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Impact of the Level of High School Math on Israeli Pupil's Academic and Career Outcomes

Ayal Kimhi and Arik Horovitz*

Abstract

This study examines how the level of high school mathematics study affects achievements in the Israeli labor market – employment rates and income levels. The employment rate of study subjects who took the math bagrut ("matriculation") exams at the 3-unit level or above is higher than that of subjects who took less than 3 units of math (or who did not take math bagrut exams at all); nevertheless, there are no employment gaps between those who took 3, 4, or 5 units of math. By contrast, significant income disparities were found between those who took math bagrut exams at each of the unit levels. Most of these disparities are indirect; it appears that higher level math study leads pupils to choose more prestigious academic study majors, leading in turn to higher

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quality, better paying jobs. However, high school math study at the 5-unit level is also directly positively correlated with income (that is, when other variables are controlled for), especially for women. An analysis of hypothetical scenarios shows that when pupils move from 4 units to 5 units of math study they can be expected to increase their wages by 8 percent on average – 5 percent due to direct effect and 3 percent due to higher income from academic study majors associated with those having completed 5 units of math in high school (computer science in particular). Women's choices of academic study discipline are more strongly affected by level of high school math study, as are their wages. To encourage pupils to raise their level of math study, the quality of instruction in the schools has to be improved, pupils and their parents must be made aware of the importance of math study, and incentives should be offered to schools that raise the level of math study.

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Introduction

Many studies have demonstrated that education is one of the most important, if not the most important factor in labor market success (for a review of the topic, see Card, 1999). Education has risen in importance as the labor market has become more technology oriented; this is especially true of Israel, whose economic growth is based largely on its high-tech sector (OECD, 2009). Ben-David (2012) showed that employment rate gaps between people of differing education levels have widened in recent decades. Kimhi and Shraberman (2014) found that, over the past ten years, wage disparities between academic degree holders and those with no more than a high school education have widened as well. While Israel has a relatively large proportion of academic degree holders, the poor performance of Israeli high school pupils on international tests casts doubt on the quality of the education provided by the school system (Kalinov, 2010). The large achievement disparities between stronger and weaker pupils, and between pupils from different population groups, raise questions about the education system's ability to close socioeconomic gaps over time (Ben-David, 2009). What is more, the gaps that emerge during the post-primary school years persist, to some degree, into the higher education years (Feniger, Ayalon and McDossi, 2012).

Mathematics is regarded by teachers, parents and pupils as the most important school subject, due to its importance later in admission to more selective university departments. Math study at the 5-unit level is regarded as an entry ticket to a prestigious career path, and is identified with personal attributes of ambition, serious effort and an overall track record of success (Pas and Lapid, 2013). However, there has been a major downturn in the numbers of pupils choosing to study math at the 4- and 5-unit level, despite a rise in the overall percentage of pupils taking the bagrut exams in math (Blass, 2014; Dvir, Manny-Ikan and Rosen, 2014). The difficulty of higher level math study may deter qualified pupils from facing the challenges posed by such study. In many cases, even pupils who choose the 5-unit math track change their minds during the course of their studies and switch to the 4-unit track. It may be that schools, teachers and parents support these moves because they are loath to deal with "borderline" pupils at the 5-unit level.

The importance of higher level math study may be two-fold. Firstly, it directly upgrades pupils' skills; and secondly – the mere fact that pupils choose to study math at a higher level attests to their ability and motivation. Both of these factors may help pupils gain admission to selective academic study programs, and, at a later stage, this may also boost their earning ability in the labor market. Empirical findings with regard to this supposition are inconsistent. For example, Morin (2013) found that an additional year of high school math in Ontario, Canada, only slightly improves performance at the post-secondary level. Altonji (1995) found that an additional year of math, science or foreign language in the United States significantly improves academic achievements, but the impact on wages is small. Similarly, Gaertner et al. (2014) showed that high level math study mainly affects later academic performance, with less of an impact on performance in the labor market. Levine and Zimmerman (1995) found that higher level math study was helpful in gaining admission to technology-oriented university departments and ultimately contributed to higher labor market wages – but only for women. Rose and Betts (2004) demonstrated that math study has a positive effect on pupils' future earnings, and that this effect is more pronounced the higher the level of math studied. Schrøter Joensen and Skyt Neilsen (2009) also found that higher level math study has a significant impact on labor market attainments, but that some of this impact was dependent on academic study. Dolton and Vignoles (2002) found that high level math study increases future wages by 7-10 percent. By contrast, Johnes (2005) found that the total number of disciplines studied at higher levels significantly affects future wages, but that math has no particular advantage over the high level study of any other discipline.

The present study is the first attempt of its kind to quantify the effect of higher level math study on attainments in the Israeli labor market. For this purpose, a special database was created to follow subjects from the time of their bagrut exams, through their academic studies and into the early stages of their careers (a detailed description of the database appears in the next section). The first section of this paper presents the database. Then there is a discussion of the correlation between math study and labor market achievements, without controlling for other variables. The third section presents a multivariate statistical analysis to separate the direct effect of math study level from indirect effects. This is followed by consideration of several different scenarios with the aim of quantitatively assessing the effect of 5-unit math study on future wages. The final section contains a summary and policy recommendations.

The Database

The study is based on an integrated data file for the 1979 birth cohort. The file contains data on bagrut exams (number of study units and final score in each subject), academic degrees (institution and majors), and personal information from the 2008 Population Census for all those born in 1979 and all members of their households. The file was created by the Central Bureau of Statistics (CBS) by merging files based on Israeli identity card numbers, then removing all identifying details. The file was made available to the authors in the CBS research room.

The choice of 1979 births was made from considerations of the limitations of available data. For example, bagrut data for earlier cohorts are less detailed; by contrast, the 2008 Census observed later cohorts at an earlier stage of labor market participation. Employment and income data were gathered when the subjects were 29 years old, that is, at a relatively early point in their careers – a clear deficiency of the study, given that the education wage premium may change over the course of a person's career.

Since bagrut exam and academic study data exist for the entire population, while employment data are sampled, the study population was drawn from subjects included in the 2008 Census sample, i.e., subjects were chosen who were born in 1979 and who were included in the 2008 Census. This sample contained 14 percent of Israeli households. The sample taken by the CBS was representative of the entire Israeli population as well as predefined sub-populations, but it is not necessarily a representative sample of the 1979 birth cohort population – another deficiency of the present analysis. Due to this, it is unclear whether there is an advantage to using the census sampling weights, or not. However, since the sampling weights' effect on the results is not significant, they were used throughout the study. The census file data have several sources: age and place of residence information were taken from the Civil Registry, income data are based on income tax and National Insurance Institute statements, while education, family status and employment data are taken from the census questionnaire.

Four main variables represent labor market attainments. The first is employment status (working versus not working). The second is gross monthly income from labor, which includes income from paid employment and self-employment income. Income is, of course, reported only for individuals who are employed. Due to concerns that self-employment income is reported less accurately than salaried employment income, the analysis was also performed for income from paid employment alone; the relevant sample in this instance is naturally smaller. Yet even this sub-analysis might be insufficient, given that monthly income from labor may reflect not only the value of the employee's labor in the eyes of the employer, but also the employee's decision regarding how many hours to work. For this reason, the analysis was also based on hourly wage (for salaried employees only), calculated by dividing monthly income from paid employment by number of monthly work hours. Since not all of those in the sample reported their number of work hours, the number of observations in this analysis is smaller than for the analysis of monthly income from paid employment. Table 1 presents the maximum number of observations that can be used in the analysis of each variable.[1]

Table 1. **Number of relevant cases for analysis of each variable**

Sample	**Variable for analysis**	**Number of relevant cases**
Total sample	Employment (employed or not)	14,014
Employed	Monthly income from work	11,851
Salaried	Monthly income from salaried work	10,813
Salaried employees reporting hours worked	Hourly wage from work for salaried employee	8,903

Source: Ayal Kimhi and Arik Horovitz, Taub Center
Data: Central Bureau of Statistics

1 Due to irregularities in the data, 564 observations were omitted, i.e., monthly income from labor, monthly income from paid employment or hourly wage were below the 3rd percentile. The Percentile 3 threshold values for the three variables were NIS 883 per month, NIS 917 per month and NIS 9.47 per hour, respectively. Omitting the observations had no effect on bagrut unit distribution, and a negligible effect on some of the other results.

1. *Distribution of Sample Population by Level of Math Study, Academic Study and Labor Market Characteristics*

The empirical analysis set forth below will look at the relationship between labor market attainments and a number of explanatory variables (i.e., variables that are likely to affect such attainments). The explanatory variable that constituted the study's central focus was number of units of math studied. Table 2 presents the unit number distribution for each of the samples noted in Table 1. The first category, No bagrut includes those who took no matriculation exams at all. The Zero units category refers to those who took at least one bagrut exam but were not tested in math, and the following category includes those who were tested in math at the 1-unit level (3 percent of the sample population). Preliminary analyses of labor market achievements found no significant differences between those who were not tested in math and those who were tested at the 1-unit level. In light of this, the three categories were combined into a single category for the analyses presented later on.

Table 2. **Distribution of units of math study by employment status, 2008**
as percent of group total

Units of study	Overall sample	Employed	Salaried employee	Salaried employee reporting work hours
No bagrut	41%	37%	36%	35%
0	8%	9%	8%	8%
1	3%	3%	3%	8%
3	25%	27%	27%	28%
4	13%	15%	15%	16%
5	9%	9%	9%	10%

* The percents do not necessarily sum to 100% due to rounding.

Source: Ayal Kimhi and Arik Horovitz, Taub Center
Data: Central Bureau of Statistics

Another explanatory variable is the math bagrut test score. Scores are grouped into categories (Table 3), and their distribution is presented in terms of the unit levels that appear in Figure 1. A positive correlation was found between score and number of units, that is, the mean test scores rise as the number of units rises. Since the material studied is supposed to be more difficult the higher the unit level, the positive correlation appears to stem from the fact that, pupils who are stronger in math choose (whether by choice or due to teacher guidance) to take the higher level math units and excel. It is also likely that, during the course of their studies, pupils who take higher-level math but perform poorly switch to lower levels of math study.

Table 3. **Distribution of math bagrut scores by employment status, 2008**

as percent of group total*

Score	Overall sample	Employed	Salaried employees	Salaried employee reporting work hours
Not tested	50%	45%	45%	43%
54 or lower	7%	8%	8%	8%
55-60	3%	3%	3%	4%
61-70	8%	8%	8%	8%
71-80	10%	11%	11%	12%
81-90	12%	13%	13%	14%
91 or higher	11%	12%	12%	13%

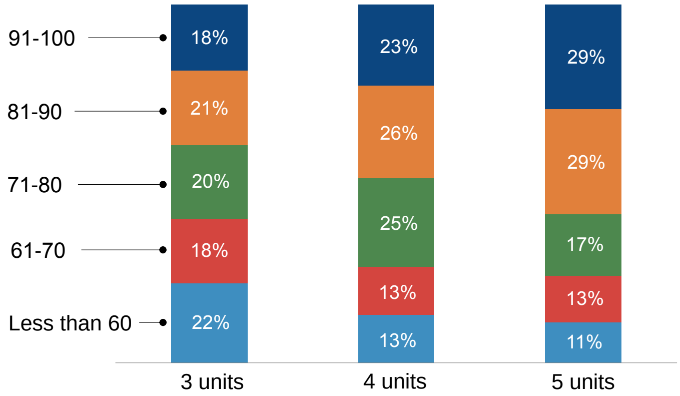
* The percents do not necessarily sum to 100% due to rounding.

Source: Ayal Kimhi and Arik Horovitz, Taub Center

Data: Central Bureau of Statistics

Figure 1

Distribution of math bagrut scores by level of math



Source: Ayal Kimhi and Arik Horovitz, Taub Center
Data: Central Bureau of Statistics

Another explanatory variable that is related to labor market achievement is academic study. The sample population was divided into four groups: subjects without academic degrees and not presently pursuing a degree; subjects without degrees who are still studying (hereinafter: “students”); subjects with undergraduate degrees from colleges; and, subjects with undergraduate degrees from universities (Table 4).[2]

2 Students pursuing advanced degrees were included in the degree holding group, rather than in the student group. Those with degrees from the Open University – a small group whose attributes are similar to those of the college graduate group – were included in the group of those with degrees from colleges.

