach statistical significance of 10%.

Figure 6

Probability of field-of-study mismatch[1] based on the objective approach, by institution type and sector,[2] 2008

Compared to graduates of public colleges employed in the public sector (in percentage points)



Source: Central Bureau of Statistics, and authors' data processing.

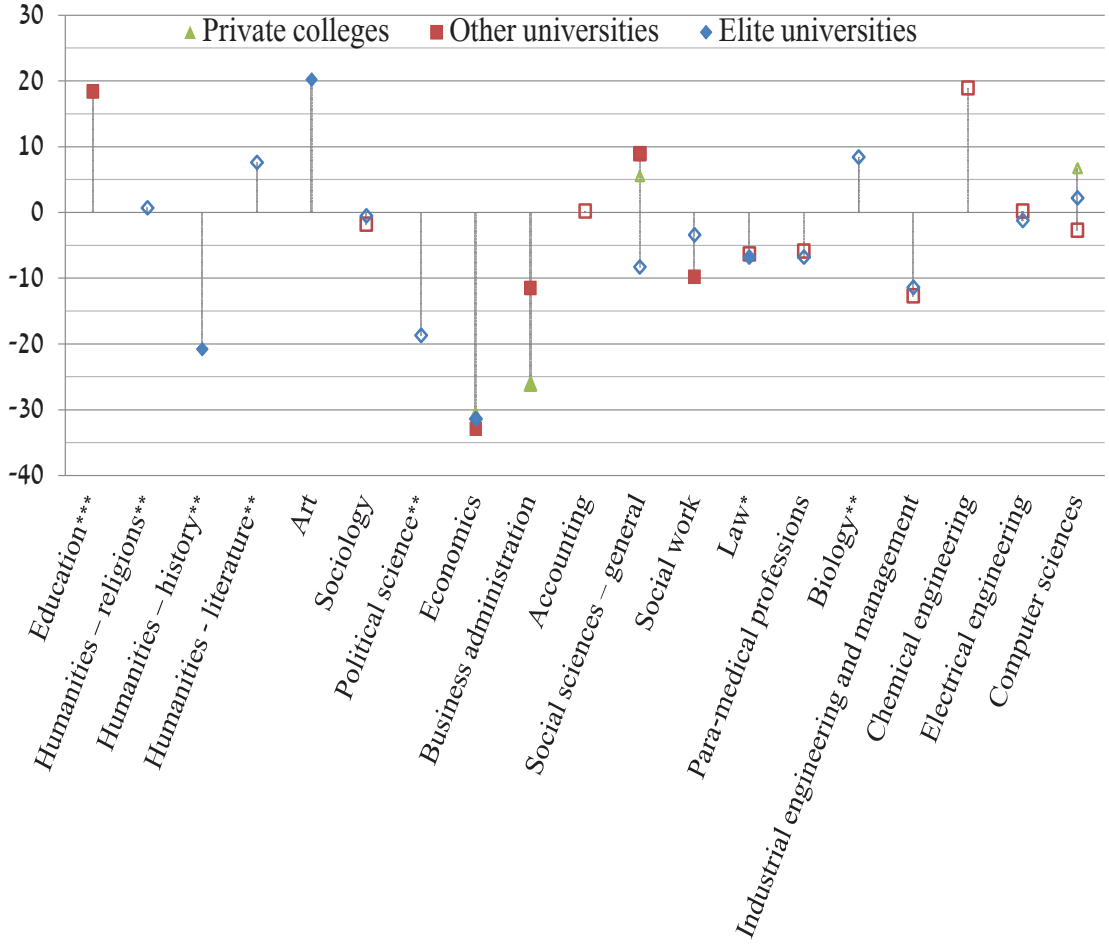
(1) Bachelor-degree graduates only.

(2) Based on estimations of interaction variables between type of tertiary institution and sector, which were added to the estimation of Eq. 1. Dashed columns represent estimations that did not reach statistical significance of 10%.

Figure 7

Probability of field-of-study mismatch[1] based on the objective approach, by field of study[2] and institution type,[3] 2008

Compared to graduates of public colleges (in percentage points)



Source: Central Bureau of Statistics, and authors' data processing.

Benchmark group: * private colleges, ** other universities, *** colleges of education.

Empty square, rhombus and triangle – estimate is not statistically significant at 10%.

(1) Bachelor-degree graduates only.

(2) Major field of study. The figure includes fields of study taught in at least two types of institutions, and at least 30 individuals in each institution completed a degree in these fields.

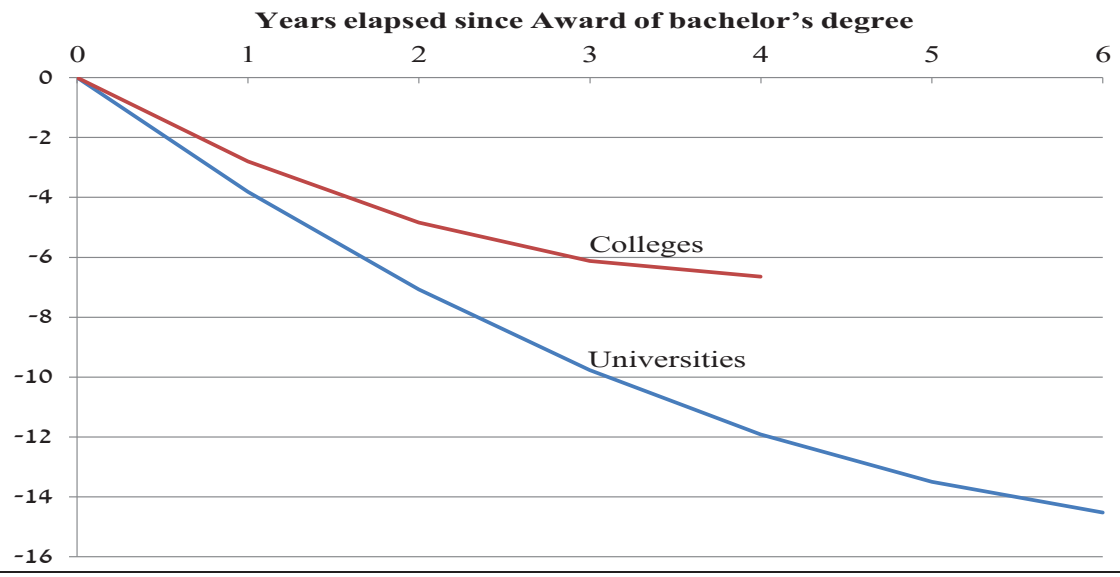
(3) Based on estimates of the dummy variables for tertiary institution type, in estimations such as in Eq. 1, separately for each field of study.

Figure 8

Effect of labor market experience on probability of field-of-study mismatch,[1] based on the subjective approach, by tertiary institution type,[2] 2002-2014

Compared to the probability of field-of-study mismatch in the degree award year

(in percentage points)



Source: Central Bureau of Statistics, and authors' data processing.

(1) Bachelor-degree graduates only.

(2) Based on estimates of the experience in labor market variables (number of years elapsed from year of bachelor degree award to 2008), and number of years squared, added to estimations such as in Eq. 1. Estimations were performed separately for universities and colleges. The figure only shows years of experience with at least 100 observations for each year. In estimations for university graduates, the estimate of labor market experience squared is not statistically significant. In estimations for college graduates, the estimate of labor market experience and market experience squared are not statistically significant.

