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Education quality and future wages

The impact of math matriculation quality in the periphery and center of Israel

Dan Ben-David and Ayal Kimhi*

Abstract

Employees who attended upper secondary schools in central Israel (the *center*) earn nearly 11% more than those from the country's periphery. This study, examining Israelis born in 1978-85 and employed during 2012-16, focuses on the relationship between wage gaps and differences in the quantity and quality of schooling, while controlling for many other characteristics affecting wages. The number of matriculation (bagrut) study units in mathematics (a higher number of units indicates a higher level of study) is found to have a much greater impact on future earnings than the number of matriculation units in other subjects. Pupils from the center tend to study more math matriculation units, have higher matriculation scores and earn higher wages. The higher the share of individuals continuing to academic studies, and the higher that level of study, the smaller the wage gap between former pupils from the center and from the periphery. The study concludes that a substantial upgrade of periphery schools – particularly in the quality of their math education – should ensure better opportunities for their pupils in the labor market, and reduce income gaps between them and their counterparts from the center.

August 2020

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Education quality and future wages

The impact of math matriculation quality in the periphery and center of Israel

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1. Introduction

It is difficult to overstate the importance of human capital investment for economic success, whether at the individual or the national level. Ben-David and Kimhi (forthcoming) find a strong relationship between education and both employment and wages in Israel. While quantitative measures of education – such as number of years of schooling or attainment of an academic degree – are inadequate predictors of labor market success, the key determinant of labor market success is education quality. Differences between education quantity and quality are particularly extreme in Israel. Israel is one of the top OECD countries in terms of average number of years of schooling and percentage of academic degree holders among the prime working age population. Yet, at the same time, its students' achievements in basic subjects – in international exams such as PISA, TIMMS and PIAAC – are among the lowest in the developed world. The impact of education quality, as opposed to quantity, on the economic growth of nations is highlighted in Hanushek and Woessmann (2015).

One of the most critical factors underlying children's scholastic achievement is parental education level – especially the mother's education (Gruber, 2017). The lower the parents' education level, the lower their income tends to be, thus limiting their options in terms of where they live and the quality of the schools that their children attend. Chetty, Friedman, Hilger, Saez, Schanzenbach and Yagan (2011) show the degree to which the scholastic level of the rest of the class affects children's future incomes. Schools in Israel's periphery areas tend to serve pupils whose parents have lower education levels, potentially reducing opportunities for these pupils to study core subjects at high levels. Schools in the periphery may also find it more difficult to attract better teachers, crucial to higher quality teaching of basic subjects that can open occupational doors in the future. Consequently, periphery pupils who may see narrow occupational horizons ahead may have a diminished desire to challenge themselves with higher-level study in basic subjects, including math.

Ben-David and Kimhi (forthcoming) found that, of all matriculation subjects, math study at the upper secondary level has the strongest impact on future wages. Goodman (2019) found that raising the upper secondary math requirement by a single additional course increases future wages by 10%, especially for weaker pupils.

Kimhi and Horowitz (2015) examined the contribution of higher-level math matriculation on labor market achievement, while controlling for numerous background variables. They found that a five-unit math matriculation leads to higher wages. They also found that math quality's contribution to wages comprises both a direct and indirect impact since higher level matriculation opens up academic possibilities in high-demand fields of study. These, in turn, are key to gaining employment in higher-paying occupations.

In Israel, barriers to math study exist at both the individual and the school levels. For example, Hurvitz (2015) shows that a third of upper secondary schools preparing pupils for matriculation exams do not offer math at the five-unit level. One reason for this is the Ministry of Education's requirement of a minimum of 15 pupils per class. As such, pupils in smaller schools are more strongly affected by such regulations. Over a ten-year period ending in 2012, there was a substantial decline in the number of pupils who took the five unit matriculation exam. This decrease led the Ministry of Education (2015), in cooperation with third-sector organizations and private businesses, to launch a nation-wide program aimed at strengthening math study, with a focus on the removal of barriers to math study at the five-unit level. These implementation of these measures more than doubled the number of pupils taking math matriculation exams at the five-unit level between 2012 and 2018 (*Ynet*, 2018).

The quality and impact of math instruction are important issues, not just at the level of the national average, but also from the perspective of domestic income disparity. Of particular note in this regard is the geographic dimension, that is, the gaps between what is commonly referred to as Israel's "center" (primarily the Tel-Aviv metropolitan region) and the country's surrounding "periphery" areas (CBS, 2019).

The objective of this study is to determine whether higher level math study in upper secondary school leads to the same extent of labor market success to pupils from the periphery as it does to pupils from the country's center. Specifically, the future wage gaps of pupils who took the math matriculation exam at various levels are estimated, while controlling for a wide variety of background variables, to determine whether these gaps differ between pupils in the periphery and pupils in the center.

Section two describes the dataset used in this study. Section three presents descriptive evidence on the main variables and how they are related to wages. Section four provides the estimation results of a statistical model that identifies each variable's partial impact on wages, while controlling for the other variables, and presents a number of simulations that provide a quantitative dimension to the results. Section five concludes.

2. Data

The study was conducted using a database containing administrative data for all Israeli citizens born during 1978-1985, about a million individuals (all information in the database is anonymous). The database was compiled by the Central Bureau of Statistics (CBS) from a number of sources, including the Ministry of Education, the National Institute for Testing and Evaluation, the Population Registry, and the Israel Tax Authority. The file contains data on upper secondary pupils, including their matriculation exam information, academic degrees by type of institution and field of study, information on place of residence and family composition, demographic and socioeconomic data on the pupils' parents, and wage data for the years 2012-2016.

The Ministry of Education's pupil data contains background information on the pupils' families, including parents' continent of birth and family status, the age of the parents when the pupil was born, and the number of siblings of each pupil.[1] The files also contain information on the municipalities where the pupils reside, the school's education stream (state, state-religious or independent), and the pupil's study track (academic or vocational). CBS municipality files made it possible to divide the municipalities into two clusters. The clusters are distinguished from one another on the basis of each municipality's peripherality index, which is calculated as a simple average of two components. The first is the potential accessibility component, based on the distance between a given municipality and every other Israeli municipality and their population sizes. The second component is proximity to the Tel Aviv district boundary.[2] Municipalities in clusters 1-5 were designated periphery, while municipalities in clusters 6-10 were designated central. According to these designations, 37% of pupils attended schools in the periphery while the remainder studied in the center.

Matriculation exam data included the number of study units for each of the 34 matriculation subjects along with the final grade on each exam for each pupil. It should be noted that one of the main drawbacks of using matriculation data is that these exams are not calibrated

[1] Neither the pupil data nor the matriculation exam data include information on 7% of the relevant cohorts who immigrated to Israel after completing their secondary school studies. In instances that required pupil and matriculation data, these observations were omitted from the analysis.

[2] Potential accessibility index A_i for municipality i is calculated as $A_i = \sum_{j=1}^{J} P_j / d_{ij}^{1.19}$, where P_j is the population of municipality j, J is the number of municipalities, and d_{ij} is the distance in kilometers between the center of the municipality i and the center of municipality j, where d_{ii} = 3 (Tsibel 2009).

over time. In other words, grades from the five-unit math exam given in one year are not necessarily comparable to the same exam's grades from a different year.