Table 4. **Distribution of the sample population by academic study status, 2008**
as percent of group total*

Academic status	Overall sample	Employed	Salaried employees	Salaried employees reporting work hours
No degree	60%	59%	58%	55%
Student	10%	9%	9%	9%
College degree	12%	14%	14%	15%
University degree	17%	19%	20%	21%

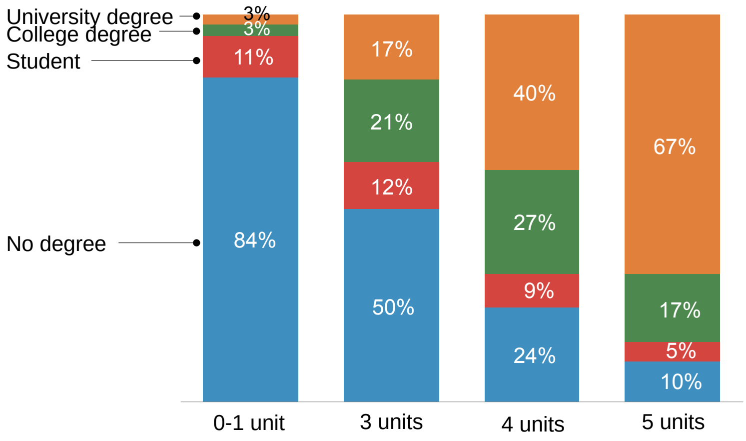
* The percents do not necessarily sum to 100% due to rounding.

Source: Ayal Kimhi and Arik Horovitz, Taub Center
Data: Central Bureau of Statistics

Not surprisingly, a close correlation was found between number of math units taken in high school and academic study status (Figure 2). The vast majority of those who took no math bagrut exams or who were tested at the lowest level did not go on to academic study. Half of those who took 3 units of math later pursued academic study, and of those who had already earned academic degrees, fewer than half had studied in university settings. Of those who took 4 units of math, fewer than a quarter did not go on to academic study, and within the degree holding group, 60 percent had attended universities. Among those who were tested at the 5-unit level, only 10 percent had not pursued academic study, and of those with academic degrees, 80 percent had studied in university settings. This correlation may be attributed to the admissions criteria of Israeli universities which are based, to a large degree, on applicant’s performance on the math bagrut, as well as to the fact that pupils whose skills are more suited to higher education choose to study math at higher levels while in high school.

Figure 2

Distribution of academic study status by level of math study



Source: Ayal Kimhi and Arik Horovitz, Taub Center
Data: Central Bureau of Statistics

For those with academic degrees, the academic majors that they pursued were examined. The sample population's distribution by study discipline is presented in Table 5. The most common area of study is the social sciences, followed by the exact sciences, Jewish studies, and the humanities. In this case as well, a clear link was found between number of math units taken and the area of study pursued (Figure 3). For instance, a higher percentage of subjects who took 5 units of math hold degrees in computer science, engineering or the exact sciences, while a higher percentage of those who took 3 or 4 units of math hold degrees in the humanities, the arts or the social sciences.

Table 5. **Distribution of the sample population by academic major, 2008**

as percent of group total*

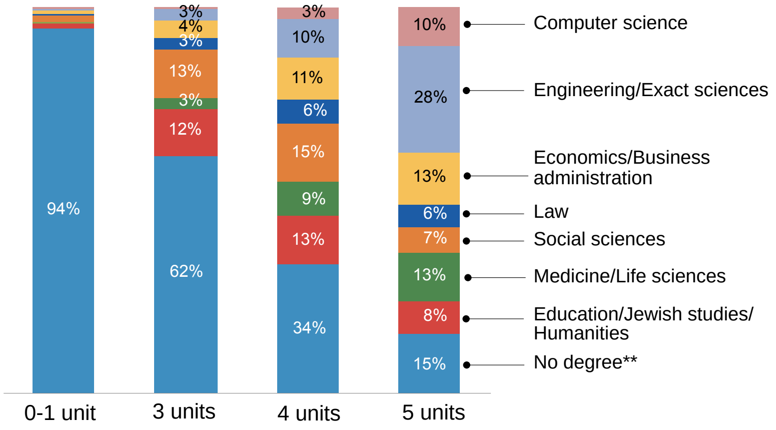
Faculty/Department	Overall sample	Employed	Salaried employee	Salaried employee reporting work hours
No degree	71%	68%	67%	64%
Education	1%	2%	2%	2%
Jewish studies/Humanities	5%	5%	5%	5%
Social sciences	7%	7%	8%	8%
Medicine/Life sciences	3%	4%	4%	4%
Law	2%	3%	3%	3%
Economics/Business administration	4%	5%	5%	5%
Engineering/Exact sciences	5%	5%	6%	6%
Computer sciences	2%	2%	2%	2%

* The percents do not necessarily sum to 100% due to rounding.

Source: Ayal Kimhi and Arik Horovitz, Taub Center
Data: Central Bureau of Statistics

Figure 3

Distribution of academic majors by level of math



* Columns that are unlabeled have 1% or less.

** Students are included in the category “No degree.”

Source: Ayal Kimhi and Arik Horovitz, Taub Center

Data: Central Bureau of Statistics

Yet another variable that is linked to income from labor is occupation. Obviously there is a close connection between occupation and academic field of study, but occupation may be expected to have an additional impact (beyond that of study discipline) on labor market achievements, at least for those who do not hold academic degrees.[3] The sample population’s occupational distribution is presented in Table 6 (it should be noted that a significant percentage of employed subjects did not provide sufficient information to determine their occupation). Based on a comparison of the occupational distribution among employees and among employees who reported their working hours, it may be concluded that most employees who did not report their occupation also failed to report their work hours. This indicates that the employee sample that reported work hours is of a higher quality in terms of the information they provided.

[3] Leimieux (2014) found that half of the impact of education on wages is due to the fact that education helps people gain entry into more lucrative occupations, in accordance with their fields of study.

Table 6. **Distribution of sample population by aggregated occupation groups, 2008**
as percent of group total*

Occupation	Overall sample	Employed	Salaried employees	Salaried employees reporting on work hours
Doesn't work	15%	-	-	-
Occupation unknown	12%	14%	14%	3%
Unskilled workers	4%	4%	4%	5%
Skilled workers in agriculture	1%	1%	1%	1%
Agents/Sales and service workers	14%	16%	16%	17%
Clerical workers	13%	15%	16%	19%
Professional workers in manufacturing, construction and other	11%	12%	12%	13%
Associate professionals/technicians	15%	18%	17%	19%
Academic professionals	13%	16%	16%	18%
Managers	3%	4%	4%	4%

* The percents do not necessarily sum to 100% due to rounding.

Source: Ayal Kimhi and Arik Horovitz, Taub Center
Data: Central Bureau of Statistics

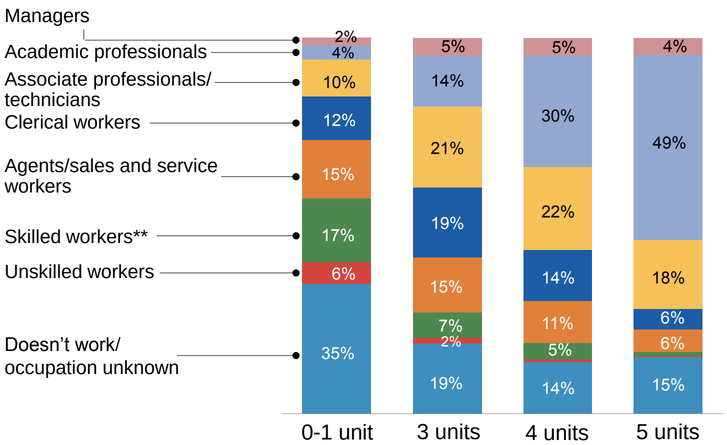
Figure 4 describes the occupational distribution by number of math units taken.[4] It can be seen that as the number of math units rises, subjects tend to be employed in more "prestigious" occupations. This is especially clear when it is considered that the percentage of those with academic occupations rose gradually from 4 percent among those who took less than 3 units of math to 49 percent among those who took 5 units. Since in

[4] Professional farmers, who were small in number, were added to the group of skilled workers in other industries. Those subjects whose occupations were unknown were added to the non-working group.

most cases an academic degree is required to work in an academic occupation, this figure actually reflects the relationship between number of math units and academic study status (Figure 3). Also, the percentage of associate professionals and technicians among those who took at least 3 units of math is double the number of those who studied math at lower levels, or who were not tested in math at all.

Figure 4

Distribution of occupations by level of math



* Columns that are unlabeled have 1% or less.

** Agriculture, manufacturing, construction and the like.

Source: Ayal Kimhi and Arik Horovitz, Taub Center

Data: Central Bureau of Statistics

By contrast, the percentage of skilled workers, who earn much less than associate professionals and technicians (Kimhi, 2012), is much lower among those who were tested at the 3-unit level or higher. It is interesting to note that the percentage of those in managerial positions does not differ significantly between 3 and 5 units.

The industry sector in which a worker is employed is also linked to income from labor. The sample population's economic industry sector distribution is shown in Table 7.

Table 7. **Distribution of the sample population by industry sector, 2008**

as percent of group total

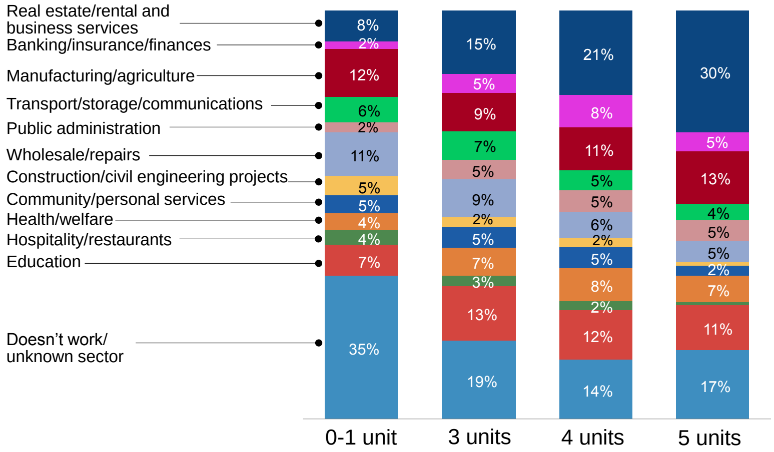
Industry sector	Overall sample	Employed	Salaried employees	Salaried employees reporting work hours
Doesn't work	15%	-	-	-
Sector unknown	11%	14%	14%	4%
Education	10%	12%	12%	14%
Hospitality/restaurants	3%	4%	3%	4%
Health/welfare services	5%	6%	6%	7%
Community/social/personal services	5%	6%	4%	5%
Construction (building and civil engineering projects)	3%	4%	4%	4%
Wholesale/repairs	10%	11%	11%	12%
Public administration	3%	4%	4%	5%
Transport/storage/ communications	6%	7%	7%	8%
Manufacturing/ agriculture	11%	13%	13%	15%
Banking/insurance/financial institutions	4%	4%	4%	5%
Real estate/rental and business services	14%	16%	15%	17%

Source: Ayal Kimhi and Arik Horovitz, Taub Center
Data: Central Bureau of Statistics

Figure 5 presents the industry sector distribution at each level of math study (i.e., the percentage of those tested at a given level who work in a given industry). Several sectors are clearly correlated with number of math units – the percentage of those employed in the food and hospitality industries, in construction, and in wholesale and retail trade and repairs declines as the number of math units rises. The percentage of those employed in community services and the like is lower among those who took 5 units of math. By contrast, the percentage of those employed in real estate and business services rises significantly as the number of math units rises. [5]

Figure 5

Distribution of industry sectors by level of math



* Columns that are unlabeled have 1% or less.

Source: Ayal Kimhi and Arik Horovitz, Taub Center

Data: Central Bureau of Statistics

In addition to looking at education and employment variables, the present study examines several socio-demographic characteristics that are likely to affect the relationship between math study and labor market achievements. The first of these is gender. Men and women show different preferences in the areas of intensive study in high school (Ayalon and Yogev, 1997) and areas of academic study; their labor market behavior also differs in terms of employment rates and occupational distribution (Kimhi, 2012). The present study's data point to a male employment rate of 90 percent, compared with 80 percent for women. The average monthly income from labor for employed men is 26 percent higher than that for the average for women, while the average

5 Business services include computing services and research and development, where most of those working in the field have pursued higher education in computer science or in the exact sciences.

man's monthly income from paid employment is 23 percent higher than that of the average woman. By contrast, men's and women's mean hourly wage does not differ by much, which suggests that the main cause of the gender disparity in monthly income is the number of monthly work hours. In any case, math study level choice patterns are clearly gender linked. Among women, 44 percent take 3-4 units of math, versus 33 percent of men. By contrast, 10 percent of men take 5 units, versus only 7 percent of women.