5.3 Correlations between over-education and field-of-study mismatch and wages

The global research literature shows, as noted earlier, that over-education and field-of-study mismatch are correlated with a wage penalty. The association between over-education, based on the empirical approach, and gross annual and hourly wages in Israel is presented in Table 6. Over-education is correlated with annual and hourly wages (in 2008) that are approx. 17% and 14% lower, respectively, than wages of non-over-educated employees. There is no difference between males and females. The negative correlation between over-education and wages among graduates of private colleges and other universities is smaller compared to graduates of elite universities and public colleges (Table 7). The negative correlation is larger for graduates of fields of study that are closely linked to the labor market. Figure 9 shows that among females, the correlation is statistically significant only for graduates of public colleges, while among men, no statistically significant differences

were found across institution types. In the private sector, the negative correlation between over-education and wages among graduates of other universities and private colleges is small compared to graduates of public colleges and elite universities, while no statistically significant differences in the correlations were found by institution type in the public sector (Figure 10).

Mismatch according to the objective approach is correlated with annual wages that are 5%-6% lower than non-mismatched graduates, with no gender-based differences (Table 8). The negative correlation between mismatch (based on the empirical approach) and wages among graduates of private colleges and other universities is smaller than the correlation among graduates of elite universities and public colleges (Table 7). In all types of institutions, the negative correlation is larger among graduates of fields of study that are closely linked to the labor market. Separate estimations for female and male graduates (not presented) show that the negative correlation is stronger for male graduates of elite universities compared to graduates of all other types of institutions (approx. 17% larger compared to graduates of public colleges), while no statistically significant difference by institution type was found for female graduates. Separate estimations for private and public sector employees (not presented) indicate no statistically significant differences in the correlations by type of institution, with the exception of graduates of private colleges employed in the private sector. Those in mismatched employment earn 14% less than non-mismatched graduates, compared to the graduates of public colleges.

Field-of-study mismatch based on the subjective approach is correlated with annual wages that are approx. 22% lower (between 2008 and 2014) than non-mismatched graduates, with no statistically significant difference between genders (Table 9). Table A-7 indicates that the negative correlation is much stronger among female graduates of public colleges, with no differences in the correlations by institution type for male graduates. Notably, the correlation between mismatch and wages based on the subjective approach is much stronger compared to the correlation based on the objective approach (Table 8). Such differences were also found in other studies around the world (see for example the differences between findings reported by Robst [2007a] and Nordin et al. [2010]).

Correlations between mismatch, based on the objective approach, and annual wages (in 2008) by field of study and type of institution are presented in Figure A-7. In the majority of fields of study, the negative correlation is similar across institution types. In some fields (accounting, para-medical professions, and computer sciences), the negative correlation

among graduates of other universities is much weaker than among graduates of public colleges. Corresponding estimations using hourly wages predicted similar results (not presented).

Correlations between mismatch and wages by field of study are presented in Figure A-8. For mismatched employees, the negative correlation for graduates of fields of study closely linked to the labor market (e.g., computer sciences, design, and para-medical professions) is, as expected, higher than the correlation for graduates of economics, and lower than the correlation for graduates of several fields of study in the humanities and social sciences. The Central Bureau of Statistics (2019) found that graduates of high-tech-related fields in mismatched employed earn relatively low wages (only 10% of this group earned more than NIS 13,000, net, a month) compared to graduates of the same fields who found a job in the high-tech sector (60%).

Arguably, when selecting a job, bachelor-degree graduates also take into account the match between their field of study, the available job, and the offered wages (which may manifest as, for example, willingness to work in mismatched employment for higher wages). Therefore, the estimates of mismatch in the wage equation, which we estimated above, are downward bias (in absolute values) compared to the situation in which mismatched is accepted in the absence of a better option. We can resolve the bias using TSLS. For this, we would have to identify an auxiliary variable that is correlated with mismatch but not with wages, and such a variable is difficult to find. Nonetheless we made an effort to use the following auxiliary variables: (a) the match between field of study in a tertiary institution and the individual's matriculation subjects (4 units or more), because these may reflect the individual's interest in the field of study in the tertiary institution and consequently, their willingness to compromise on a job that does not match that field of study; (b) the match between the ranking of the fields of study in a tertiary institution to which the individual registered and the fields of study completed, based on a similar logic as in (a). In both cases, the estimates of the auxiliary variables were not statistically significant in the first-stage equation and therefore second-stage estimations could not be performed.

Another possible argument is that there are traits that were not observed by the researchers that are correlated with both mismatch and low wages (e.g., non-cognitive abilities such as social skills). If we were able to bring these variables into account, the negative correlations would be weaker than those reported above. Obviously, this argument cannot be tested.

Table 6: Correlations between over-education based on the empirical approach and hourly/annual wages,[1] 2008

	Model 1		Model 2	
	Annual	Hourly	Annual	Hourly
Dummy variable for over-education	-0.169*** (0.029)	-0.138*** (0.026)	-0.172*** (0.033)	-0.132*** (0.030)
Dummy variable for over-education × male			0.012 (0.062)	-0.020 (0.056)
Control variables[2]	V	V	V	V
No. of observations	4,898	4,898	4,898	4,898
Adjusted R^2	0.358	0.226	0.358	0.226

Source: Central Bureau of Statistics, and authors' data processing.
*,**,*** - statistically significant at 10%, 5%, and 1%, respectively. Standard errors in parentheses.
(1) Bachelor-degree graduates only.
(2) The control variables are included in Table 3 (in the Total column).

Table 7: Correlations between over-education based on the empirical approach, and field-of-study mismatch[1] based on the objective approach, and annual wages, 2008

	Over-education		Field-of-study mismatch	
	Total	Graduates of fields closely linked to the labor market[2]	Total	Graduates of fields closely linked to the labor market[2]
Dummy variable for over-education/mismatch	-0.300*** (0.054)	-0.443*** (0.064)	-0.116*** (0.038)	-0.203*** (0.044)
Dummy variable for over-education/ mismatch × elite universities	0.068 (0.085)	0.309*** (0.104)	0.040 (0.054)	0.091 (0.064)
Dummy variable for over-education/ mismatch ×other universities	0.204*** (0.070)	0.246*** (0.100)	0.071 (0.047)	0.113* (0.063)
Dummy variable for over-education/ mismatch × private colleges	0.237*** (0.086)	0.323*** (0.108)	0.132** (0.055)	0.166** (0.066)
Control variables[3]	V	V	V	V
No. of observations	4,898	3,450	6,620	4,479
Adjusted R^2	0.359	0.378	0.336	0.346

Source: Central Bureau of Statistics, and authors' data processing.
*,**,*** - statistically significant at 10%, 5%, and 1%, respectively. Standard errors in parentheses.
(1) Bachelor-degree graduates only.
(2) Graduates of the following fields: education, design, economics, business education, accounting, social work, law, para-medical professions, agriculture, biology, chemistry, earth sciences, physics, mathematics, industrial engineering and management, bio-medical engineering, chemical engineering, civil engineering, mechanical engineering, electrical engineering, computer sciences, and architecture.
(3) The control variables are included in Table 3/Table 5 (in the Total column).

Table 8: Correlations between field-of-study mismatch[1] based on the objective approach, and hourly/annual wages, 2008

	Model 1		Model 2	
	Annual	Hourly	Annual	Hourly
Dummy variable for mismatch	-0.057*** (0.020)	-0.055*** (0.018)	-0.063*** (0.023)	-0.066*** (0.021)
Dummy variable for mismatch × male			0.021 (0.039)	0.035 (0.035)
Control variables[2]	V	V	V	V
No. of observations	6,620	6,620	6,620	6,620
Adjusted R^2	0.336	0.203	0.336	0.203

Source: Central Bureau of Statistics, and authors' data processing.