The academic degree information was broken down by primary field of study and by type of academic institution: Israeli research university, Israeli non-research college, and foreign academic institution (heretofore, the language will follow the Israeli convention with "university" representing research higher education institutions, while "college" refers to non-research higher education institutions). Population Registry data includes the individual's place of residence in 2015, his/her family status, number of children, and their age when their first child was born.

Income data includes the annual income of salaried employees as reported in tax authority records, the number of months worked in each year, and the sector in which the individual was employed during the largest number of months. Average monthly wages in 2016 prices were calculated for the period 2012-2016 using the Consumer Price Index.[3] Wage data exist for three-quarters of the total relevant population, 80% of whom were employed continuously throughout the period.

Wage percentile data, within the total wage distribution, for each parent in the year that their child was 17 years old, was also utilized.

3. Descriptive statistics

There is an 11% wage gap between the average pupil from the center and the average pupil from the periphery. Wages are highly dependent on the field of employment, which itself is strongly influenced by decisions made at a young age and by the circumstances that led to those decisions. Figure 1 shows that the higher tendency of upper secondary pupils in the center to work in the communication and financial sectors exists at all levels of upper secondary math

[3] The average monthly income was obtained by dividing the total five-year aggregate income from wages by the total cumulative number of months worked over the same five-year period.

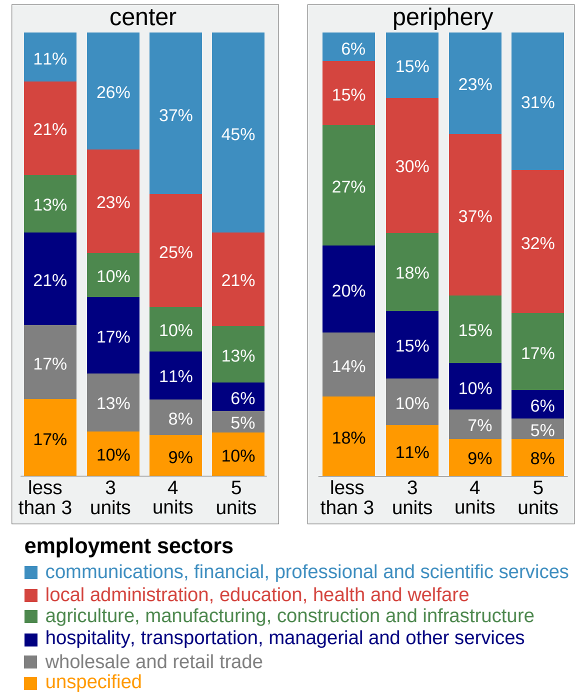
study. At the same time, the greater tendency of upper secondary pupils in the periphery to work in the manufacturing, construction, and infrastructure sectors exists at all levels of upper secondary math study, though it diminishes as the level of math study rises.

Additionally, upper secondary pupils in the periphery who took the math matriculation exam have a stronger tendency to work in the administrative and public service sectors. Figure 1 also shows that the likelihood of being employed in the communication and financial sectors – where wages are relatively high – grows substantially as the math matriculation level rises, both for pupils in the center and for those in the periphery.

A deeper understanding of the link between the level of upper secondary math study and future labor market achievement – particularly in terms of wage – entails a more in-depth examination of the trajectory along which pupils move from upper secondary school, through academic study (should they choose this path), and their occupational choices. Figure 2 shows that 45% of pupils in the relevant cohorts did not take the math matriculation exam. A third (32%) were tested at the three-unit level or below. 14% of the pupils were tested at the

Figure 1

Distribution of employees in primary business sectors by math levels*



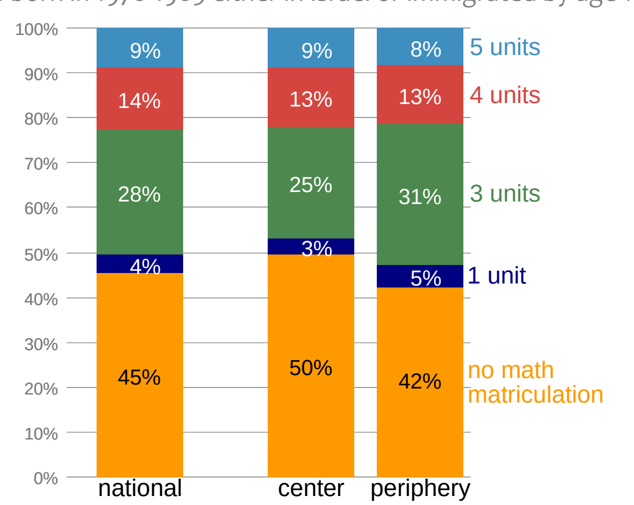
* Data for salaried employees working at least one month in 2012-2016 and born in 1978-1985 either in Israel or immigrated by age 17.

Source: Dan Ben-David and Ayal Kimhi, Shoresh Institution
Data: Central Bureau of Statistics

Figure 2

Distribution of math units*

Pupils born in 1978-1985 either in Israel or immigrated by age 17



* The percentages do not necessarily sum to 100% because of rounding.

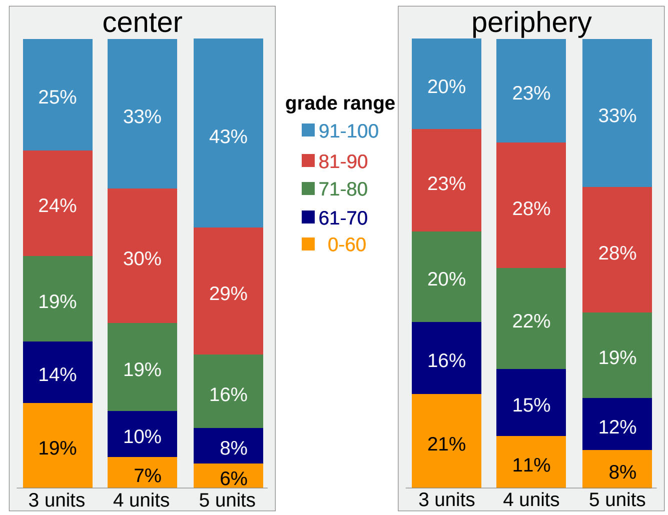
Source: Dan Ben-David and Ayal Kimhi, Shoresh Institution
Data: Central Bureau of Statistics

four-unit level, and only 9% at the highest level – five units. Differences between pupils from the center and those from the periphery are not substantial when the focus is on the percentage of those tested at the higher levels, but the share of those tested at the lower levels in the periphery is considerably greater than in the center, while the fraction of pupils who were not tested in math at all is higher in the center.

Figure 3

Distribution of math matriculation grades

by number of math units*



* The percentages do not necessarily sum to 100% because of rounding. Data for pupils born in 1978-1985 either in Israel or immigrated by age 17.

Source: Dan Ben-David and Ayal Kimhi, Shoresh Institution
Data: Central Bureau of Statistics

Figure 3 displays the distribution of math matriculation scores. The higher the number of study units, the higher the average grade, both in the center and in the periphery. The scores of pupils in the center are generally higher, on average, than those of pupils in the periphery. Higher grades in the center of the country are also evident at each number of study units. Of special note is the fact that the grades in the center are higher for those who studied math at a higher level, even though the center and the periphery show similar shares of pupils studying at higher level math. This may attest to less-careful screening of pupils in the periphery, or to lower levels of instructional quality in those schools.