Another variable is sector. Of the sample population, 78 percent is Jewish, and Jews have a much greater tendency to study higher level math than do Arab Israelis or those from other sectors (Table 8). Christians and Druze exhibit a greater tendency to study advanced math than do Muslims and others, but they constitute a 15 percent minority of the non-Jews in the sample.

Table 8. **Distribution of math study unit levels by religion**

Religion	**Units of math study**			
	0-1	3	4	5
Jews	46%	28%	16%	10%
Muslims	72%	18%	6%	4%
Christians	58%	22%	11%	9%
Druze	55%	26%	12%	7%
Other	83%	7%	7%	3%

Source: Ayal Kimhi and Arik Horovitz, Taub Center
Data: Central Bureau of Statistics

Other variables that may be linked to labor market performance are homeownership (52 percent of the sample), family status (65 percent of the subjects are married and 32 percent have children), new immigrant status (18 percent of the sample), parents' country of birth, and area of residence.

2. *Descriptive Analysis*

In this section, the relationship between level of math study and labor market achievements will be examined, focusing on the other variables addressed previously – academic status and majors, industry sector and occupation. The analysis is descriptive in the sense that each variable will be analyzed separately without controlling for the other variables (results of a multivariate analysis will be presented in the following section).

Table 9 shows the positive correlation between labor market achievements and number of math units taken. Only 75 percent of the subjects who took no bagrut exams are employed, while the employment rate of those who took bagrut exams but were not tested in math is 86 percent. Those who took at least 3 units of math have an employment rate of over 90 percent. Income from labor also increases along with units of math study. Both the monthly income and the hourly wage of those who took 5 units of math are double those of the subjects who were not tested in math. The disparity between those who took 5 units and those who took 4 units are wider than the gap between subjects who took 4 units and those who took 3 units.

Table 9. **Labor market achievements by number of math study units, 2008**

Math study level	Employment rate	Monthly income from labor (NIS)	Monthly income from salaried employment (NIS)	Hourly wage from salaried employment (NIS)
No bagrut	75%	5,579	5,488	33
0-1	86%	5,989	5,839	34
3	91%	6,767	6,693	40
4	94%	8,438	8, 225	48
5	94%	11,896	11,604	64

Source: Ayal Kimhi and Arik Horovitz, Taub Center
Data: Central Bureau of Statistics

From the data in Table 10 it can be seen whether the relationship between labor market achievement and level of math study persists when bagrut exam scores are controlled for.[6] About employment rates not much can be said: the rate is at least 90 percent for all those who were tested in math, and the differences between the groups are quite small. Regarding income, it rises along with math study level even when the score range remains identical; this is particularly noticeable when looking at those who took 4 and 5 units of math, within the same score range. In addition, in most cases, income rose along with exam scores, and this was especially true as scores moved from the 80-90 range to the 90-100 range for study subjects who took 5 units of math. The conclusion is that income is positively correlated both with math study levels and with matriculation exam scores.[7]

6 Those who were tested in math at the 1-unit level were not included in the table, as they are a very small group.

7 French et al. (forthcoming) demonstrated the relationship between high school grades and future income.

Table 10. **Labor market achievements by math study units and bagrut exam score, 2008**

Score	Bagrut math units		
	3	4	5
Employment rate			
60 or lower	91%	90%	92%
61-70	90%	95%	96%
71-80	90%	94%	93%
81-90	93%	95%	95%
91-100	94%	96%	95%
Monthly income from labor (NIS)			
60 or lower	6,427	7,596	9,041
61-70	6,394	7,766	10,038
71-80	7,002	7,877	11,281
81-90	6,820	8,726	11,001
91-100	7,192	9,528	14,979
Monthly income from salaried employment (NIS)			
60 or lower	6,407	7,115	9,326
61-70	6,244	7,333	9,527
71-80	6,873	7,821	11,534
81-90	6,772	8,501	10,759
91-100	7,169	9,421	14,252
Hourly wage from salaried employment (NIS)			
60 or lower	39	40	54
61-70	37	46	51
71-80	42	44	63
81-90	41	51	62
91-100	44	56	78

Source: Ayal Kimhi and Arik Horovitz, Taub Center
Data: Central Bureau of Statistics

Another question is whether the relationship between labor market achievement and math study level persists even when academic study status is controlled for (Table 11). Among the study subjects who did not go on to academic education, the employment rate is higher for those who took 3 units or more of math than for those who took less than 3 units. This group's employment rate also increases as the level of math study rises from 3 to 4 units and from 4 to 5 units; the differences, however, are not substantial. Among students currently enrolled in academic programs, the employment rate is also much lower for those who took less than 3 units of math, but in this instance the employment rate for those who took 5 units is also lower than for those who took 3 or 4 units. A possible reason for this is that intensive academic study is hard to combine with employment; one should remember, however, that this is a particularly small population group and so conclusions should not be drawn from this finding. Among academic degree holders, no significant relationship was found between employment rates and math study level; in any case the rates were 94-97 percent for all groups.

Regarding income, in nearly all cases a rise in income as math study level increased was seen. The exception is university degree holders who took less than 3 units of math: they earn more than university graduates who took 3 units.[8] Interestingly, there are no significant income gaps between university and college graduates, and such gaps as do exist are generally in favor of college graduates. Only those who took fewer than 3 units of math display substantial income disparities favoring university graduates.

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8 This group amounts to 6 percent of employed university degree holders and appears to include some unusual cases. University admission without math study is possible via the pre-academic mechinot (university preparatory program).

Table 11. **Labor market achievement by math study units and academic study status, 2008**

Academic study status	Math bagrut units			
	0-1	3	4	5
Employment rate				
No academic studies	79%	88%	91%	92%
Student	57%	89%	89%	73%
College degree	94%	96%	97%	96%
University degree	96%	97%	95%	96%
Monthly income from labor (NIS)				
No academic studies	5,574	6,482	7,941	10,077
Student	5,531	6,659	7,909	9,553
College degree	6,750	7,229	8,704	12,281
University degree	7,563	6,975	8,646	12,185
Monthly income from salaried employment (NIS)				
No academic studies	5,437	6,454	7,697	9,920
Student	5,541	6,670	7,087	8,499
College degree	6,834	7,054	8,687	11,619
University degree	7,607	6,834	8,407	11,989
Hourly wage from salaried employment (NIS)				
No academic studies	33	38	42	51
Student	41	42	43	61
College degree	40	43	51	62
University degree	47	42	51	67

Source: Ayal Kimhi and Arik Horovitz, Taub Center
Data: Central Bureau of Statistics

Table 12 shows whether the link between labor market achievement and level of math study persists even when academic study status is controlled for.[9] First, a ranking of study disciplines by income is evident: education and the humanities at the bottom, followed by the social sciences, medicine and the life sciences, with law, economics/business administration, engineering/exact sciences and computer science at the top.[10] Second, it was found that subjects without academic degrees earn more than do academic degree holders in certain occupations, especially when they have studied math at higher levels. For example, the monthly income from labor of those without a degree was higher than that of graduates in Jewish studies and humanities, among those who took less than 3 units of math, as was the income of those without a degree vis-à-vis graduates in education, medicine and the life sciences among those who took 3 units of math.[11] Additionally, the income of those without a degree was higher than that of social science graduates among those who took more than 3 units of math.

In most study disciplines, the positive correlation between income and math study persisted. Interestingly, this correlation is especially strong at both ends of the study discipline distribution: those without a degree on the one hand and, on the other, graduates in economics/business administration, engineering, the exact sciences and computer science.

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9 Employment rates were not included in this table, as the vast majority of academic degree holders are employed.

10 Hastings, Neilson and Zimmerman (2013) found that choice of academic study discipline significantly affects labor market achievement.

11 It should be remembered that, in the context of the present study, medical school graduates are at an earlier career stage due to their lengthy course of study; some are likely still at the training stage, when wages are relatively low.

Table 12. **Income from labor by mat study units and academic study status, 2008**

	Bagrut math study units			
Area of academic study	0-1	3	4	5
Monthly income from labor (NIS)				
No academic study	5,570	6,525	7,903	9,935
Education	5,801	5,827	6,907	6,913
Jewish studies/Humanities	5,198	5,794	6,896	6,405
Social sciences	6,095	7,002	6,967	8,612
Medicine/Life sciences	6,782	5,988	6,943	7,600
Law	6,867	7,336	9,355	11,252
Economics/Business administration	9,026	9,008	9,816	13,252
Engineering/Exact sciences	9,629	9,295	10,894	13,981
Computer science	12,195	13,949	16,014	18,817
Monthly income from salaried employment (NIS)				
No academic study	5,446	6,508	7,544	9,496
Education	5,907	5,951	5,794	6,451
Jewish studies/Humanities	5,235	5,745	6,677	6,201
Social sciences	5,956	6,869	6,962	8,831
Medicine/Life sciences	6,827	5,830	6,756	7,397
Law	6,968	7,333	9,157	9,804
Economics/Business administration	9,059	8,481	9,790	12,953
Engineering/Exact sciences	9,629	8,754	10,240	13,755
Computer science	12,195	13,628	16,014	18,129
Hourly wage (NIS)				
No academic study	33	39	43	53
Education	45	42	42	47
Jewish studies/Humanities	34	41	48	40
Social sciences	36	40	44	51
Medicine/Life sciences	49	42	50	52
Law	37	40	48	49
Economics/Business administration	49	46	52	67
Engineering/Exact sciences	55	46	58	75
Computer science	69	72	81	92

Source: Ayal Kimhi and Arik Horovitz, Taub Center
Data: Central Bureau of Statistics

Table 13 looks at whether the relationship between labor market achievement and math study also persists when controlling for occupation. Nearly all occupations show a positive correlation between level of study and income; the correlation is particularly strong for occupations characterized by relatively high incomes.

Table 13. **Income from labor by math study units and occupation, 2008**

	Bagrut math study units			
Occupation	0-1	3	4	5
Monthly income from labor (NIS)				
Unknown	4,720	5,628	7,822	8,888
Unskilled workers	4,539	4,574	4,785	6,728
Agents/Sales and service workers	5,257	6,241	6,987	7,821
Clerical workers	5,412	6,251	7,125	7,724
Skilled workers	6,077	7,276	7,244	10,361
Associate professionals/ technicians	6,211	6,653	7,801	11,966
Academic professionals	8,028	8,007	9,804	13,099
Managers	9,138	9,698	12,157	15,558
Monthly income from salaried employment (NIS)				
Unknown	4,580	5,584	7,141	8,178
Unskilled workers	4,541	4,421	4,637	5,585
Agents/Sales and service workers	5,103	6,203	7,063	7,003
Clerical workers	5,361	6,280	7,116	7,724
Skilled workers	6,036	7,153	7,371	10,418
Associate professionals/ technicians	6,214	6,560	7,837	11,934
Academic professionals	7,939	7,973	9,324	12,873
Managers	8,601	9,502	11,687	14,892
Hourly wage from employment (NIS)				
Unknown	35	43	48	55
Unskilled workers	29	33	31	34
Agents/Sales and service workers	30	36	42	41
Clerical workers	32	36	40	43
Skilled workers	31	36	38	59
Associate professionals/ technicians	41	44	49	68
Academic professionals	53	45	54	69
Managers	44	50	56	74

Source: Ayal Kimhi and Arik Horovitz, Taub Center
Data: Central Bureau of Statistics

Similarly, Table 14 shows that the positive correlation between income and level of math study persists in industry sector. In this instance as well, the income gaps favoring those who took 5 units of math are particularly striking in the industry sectors characterized by higher wages.[12]

Table 14. **Income from labor by math study units and industry sector, 2008** (continued on next page)

Industry sector	0-1	3	4	5
Monthly income from labor (NIS)				
Sector unknown	4,784	5,572	8,115	10,410
Education	4,417	5,122	5,630	5,331
Hospitality/restaurants	5,405	5,672	5,672	5,145
Health/welfare	5,222	6,013	6,195	7,216
Community/social/personal services	5,383	5,552	6,452	10,233
Construction (building and civil engineering projects)	5,839	7,246	9,849	10,244
Wholesale/repairs	5,825	7,331	9,052	9,475
Public administration	6,559	6,886	8,687	9,978
Transport/storage/ communications	6,432	7,475	8,587	10,903
Manufacturing/ agriculture	6,143	8,068	10,439	14,628
Banking/insurance/financial institutions	7,247	8,226	9,926	14,439
Real estate/rental and business services	6,667	7,909	9,814	15,378

[12] There are several exceptions, such as the community and personal services sector in which the income gap between the 5-unit population and the 4-unit population is the largest – and the construction sector, in which there is a large wage jump as one moves from 3 to 4 units of math. However, very few workers in these industries pursued higher level math study, meaning that little importance should be attached to these instances.