*,**,*** - statistically significant at 10%, 5%, and 1%, respectively. Standard errors in parentheses.

(1) Bachelor-degree graduates only.

(2) The control variables are included in Table 5 (in the Total column).

Table 9: Correlations between field-of-study mismatch and field of study in a tertiary institution,[1] based on the subjective approach, and hourly/annual wages,[2] 2008-2014

	Model 1	Model 2
Dummy variable for mismatch	-0.224*** (0.060)	-0.255*** (0.074)
Dummy variable for mismatch × male		0.081 (0.115)
Control variables[3]	V	V
No. of observations	883	883
Adjusted R^2	0.291	0.290

Source: Central Bureau of Statistics, and authors' data processing.

*,**,*** - statistically significant at 10%, 5%, and 1%, respectively. Standard errors in parentheses.

(1) Bachelor-degree graduates only.

(2) In current prices. Note that two dummy variables for wage years were added the control variables in the wage formula.

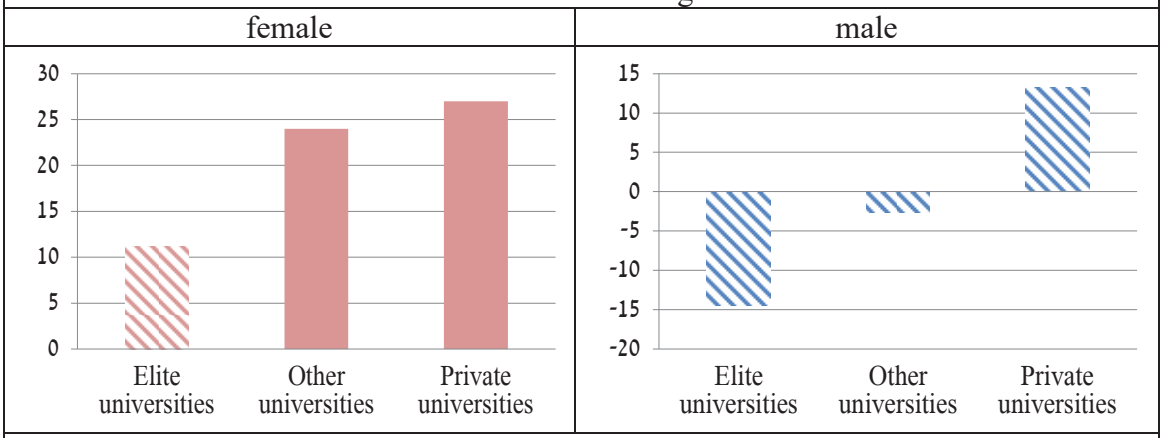
(3) The control variables are included in Table 5 (in the Total column).

Figure 9

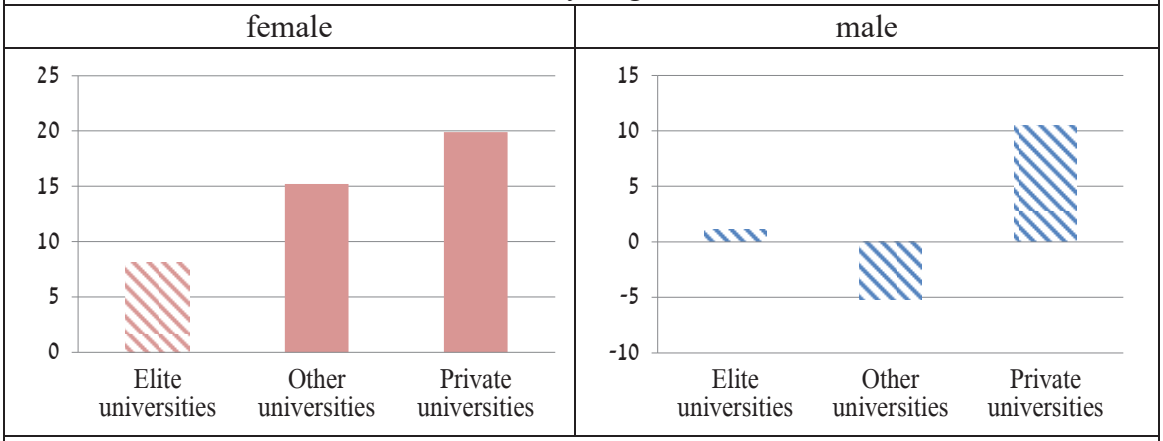
Correlations between over-education based on the empirical approach, and hourly/annual wages, by gender and institution type,[1,2] 2008

Compared to graduates of public colleges (in percentage points)

A. Annual wages



B. Hourly wages



Source: Central Bureau of Statistics, and authors' data processing.

Dashed columns represent estimates that did not reach 10% statistical significance.

(1) Bachelor-degree graduates only.

(2) Based on estimates of dummy variables for institution type in estimations such as Eq. 2, separately for male and female graduates, and for annual and hourly wages.

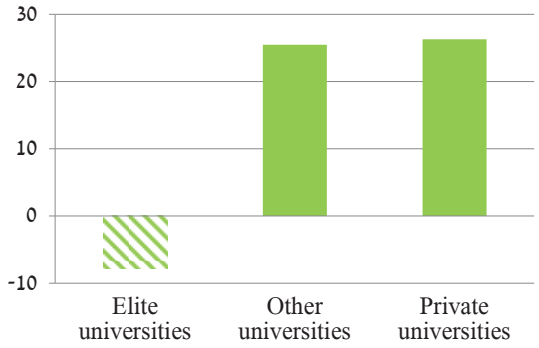
Figure 10

Correlations between over-education based on the empirical approach, and hourly/annual wages, by sector and institution type,[1,2] 2008

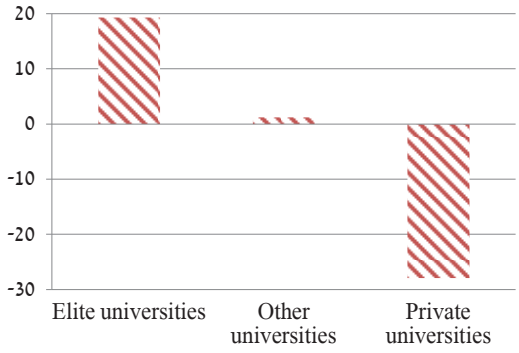
Compared to graduates of public colleges (in percentage points)

A. Annual wages

Private sector

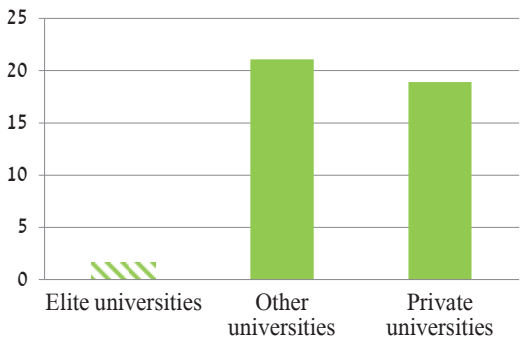


Public sector

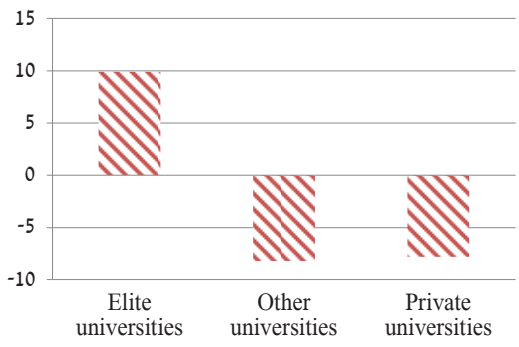


B. Hourly wages

Private sector



Public sector



Source: Central Bureau of Statistics, and authors' data processing.