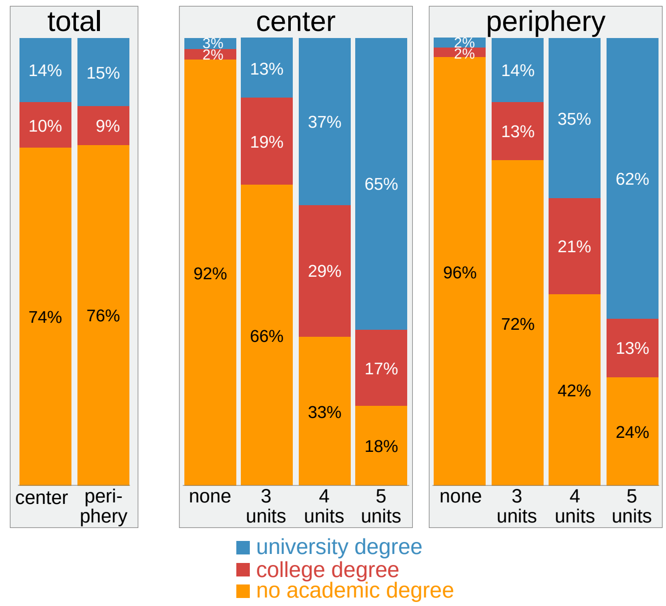
Figure 4 displays the percentage of academic degree holders by university and college categories. There is no substantial difference between the percentage of degree holders among pupils from the center and pupils from the periphery, or in the degree distribution between universities and colleges. However, the relationship between academic study and higher-level math matriculation is clearly evident.

The share of degree holders rises substantially with the number of math units studied. There is a greater share of academic graduates among persons who studied four units of math than among those who completed only three units. That share is even higher for those who studied five units of math. Moreover, an increase from four to five units of math is accompanied by an even steeper rise in the percentage of university degrees, at the expense of college degrees. This distinction can be seen among pupils from both the center and the periphery.

Figure 4

Distribution of academic degrees

by type of academic institution and number of math units*



* The percentages do not necessarily sum to 100% because of rounding. Pupils taking matriculation exams in math at less than 3 units are not included because of their negligible share in the population. Data for persons born between 1978 and 1985 either in Israel or immigrated to the country by the age of 17.

Source: Dan Ben-David and Ayal Kimhi, Shoresh Institution
Data: Central Bureau of Statistics

The share of academic degree holders among pupils from the center is higher than among pupils from the periphery, at every math matriculation level. Among pupils from the center who studied math at the five-unit level, a larger proportion of degrees were earned at universities (65%) than among pupils from the periphery who studied math at the five-unit level (62%).

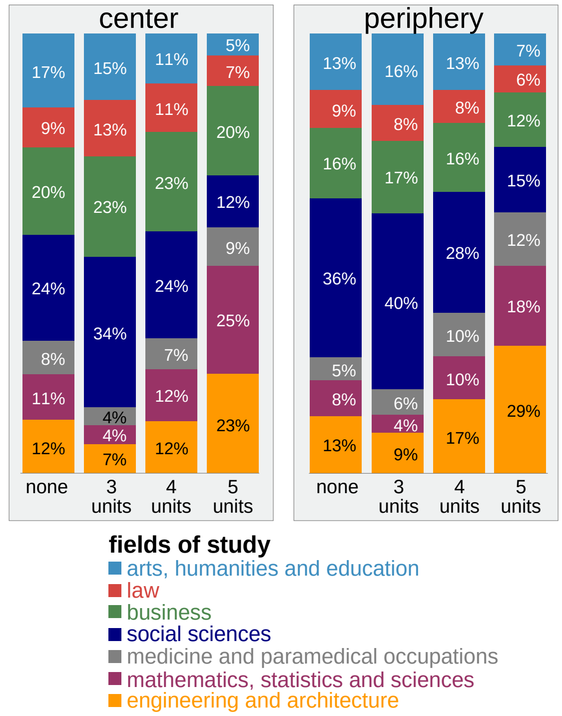
Upper secondary pupils in the periphery have a greater tendency to pursue studies in the social sciences (Figure 5). This finding applies at all levels of math study, but is more pronounced among those who did not take the higher-level math matriculation exam. Upper secondary pupils in the center exhibit a greater tendency to study business administration, a tendency that can be seen at all math matriculation levels. Among pupils who did take the higher-level math matriculation, those from the center tended more toward academic study in mathematics, computer science, and the natural sciences, while those from the periphery were more likely to study engineering and architecture.

For pupils from both the center and the periphery, the move from three to four math units doubles, or more than doubles, the likelihood of earning an academic degree in math, computers, or the natural sciences. This is true of engineering and architecture as well. Increasing the level of math from four to five units doubles the chance of holding an academic degree in math, computers, the natural sciences, engineering, and architecture for pupils in the center. This effect is smaller for periphery pupils.

Figure 5

Distribution of academic study fields

by number of math units*



* Pupils taking matriculation exams in math at less than 3 units are listed as "none". Data for persons born between 1978 and 1985 in Israel or immigrated to the country by the age of 17.

Source: Dan Ben-David and Ayal Kimhi, Shoresh Institution
Data: Central Bureau of Statistics

The relationship between wages and number of math matriculation units is shown in Figure 6. The wages of pupils who tested at the three-unit level were 27% higher than those of pupils who tested at lower levels, or did not take the math matriculation exam at all.[4] Pupils matriculating at the four-unit level attained wages that were 62% higher than those of pupils who tested at levels lower than three units, or of those who did not take the math matriculation exam. Pupils who were tested at the five-unit level earned wages that were 115% higher than those who were tested at levels lower than three units, or who did not take the math matriculation.

[4] 3% of the pupils were tested at the one-unit level, and a tiny number of pupils tested at the two-unit level. It is reasonable to assume that these are pupils who did not continue with testing after the first exam questionnaires, and were not eligible for the matriculation certificate.

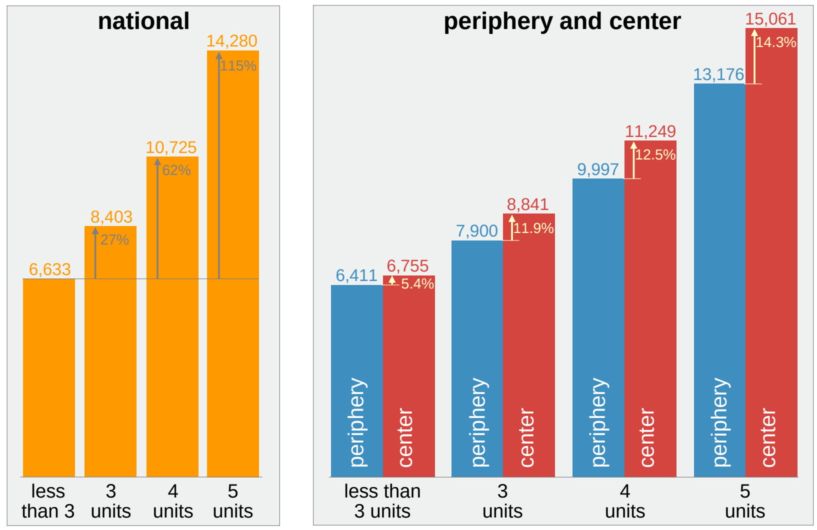
Beyond the wage gaps between upper secondary graduates at the various math study levels, there are further disparities between pupils from the center of the country and pupils from the periphery who studied at the same math levels. Among pupils who took less than three units of math, those from the center earned 5.4% more than did those from the periphery. This gap widened as the math levels increased. Among those who were tested at the five-unit level, pupils from the center earned 14.3% more than did pupils from the periphery.