Table 14. **Income from labor by math study units and industry sector, 2008** (continued from previous page)

Industry sector	0-1	3	4	5
Monthly income from salaried employment (NIS)				
Sector unknown	4,649	5,562	7,338	10,159
Education	4,404	5,181	5,392	5,359
Hospitality/restaurants	5,059	5,679	5,817	5,145
Health/welfare	5,186	5,764	6,293	6,906
Community/social/personal services	5,268	5,705	6,453	10,821
Construction (building and civil engineering projects)	5,672	7,287	10,043	10,244
Wholesale/repairs	5,656	7,155	8,346	9,097
Public administration	6,384	6,878	7,859	9,573
Transport/storage/ communications	6,498	7,322	8,601	10,903
Manufacturing/ agriculture	6,014	7,888	10,002	14,475
Banking/insurance/financial institutions	7,029	8,040	9,967	12,835
Real estate/rental and business services	6,702	7,763	9,746	15,029
Hourly wage for employment (NIS)				
Sector unknown	34	39	52	72
Education	36	42	52	51
Hospitality/restaurants	27	33	34	38
Health/welfare	36	39	45	41
Community/social/personal services	36	41	41	60
Construction (building and civil engineering projects)	30	37	53	55
Wholesale/repairs	32	40	43	51
Public administration	37	38	41	52
Transport/storage/ communications	35	38	46	57
Manufacturing/ agriculture	33	42	51	73
Banking/insurance/financial institutions	40	43	53	68
Real estate/rental and business services	37	42	50	75

Source: Ayal Kimhi and Arik Horovitz, Taub Center
Data: Central Bureau of Statistics

To conclude, it was found that the higher the level of math study, the greater the achievements (employment and income) in the labor market. Nevertheless, as will be demonstrated in the following section, this effect is partly direct (higher attainments for advanced math graduates even when controlling for field of academic study, occupation and industry), and partly indirect (math study leads to academic study in selective disciplines and to employment in occupations and sectors that offer high wages).

3. Multivariate Analysis

In addition to the descriptive analysis provided in the previous section, a multivariate analysis using linear multiple regression was performed. This was for the purpose of distinguishing between the direct correlation between the level of math studied in high school and labor market achievements and the indirect correlation – that mediated by bagrut exam score, academic education, occupation, and industry sector. Each of the achievement variables (employment, monthly income from labor, monthly income from paid employment, and hourly wage) served, in its turn, as a dependent variable in the regression. Level of math study served as a primary explanatory variable, with the gradual addition of other variables, to determine the degree to which the addition of each variable group, with its potential indirect effects, alters the direct effect of math study level on labor market achievement.

Employment

The regression results that shed light on the effects of the different variables on employment appear in Table 15.[13] The higher the coefficient used, the stronger the link between the explanatory variable and the labor market attainment at issue (e.g., employment rate or monthly wage). The regression whose outcomes are reported in Column (1) includes only three explanatory variables likely to have an effect on employment (math

[13] Since the employment variable is binary (employed/not-employed), it is commonly estimated via logit or probit models based on the maximum visibility method. However, these models entail firm assumptions regarding the distribution of the variables, and studies have shown that use of the least squares method may be preferable, especially when the number of observations is relatively large. See Wooldridge (2009), pp. 246-251.

study level of 3, 4 or 5 units). The meaning of the coefficients presented in the column is that the probability that subjects who took 3 units of math will be employed is 14 percentage points higher than for those who were not tested in math, or who were tested at the 1-unit level. The likelihood of employment for subjects who took 4 units is 2.3 percentage points higher than that of those who took 3 units, while the probability for those who took 5 units is 0.4 percentage points higher than that of subjects who took 4 units. The results indicate that, like the findings presented in Table 9, most of the employment variance is between those who took math matriculation exams and those who did not, while the differences by level of math study are relatively small. The regression correlation coefficient (R^2), which represents the strength of the relationship between all of the variables and the employment rate (appears at the bottom of the column), indicates that math study level explains less than 5 percent of the employment variance.

Column (2) presents the regression results, which include, in addition to math study level, the effect of math bagrut score on employment.[14] It can be seen that the score coefficient is positive, that is, there is a positive relationship between employment and bagrut score. At the same time, math study level coefficients lost half of their value after the bagrut score was added to the regression. The conclusion is that the positive relationship between employment and math study level is largely indirect and mediated by math bagrut score – i.e., the effect of math study level is rooted, to a great degree, in the fact that test scores rise, on average, as the number of units studied rises (Figure 1). However, the correlation coefficient shows almost no increase relative to the previous regression, leading to the conclusion that the score itself has no independent effect on employment beyond the effect of math study level.

Column (3) presents the regression results that include academic study status in addition to math study level and math bagrut exam score. The probability of students being employed is nearly 12 percentage points lower than that of subjects without a degree who are not students. The probability that those with college and university degrees will be

[14] Scores are reported by category (see Table 3), but in the regression they are included as numerical values determined as follows: 0 for those who have no math score; 27 for those with scores of up to 54; 58 for those with scores between 55 and 60; 65 for those whose scores fall between 61 and 70; 75 for those with scores between 71 and 80; 85 for those who received scores of 81-90; and 95 for those with scores above 91.

employed is 8 percentage points higher and 7 percentage points higher, respectively, than the likelihood that subjects without a degree who are not students will be employed. These findings are similar to those seen in Table 11.

To the regression reported in Column (4) were added variables pertaining to academic major. This analysis found that academic major does not affect the probability of being employed. Compared with the regression reported in Column (3), the coefficients of math study level and bagrut score did not change, the academic degree coefficients changed to an insignificant degree, and the correlation coefficient of the regression did not change at all. The conclusion reached is that, beyond the effect of the status that academic degrees confer, study discipline had no impact on employment probability.

One problem with determining the degree to which math study levels alone affect employment is the possible existence of latent variables that could be affecting both the explanatory variables (math study levels) and the dependent variable (employment). Factors of this kind include IQ, learning skills and non-cognitive abilities such as social skills, emotional intelligence, and the like. These factors may positively affect income, meaning that pupils with these traits may be more motivated to study higher level math, so as to increase their future compensation from work. In this case the impact of math study level on employment may represent, to some degree, the effect of such unobserved factors.

The solution to this problem lies in the use of instrumental variables, which affect explanatory variables (number of math units) but do not directly affect the dependent variable (employment). It is hard to come up with appropriate instrumental variables in this instance, but an alternate means that was taken to reduce the effects of the problem was that of controlling for bagrut exam scores in other subjects. This method is based on the assumption that the same instrumental variables also affect outcomes on other matriculation exams, and that controlling for all scores may neutralize some of the dependency of math study level on those factors. Moreover, there can be no doubt that the outcome variables (employment and income) are affected by other traits and skills besides math knowledge that may be reflected in bagrut scores in other disciplines.

The regression reported in Column (5) includes bagrut scores in other subjects, and as shown by the coefficients, some of the scores significantly affect employment probability (see Appendix Table 1). Even more important is the fact that controlling for other scores substantially changed the degree of correlation between math study level and likelihood of being employed. In particular, the gap between the employment probability of those who were tested at the 3-unit level and those who were tested at lower levels, or not tested at all, was reduced by half compared with a regression that did not include the scores on all of the bagrut exams (Column 4), while the gap between those tested at the 3-unit level in math and those tested at higher levels was eliminated entirely. The impact of math bagrut score on employment probability also lost its statistical significance. By contrast, the employment probability gap favoring academic degree holders remained substantial, though smaller than in Column (4).

The final regression reported in Column (6) includes, in addition to all of the previous explanatory variables, an array of traits relating to the subjects and their households – variables of gender, religion, family status, children, homeownership, parent’s countries of origin, immigration status, and area of residence. When controlling for these variables, whose coefficients appear in Appendix Table 2, the correlation coefficient of the regression increases from 8 percent to nearly 20 percent – that is, these socioeconomic characteristics explain nearly 12 percent of employment status differences. Moreover, in this regression, math unit variables are no longer significant, leading to the conclusion that, when the impact of other variables is negated, level of math study has no direct impact on employment probability, but only an indirect effect through academic study.

Table 15. **Direct and indirect effects of math studies on employment rate,** estimated regression coefficient of employment*

Explanatory variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Number of units						
3 units of math	0.1430***	0.0694***	0.0671***	0.0678***	0.0326**	0.0166
(standard deviation)	(0.0072)	(0.0140)	(0.0139)	(0.0139)	(0.0146)	(0.0137)
4 units of math	0.1660***	0.0867***	0.0629***	0.0629***	0.0143	-0.0083
(standard deviation)	(0.0091)	(0.0158)	(0.0160)	(0.0160)	(0.0173)	(0.0163)
5 units of math	0.1700***	0.0871***	0.0492***	0.0469**	-0.0244	-0.0343*
(standard deviation)	(0.0111)	(0.0174)	(0.0179)	(0.0183)	(0.0216)	(0.0203)
Bagrut math score						
		0.0011***	0.0008***	0.0008***	0.0002	0.0003*
(standard deviation)		(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Academic status						
Student			-0.1170***	-0.1170***	-0.1280***	-0.1970***
(standard deviation)			(0.0100)	(0.0100)	(0.0100)	(0.0096)
College degree			0.0802***	0.0704***	0.0594***	0.0594***
(standard deviation)			(0.0104)	(0.0162)	(0.0163)	(0.0153)
University degree			0.0676***	0.0635***	0.0444***	0.0406***
(standard deviation)			(0.0103)	(0.0159)	(0.0161)	(0.0152)
				Additional variables controlled for		
				Study major	**Study major Other scores**	**Study major Other scores Socioeconomic characteristics**
R^2 (correlation coefficient)	0.046	0.049	0.067	0.067	0.079	0.197

* The number of asterisks represents the level of statistical significance; the lower the level, the greater the confidence that there is in the correlation between the dependent and explanatory variables. One asterisk significance a statistical significance level of 10%; two asterisks is 5%; three asterisks represents statistical significance at the 1% level.

Source: Ayal Kimhi and Arik Horovitz, Taub Center

Income from Labor

Regression results demonstrating the relationship between explanatory variables and income from labor appear in Table 16.[15] The meaning of the coefficients in the regression whose results are reported in Column (1), which includes only the number of math study units, is that income from labor of subjects who took 3 units of math is 17 percent higher than that of those who were not tested, or who were tested at the 1-unit level. The income from labor of subjects tested at the 4-unit level is 19 percent higher than that of subjects who took 3 units, while the gap between those who took 5 units and those who took 4 units is 26 percent.

As may be seen from Column (2), when math bagrut score is added as an explanatory variable, the income gap favoring those who took 3 units over those who took fewer units of math (or none at all) can be attributed mainly to their bagrut score (although this is of no importance, as scores are reported only for those who were tested in math), while the gaps favoring those who were tested at the 4- and 5-unit levels remained unchanged. As may be seen from Column (3), the addition of academic study status reduces these gaps by an insignificant degree of 2-3 percent. Students' income from labor is nearly 5 percent lower than that of those without an academic degree who are not students, while the income of those with college and university degrees is higher by 12 percent and 10 percent, respectively, than that of those without a degree who are not students.

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[15] In this regression only subjects who were employed and who reported their income were included. The dependent variable in the regression was logarithmically transformed, such that the regression coefficients express differences in income from labor in percentages. The dependent variables in the other income regressions also underwent this transformation.