Dashed columns represent estimates that did not reach 10% statistical significance.

(1) Bachelor-degree graduates only.

(2) Based on estimates of dummy variables for institution type in estimations such as Eq. 2, separately for private and public sectors, and for annual and hourly wages.

6. Summary

Over-education and field-of-study mismatch have adverse effects on employees, employers, and the economy, in myriad ways. This study examined the probability that bachelor-degree graduates in Israel will be in over-education and field-of-study mismatch, by type of tertiary institution and field of study, and examined the associations of these phenomena with graduates' wages. To the best of our knowledge, very few studies around the world have examined over-education among graduates of different types of tertiary institutions, and no study has examined the probability of field-of-study mismatch by institution type.

This research was based on diverse data on all bachelor-degree graduates in Israel who were born between 1978 and 1985. This cohort acquired their higher education several years after the accelerated expansion of tertiary institutions in Israel began, especially the expansion of academic colleges, which led to a sharp rise in the number of university and college graduates, especially in social sciences and law.

The literature uses several approaches to measure over-education and mismatch, which are used in the current study. Over-education was defined using empirical, objective, and subjective approaches, while mismatch was defined using objective and subjective approaches. Few studies have used more than one definition of these phenomena, yet this is warranted in view of the differences in incidence rates obtained when different approaches to measurement are used.

The main findings of this study are as follows: Graduates of public colleges have the highest probability of experiencing over-education and field-of-study mismatch in the first years after their graduation; They are followed by graduates of universities (3-6 percentage points lower), and the graduates that have the smallest probability are graduates of private colleges (8-9 percentage points lower than graduates of public colleges). Among graduates who studied in a vocational track in high school, graduates of electrical engineering and computer sciences in public colleges have a lower probability of over-education than individuals who earned a non-academic post-secondary diploma.

Probabilities of over-education show no gender differences, while men are less at risk of field-of-study mismatch than are women. The probability of over-education and field-of-study mismatch are relatively lower for individuals with high aptitudes, graduates of fields

of study closely related to the labor market, public sector employees, and individuals with experience in the labor market.

Over-education is correlated with gross annual wages, which are 17% lower than when occupation is matched to education, irrespective of gender. Mismatched employment measured according to the objective or subjective approach is correlated with wages that are 5-6%, and 22% lower than matched employment, for both males and females. The negative correlation between over-education and mismatch and wages among graduates of private colleges and other universities is weaker than the correlation found for graduates of elite universities and graduates of public colleges.

Findings of the study, which show that public college graduates are at greater risk of experiencing over-education and mismatch in the first years after their graduation, are consistent with findings of Ahdut et al. (2018), which were based on a similar dataset: The gross annual wages of university graduates between 2008 and 2015 were higher by approx.. 10% than graduates of public colleges, and the annual wages of graduates of private colleges were 6%-7% higher than the wages of graduates of public colleges, holding all other things including individual skills, constant. No statistically significant differences were found between the gross hourly wages (in 2008) of graduates of universities and graduates of private colleges, and these wages were 4%-6% higher than the wages of graduates of public colleges.

Over-education and field-of-study mismatch (and wage penalties) are not the only measures to assess the quality of tertiary institutions; Other measures such as satisfaction with studies,[27] and of course, institutions' contribution to research, are also used. In recent years, the Adult Survey of Skills have triggered interest in over- or under-qualifications, phenomena that are tangential to over-education and mismatch, and which also may provide an indication of the quality of tertiary institutions (e.g., Perry et al., 2014). The exploration of those measures and skills warrants a separate study.

[27] We performed estimations based on the social survey of work satisfaction, similarly to Eq. 1. These estimations indicate no statistically significant differences between the graduates of different types of tertiary institutions in the probability of being satisfied or very satisfied with their work. Nonetheless, when we collapsed two types of universities, and two types of colleges, in our estimations, we found that college graduates have a higher probability of being very satisfied with their work compared to university graduates, mainly due to the high satisfaction of graduates of private colleges.

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Appendices

Table A-1: Proportion of tertiary graduates[1] in mismatched employment, based on the objective approach using multiple definitions, by institution type, gender, and nationality,[2] 2008 (in %)

		Total	Elite universities	Other universities	Private colleges	Public colleges
OCED definition	Total	26.5	23.2	25.1	10.6	26.5
	Female	27.6	23.1	24.4	10.6	27.4
	Male	21.4	22.8	22.9	10.7	24.6
	Jews	24.3	23.3	23.2	10.1	26.2
	Arabs	35.7	19.3	30.4	17.1	28.7
Amended OECD definition	Total	29.4	24.7	32.4	24.1	35.1
	Female	31.4	26.4	34.8	25.2	39.2
	Male	24.3	21.0	25.2	22.1	28.2
	Jews	30.3	25.7	32.8	25.2	34.2
	Arabs	23.7	16.5	29.7	11.3	51.0
BOI definition	Total	39.9	34.0	46.5	37.1	42.6
	Female	42.3	35.1	48.8	40.8	48.2
	Male	33.7	31.7	39.4	30.8	33.0
	Jews	41.4	35.2	48.5	38.5	41.9
	Arabs	30.6	24.4	32.3	21.1	54.2

Source: Central Bureau of Statistics, and authors' data processing.

(1) Bachelor-degree graduates only.

(2) The number of observations is identical to the number of observations in Table 2.

Table A-2: Over-education:[1] Comparison of objective and subjective approaches, 2014

(% of total in the table)

	Objective approach		
Subjective approach		Yes	No
	Yes	8	9
	No	4	79

Source: Central Bureau of Statistics, and authors' data processing.
(1) Bachelor-degree graduates only.

Table A-3: Field-of-study mismatch:[1] Comparison of objective and subjective approaches (% of total in the table)

	Objective approach (2008)		
Subjective approach (2002-2014)		Mismatch	Match
	Mismatch	52	7
	Match	17	24

Source: Central Bureau of Statistics, and authors' data processing.
(1) Bachelor-degree graduates only.

Table A-4: Over-education based on the empirical approach and field-of-study mismatch[1] based on the objective approach, 2008 (% of total in the table)

	Over-education		
Mismatch		Yes	No
	Yes	14	23
	No	5	58

Source: Central Bureau of Statistics, and authors' data processing.
(1) Bachelor-degree graduates only.

Table A-5: Probability of field-of-study mismatch,[1] based on the objective approach, multiple definitions, 2008

	OCED definition	OCED definition	OCED definition
Elite universities[2]	-0.039**	-0.046**	-0.034*
	(0.019)	(0.022)	(0.018)
Other universities[2]	-0.053***	-0.064***	-0.050***
	(0.015)	(0.017)	(0.015)
Private colleges[2]	-0.101***	-0.133***	-0.094***
	(0.018)	(0.020)	(0.018)
Control variables[3]	V	V	V
No. of observations	5,479	5,479	6,859
Adjusted R^2	0.200	0.167	0.264

Source: Central Bureau of Statistics, and authors' data processing.
*, **, *** - statistically significant at 10%, 5%, and 1%, respectively. Standard errors in parentheses.
(1) Bachelor-degree graduates only.
(2) Benchmark group: public colleges.
(3) Control variables are included in Table 5 (Total column).