The impact of math study on wages is strongly related to pupil achievements, as indicated in Figure 7, which displays the relationship between wages and math matriculation grade by number of study units. The higher the grade, the higher the wage, and this is especially true for those who studied math at the five-unit level in both the center and the periphery. Pupils who barely passed the math matriculation exam – or even failed it – tended to earn higher wages in the future than pupils who

Figure 6

Average monthly wages, 2012-2016

by number of math units*, 2016 prices



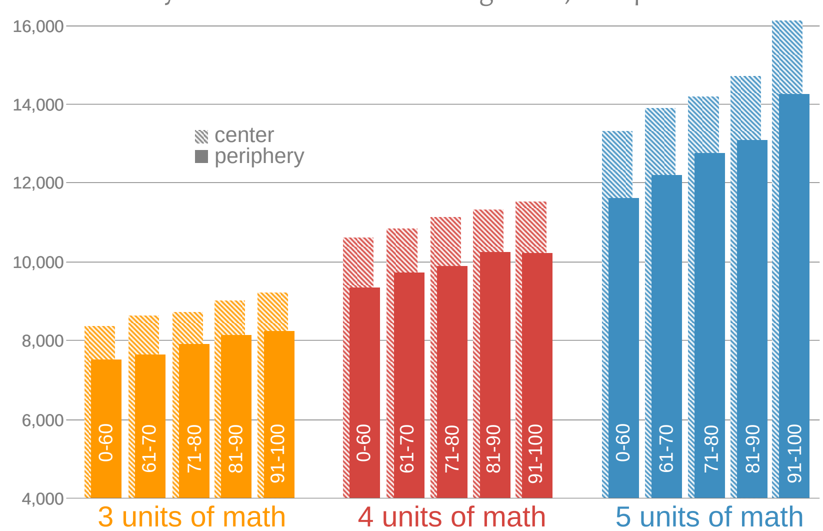
* Data for salaried employees working at least one month in 2012-2016 and born in 1978-1985 either in Israel or immigrated by age 17.

Source: Dan Ben-David and Ayal Kimhi, Shoresh Institution
Data: Central Bureau of Statistics

Figure 7

Average monthly wages, 2012-2016

by number of math units and grades*, 2016 prices



* Data for salaried employees working at least one month in 2012-2016 and born in 1978-1985 either in Israel or immigrated by age 17.

Source: Dan Ben-David and Ayal Kimhi, Shoresh Institution
Data: Central Bureau of Statistics

excelled at the next level below. This outcome was found in both the center and the periphery. That said, the wage gap between pupils from the center and pupils from the periphery is visible here as well, and it's relatively stable across the test score distribution.

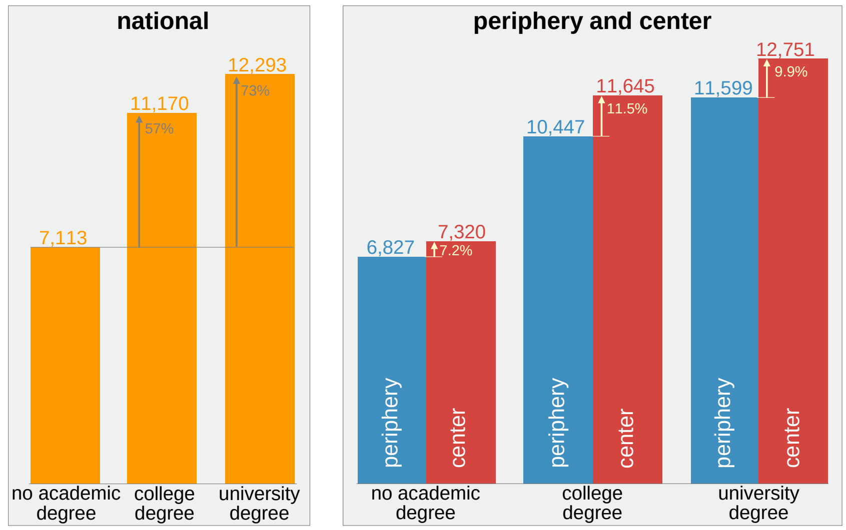
Some of the upper secondary school graduates choose to further upgrade their skills through academic study. Figure 8 shows the importance of an academic degree for future earnings. Academic degree holders earn dozens of percentage points more than do those without such degrees. University graduates earn more than college graduates. Gaps between pupils from the center and those from the periphery are wider among academic degree holders, though the reason for this is that the wages of non-degree holders are much lower overall. This disparity is similar for university and college graduates.

However, a more complex picture emerges in Figure 9 when the focus shifts to the wage gap favoring pupils from the center on the combined basis of the type of

Figure 8

Average monthly wages, 2012-2016

by type of academic institution*, 2016 prices



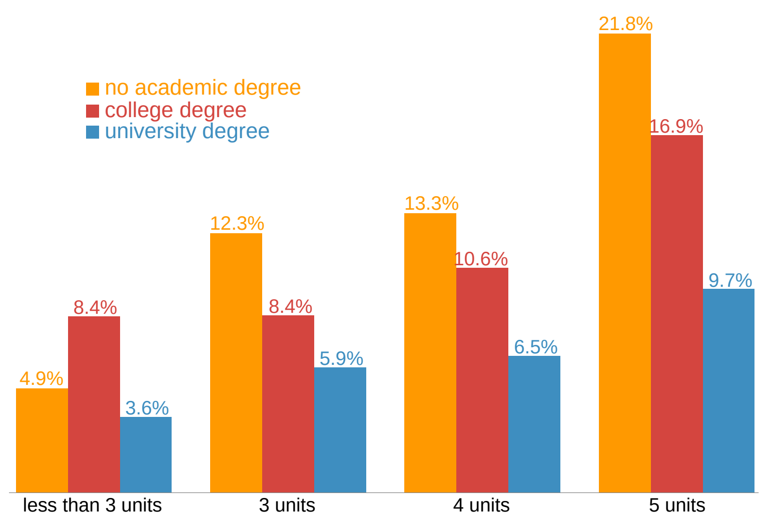
* Share of persons earning academic degree earners abroad is very low, so not included here. Data for salaried employees working at least one month in 2012-2016 and born in 1978-1985 either in Israel or immigrated by age 17.

Source: Dan Ben-David and Ayal Kimhi, Shoresh Institution
Data: Central Bureau of Statistics

Figure 9

Wage gaps in favor of pupils from the center

by type of academic institution and number of math units*



* Share of persons earning academic degree earners abroad is very low, so not included here. Data for salaried employees working at least one month in 2012-2016 and born in 1978-1985 either in Israel or immigrated by age 17.