Table 16. **Direct and indirect effects of math study on income from labor,** estimated regression coefficient of employment*

Explanatory variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Number of units							
3 units of math	0.1660***	0.0243	0.0162	0.0508**	0.0311	0.0304	0.0188
(standard deviation)	(0.0134)	(0.0252)	(0.0253)	(0.0246)	(0.0232)	(0.0245)	(0.0239)
4 units of math	0.3520***	0.1980***	0.1620***	0.1550***	0.1050***	0.0961***	0.0708**
(standard deviation)	(0.0166)	(0.0285)	(0.0290)	(0.0283)	(0.0267)	(0.0290)	(0.0284)
5 units of math	0.6140***	0.4550***	0.4020***	0.2850***	0.2210***	0.1730***	0.1420***
(standard deviation)	(0.0200)	(0.0313)	(0.0324)	(0.0320)	(0.0302)	(0.0361)	(0.0352)
Math bagrut score							
		0.0021***	0.0017***	0.0015***	0.0012***	0.0010***	0.0009***
(standard deviation)		(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
Academic status							
Student			-0.0482**	-0.0442**	-0.0371**	-0.0423**	-0.0677***
(standard deviation)			(0.0204)	(0.0199)	(0.0188)	(0.0189)	(0.0186)
College degree			0.1170***				
(standard deviation)			(0.0187)				
University degree			0.1000***				
(standard deviation)			(0.0186)				
				Additional variables controlled for			
				Study major	**Study major**	**Study major**	**Study major**
					Industry/ occupation	**Industry/ occupation**	**Industry/ occupation**
						Bagrut scores	**Bagrut scores**
							Socioeconomic characteristics
R^2 (correlation coefficient)	0.091	0.094	0.096	0.145	0.247	0.251	0.290

* The number of asterisks represents the level of statistical significance; the lower the level, the greater the confidence that there is in the correlation between the dependent and explanatory variables. One asterisk significance a statistical significance level of 10%; two asterisks is 5%; three asterisks represents statistical significance at the 1% level.

Source: Ayal Kimhi and Arik Horovitz, Taub Center

Added to the regression reported in Column (4) is academic major. Controlling for this makes it unnecessary to control for academic study status; academic degree variables were therefore omitted from this regression (and from those that follow).[16] When a comparison is made with the regression reported in Column (3), which includes only academic status, the gap in income from labor explained by the move from 3 to 4 units of math declines to 10 percent, while the gap explained by the additional fifth unit of math declines to 13 percent. What this means is that some of the higher level math study contribution to income from labor is mediated by academic study discipline which, as noted in Section 1, is linked to the number of math units taken by the subjects. The fact that the regression's correlation coefficient rose from 10 percent when it included academic status (Column 3) to nearly 15 percent when academic major was taken into account (Column 4) testifies to the fact that academic major also has an autonomous effect on income from labor – a finding that, of course, should not be a surprise.

The relationship between academic study major and income from labor can be seen in Table 17. The income ranking by study discipline is similar to that found in the descriptive statistics (Table 12). According to the regression reported in Column (4), computer science degree holders earn 77 percent more than do those without a degree, 90 percent more than those with degrees in Jewish studies or the humanities, and 40 percent more than those just below them in the ranking – graduates in engineering and the exact sciences.

The regression reported in Column (5) of Tables 16 and 17 also included occupation and the industry sector of employment.[17] Compared with the regression that includes only academic major (Column 4), the correlation coefficient between the variables and income from labor increased from 15 to 25 percent, which indicates the importance of these variables in explaining the income distribution. The income gap between those who were tested at the 3-unit level and those who were tested at lower levels (or not at all) once again became statistically insignificant, though the gaps between the various levels of math study (4 units versus

[16] When the regression included the variables related to academic status, the coefficients of these variables were not statistically significant.

[17] The detailed coefficients of the occupation and industry variables are found in Appendix Table 3. The group that is omitted in the case of occupation (or industry sector) is that of workers who did not report their occupation (or the industry sector in which they are employed).

3 and 5 units versus 4) remained significant (7 and 12 percent, respectively). When controlling for occupation and industry sector, the income gaps by academic concentration narrowed slightly (Table 17). For example, the wage gap between law graduates and those without a degree was eliminated altogether, while the economics/business administration wage gap dropped to half of what it was when occupation and employment sector were not controlled for.

The regression reported in Column (6) of Tables 16-17, in addition to controlling for all of the previous variables, also controls for bagrut scores in other disciplines. In contrast to the employment regressions, controlling for bagrut scores only slightly weakens the relationship between income and math study level. This relationship does not stem from unobserved traits such as innate ability, given that bagrut scores in other subjects controls for the effect on wages of unobserved attributes. Controlling for socioeconomic characteristics, as may be seen in Column (7), also weakens the correlation slightly, though it does not entirely eliminate it. The conclusion to be drawn is that math study level has a direct effect on monthly income from labor, beyond its indirect effect through academic major (as seen in Table 17).

Table 17. Effect of academic major on income from labor

estimated regression coefficient of income from labor*

Explanatory variable	(4)	(5)	(6)	(7)
Academic major				
Jewish studies/ Humanities	-0.1340***	-0.0815***	-0.0706***	-0.0527***
(standard deviation)	(0.0262)	(0.0253)	(0.0256)	(0.0251)
Education	-0.0928**	0.0497	0.0575	0.0867**
(standard deviation)	(0.0424)	(0.0409)	(0.0410)	(0.0401)
Medicine/Life sciences	-0.1040***	-0.0741**	-0.0725**	-0.0649**
(standard deviation)	(0.0318)	(0.0311)	(0.0319)	(0.0312)
Social sciences	0.0392*	0.0055	0.0067	0.0159
(standard deviation)	(0.0226)	(0.0217)	(0.0223)	(0.0219)
Law	0.2090***	-0.0040	0.0064	0.0010
(standard deviation)	(0.0353)	(0.0354)	(0.0359)	(0.0350)
Economics/Business administration	0.3710***	0.1900***	0.1860***	0.1570***
(standard deviation)	(0.0280)	(0.0278)	(0.0281)	(0.0275)
Engineering/Exact sciences	0.3660***	0.2310***	0.2060***	0.1770***
(standard deviation)	(0.0278)	(0.0276)	(0.0280)	(0.0274)
Computer science	0.7710***	0.5980***	0.5720***	0.5470***
(standard deviation)	(0.0438)	(0.0422)	(0.0425)	(0.0416)
		Industry/ Occupation	**Industry/ Occupation** **Bagrut scores**	**Industry/ Occupation** **Bagrut scores** **Socioeconomic characteristics**

* The number of asterisks represents the level of statistical significance; the lower the level, the greater the confidence that there is in the correlation between the dependent and explanatory variables. One asterisk significance a statistical significance level of 10%; two asterisks is 5%; three asterisks represents statistical significance at the 1% level.

Source: Ayal Kimhi and Arik Horovitz, Taub Center

Income from Paid Employment

The results of the paid employment income regressions, which indicate the aforementioned variables' degree of impact solely on income from paid employment, are reported in Tables 18-19. On the whole, the results are essentially no different from those reported previously with regard to total income from labor, and will therefore not be discussed at length.

Table 18. **Direct and indirect effects of math study on income from salaried employment,** estimated regression coefficient of income from salaried employment*

Explanatory variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Number of units							
3 units of math	0.1790***	0.0241	0.0144	0.0535**	0.0332	0.0314	0.0217
(standard deviation)	(0.0135)	(0.0256)	(0.0257)	(0.0250)	(0.0234)	(0.0234)	(0.0240)
4 units of math	0.3550***	0.1860***	0.1500***	0.1430***	0.0910***	0.0819***	0.0572**
(standard deviation)	(0.0168)	(0.0290)	(0.0294)	(0.0286)	(0.0268)	(0.0292)	(0.0285)
5 units of math	0.6140***	0.4390***	0.3920***	0.2740***	0.2080***	0.1670***	0.1380***
(standard deviation)	(0.0202)	(0.0317)	(0.0328)	(0.0320)	(0.0304)	(0.0361)	(0.0353)
Math bagrut score							
		0.0023***	0.0019***	0.0017***	0.0013***	0.0012***	0.0011***
(standard deviation)		(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
Academic status							
Student			-0.0483**	-0.0449**	-0.0391**	-0.0439***	-0.0700***
(standard deviation)			(0.0205)	(0.0199)	(0.0188)	(0.0188)	(0.0185)
College degree			0.1210***				
(standard deviation)			(0.0189)				
University degree			0.0866***				
(standard deviation)			(0.0187)				
Additional variables controlled for				**Study major**	**Study major** **Industry/ occupation**	**Study major** **Industry/ occupation** **Bagrut scores**	**Study major** **Industry/ occupation** **Bagrut scores** **Socioeconomic characteristics**
R^2 (correlation coefficient)	0.098	0.102	0.103	0.156	0.267	0.270	0.311

* The number of asterisks represents the level of statistical significance; the lower the level, the greater the confidence that there is in the correlation between the dependent and explanatory variables. One asterisk significance a statistical significance level of 10%; two asterisks is 5%; three asterisks represents statistical significance at the 1% level.

Source: Ayal Kimhi and Arik Horovitz, Taub Center

Table 19. Effect of academic major on income from salaried employment
estimated regression coefficient of income from salaried employment*

Explanatory variable	**(4)**	**(5)**	**(6)**	**(7)**
Academic major				
Jewish studies/ Humanities	-0.1390***	-0.0842***	-0.0767***	-0.0642**
(standard deviation)	(0.0266)	(0.0255)	(0.0259)	(0.0253)
Education	-0.0988**	0.0387	0.0427	0.0652
(standard deviation)	(0.0427)	(0.0409)	(0.0411)	(0.0400)
Medicine/Life sciences	-0.1190***	-0.0937***	-0.0961***	-0.0928***
(standard deviation)	(0.0316)	(0.0308)	(0.0315)	(0.0308)
Social sciences	0.0309	-0.0046	-0.0078	-0.0031
(standard deviation)	(0.0226)	(0.0216)	(0.0222)	(0.02179)
Law	0.1960***	-0.0172	-0.0102	-0.0199
(standard deviation)	(0.0360)	(0.0358)	(0.0362)	(0.0353)
Economics/Business administration	0.3620***	0.1800***	0.1730***	0.1420***
(standard deviation)	(0.0278)	(0.02748)	(0.0278)	(0.0271)
Engineering/Exact sciences	0.3502***	0.2140***	0.1920***	0.1590***
(standard deviation)	(0.0277)	(0.0273)	(0.0277)	(0.0271)
Computer science	0.7590***	0.5760***	0.5580***	0.5320***
(standard deviation)	(0.0435)	(0.0417)	(0.0420)	(0.0410)
		Industry/ Occupation	**Industry/ Occupation** **Bagrut scores**	**Industry/ Occupation** **Bagrut scores** **Socioeconomic characteristics**

* The number of asterisks represents the level of statistical significance; the lower the level, the greater the confidence that there is in the correlation between the dependent and explanatory variables. One asterisk significance a statistical significance level of 10%; two asterisks is 5%; three asterisks represents statistical significance at the 1% level.

Source: Ayal Kimhi and Arik Horovitz, Taub Center

Hourly wage of salaried employees

The results of the hourly wage regression indicate the effect of the variables reviewed on labor market success; these are reported in Tables 20-21. The data in Columns (1) to (5) do not differ substantially from those of monthly income from labor. However, the hourly wage gaps between the math study levels assessed are smaller than in the case of monthly income. When controlling for other bagrut scores, no statistically significant hourly wage disparity is found in favor of those who took 4 units of math, and the gap favoring those who took 5 units amounts to just 7 percent relative to those who took fewer than 3 units or none at all (Column 6). In Column (7) it can be seen that this result does not change substantially even when controlling for socioeconomic characteristics.