Table A-6: Probability of mismatch between occupation and field of study in tertiary education,[1] based on multiple approaches

	Subjective approach			Objective approach
	Linear probability model (LPM)	Ordinary least squares[2]	Ordered multinomial logit (odds ratio)	Linear probability model (LPM)[3]
	Social surveys 2002-2014			2008 Census
Elite universities[4]	0.053	0.154	1.358	-0.034*
	(0.045)	(0.111)	(0.291)	(0.018)
Other universities[4]	0.015	0.018	0.981	-0.050***
	(0.038)	(0.094)	(0.177)	(0.015)
Private colleges[4]	-0.066	-0.134	0.731	-0.094***
	(0.047)	(0.116)	(0.162)	(0.018)
Control variables[5]	V	V	V	V
No. of observations	1,001	1,001	1,001	6,859
Adjusted R^2	0.137	0.220	0.121[6]	0.264

Source: Central Bureau of Statistics, and authors' data processing.
*, **, *** - statistically significant at 10%, 5%, and 1%, respectively. Standard errors in parentheses.
(1) Bachelor-degree graduates only.
(2) Explained variable obtains the following values: 1 – very much, 2 – a lot, 3 – very little, 4 – not at all.
(3) Identical to the results presented in Table 5 (Total column)
(4) Benchmark group: public colleges.
(5) Control variables are included in Table 5 (Total column).
(6) Pseudo R^2

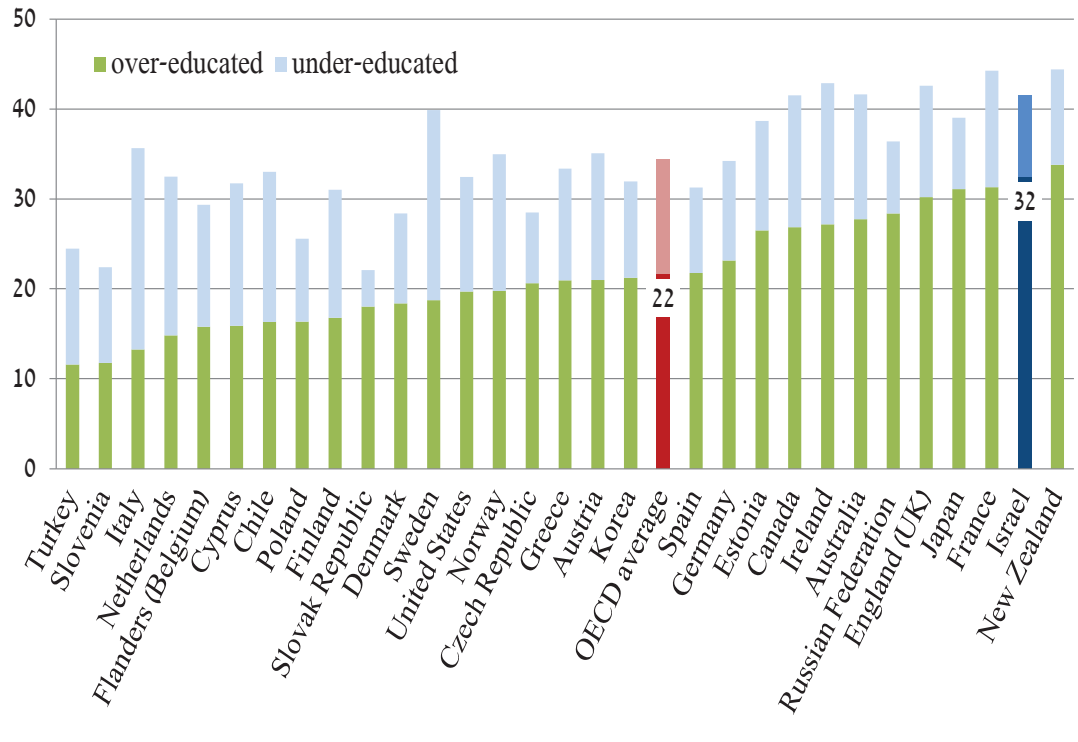
Table A-7: Correlations between field-of-study mismatch[1] based on the subjective approach, and annual wages,[2] by gender and institution type, 2008-2014

	Female	Male
Mismatch	-0.299*** (0.148)	-0.021 (0.154)
Mismatch × elite universities	0.316 (0.219)	-0.047 (0.274)
Mismatch × other universities	0.036 (0.180)	-0.147 (0.239)
Mismatch × private colleges	-0.158 (0.221)	-0.285 (0.265)
Control variables[3]	V	V
No. of observations	533	350
Adjusted R^2	0.180	0.349

Source: Central Bureau of Statistics, and authors' data processing.
*,**,*** - statistically significant at 10%, 5%, and 1%, respectively. Standard errors in parentheses.
(1) Bachelor-degree graduates only.
(2) In current prices. Dummy variables for wage years were added to the explanatory variables.
(3) Control variables are included in Table 5 (Total column).

Figure A-1

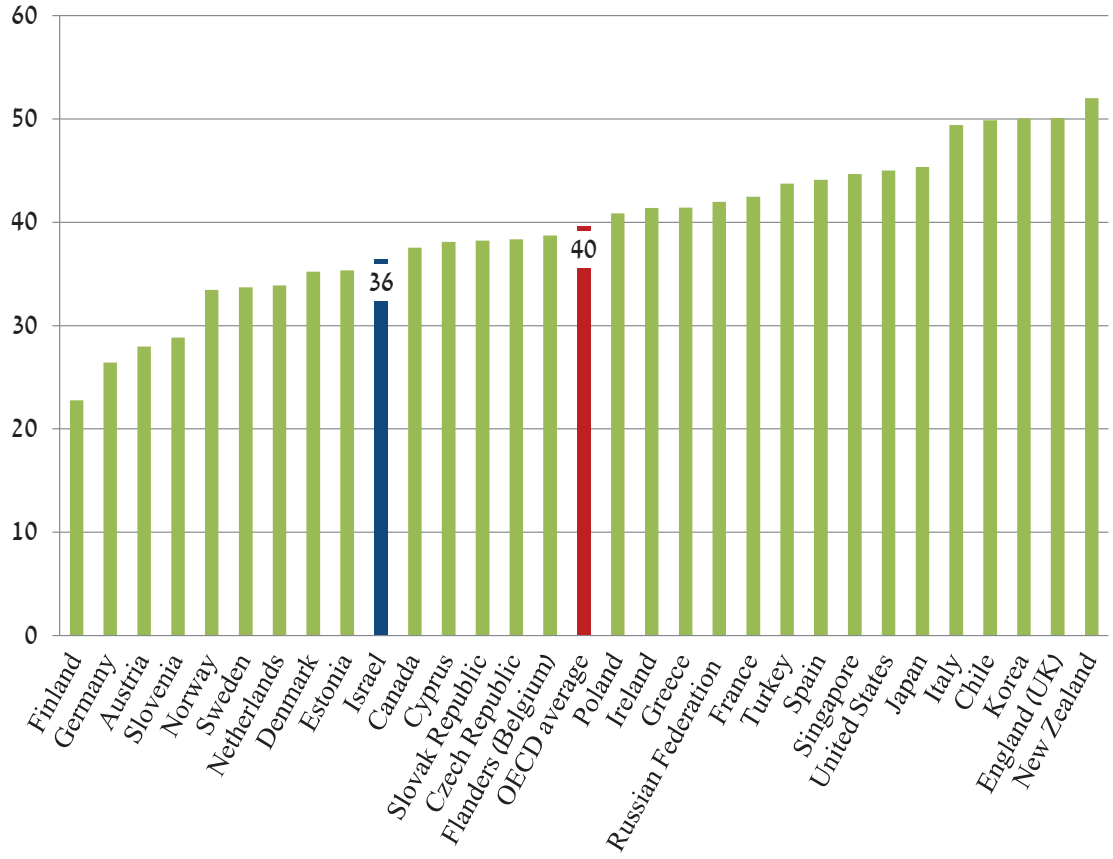
International comparison of individuals in over-education based on the objective approach: Israel (2014) and other countries (2012/2014) (%)



Source: OECD (2016), Figure 5.7.