Source: Dan Ben-David and Ayal Kimhi, Shoresh Institution
Data: Central Bureau of Statistics

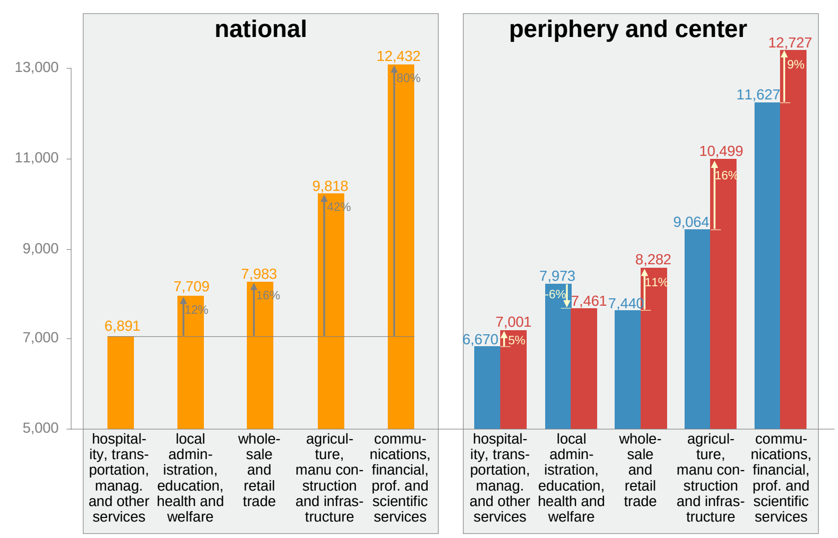
academic institution from which they received their degree – if at all – and the number of math matriculation units that they studied in high school. The wage gap in favor of pupils from the center increases as the number of math study units rises. However, for those who studied at least three units of math, the attainment of an academic degree reduced the wage disparity for each level of high school math. When the academic degree was obtained from a university rather than a college, the gap narrowed even further. These findings suggest that higher-level academic study more effectively bridges wage gaps that emerge at the upper secondary level. In other words, university studies would appear to be more beneficial than college studies in closing the wage gap between pupils from the center and pupils from the periphery.

While Figure 1 showed the distribution of employment sectors and the differences between pupils from the center and the periphery, Figure 10 displays the wage distribution by main employment sector. At the national level, there are substantial wage disparities between the various employment sectors. In all sectors, except for local administration, education, healthcare, and welfare, those who attended upper secondary schools in the center earn more. This disparity is particularly large in the agriculture, manufacturing, construction, and infrastructure sectors.

Figure 10

Average monthly wages, 2012-2016

by primary sector of employment*, 2016 prices



* Data for salaried employees working at least one month in 2012-2016 and born in 1978-1985 either in Israel or immigrated by age 17.

Source: Dan Ben-David and Ayal Kimhi, Shoresh Institution

Data: Central Bureau of Statistics

4. Multivariate analysis

The descriptive analyses of wage gaps in the previous section, between pupils from the center and pupils from the periphery, showed some fairly simple depictions of relationships on the basis of one or two characteristics. But they did not net out the impact of additional characteristics that also have an effect on wages. For example, a large proportion of the link between wage and employment sector is likely to stem from the fact that certain employment sectors mainly employ people with academic training in specific fields. Multivariate statistical analysis using multiple linear regression makes it possible to isolate the impact of each relevant characteristic on wages, while controlling for all the other characteristics. In the case of employment sectors, for example, this analysis answers the question of what the wage gaps between employees in different sectors would be if all other employee attributes had been identical.

The dependent variable in the statistical analysis – the natural log of the average monthly wage – is explained by the characteristics of education, employment sector, employee socioeconomic background, and peripherality level. In the analysis, the emphasis is on center-periphery differences in math and English study levels, while controlling for the rest of the matriculation variables. To avoid weighing down the analysis, the matriculation variables in subjects other than English and math were grouped in several clusters: other scientific and technological subjects; arts and humanities; and other foreign languages. Appendix 1 provides the subject composition of each cluster.

Specifically, the list of variables contains dummy variables for the number of study units in both math and English, the matriculation score in each of these subjects, and a dummy variable for the receipt of a passing score on the test.[5] For each of the three "other study subject" clusters, the score itself was included as well as dummy variables for pupils who took the

[5] Because the number of those tested at the two-unit level in math and English was miniscule, they were merged with those who were tested at the one unit level.

matriculation exam in at least one of the cluster subjects, for the total number of cluster-subject study units, and if the average score for the cluster subject is a passing score. Other study characteristics are: type of school supervision (state, state-religious, and other, with the latter category consisting mainly of Haredi schools); study track (academic, technological, or undefined track); and whether the school is in the center or the periphery.

Other educational characteristics – for those who earned academic degrees – include dummy variables for the field of study of the degree and type of institution. Specifically, the clustered faculty list includes: arts, humanities and education; social sciences; business administration; law; medicine and paramedical occupations; mathematics, statistics and computer science; natural sciences and agriculture; engineering and architecture. These variables appear separately for Israeli universities, Israeli colleges, and foreign academic institutions.

The employment characteristics include dummy variables for the business sectors, grouped as follows: agriculture, forestry, and fishing; manufacturing, mining, water, and electricity; construction; trade; transportation, communications, and hospitality; financial, professional, scientific, and technical services; administration, health, education and welfare.

The employee’s demographic characteristics include year of birth, gender, a dummy variable for immigrants who attended schools in Israel (those who studied outside of Israel were omitted from the analysis, as there are no school characteristics for them), number of years in Israel (for immigrants), whether the employee has children, number of children (as of 2015), age at the time the first child was born, and family status (married, divorced/widowed, or single).

The geographic attributes include migration status between center and periphery. Specifically, one dummy variable is for those who attended upper secondary school in the periphery and later moved to the center of the country, while another variable is for those who attended upper secondary school in the center and moved to the periphery. Also included were the peripherality values of the municipalities of residence. For these variables, the place of residence was the one that applied in the year 2015.

The parental home attributes include dummy variables for the mother's country of origin, the mother's family status when the pupil was 17 years old (married, divorced/widowed, or single), the mother's age and the father's age when the pupil was born, the number of siblings when the pupil was in 12th grade, and the percentile of each parent in the Israeli wage distribution for the year the pupil was age 17.[6]

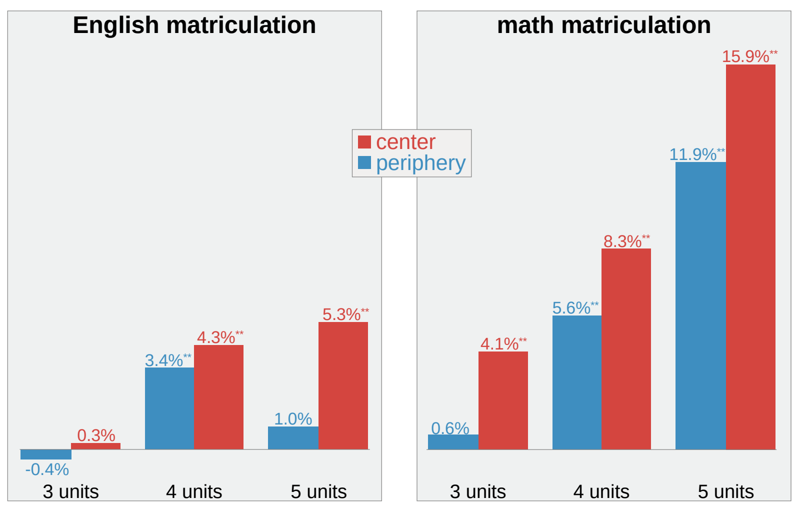
The variables taken from the pupil files (type of school supervision, study track, parents' characteristics and number of siblings) were not complete, and led to the omission of many observations, but a parallel analysis conducted without these variables found that the omission of these observations did not lead to any meaningful change in the results. Ultimately, the analysis was carried out on 511,327 observations, 271,936 of them in the center and 239,391 in the periphery. In addition, the analysis was conducted separately for those born in 1978-1981 and for those born in 1982-1985, to facilitate the examination of changes over time. Variable averages and regression coefficients appear in Appendix 2.