Table 20. **Direct and indirect effects of math study on hourly wage for salaried employees,** estimated regression coefficient of hourly wage for salaried employment*

Explanatory variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Number of units							
3 units of math	0.1920***	0.0223	-0.0006	0.0279	0.0116	0.0051	0.0099
(standard deviation)	(0.0127)	(0.0237)	(0.0237)	(0.0232)	(0.0226)	(0.0238)	(0.0237)
4 units of math	0.3620***	0.1780***	0.1150***	0.1110***	0.0695***	0.0396***	0.0375
(standard deviation)	(0.0153)	(0.0266)	(0.0269)	(0.0265)	(0.0258)	(0.0281)	(0.0280)
5 units of math	0.5960***	0.4060***	0.3190***	0.2290***	0.1670***	0.0768**	0.0702**
(standard deviation)	(0.0185)	(0.0290)	(0.0300)	(0.0299)	(0.0292)	(0.0348)	(0.0346)
Math bagrut score							
		0.0025***	0.0019***	0.0017***	0.0014***	0.0009***	0.0008***
(standard deviation)		(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
Academic status							
Student			0.1040**	0.1050**	0.0726**	0.0669***	0.0644***
(standard deviation)			(0.0196)	(0.0192)	(0.0188)	(0.0188)	(0.0189)
College degree			0.1580***				
(standard deviation)			(0.0172)				
University degree			0.1710***				
(standard deviation)			(0.0171)				
Additional variables controlled for				**Study major**	**Study major** **Industry/ occupation**	**Study major** **Industry/ occupation** **Bagrut scores**	**Study major** **Industry/ occupation** **Bagrut scores** **Socioeconomic characteristics**
R^2 (correlation coefficient)	0.130	0.137	0.150	0.183	0.267	0.238	0.254

* The number of asterisks represents the level of statistical significance; the lower the level, the greater the confidence that there is in the correlation between the dependent and explanatory variables. One asterisk significance a statistical significance level of 10%; two asterisks is 5%; three asterisks represents statistical significance at the 1% level.

Source: Ayal Kimhi and Arik Horovitz, Taub Center

Table 21. Effect of academic major on hourly wage for salaried employees
estimated regression coefficient of hourly wage for salaried employment*

Explanatory variable	(4)	(5)	(6)	(7)
Academic major				
Jewish studies/ Humanities	0.0456*	-0.0196	-0.0175	-0.0086
(standard deviation)	(0.0242)	(0.0242)	(0.0245)	(0.0244)
Education	0.1360***	0.0524	0.0488	0.0575
(standard deviation)	(0.0388)	(0.0387)	(0.0389)	(0.0386)
Medicine/Life sciences	0.1170***	0.0467	0.0373	0.0383
(standard deviation)	(0.0286)	(0.0290)	(0.0297)	(0.0296)
Social sciences	0.0750***	0.0208	0.0124	0.0166
(standard deviation)	(0.0206)	(0.0204)	(0.0210)	(0.0210)
Law	0.0725**	-0.0331***	-0.0907***	-0.1010***
(standard deviation)	(0.0326)	(0.0339)	(0.0343)	(0.0341)
Economics/Business administration	0.2740***	0.1420***	0.1330***	0.1230***
(standard deviation)	(0.0253)	(0.0260)	(0.0263)	(0.0262)
Engineering/Exact sciences	0.3660***	0.2190***	0.1940***	0.1900***
(standard deviation)	(0.0252)	(0.0259)	(0.0263)	(0.0262)
Computer science	0.7010***	0.5580***	0.5330***	0.5210***
(standard deviation)	(0.0389)	(0.0387)	(0.0390)	(0.0388)
		Industry/ Occupation	**Industry/ Occupation**	**Industry/ Occupation**
			Bagrut scores	**Bagrut scores**
				Socioeconomic characteristics

* The number of asterisks represents the level of statistical significance; the lower the level, the greater the confidence that there is in the correlation between the dependent and explanatory variables. One asterisk significance a statistical significance level of 10%; two asterisks is 5%; three asterisks represents statistical significance at the 1% level.

Source: Ayal Kimhi and Arik Horovitz, Taub Center

As noted, using hourly wage as a dependent variable reduces the sample size, given that a significant number of workers did not report their working hours. However, the problem can be overcome by using a selection correction – a method for estimating the potential hourly wage of the entire population, not just for the working population.[18]

The association between hourly wage and math study level/academic major, after the correction, for the population as a whole is presented in Table 22. The coefficients presented in the table can be compared with Column (7) in Tables 20-21, which shows the relationship between wage and math study level (Table 20) or academic major (Table 21) when controlling for employment sector, occupation, bagrut scores, and socioeconomic characteristics. The outcome remains unchanged, i.e., math study at the 4-unit level has no significant direct effect on wages even for the population as a whole, while the direct positive effect of 5-unit math study is slightly strengthened, reaching nearly 10 percent – that is, even when accounting for the impact of all of the study variables, 5 units of math have value in determining wages. The impact of academic major did not change substantially, though the significant effects of some study disciplines became slightly more moderate.

Table 22 also includes the results of a similar regression performed separately for men and for women, in which several meaningful

[18] This method is commonly used in estimating an income regression when the income is known only for individuals who are employed. Essentially, this is a simultaneous estimation for two equations – the employment equation and the income equation – while correcting the income equation by means of the employment equation, such that the estimated coefficients reflect the explanatory variables' effect on the entire population's income, not just on that of the employed sub-population. Using this method requires that the employment equation have explanatory variables that do not affect income. In the case of hourly wage, some of the socioeconomic variables fulfill this requirement, given that hourly wage reflects the employee's productivity, while variables such as homeownership, family status and number of children should not affect productivity. However, these variables may affect monthly income, since monthly income is affected both by hourly wage and by number of work hours, while number of work hours may be affected by family characteristics. For this reason selection correction cannot be applied in monthly income equations.

differences were found. In particular, the positive effect of 5 units of math study was found to be significant solely for women, with a marginally significant effect for 4 units of math study as well. The positive impact of math bagrut score was also found to be significant only for women.

The effects of academic major on men's and women's wages are completely different. Men with academic degrees in Jewish studies, the social sciences and law earn less than do employed persons without academic degrees, while degrees in education, medicine/life sciences, economics and business administration have no impact on wage. For women, by contrast, a degree in Jewish studies, the humanities, medicine/life sciences, economics or business administration raises wages relative to employed persons without a degree. A degree in engineering, the exact sciences or computer science significantly increases wage levels for both men and women, but the impact for women is greater.[19]

Coefficients for the occupation and industry sector variables do not differ markedly between men and women (Appendix Table 4A). Although the differences between occupation and industry sector among men are statistically more significant than for women, the main reason for this is that these coefficients are estimated less accurately for women, that is, the standard deviations in the women's sample are larger.

In conclusion, it is worthwhile to distinguish between men and women when assessing the direct and indirect effects of math study level on labor market outcomes. Such a distinction is made in the following section when scenarios aimed at quantifying these effects are assessed.

[19] This result is surprising given the findings of Altonji, Blom, and Meghir (2012) who maintain that the premium on prestigious study disciplines is actually greater for men.

Table 22. **The effect of math study and academic major on wages, by gender**
regression coefficient of potential hourly wage of the overall population, controlling for occupation, other bagrut scores and socioeconomic characteristics*

Explanatory variable	Population	Men	Women
Math study units			
3 math units	-0.0069	0.0059	0.0172
(standard deviation)	(0.0243)	(0.0348)	(0.0335)
4 math units	0.0361	0.0339	0.0698*
(standard deviation)	(0.0285)	(0.0443)	(0.0392)
5 math units	0.0956***	0.0715	0.1253***
(standard deviation)	(0.0351)	(0.0545)	(0.0482)
Math bagrut score	0.0009***	0.0004	0.0018***
(standard deviation)	(0.0003)	(0.0005)	(0.0004)
Academic major			
Students	0.0994***	0.1112***	0.1013***
(standard deviation)	(0.0290)	(0.0298)	(0.0287)
Jewish studies/Humanities	-0.0348	-0.0913*	0.0606**
(standard deviation)	(0.0251)	(0.0472)	(0.0302)
Education	0.00320	0.0363	0.0765*
(standard deviation)	(0.0406)	(0.0991)	(0.0452)
Medicine/Life sciences	0.0143	0.0105	0.0969***
(standard deviation)	(0.0303)	(0.0587)	(0.0365)
Social sciences	-0.0102	-0.0902**	0.1179***
(standard deviation)	(0.0222)	(0.0415)	(0.0264)
Law	-0.0888***	-0.1896***	0.0435
(standard deviation)	(0.0340)	(0.0518)	(0.0470)
Economics/Business administration	0.0858***	-0.0055	0.2906***
(standard deviation)	(0.0273)	(0.0408)	(0.0371)
Engineering/Exact sciences	0.1731***	0.1221***	0.3563***
(standard deviation)	(0.0278)	(0.0378)	(0.0431)
Computer science	0.4889***	0.4960***	0.5917***
(standard deviation)	(0.0400)	(0.0555)	(0.0605)

* The number of asterisks represents the level of statistical significance; the lower the level, the greater the confidence that there is in the correlation between the dependent and explanatory variables. One asterisk significance a statistical significance level of 10%; two asterisks is 5%; three asterisks represents statistical significance at the 1% level.

Source: Ayal Kimhi and Arik Horovitz, Taub Center

4. Measuring the Effect of Math Study on Wages by Means of Hypothetical Scenarios

The multivariate analysis found that the overall effect of math study level on employment and income is substantial; however, the more mediating variables that are controlled for, the smaller the direct effect becomes. This section attempts to quantify the direct and indirect effects by looking at a few alternate scenarios. In this analysis the effects on hourly wage will be assessed by using the results of the selection corrected regression, since this is the methodologically preferred regression as explained previously. There is also a focus on the indirect effects of math study level stemming from choice of academic major. (Additional indirect effects mediated by occupation and industry sector can also be assessed, but that is a more complex undertaking that goes beyond the work of the present study.)

The first scenario to be assessed is one in which all of the pupils who took 4 units of math are moved up to 5 units. First, consider how the hypothetical upgrading in math study would affect the choice of academic study discipline. For this purpose academic major probabilities were estimated as a function of several explanatory variables – math study level among them – by the use of a multinomial logit model.[20] Table 23 presents the mean probabilities for selection of each academic discipline for the sample of those who took 4 units of math, and the mean probabilities recalculated after these same subjects were moved up from 4 to 5 units. The probabilities were calculated for all those who took 4 units and for men and women separately. A comparison with Figure 3 shows that the probabilities predicted using the model for the entire sample are very similar to the figures for the actual sample of 4-unit pupils.

[20] The detailed coefficients of math study level in this model are presented in Appendix Table 5.

Table 23. **Probability of choosing an academic major among those who studied 4 units of math**
before and after simulation to raise their math study to 5 units

Academic major	Population		Men		Women	
	Before level raise	After level raise	Before level raise	After level raise	Before level raise	After level raise
No academic study	33.4%	21.9%	43.4%	32.4%	25.5%	12.1%
Jewish studies/ Humanities	10.1%	9.1%	5.9%	7.4%	13.4%	9.3%
Education	2.6%	3.3%	0.5%	0.5%	4.2%	6.1%
Medicine	8.6%	11.8%	4.9%	7.3%	11.5%	15.7%
Social sciences	14.9%	8.5%	9.4%	3.9%	19.3%	12.6%
Law	6.2%	5.6%	5.6%	5.5%	6.6%	5.9%
Economics/Business Administration	11.5%	15.3%	13.1%	14.2%	10.2%	16.2%
Exact sciences	9.7%	17.8%	13.1%	22.4%	6.8%	14.0%
Computer science	3.0%	6.7%	4.1%	6.1%	2.2%	7.9%

Source: Ayal Kimhi and Arik Horovitz, Taub Center

First, among subjects who were tested in math at the 4-unit level, the percentage of women with academic degrees is significantly greater than the percentage of men. However, in academic majors leading to higher wages, such as economics, business administration, the exact sciences and computer science, men are the majority. Moreover, raising the math study level of whose who took 4 units significantly increases the likelihood of completing an academic degree, especially for women, and affects the choice of academic major. The most prominent changes are a decline in the tendency to study the social sciences and a rise in the likelihood to study medicine, economics/business administration, the exact sciences, and computer science.

The differences between men and women are particularly striking in a few specific disciplines. The prevalence of computer science study increased by half for men and over three-fold for women. The incidence of economics and business administration study increased only slightly for men, but significantly for women. The prevalence of education studies did not change for men but increased for women. The incidence of Jewish studies and humanities study rose for men and dropped for women.

To conclude, moving from 4 to 5 units of math fosters the study of academic disciplines associated with higher wages, and the effect on women is greater than on men. The move thereby reduces the gender disparities that characterize the distribution of academic majors.