Figure A-2

International comparison of individuals in field-of-study mismatch[1] based on the objective approach: Israel (2014) and other countries (2012/2014) (%)

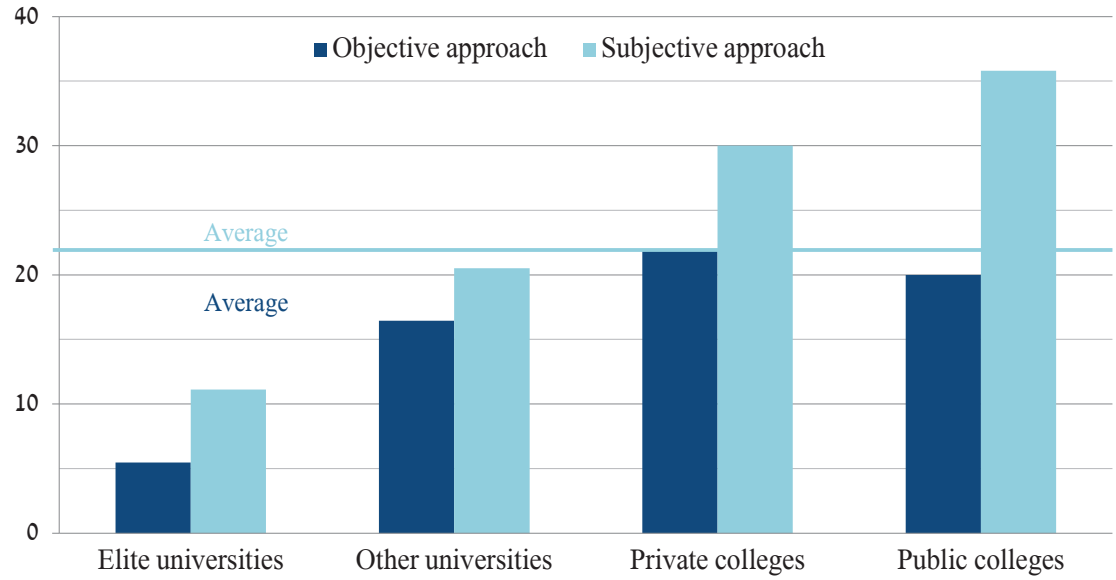


Source: OECD (2016), Figure 5.7.

(1) Field of study of the highest diploma.

Figure A-3

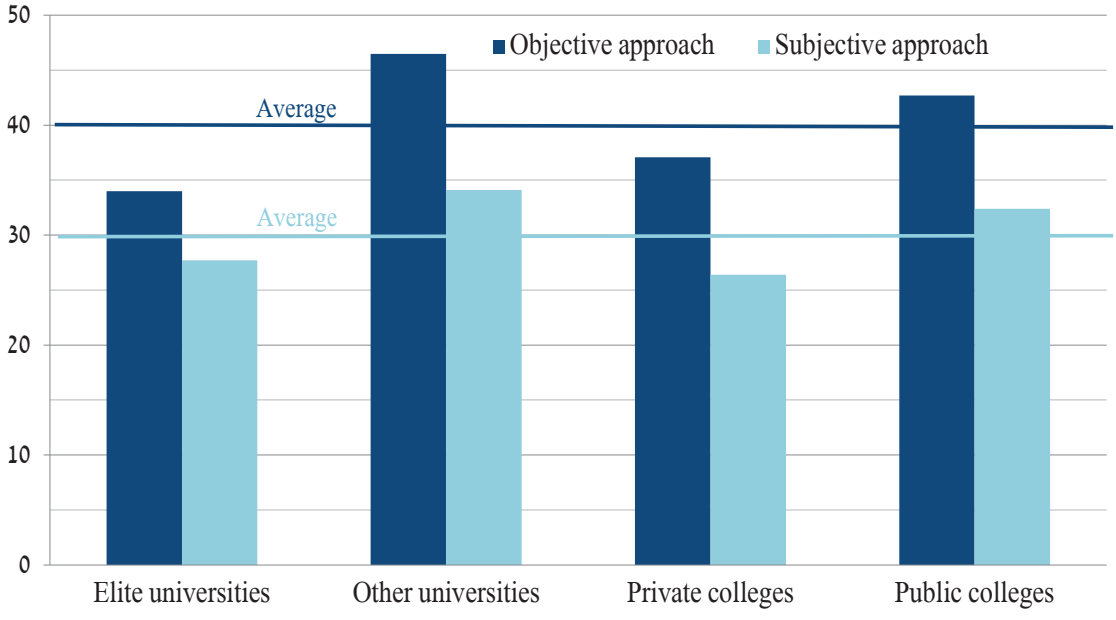
Tertiary graduates[1] in over-education, based on the objective and subjective approaches, by institution type, 2014 (%)



Source: Central Bureau of Statistics and authors' data processing.
(1) Bachelor-degree graduates only.

Figure A-4

Tertiary graduates[1] in field-of-study mismatch, based on the objective approach (2008) and the subjective approach (2002-2014), by institution type (%)