Figure 11 displays the main findings pertaining to math and English matriculation studies (the full results can be found in Appendix 2). After controlling statistically for all the other variables (that is, isolating the impact of math after netting out additional effects from the remaining variables), math matriculation studies were

Figure 11

Wage increments by units of math and English*

relative to individuals with no math matriculation, after controlling for other factors that influence wages



* Data for salaried employees working at least one month in 2012-2016 and born in 1978-1985 either in Israel or immigrated by age 17.

** Statistically significant coefficients (at the 1% level. All other variables that aren't marked are not significant.

Source: Dan Ben-David and Ayal Kimhi, Shoresh Institution
Data: Central Bureau of Statistics

[6] The maternal education level was originally included in the estimation, but was found to have no impact on the wage, after controlling for the other variables.

found to contribute positively to future wages: the higher the number of math units in school, the greater the contribution to wages. Math raises wages more for pupils in the center than for those in the periphery, and its effect is particularly large at the five-unit level in math. Wages of pupils from the center were 16% higher than those who did not take the math matriculation, while the wages of pupils from the periphery were only 12% higher.

As shown in Figure 11, the contribution of English matriculation studies to future wages is substantially lower than that of math matriculation studies. The contribution of English study is higher for pupils in the center, relative to pupils in the periphery, but the gap is substantial only at the five-unit level.

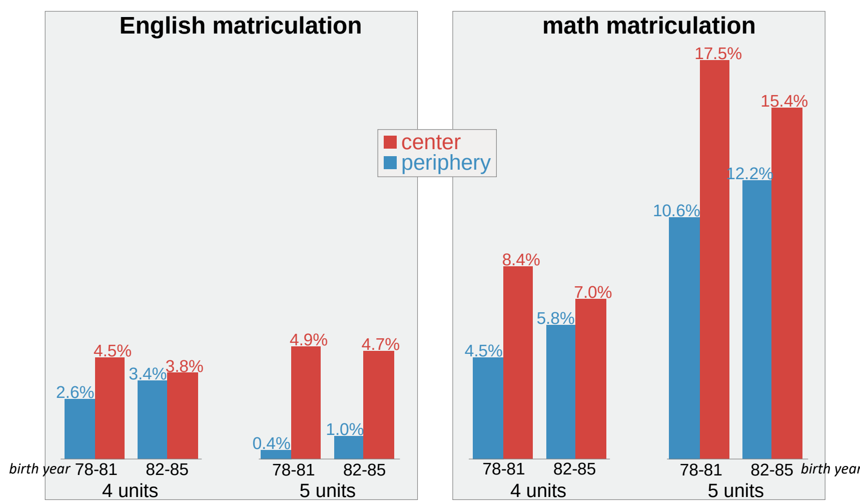
Figure 12 shows that the center-periphery gaps in the return on higher-level math and English matriculation studies are smaller for the later birth cohorts (those born in 1982-1985), but still remained substantial at least in the case of those tested at the five-unit level.[7]

For the other matriculation subjects, the contribution of higher-level study is less substantial. For example, adding one unit of study in the scientific subjects other than math contributes 0.6% to wages for those who attended schools in the center, and 0.4% to wages for those who studied in the periphery.

Figure 12

Wage increments by units of math and English*

for different birth cohorts, in center and periphery, after controlling for other factors



* Relative to individuals with no math matriculation. Data for salaried employees working at least one month in 2012-2016 and born in 1978-1985 either in Israel or immigrated by age 17.

Source: Dan Ben-David and Ayal Kimhi, Shoresh Institution
Data: Central Bureau of Statistics

[7] For this purpose, the wage regression was estimated separately for those born in 1978-1981 and those born in 1982-1985. The results can be obtained from the authors.

To quantify the potential impact of upgraded math study on wage gaps between pupils from the center and the periphery, simulations were performed on the basis of the regression results. The simulations examined two alternate hypothetical scenarios:

Simulation A: All pupils tested at the three-unit level switch to the four-unit level.

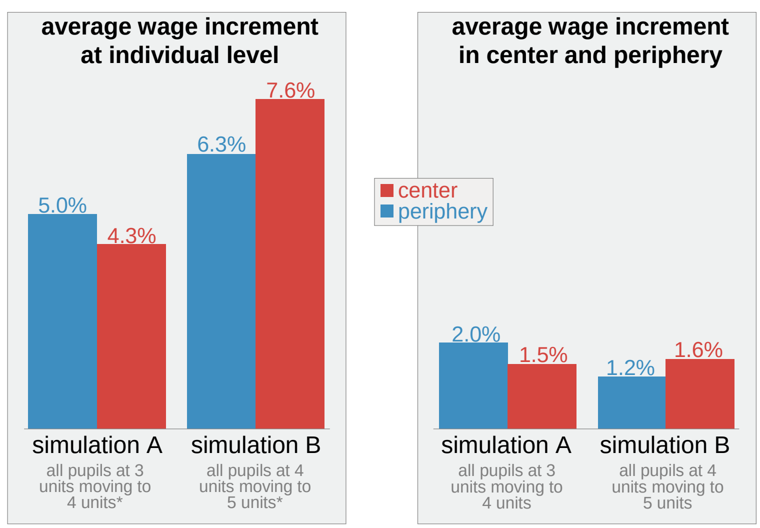
Simulation B: All pupils tested at the four-unit level switch to the five-unit level.

The calculations were carried out separately for pupils in the center and the periphery. For pupils in the center who studied math at the three-unit level, the move to 4 units would have increased their wage by 4.3% (Figure 13).[8] The corresponding result for pupils in the periphery is 5.0%. The percentage of pupils who studied math at the three-unit level is 36% in the center and 41% in the periphery. Thus, assuming that the wage of all remaining pupils (i.e. those who did not study at the three-unit level) remained the same, the average wage of all pupils from the center would go up by 1.5% in simulation A, while the average wage of all pupils in the periphery would rise by 2.0%. As such, raising the level of math for all pupils who studied math at the three-unit level to 4 units would likely reduce the average wage gap between pupils from the center and the periphery by half a percentage point.

Simulation B does a comparable calculation of the wage increase if those who took 4 units of math would go up to 5 units.

Figure 13

Average wage increment from increase of one math unit*



* Simulations showing wage increments resulting from increase of one math unit, assuming that the wages of the other pupils remain constant.