In addition to the effect on choice of academic major, in this scenario the direct effect of the 4-5 unit increase on wages was calculated: the income of each individual who took 4 units of math changed in accordance with the size of the difference between the 5-unit regression coefficient and the 4-unit regression coefficient (Table 22).[21] The indirect effect of the move between the groups through academic major was calculated in several stages. Hourly wage was calculated first, with the variables for academic major replaced by the probabilities of choosing all of the disciplines that appear in the Before math study level move column in Table 23. In the second stage, the wage difference was calculated, with the probabilities replaced by data from the After math study level move column. The total wage variance in this scenario is the sum of the direct and indirect effects.

Results of these calculations show that raising the math study level from 4 to 5 units increases hourly wage for the pupils in question by 8 percent – 5 percent via direct effect and 3 percent indirectly through choice of academic major. The results differ slightly between men and women: the direct effect is 4 percent for men and 6 percent for women, and the indirect effect is 2 percent for men and 7 percent for women, which reflects the greater impact of math study level on choice of academic major for women. All told, the effect of moving from 4 to 5 units of math increases men's wages by 6 percent and women's by 13 percent on average.

The second scenario assessed is similar to the first, but the level of math study is increased from 4 to 5 units only for 4-unit pupils who earned scores of at least 80 on the bagrut exam. As may be seen in Figure 1, this group amounts to a little less than half of all pupils tested at the 4-unit level. When wage changes were assessed, results similar to those of the first scenario were obtained, that is, an overall wage change of 10 percent – 6 percent via the direct effect of math study level and 4 percent

[21] The difference is in units of wage percentages, given that the regression is logarithmic.

via the indirect effect of choice of academic discipline. Here as well, women's wage change (13 percent) is larger than that of men (7 percent), due to a greater effect of math study level on the choice of academic major for women.

In Scenario 3, the math study level is raised from 4 to 5 units for all 4-unit pupils, but the math bagrut exam scores are reduced by 20 points. The results show that the drop in score reduces the positive effect on income of the increase in math units, though without negating it altogether. The mean wage increase in this case is 7 percent, versus 8 percent when math study level is raised from 4 to 5 units with no change in exam scores. The direct impact (controlling for all variables except number of units) is 4 percent (versus 5 percent in the first scenario), and the indirect effect (through academic major) is just 2 percent (versus 3 percent in the scenario featuring only the increase in number of units taken). Here as well, the indirect effect on women's wages is greater than on men's (5 percent versus 2 percent). As a result, the total effect of increasing the math study level at the expense of exam score is greater for women than for men (7 percent versus 4 percent).

5. Summary and Conclusions

In this study, the importance of higher level math study with regard to labor market outcomes was examined. In particular, estimates of the direct and indirect effects of math study level on employment and income were made. The indirect effect relates to the fact that higher level math study facilitates admission to selective university programs, meaning that academic degrees earned by those who took 5 units of math in high school translate into prestigious occupations and industry sectors where wages are relatively high. The direct effect has to do with the fact that even when academic major, industry sector and occupation are controlled for, income gaps between those who studied math at different levels remain.

The findings attest to substantial employment rate disparities by math study level; these, however, are due to indirect effects, stemming from the fact that higher level math study aids in the attainment of an academic degree which, in and of itself, significantly increases the likelihood of employment.

Large income gaps by math study level were observed as well, mainly resulting from the indirect effect of math study level, especially via academic study. Academic degrees in computer science are particularly effective at raising income; but positive impact may also be attributed to degrees in engineering, the exact sciences, economics, and business administration – all disciplines that are more prevalent among those who have studied higher level math. The direct impact of math study level on income is relatively small and may be associated almost entirely with having been tested in math at the highest 5-unit level – especially for women.

To illustrate the contribution of higher level math study to income, several hypothetical scenarios were assessed. In Scenario 1, pupils who had been tested at the 4-unit level were moved up to 5 units with no change in their exam scores. The results showed that a rise in the math study level may be expected to produce a 8 percent hourly wage increase – 5 percent due to direct effect and 3 percent owing to indirect effect via academic study discipline.

Separate examination of the scenarios for men and women indicated that 5-unit math study has a greater effect on women's choice of academic major than on men's, translating into a larger indirect positive effect on women's wages. The indirect effect on men's wages of higher level math study (via academic major) is 2 percent, while women's wages rise by 7 percent when a similar shift upward is made.

Another scenario consisted of limiting the math study level move upward to those who had been tested at the 4-unit level and earned scores of 80 or above; this scenario produced similar results. A more complex scenario, which combines a math study move from 4 to 5 units with a 20 point reduction in exam score, shows that a score reduction curtails the positive impact on wage of the math level move, but does not entirely neutralize it. Clearly, a steeper decline in the exam score would probably make the math study level move economically infeasible.

When considering these results, it should be recalled that the income data presented in the study are for a specific group, that of young people beginning their careers, and that the contribution of math study to income may increase or decrease over time. Also, it would be interesting, in future research, to look at issues such as differences between Jews and Arab Israelis, between residents of the country's geographic center and periphery, and the like. Attention might also be paid to the indirect effect of math study on income through choice of occupation.

The main conclusions that emerge from the present study are that math study level greatly impacts on labor market performance, including employment rates and income, and that a large share of this impact is due to choice of academic major. Higher level math study enables pupils to gain admission to more selective academic programs in engineering, the exact sciences and computer science, and completion of these programs, in turn, helps them obtain high quality, well-paying jobs. In light of these conclusions, it may be asked why the percentage of pupils who choose to study higher level math has been declining? Are pupils and their parents aware of how important higher level math study is? Does the price exacted by more intensive math study, in terms of effort and money (private tutors, etc.) deter them? Do the interests of the school and the teachers coincide with those of pupils?

From a national perspective, the continuing decline in the percentage of high school pupils taking higher level math is a concern, as it casts doubt on Israel's ability to rely on the high-tech sector as an economic growth engine.

There are various solutions to this problem. First, math needs to be made more attractive and less threatening, through better teaching – not just at the high school level, but at earlier stages as well. Second, awareness among pupils and parents of the importance of high level math needs to be raised, through a number of means, including exposure to academic institutions and to the business sector. Third, schools should be offered financial incentives to increase the percentage of pupils taking the higher level math bagrut exam. These methods, employed in tandem, should be useful in removing barriers to higher level math study. It would be appropriate, of course, to fund implementation of these measures differentially, so that higher level math study can become a means of closing socioeconomic gaps.

Appendices

Appendix Table 1. Effect of other (non-math) bagrut scores on labor force achievement

coefficients of bagrut scores on different regressions*

Bagrut subject	Employment	Income from labor	Income from salaried employment	Hourly wage from labor
	(5)‡	(6)‡	(6)‡	(6)‡
English	0.0104***	-0.0027	-0.0057	-0.0070
(standard deviation)	(0.0030)	(0.0050)	(0.0050)	(0.0048)
Bible studies	0.0090***	0.0022	0.0055	0.0081
(standard deviation)	(0.0032)	(0.0053)	(0.0054)	(0.0051)
Literature	0.0081***	0.0107**	0.0104**	0.0080*
(standard deviation)	(0.0028)	(0.0047)	(0.0047)	(0.0044)
Hebrew/Grammar	0.0216***	-0.0048	-0.0033	-0.0006
(standard deviation)	(0.0041)	(0.0070)	(0.0071)	(0.0069)
History	-0.0067***	-0.0194***	-0.0191***	-0.0050
(standard deviation)	(0.0025)	(0.0042)	(0.0042)	(0.0040)
Civics	-0.0132***	0.0155***	0.0156***	0.0089*
(standard deviation)	(0.0032)	(0.0055)	(0.0055)	(0.0053)
Physics	0.0059*	0.0149***	0.0133**	0.0218***
(standard deviation)	(0.0032)	(0.0053)	(0.0053)	(0.0050)
Chemistry	-0.0010	0.0058	0.0040	0.0098**
(standard deviation)	(0.0028)	(0.0047)	(0.0046)	(0.0044)
Biology	-0.0019	0.0017	0.0033	0.0008
(standard deviation)	(0.0025)	(0.0042)	(0.0042)	(0.0039)
Computers	-0.0011	0.0070*	0.0017	0.0049
(standard deviation)	(0.0022)	(0.0037)	(0.0037)	(0.0035)

* The number of asterisks represents the level of statistical significance; the lower the level, the greater the confidence that there is in the correlation between the dependent and explanatory variables. One asterisk signifies a statistical significance level of 10%; two asterisks is 5%; three asterisks represents statistical significance at the 1% level.

‡ The numbered columns match the similarly numbered columns of the relevant dependent variables in the tables within the body of the text.

Appendix Table 2. Effect of socioeconomic variables on labor force achievements

regression coefficient for socioeconomic variables in various regressions* (continued on next page)

Variable	Employment	Income from labor	Income from salaried employment	Hourly wage from labor
	(5)‡	(6)‡	(6)‡	(6)‡
Parents country of origin				
Father born in Asia	0.0178	0.0138	0.0048	0.0084
(standard deviation)	(0.0123)	(0.0215)	(0.0217)	(0.0212)
Father born in Africa	0.0247**	0.0029	0.0076	-0.0110
(standard deviation)	(0.0106)	(0.0186)	(0.0187)	(0.0184)
Father born in Europe	0.00821	0.0274	0.0273	0.0060
(standard deviation)	(0.0113)	(0.0200)	(0.0200)	(0.0193)
Father born in America/Oceania	-0.0168	-0.0040	0.0058	0.0096
(standard deviation)	(0.0221)	(0.0397)	(0.0400)	(0.0383)
Mother born in Asia	-0.0212	-0.0489**	-0.0580**	-0.0768***
(standard deviation)	(0.0140)	(0.0246)	(0.0248)	(0.0243)
Mother born in Africa	0.0106	-0.0083	-0.0179	-0.0231
(standard deviation)	(0.0108)	(0.0189)	(0.0189)	(0.0187)
Mother born in Europe	-0.0130	-0.0055	-0.0042	-0.0165
(standard deviation)	(0.0117)	(0.0208)	(0.0207)	(0.0199)
Mother born in America/Oceania	-0.0681***	-0.0291	-0.0149	-0.0350
(standard deviation)	(0.0219)	(0.0395)	(0.0403)	(0.0381)
District of residence				
Jerusalem	-0.0719***	-0.1120***	-0.1140***	-0.0528***
(standard deviation)	(0.0106)	(0.0197)	(0.0198)	(0.0194)
North	-0.0085	-0.1510***	-0.1510***	-0.110***
(standard deviation)	(0.0103)	(0.0188)	(0.0189)	(0.0188)
Haifa	0.0067	-0.0903***	-0.0858***	-0.0714***
(standard deviation)	(0.0108)	(0.0192)	(0.0192)	(0.0189)
Center	0.0164*	-0.0450***	-0.0400***	-0.0277*
(standard deviation)	(0.0089)	(0.0155)	(0.0155)	(0.0149)

Appendix Table 2. Effect of socioeconomic variables on labor force achievements

regression coefficient for socioeconomic variables in various regressions* (continued from previous page)

Variable	Employment (5)‡	Income from labor (6)‡	Income from salaried employment (6)‡	Hourly wage from labor (6)‡
District of residence				
South	-0.0218**	-0.0881***	-0.0872***	-0.0988***
(standard deviation)	(0.0101)	(0.0184)	(0.0184)	(0.0185)
Judea/Samaria	-0.0493***	-0.1620***	-0.1790***	-0.1170***
(standard deviation)	(0.0153)	(0.0282)	(0.0284)	(0.0276)
Religion				
Muslim	-0.1930***	-0.0546***	-0.0548***	-0.0644***
(standard deviation)	(0.0101)	(0.0202)	(0.0203)	(0.0211)
Christian	-0.0177	0.0060	-0.0547	-0.0854**
(standard deviation)	(0.0204)	(0.0365)	(0.0370)	(0.0378)
Druze	-0.1690***	-0.1420***	-0.1220***	-0.1500***
(standard deviation)	(0.0219)	(0.0424)	(0.0427)	(0.0480)
Other religion	0.0383**	0.0012	0.0115	-0.0266
(standard deviation)	(0.0164)	(0.0285)	(0.0282)	(0.0275)
Year of Aliyah (arrival in Israel)				
Since 1990	0.0661***	0.0120	0.00323	0.00703
(standard deviation)	(0.0117)	(0.0208)	(0.0206)	(0.0201)
Before 1990	0.0639***	-0.0240	-0.0364	-0.0380
(standard deviation)	(0.0209)	(0.0364)	(0.0365)	(0.0356)
Demographic characteristics				
Family status (married +1)	0.0171***	0.1570***	0.1550***	0.0969***
(standard deviation)	(0.0066)	(0.0116)	(0.0116)	(0.0116)
Parents with children	-0.1310***	-0.1520***	-0.1520***	0.0969***
(standard deviation)	(0.0092)	(0.0167)	(0.0165)	(0.0162)
Homeownership	-0.0175***	0.0548***	0.0569***	0.0336***
(standard deviation)	(0.0058)	(0.0106)	(0.0106)	(0.0105)
Gender	0.0751***	0.1470***	0.1370***	0.0408***
(standard deviation)	(0.0082)	(0.0149)	(0.0147)	(0.0147)

* The number of asterisks represents the level of statistical significance; the lower the level, the greater the confidence that there is in the correlation between the dependent and explanatory variables. One asterisk signifies a statistical significance level of 10%; two asterisks is 5%; three asterisks represents statistical significance at the 1% level.