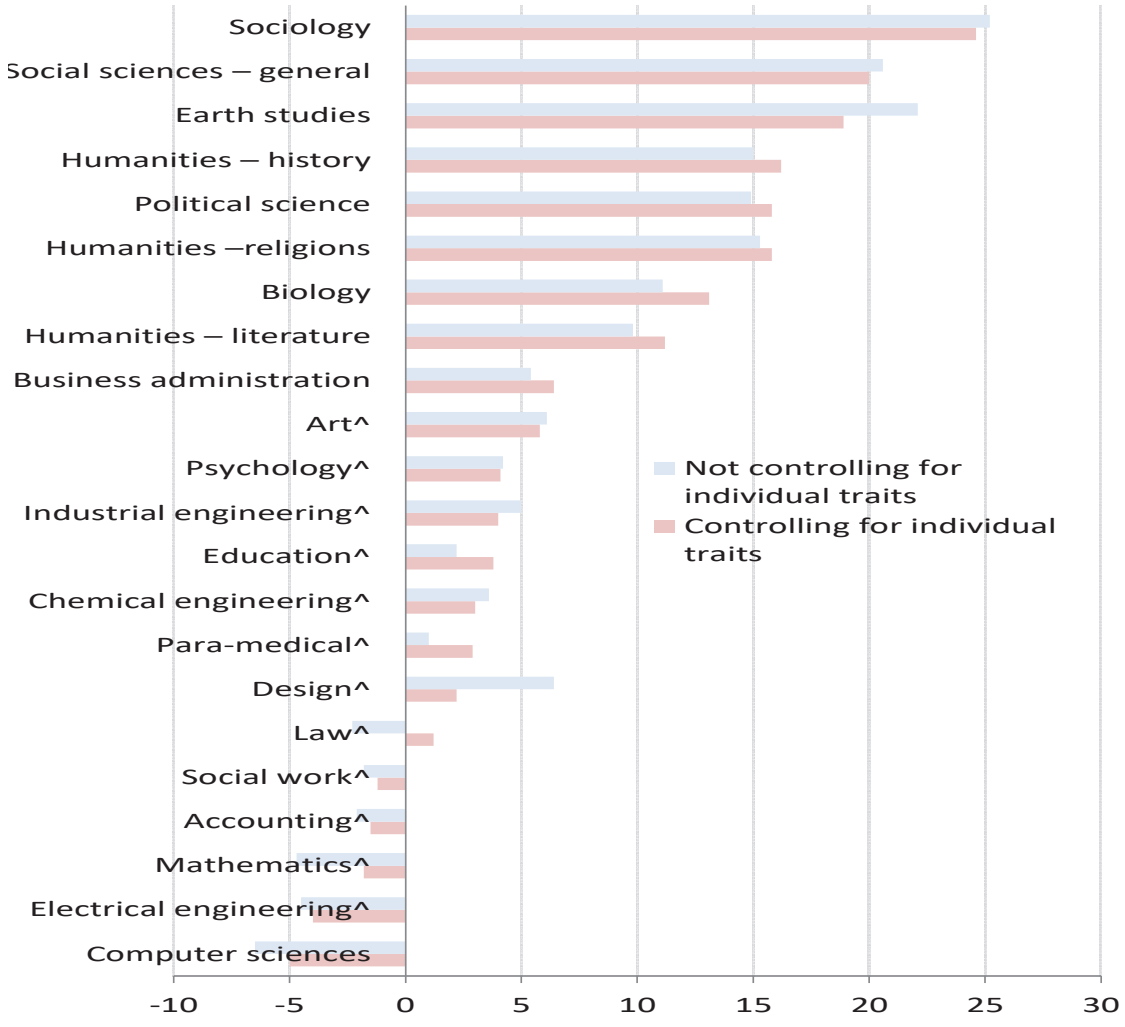


Source: Central Bureau of Statistics and authors' data processing.
(1) Bachelor-degree graduates only.

Figure A-5

Probability of over-education based on the empirical approach, by field of study in tertiary institution,[1,2,3] 2008

Compared to graduates of economics (percentage points)



Source: Central Bureau of Statistics and authors' data processing.

^ Difference in wages after controlling between field-of-study graduates and economics graduates is not statistically significant at 10%

(1) Bachelor-degree graduates only.

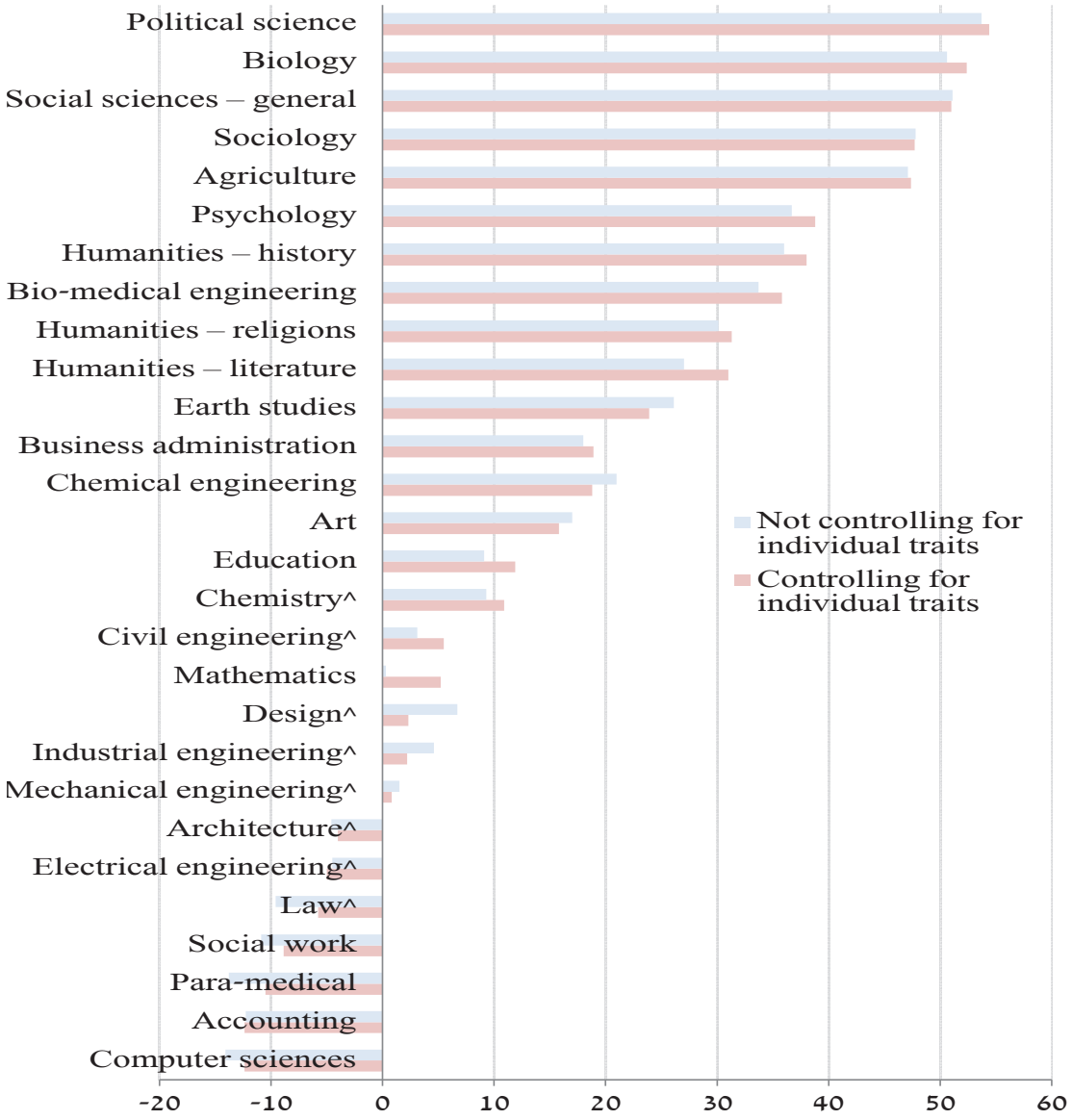
(2) Major field of study. Figure includes programs in which at least 30 individuals completed a degree.

(3) Without control variables – estimated dummy variables for fields of study in estimating over-education as a function of dummy variables for fields of study and dummy variable for males only. With control variables – estimates of dummy variables for fields of study appear in Table 3 (Total column).

Figure A-6

Probability of field-of-study mismatch[1] based on the objective approach, by field of study,[2,3] 20008

Compared to graduates of economics (percentage points)



Source: Central Bureau of Statistics and authors' data processing.

^ Difference in wages after controlling between field-of-study graduates and economics graduates is not statistically significant at 10%.

(1) Bachelor-degree graduates only.

