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The Development of Education in Israel and its Contribution to Long-Term Growth

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Abstract

This study discusses the contribution of human capital to Israel's economic output and long-term growth. For this we built historical time series for Israel's average years of schooling, while correcting individual data in order to account only for effective years of schooling, i.e. those that contribute to labor productivity. We find that in 2011 the average years of schooling among the prime working age (25–64) population was 13.5 years—in the center of the OECD distribution. Combining these data with estimates for the macroeconomic return on schooling allowed us to use Growth Accounting methods in order to estimate how increases in schooling contributed to growth. We found that the increase in schooling since the mid-1970's contributed 0.6 to 0.8 percentage points to the average annual growth rate, which is equivalent to 33-45 percent of the total per-capita growth rate during the period.

However, the contribution of schooling to growth began to abate in the last decade, and it is expected to continue fading out: We conducted forecasts for the average years of schooling in the next 50 years, which point to the contribution to growth further declining, to 0.1 to 0.3 percentage points. The range partly reflects uncertainty regarding the ultra-Orthodox population's degree of integration in the effective education systems.

When examining additional aspects of human capital beyond that of the quantity of schooling, we find that Israel is behind the OECD countries in the quality of education, mainly at the secondary level. However, it is not out of line in the quality of universities or in the inequality in the distribution of years of schooling.

התפתחות ההשכלה בישראל ותרומתה לצמיחה ארוכת הטווח

איל ארגוב

תקציר

מחקר זה דן בתרומה שההון האנושי מרים להתפתחות התוצר ולצמיחה ארוכת הטווח. כדי לערוך אותו בנינו סדרות עתיות למספר הממוצע של שנות ההשכלה במשק, תוך שאנו מתקנים את נתוני הפרט כדי לשקף את ההשכלה האפקטיבית, כלומר ההשכלה התורמת לפריון בשוק העבודה. מצאנו כי המספר הממוצע של שנות הלימוד באוכלוסייה המצויה בגילי העבודה העיקריים (25—64) עמד ב-2011 על 13.5 שנים – במרכזה של התפלגות הנתון במדינות ה-OECD. שילוב אומדנים לתשואה המקרו-כלכלית מהשכלה אִפשר לנו להשתמש בחשבונאות צמיחה (Growth Accounting) כדי לאמוד כיצד הגידול בהשכלה תורם לצמיחה. מצאנו כי העלייה שחלה בהשכלה מאמצע שנות ה-70 תרמה לצמיחה השנתית בין 0.6 ל-0.8 נקודת אחוז בממוצע, ותרומה זו מהווה 33%—45% מסך הגידול שחל באותה תקופה בתוצר לנפש.

אולם אפקט ההשכלה החל להתמצות בעשור הקודם, והוא צפוי להמשיך לדעוך: ערכנו תחזית לגבי התפתחות המספר הממוצע של שנות ההשכלה בחמישים השנים הבאות, ומצאנו כי תרומת הגידול בהשכלה לצמיחה תתכווץ במרוצת תקופה זו ל-0.1—0.3 נקודת אחוז. המיקום בטווח זה תלוי בין היתר באופן שבו האוכלוסייה החרדית הגדֵלה תשתלב במעגל ההשכלה.

כאשר בוחנים מדדים נוספים להון האנושי מוצאים כי ישראל מפגרת אחרי מדינות ה-OECD באיכות ההשכלה, בעיקר בשלב התיכון. לעומת זאת, ישראל אינה חריגה באיכות האוניברסיטאות ובאי-השוויון בהתפלגות ההשכלה.

1. Introduction

Israel's expected growth rate in coming decades is an issue of great importance to the welfare of its citizens, the planning of long-term fiscal policy, and the formulation of short-term policy, including monetary policy, and it is therefore important to estimate it. However, the rate of growth is determined by numerous factors, the estimation of which presents many challenges. This study is part of a large-scale project that is meant to deal with those challenges.

An analysis of the rate of long-term economic growth is usually based on the Growth Accounting methodology developed by Solow, which decomposes the components of growth into factors of production and the efficiency of their use (i.e. productivity). This framework examines the expected rate of growth of each factor of production and of productivity, and combines them using an aggregate production function.[1] The basic analysis of the sources of growth includes among the factors of production only labor input and the stock of physical capital. Braude (2013) and Geva (2013) have carried out such an analysis, and found that the demographic changes that Israel is undergoing are expected to slow the economy's rate of growth relative to previous decades. In particular, the expansion of labor input (and of output as a result) will be influenced by both the expected slowdown in the growth of the non-ultra-Orthodox Jewish prime working age population and the increased share of the sectors characterized by low participation rates, such as the ultra-Orthodox, Arabs and individuals aged 65 and over. However, Romer, Mankiw and Weil (1992), followed by Hall and Jones (1999), showed that Solow's neo-classical model can be extended to also include the quality of the labor input, since this will help to explain the income gap between countries and to bridge the gap between the model and the empirical data.[2] Therefore, the current study adds the stock of human capital—which reflects the quality of labor input— to the analysis of sources of growth.

A commonly used and feasible way of measuring the stock of human capital in the economy uses the average years of schooling in the population (or among the employed) and combines it with estimates of the return on schooling, i.e. the extent to which years of schooling affects income. An estimate of the return on schooling serves as one of the main components in a model that includes human capital. The return on schooling can be estimated using either a microeconomic approach (using data on individuals) or a macroeconomic approach (using international cross-sections). Below we will survey the empirical findings obtained using these two approaches, and will see that despite the

[1] See, for example, Johansson et al. (2012). They created long-term forecasts for each of the OECD countries, including Israel.