‡ The numbered columns match the similarly numbered columns of the relevant dependent variables in the tables within the body of the text.

Source: Ayal Kimhi and Arik Horovitz, Taub Center

Appendix Table 3A. Effect of occupation on income from labor

coefficients for occupation in regressions with various income types

Occupation	Income from labor (5)‡	Income from salaried employment (5)‡	Hour wage from labor (5)‡
Unskilled workers	-0.0993***	-0.0905**	-0.2230***
(standard deviation)	(0.0363)	(0.0359)	(0.0384)
Skilled workers in agriculture	-0.0154	-0.0848	-0.2210***
(standard deviation)	(0.0618)	(0.0674)	(0.0656)
Agents, sales and service workers	0.0721**	0.0889***	-0.1350***
(standard deviation)	(0.0291)	(0.0291)	(0.0331)
Clerks	0.0913***	0.1070***	-0.0954***
(standard deviation)	(0.0285)	(0.0282)	(0.0325)
Skilled workers in manufacturing, construction, other	0.1740***	0.1900***	-0.1140***
(standard deviation)	(0.0304)	(0.0303)	(0.0342)
Associate professionals and technicians	0.3020***	0.3370***	0.1210***
(standard deviation)	(0.0291)	(0.0291)	(0.0331)
Academic professions	0.3800***	0.3980***	0.1760***
(standard deviation)	(0.0310)	(0.0300)	(0.0336)
Managers	0.5630***	0.5650***	0.2110***
(standard deviation)	(0.0364)	(0.0367)	(0.0390)

* The number of asterisks represents the level of statistical significance; the lower the level, the greater the confidence that there is in the correlation between the dependent and explanatory variables. One asterisk signifies a statistical significance level of 10%; two asterisks is 5%; three asterisks represents statistical significance at the 1% level.

‡ The numbered columns match the similarly numbered columns of the relevant dependent variables in the tables within the body of the text.

Source: Ayal Kimhi and Arik Horovitz, Taub Center

Appendix Table 3B. Effect of industry sector on income from labor
coefficients for industry sector in regressions with various income types

Industry sector	Income from labor	Income from salaried employment	Hour wage from labor
	(5)‡	(5)‡	(5)‡
Education	-0.3060***	-0.3070***	-0.0782**
(standard deviation)	(0.0303)	(0.0302)	(0.0308)
Hospitality/restaurants	0.0738*	0.0573	-0.1080***
(standard deviation)	(0.0377)	(0.0380)	(0.0379)
Health/welfare	-0.1250***	-0.1340***	-0.1050***
(standard deviation)	(0.0331)	(0.0329)	(0.0331)
Community, social, personal services	-0.1180***	-0.1030***	-0.0625*
(standard deviation)	(0.0335)	(0.0351)	(0.0355)
Construction (buildings and civil engineering projects)	0.1140***	0.1100***	-0.0719*
(standard deviation)	(0.0369)	(0.0370)	(0.0368)
Wholesale/repairs	0.1310***	0.1270***	-0.0210
(standard deviation)	(0.0298)	(0.0298)	(0.0306)
Public administration	0.1660***	0.1510***	-0.0544
(standard deviation)	(0.0340)	(0.0336)	(0.0349)
Transport/storage/communications	0.2300***	0.2280***	0.0189
(standard deviation)	(0.0316)	(0.0314)	(0.0320)
Manufacturing/agriculture	0.1960***	0.1880***	0.0012
(standard deviation)	(0.0289)	(0.0286)	(0.0297)
Banking/financial institutions/others	0.2790***	0.2650***	0.0932***
(standard deviation)	(0.0361)	(0.0357)	(0.0351)
Real estate/rental/business services	0.1630***	0.1730***	-0.0200
(standard deviation)	(0.0285)	(0.0283)	(0.0293)

* The number of asterisks represents the level of statistical significance; the lower the level, the greater the confidence that there is in the correlation between the dependent and explanatory variables. One asterisk signifies a statistical significance level of 10%; two asterisks is 5%; three asterisks represents statistical significance at the 1% level.

‡ The numbered columns match the similarly numbered columns of the relevant dependent variables in the tables within the body of the text.

Source: Ayal Kimhi and Arik Horovitz, Taub Center

Appendix Table 4A. Effect of occupation of hourly wage, by gender
regression coefficients of occupation in regression of hourly wage after calculation for the total population

Occupation	Population	Men	Women
Unskilled workers	-0.1747***	-0.1292**	-0.2382**
(standard deviation)	(0.0490)	(0.0565)	(0.1160)
Skilled workers in agriculture	-0.2308***	-0.1427	-0.4575***
(standard deviation)	(0.0807)	(0.0872)	(0.1569)
Agents/sales and service workers	-0.1107***	-0.0669	-0.1574
(standard deviation)	(0.0419)	(0.0460)	(0.1088)
Clerks	-0.0531	0.0136	-0.0918
(standard deviation)	(0.0417)	(0.0490)	(0.1083)
Professional workers in manufacturing, construction, other	-0.0728**	-0.0624	-0.1052
(standard deviation)	(0.0423)	(0.0441)	(0.1170)
Associate professionals/ technicians	0.1399**	0.1392***	0.1153
(standard deviation)	(0.0419)	(0.0465)	(0.1082)
Academic professions	0.1897***	0.2114***	0.1519
(standard deviation)	(0.0425)	(0.0489)	(0.1071)
Managers	0.2337***	0.2623***	0.1776
(standard deviation)	(0.0473)	(0.0558)	(0.1128)

* The number of asterisks represents the level of statistical significance; the lower the level, the greater the confidence that there is in the correlation between the dependent and explanatory variables. One asterisk signifies a statistical significance level of 10%; two asterisks is 5%; three asterisks represents statistical significance at the 1% level.

Source: Ayal Kimhi and Arik Horovitz, Taub Center

Appendix Table 4B. Effect of industry sector on hourly wage, by gender

coefficients of industry sector on regressions for hourly wages after calculations for the overall populations

Industry sector	**Population** (5)‡	**Men** (5)‡	**Women** (5)‡
Education	-0.0161	-0.0454	0.0006
(standard deviation)	(0.0378)	(0.0531)	(0.0694)
Hospitality/restaurants	-0.1074**	-0.1400***	-0.0341
(standard deviation)	(0.0433)	(0.0531)	(0.0767)
Health/welfare	-0.0465	-0.0078	-0.0365
(standard deviation)	(0.0408)	(0.0701)	(0.0693)
Community, social, personal services	-0.0488	-0.0450	-0.0399
(standard deviation)	(0.0421)	(0.0583)	(0.0720)
Construction (buildings and civil engineering projects)	-0.0266	-0.0337	0.0107
(standard deviation)	(0.0414)	(0.0471)	(0.0820)
Wholesale/repairs	0.0061	0.0020	0.0196
(standard deviation)	(0.0355)	(0.0426)	(0.0668)
Public administration	-0.0227	-0.0509	0.0147
(standard deviation)	(0.0420)	(0.0538)	(0.0755)
Transport/storage/communications	0.0486	0.0375	0.0729
(standard deviation)	(0.0372)	(0.0459)	(0.0679)
Manufacturing/agriculture	0.0426	0.0517	0.0309
(standard deviation)	(0.0351)	(0.0406)	(0.0678)
Banking/financial institutions/others	0.1067***	0.1233**	0.1093
(standard deviation)	(0.0391)	(0.0551)	(0.0678)
Real estate/rental/business services	0.0055	0.0043	0.0228
(standard deviation)	(0.0348)	(0.0421)	(0.0658)

* The number of asterisks represents the level of statistical significance; the lower the level, the greater the confidence that there is in the correlation between the dependent and explanatory variables. One asterisk signifies a statistical significance level of 10%; two asterisks is 5%; three asterisks represents statistical significance at the 1% level.

Source: Ayal Kimhi and Arik Horovitz, Taub Center

Appendix Table 5. Coefficients for math unit level in a model of choice of academic major* (continued on next page)

Academic major	Math unit level	Population	Men	Women
Jewish studies/Humanities	3	0.2956	-0.1224	0.4374*
(standard deviation)		(0.2109)	(0.4582)	(0.2327)
	4	0.6263***	0.0636	0.8768***
(standard deviation)		(0.2301)	(0.4692)	(0.4047)
	5	0.9599***	0.6235	1.3400***
(standard deviation)		(0.2907)	(0.5287)	(0.3781)
Education	3	0.5197	0.6464	0.4419
(standard deviation)		(0.3201)	(0.6990)	(0.3593)
	4	0.5072	-0.4062	0.6472
(standard deviation)		(0.3582)	(1.0102)	(0.4047)
	5	1.2037***	0.0102	1.8617***
(standard deviation)		(0.4380)	(1.2547)	(0.4924)
Medicine/Life sciences	3	-0.2641	0.0476	-0.3761
(standard deviation)		(0.2774)	(0.5333)	(0.3332)
	4	0.4983*	0.7454	0.4800
(standard deviation)		(0.3012)	(0.5600)	(0.3658)
	5	1.3617***	1.5094**	1.7832***
(standard deviation)		(0.3301)	(0.6028)	(0.4271)
Social Sciences	3	0.4449**	0.6631**	0.3212
(standard deviation)		(0.1877)	(0.3028)	(0.2320)
	4	0.6868***	0.9274***	0.6069**
(standard deviation)		(0.2131)	(0.3433)	(0.2679)
	5	0.6010**	0.3840	1.0780***
(standard deviation)		(0.2769)	(0.4448)	(0.3668)

Appendix Table 5. Coefficients for math unit level in a model of choice of academic major* (continued from previous page)

	Math unit level	Population	Men	Women
Law	3	-0.4280	-0.5145	-0.3814
(standard deviation)		(0.2783)	(0.3920)	(0.3977)
	4	0.1232	-0.2394	0.3331
(standard deviation)		(0.2833)	(0.4056)	(0.4046)
	5	0.5314*	0.1048	1.1724**
(standard deviation)		(0.3228)	(0.4571)	(0.4817)
Economics/Business administration	3	0.4397*	0.6868*	0.1760
(standard deviation)		(0.2514)	(0.3700)	(0.3333)
	4	1.4895***	1.5934***	1.3911***
(standard deviation)		(0.2748)	(0.3911)	(0.3814)
	5	2.3093***	2.0388***	2.8265***
(standard deviation)		(0.3156)	(0.4478)	(0.4594)
Engineering/Exact sciences	3	0.3126	0.3513	0.2899
(standard deviation)		(0.2835)	(0.3535)	(0.4741)
	4	1.5626***	1.1699***	2.1750***
(standard deviation)		(0.3088)	(0.3890)	(0.4894)
	5	2.7356***	2.0948***	3.8975***
(standard deviation)		(0.3411)	(0.4313)	(0.5355)
Computer science	3	-1.4181***	-1.2875***	-1.7500***
(standard deviation)		(0.3615)	(0.4885)	(0.5606)
	4	0.1276	-0.1957	0.2923
(standard deviation)		(0.3429)	(0.4417)	(0.6019)
	5	1.5051***	0.6180	2.6438***
(standard deviation)		(0.4040)	(0.5218)	(0.7164)

* The number of asterisks represents the level of statistical significance; the lower the level, the greater the confidence that there is in the correlation between the dependent and explanatory variables. One asterisk signifies a statistical significance level of 10%; two asterisks is 5%; three asterisks represents statistical significance at the 1% level.

Source: Ayal Kimhi and Arik Horovitz, Taub Center

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