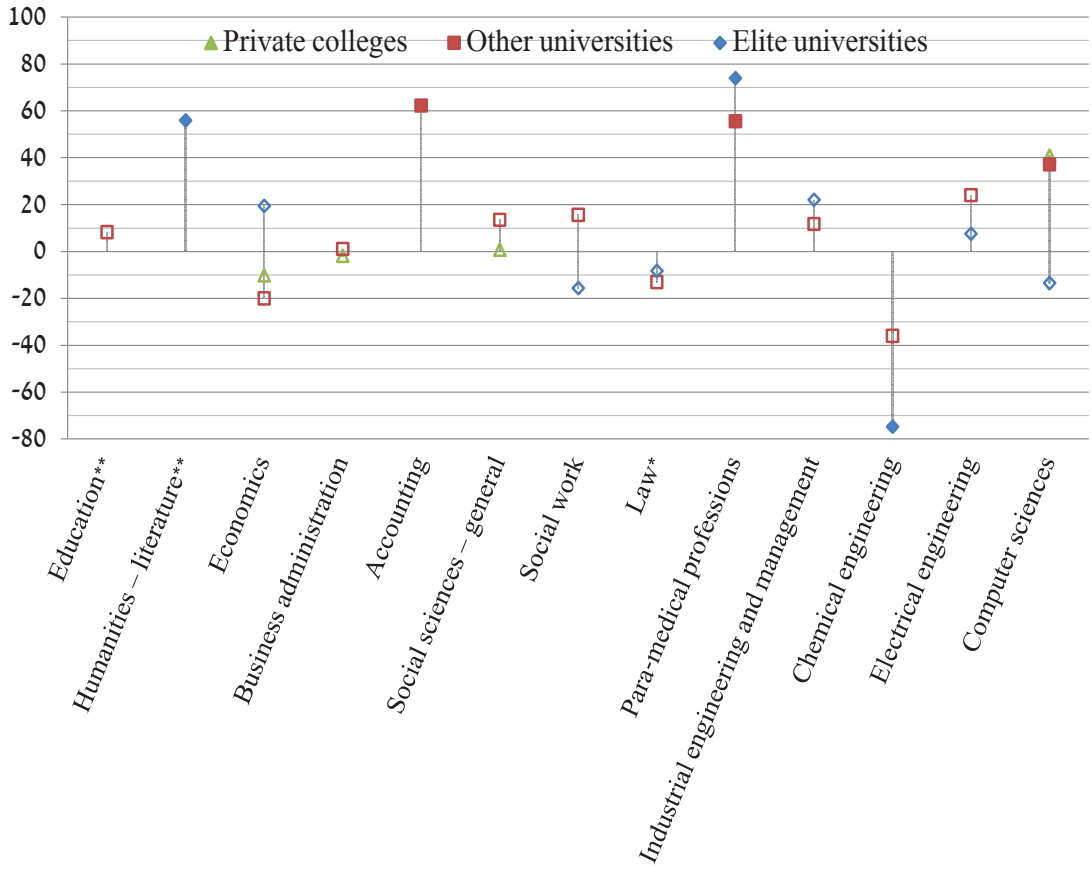
(2) Major field of study. Figure includes programs in which at least 30 individuals completed a degree.

(3) Without control variables – estimated dummy variables for fields of study in estimating mismatch as a function of dummy variables for fields of study and dummy variable for males only. With control variables – estimates of dummy variables for fields of study appear in Table 5 (Total column).

Figure A-7

Correlations between field-of-study mismatch based on the objective approach,[1] and annual wages, by field of study and institution type,[2,3] 2008

Compared to graduates of public colleges (percentage points)



Source: Central Bureau of Statistics and authors' data processing.

Benchmark group: * private colleges, ** other universities, *** colleges of education.

Empty square, rhombus and triangle – not statistically significant at 10%.

(1) Bachelor-degree graduates only.

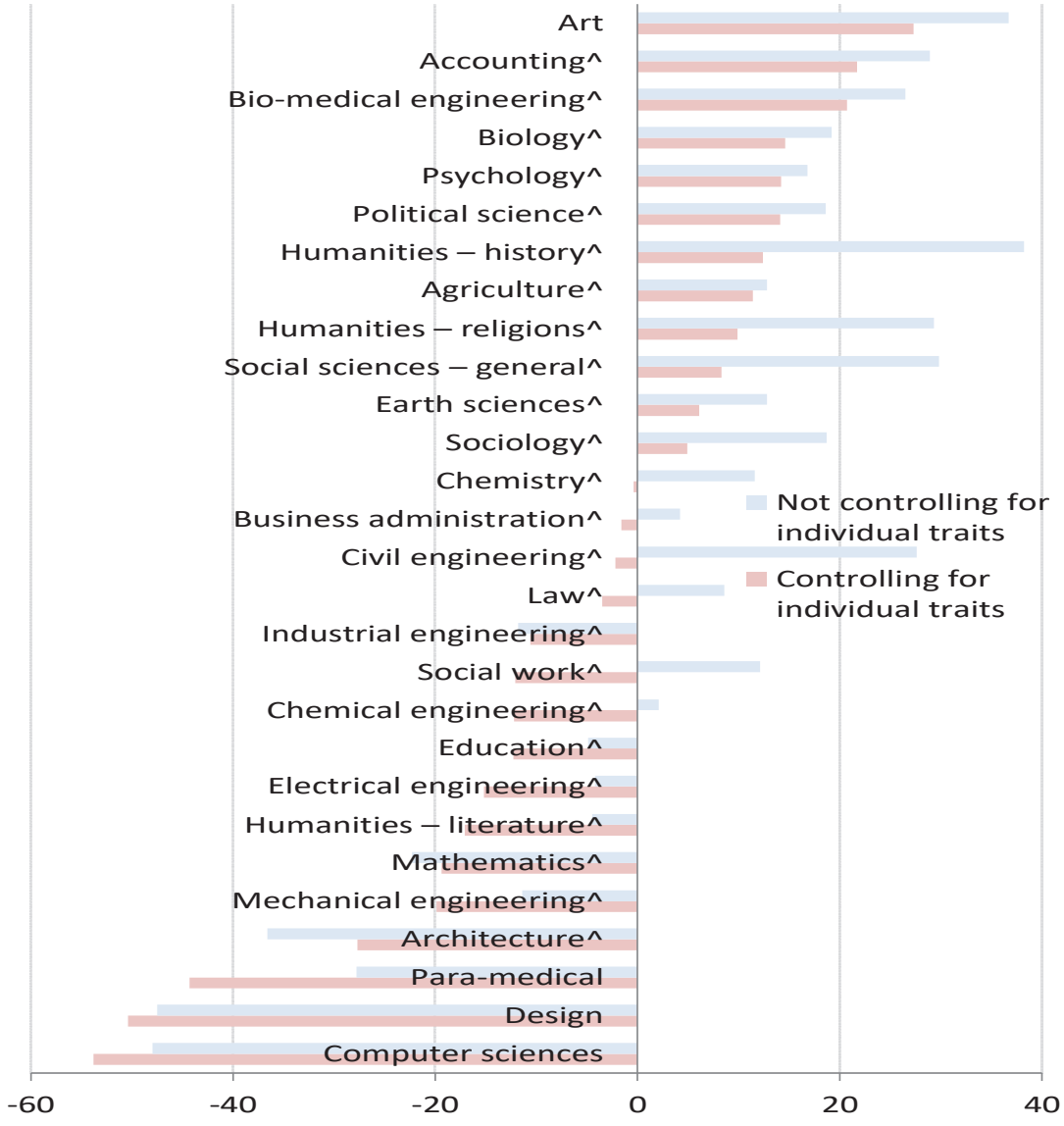
(2) Major field of study. Figure includes programs taught in at least two institutions, in which at least 30 individuals completed a degree in each institution.

(3) Based on estimates of the dummy variables for institution type in estimations such as those in Eq. 2, separately for each field of study.

Figure A-8

Correlations between field-of-study mismatch[1] based on the objective approach, and annual wages, by field of study,[2,3] 2008

Compared to graduates of economics (percentage points)



Source: Central Bureau of Statistics and authors' data processing.

* Difference in wages after controlling between field-of-study graduates and economics graduates is not statistically significant at 10%.

(1) Bachelor-degree graduates only.

(2) Major field of study. Figure includes programs in which at least 30 individuals completed a degree.

(3) Before controlling – estimates of the interaction variables between the dummy variables for field of study and the dummy variables of mismatch, in estimations of annual wages as a function of the interaction variables, dummy variables for fields of study, dummy variables for mismatch and for males.

After controlling – estimates of the interaction variables between the dummy variables for field of study and dummy variable for mismatch, in estimations of annual wages as a function of the interaction variables and the remaining explanatory variables appearing in Eq. 2.