Source: Dan Ben-David and Ayal Kimhi, Shoresh Institution
Data: Central Bureau of Statistics

[8] The wage change in percentage points of pupils tested at the three-unit level, should they move to 4 units, is the difference between the regression coefficients of the variable representing a four-unit math bagrut and the variable representing a three-unit math bagrut.

In this case, the wages of pupils in the center would rise by 7.6%, versus 6.3% for a similar exercise in the periphery. The percentage of pupils who took 4 units of math is 20% in the center and 18% in the periphery. Consequently, if the wage of all pupils not studying math at the four-unit level remains fixed, the average wage of all pupils from the center would rise by 1.5% in simulation B, while the average wage of all pupils from the periphery would increase by 1.2%. In other words, moving all pupils who studied math at the four-unit level to five units would widen the average wage gap between pupils from the center and pupils from the periphery by 0.3 percentage points.

The overall conclusion from these simulations is that while math levels should be raised in both the center and the periphery, this should not be expected to substantially change wage gaps between pupils in the two areas. Boosting the math level only in the periphery would reduce the wage gaps, but even if all pupils in the periphery (and not in the center) were to upgrade their math study level by one unit (a combination of simulation A and simulation B), the wage gap would be expected to decline by 3.2 percentage points, out of a total gap of 11%.

5. Conclusion

Education is a key factor in determining employees' earning ability, with gaps in the quantity and quality of education playing a significant role in the size of wage disparities. This study focused on gaps in the quality of education between upper secondary pupils who studied in the center and those who studied in the periphery, and on the impact of these educational quality gaps on wage gaps between the two groups years later. Disparity in school quality between the center and periphery may stem from inequality in public funding as well as gaps in both teacher and managerial quality.

As in earlier studies, the math matriculation exam level is found to be far more predictive of future earning ability than other matriculation subjects. Those who studied math at the three-unit level earned 27% more than those who studied math at lower levels. This gap grows to 62%

for those who studied math at the four-unit level, and to 115% for those who studied math at the five-unit level.

The wage gap between an average pupil from the center and an average pupil from the periphery is approximately 11%. Wage gaps between pupils from the center and the periphery are not the result of gaps in math levels alone – they also appear among pupils who studied math at similar levels. For example, pupils who studied math at the five-unit level in the center earned 14.3% more than did pupils who took 5 units of math in the periphery.

Academic study narrows the gaps that emerge during upper secondary schooling between pupils from the center and from the periphery. The higher the level of academic study, the smaller the wage gaps between the two groups of pupils. However, the path toward high-level academic study begins with high-level study at the upper secondary level. The lower the level of study in the periphery relative to the center, the harder it is to gain admission to high-level academic study programs, and to successfully complete them. An indication of the quality gap between the center and the periphery is provided by the matriculation scores of pupils from these areas. For example, 43% of pupils from the center – versus 33% of pupils in the periphery – who took five units of math attained scores higher than 90.

The population of the center is not identical in its attributes to that of the periphery. Thus, identification of the wage-education relationship necessitates controlling for as many other population characteristics as possible. This is done by examining the relationship between monthly wages and education via a multivariate regression analysis, which enables identification of the unique contributions of numerous characteristics. These characteristics include detailed data on matriculation exams, academic degrees by type of institution and field of study, information on place of residence and family composition, primary employment sector, and parental demographic and socioeconomic attributes. The regression was estimated separately for pupils from the center and pupils from the periphery. This method made it possible to isolate wage increases resulting from math study. At the four-unit level, subsequent wages were 5.6%

higher in the periphery and 8.3% in the center, relative to pupils who did not take the math matriculation. Math study at the five-unit level adds 11.9% to wages in the periphery and 15.9% in the center of the country. Assuming that the long list of background characteristics included in the regression is sufficient to control for the pupils' background data (socio-economic and other), these gaps reflect differences in the quality of study between schools in the center and the periphery.

The study's simulations suggest that a policy increasing math level would likely reduce the future wage gaps between pupils in the center and the periphery by just a few percentage points. A policy equalizing the quality of study in schools in the periphery with those of the center would produce even better results in terms of narrowing the wage gaps.

In light of the poor mastery of core subjects demonstrated by Israeli pupils compared with those of other developed nations (Israel's average scores in math, science, and reading on the last PISA exam, administered in 2018, place the country near the bottom of the OECD countries), a comprehensive structural reform is urgently needed in the education system to substantially upgrade the level of education throughout the country.

But this is insufficient. For pupils in the periphery to have better opportunities in the labor market and to narrow the gap between them and their counterparts in the center, affirmative action should be practiced vis-à-vis schools in the periphery. That said, the many disparities in key factors affecting education levels indicate that equalization of funding does not translate directly into equal opportunities. Budget increases alone do not provide the complete answer to reducing gaps between schools in the center and those in the periphery. What's important is the way in which these budgets are utilized. One of the main conclusions from this study is that schools in the periphery need to more strongly emphasize math study, as pupil performance in math is a better predictor of labor market achievement than is any other matriculation subject.

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Appendix 1

Division of matriculation subjects to clusters

Scientific subjects	Humanities	Artistic subjects	Foreign languages other than English
Computer sciences	Hebrew	Art	Arabic
Biology	Citizenship	Applied arts	Russian
Physics	Bible	Design	French
Chemistry	History	Music	
Management and economics	Literature		
Electronics	Social sciences		
Electric systems	Geography		
Accounting	Philosophy		
Control systems	Talmudic literature		
Command systems			
Office management			
Chemical technology			
Technological sciences			
Mechanics			
Agriculture			

Appendix 2

Variable means and regression coefficients

Variable	Variable means		Regression coefficients	
	Center	Periphery	Center	Periphery
1-2 math units	0.0455	0.0596	0.0318 ***	-0.0167 ***
3 math units	0.3327	0.3748	0.0407 ***	0.0063
4 math units	0.1810	0.1639	0.0834 ***	0.0558 ***
5 math units	0.1195	0.1019	0.1594 ***	0.1190 ***
Passing grade in math	0.6127	0.6068	-0.0890 ***	-0.0960 ***
Math grade	50.5630	48.6690	0.0014 ***	0.0018 ***
1-2 English units	0.0160	0.0313	-0.0234 **	-0.0074
3 English units	0.1205	0.1992	0.0032	-0.0036
4 English units	0.2054	0.2906	0.0433 ***	0.0339 ***
5 English units	0.3680	0.2113	0.0532 ***	0.0100
Passing grade in English	0.6767	0.6528	0.0101	0.0601 ***
English grade	52.5214	48.8333	0.0001	-0.0005 ***
Studied other languages	0.7007	0.7288	0.0024	-0.0587 ***
Other languages units	1.8839	2.8699	-0.0019 **	0.0057 ***
Passing grade in other languages	0.6799	0.6627	0.0423 ***	-0.0086
Other languages grade	52.6111	51.0035	-0.0004 **	0.0011 ***
Studied other scientific subjects	0.4153	0.4929	-0.0515 ***	-0.0409 ***
Other scientific subjects units	2.6070	3.1961	0.0063 ***	0.0043 ***
Passing grade in other scientific subjects	0.3931	0.4593	-0.0898 ***	-0.0692 ***
Other scientific subjects grade	32.2916	36.9259	0.0019 ***	0.0016 ***
Studied humanities	0.7309	0.7625	0.0033	0.0124 *
Humanities units	6.8243	6.2244	0.0031 ***	0.0002
Passing grade in humanities	0.6040	0.6167	0.0067	-0.0500 ***
Humanities grade	50.5120	51.3977	0.0000	0.0011 ***
Studied arts	0.1031	0.0919	0.0128	-0.0313
Arts units	0.5380	0.4779	-0.0053 ***	-0.0049 ***
Passing grade in arts	0.1008	0.0893	0.1323 ***	0.1272 ***
Arts grade	8.5353	7.5501	-0.0019 ***	-0.0013 ***
Unknown school track	0.0266	0.0112	-0.0914 ***	-0.1175 ***
Vocational school track	0.2758	0.3314	-0.0012	0.0023
National-religious school stream	0.1487	0.1479	-0.0976 ***	-0.0822 ***
Non-national school stream	0.1212	0.0315	-0.1192 ***	-0.1280 ***
Arab	0.0466	0.3039	-0.1093 ***	-0.1689 ***
Humanities, education and arts in university	0.0251	0.0260	0.0308 ***	0.1301 ***
Social sciences in university	0.0527	0.0622	0.1054 ***	0.1285 ***
Business administration in university	0.0313	0.0190	0.4120 ***	0.3892 ***
Law in university	0.0184	0.0107	0.3416 ***	0.3389 ***
Medicine and paramedical occupations in university	0.0211	0.0224	0.2115 ***	0.3063 ***
Mathematics, statistics and computer sciences in university	0.0119	0.0094	0.5259 ***	0.4194 ***
Natural sciences in university	0.0227	0.0144	-0.0208 ***	-0.0566 ***
Engineering in university	0.0271	0.0278	0.3770 ***	0.3559 ***
Humanities, education and arts in college	0.0157	0.0137	-0.0335 ***	0.0818 ***
Social sciences in college	0.0405	0.0320	0.1017 ***	0.0996 ***
Business administration in college	0.0501	0.0259	0.2620 ***	0.2400 ***
Law in college	0.0228	0.0124	0.1130 ***	0.1068 ***
Medicine and paramedical occupations in college	0.0028	0.0027	-0.0247	0.1169 ***
Mathematics, statistics and computer sciences in college	0.0091	0.0036	0.5574 ***	0.4409 ***
Natural sciences in college	0.0018	0.0024	0.0181	-0.0140
Engineering in college	0.0169	0.0200	0.2816 ***	0.2494 ***

(continued on next page)

* coefficient significant at the 10% level
** coefficient significant at the 5% level
*** coefficient significant at the 1% level

Appendix 2 (continued)

Variable means and regression coefficients

Variable	Variable means Center	Variable means Periphery	Regression coefficients Center	Regression coefficients Periphery
Humanities, education and arts abroad	0.0010	0.0023	0.2300 ***	0.2998 ***
Social sciences abroad	0.0011	0.0010	0.1094 ***	0.0437
Business administration abroad	0.0031	0.0020	0.2251 ***	0.2002 ***
Law abroad	0.0002	0.0005	0.3087 ***	-0.0880 *
Medicine and paramedical occupations abroad	0.0012	0.0033	0.2383 ***	0.2790 ***
Mathematics, statistics and computer sciences abroad	0.0003	0.0002	0.3444 ***	0.2340 ***
Natural sciences abroad	0.0002	0.0002	0.1001	0.0695
Engineering abroad	0.0004	0.0003	0.1704 ***	0.1224 *
Agriculture, forestry and fishery	0.0041	0.0210	0.3580 ***	0.3766 ***
Manufacturing, mining, water and electricity	0.0682	0.1141	0.6913 ***	0.6619 ***
Construction	0.0259	0.0551	0.5252 ***	0.4302 ***
Trade	0.1242	0.1073	0.5004 ***	0.4734 ***
Transportation, communication and hospitality	0.1588	0.1524	0.3363 ***	0.3479 ***
Financial, professional, scientific and technical services	0.2552	0.1491	0.6609 ***	0.6197 ***
Administration, health, education and welfare	0.2450	0.2749	0.3826 ***	0.4967 ***
Born in 1979	0.1106	0.1123	-0.0374 ***	-0.0343 ***
Born in 1980	0.1168	0.1179	-0.0646 ***	-0.0660 ***
Born in 1981	0.1118	0.1126	-0.1068 ***	-0.1088 ***
Born in 1982	0.1301	0.1297	-0.1421 ***	-0.1358 ***
Born in 1983	0.1373	0.1372	-0.1826 ***	-0.1807 ***
Born in 1984	0.1411	0.1415	-0.2269 ***	-0.2191 ***
Born in 1985	0.1445	0.1479	-0.2770 ***	-0.2595 ***
Female	0.5360	0.5193	-0.2418 ***	-0.3975 ***
Immigrant who studied in Israel	0.1053	0.1005	0.0046	-0.0097
Immigrant's years in Israel	2.8414	2.7329	0.0006	0.0007
Presence of children	0.6348	0.6733	-0.1166 ***	-0.2713 ***
Age when first child was born	17.1742	18.1066	0.0066 ***	0.0109 ***
Number of children in 2015	1.6113	1.5892	-0.0153 ***	-0.0115 ***
Married	0.6700	0.7041	0.1277 ***	0.1176 ***
Divorced or widowed	0.0373	0.0373	0.0074	0.0277 ***
Migrated from periphery to center or from center to periphery	0.9081	0.8079	0.0428 ***	-0.0414 ***
Peripheriality index as of 2015	2.5143	0.3878	0.0153 ***	0.0106 ***
Mother born in Asia	0.0794	0.0360	-0.0081 **	0.0114 *
Mother born in Africa	0.0948	0.1399	0.0387 ***	0.0479 ***
Mother born in Europe	0.0621	0.0369	0.0045	-0.0046
Mother born in North America or Oceania	0.0140	0.0111	-0.0230 ***	-0.0350 ***
Mother born in Central or Southern America	0.0113	0.0108	-0.0294 ***	-0.0170
Mother born in the former USSR	0.0394	0.0284	-0.0121 **	-0.0181 ***
Mother was married when the child was 17 years-old	0.8905	0.9038	0.0672 ***	-0.0217
Mother was divorced when the child was 17 years-old	0.0832	0.0603	0.0458 *	-0.0357 **
Mother was widowed when the child was 17 years-old	0.0244	0.0315	0.0652 ***	-0.0218
Age of mother when pupil was born	27.8985	27.3258	-0.0016 ***	-0.0024 ***
Age of father when pupil was born	31.2869	30.9962	-0.0001	0.0004
Number of siblings when the pupil was in 12th grade	2.7123	3.3051	0.0014 **	-0.0009 *
Father's income percentile when the child was 17	41.2980	34.5163	0.0004 ***	0.0006 ***
Mother's income percentile when the child was 17	37.9182	28.3002	0.0006 ***	0.0006 ***
Intercept			8.2976 ***	8.5363 ***
Number of observations	271,936	239,391		

* coefficient significant at the 10% level
** coefficient significant at the 5% level
*** coefficient significant at the 1% level