[2] Other researchers feel that education can only somewhat explain the income variation between countries, and that the correlation between education on the one hand and income and growth on the other reflects reverse causation (from income to education) or some omitted variable. See Klenow and Rodriguez-Clare (1997) and Bils and Klenow (2000).

differences between them, the estimates of the return on schooling are similar (about 10 percent per year of schooling).

In the main body of the article, we will use the Labor Force Survey to calculate historical estimates of the average years of schooling in the economy since the end of the 1960s. We process the raw data in the Survey in order to take into account that a portion of the reported years of schooling makes only a negligible contribution to professional skills and to productivity in the labor market. In particular, we adjust the data on the schooling of ultra-Orthodox men, which the Survey treats as regular years of schooling even though their education largely consists of religious learning and does not improve productivity in the labor market (a claim which is partly based on the empirical estimation of a wage regression). The calculation of the historical series makes it possible to estimate the contribution of the increase in education to output and growth during the last forty years. In addition, the research includes a forecast of the average years of schooling during the next fifty years.[3] The forecast is based on assumptions regarding the schooling patterns of various population groups in the long term (regarding the rate of growth of years of schooling among the young, the patterns of schooling among the ultra-Orthodox as they enter the labor market, etc.) and on a demographic forecast of the proportions of the various groups in the population. As will be seen, the aforementioned demographic changes are expected to also affect the stock of human capital.

The analysis shows that overall, the growth in years of schooling has made a significant contribution to the growth in per capita GDP during the last forty years, but that this contribution is expected to diminish significantly during the next fifty years, due in large part to the exhaustion of the growth in years of schooling that educated individuals decide to acquire. Thus, the proportion of individuals with 13 or more years of schooling has already doubled, from about 25 percent in the 1980s to more than 50 percent in 2011. In order for the average years of schooling to increase, the period of schooling must be extended to beyond just undergraduate and graduate degrees. However, this extension is constrained both from the supply side (i.e. the liquidity constraint that forces individuals to enter the labor market at some point) and from the demand side (i.e. there are apparently only a limited number of professions in the business sector in which there is a return on schooling beyond a graduate degree). This phenomenon of the exhaustion of growth potential can also be seen in other advanced countries. Thus, Gordon (2014) estimates that in the US this exhaustion of potential will reduce the contribution of education to growth by about 0.2 percentage points relative to previous decades.

Although the average years of schooling is generally viewed as an indicator of the stock of human capital, there are clearly other variables that affect it. Some of them are unrelated to education (such as the health of the population and work experience), while

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[3] For the sake of brevity, we sometimes use “average education” instead of "average years of schooling".

others are related to education, though they are not reflected in the average years of schooling, which only measures quantity. It may be, for example, that the economy's return on the schooling that individuals acquire is influenced by the manner in which education is distributed among individuals (Castello and Domenech, 2002). Furthermore, the return is also influenced by the quality of the education system at it various levels (Hanushek and Woessmann, 2012 and Islam et al., 2014). In the context of this study, we do not attempt to estimate the contribution of these factors to growth in Israel or to predict their future contribution, although in the final section of the paper we will discuss the various ways to measure them and Israel's ranking according to the various rating methods for the advanced countries. In particular, we will examine inequality in the distribution of years of education according to the Gini index, and the quality of education in Israel according to the inputs invested in education (expenditure on education, class size, etc.) and according to the results of the education system (test scores and international rankings of universities). In addition, we will relate the findings to the empirical literature that has estimated the effect of these variables on long-term growth.

The rest of the paper proceeds as follows: Section 2 presents the methodology for calculating the contribution of human capital to GDP and to growth in Israel. In Section 3, we calculate the average years of schooling in Israel and apply the aforementioned methodology in order to examine the contribution of education to GDP and growth from 1970 to 2011. In Section 4, we present a forecast of the average years of schooling in Israel and its expected contribution to growth until the year 2059. In Section 5, we examine the sensitivity of the forecast to the main assumptions. In Section 6, we look at Israel's ranking according to measures that reflect additional aspects of the level of human capital. We conclude by summarizing the main results.

2. The methodology for calculating the contribution of human capital to GDP and growth

The methodological framework is based on the Growth Accounting methodology developed by Solow (1957). This framework is frequently used to analyze the sources of growth (see, for example, Jorgenson, 1995). In addition, it is used for Development Accounting, i.e. to estimate the sources of gaps between countries in level of per capita (or per worker) GDP. The latter includes studies that have estimated the contribution of the stock of human capital to such gaps, including key studies such as Mankiw, Romer and Weil (1992), Kenow and Rodriguez-Clare (1997), and Hall and Jones (1999).

We will assume that the economy uses labor input (hours) and the physical and human stocks of capital to produce output according to a neo-classical Cobb-Douglas production function, which is characterized by constant returns to scale:

$$(1) \qquad Y_t = A_t K_t^{\alpha} \left(h_t L_t\right)^{1-\alpha}$$

where:

Y – GDP
A – total factor productivity (TFP)
K – stock of physical capital
h – stock of human capital
L – labor input (hours)
α – share of capital in output

In this equation, the stock of human capital (h) is included in the basic Cobb-Douglas function as labor-augmenting. We could have also included it in total factor productivity (TFP) since it does not affect the analysis of contributions to growth that we are focusing on. Although some researchers have taken a different route by including the stock of human capital as a third input that receives a share of output (at the expense of the shares of physical capital and labor)[4], we prefer the functional form in Equation (1) since it emphasizes that unlike the stock of physical capital, the stock of human capital cannot be separated from the worker that uses it or from labor input in terms of hours.[5]

The data for GDP and labor input appear in the National Accounts. The data for the stock of physical capital is generally estimated using the Perpetual Inventory Method, which sums the investments over time on the basis of assumptions regarding the lifespan of capital. The stock of human capital is measured using the Mincerian method (Mincer, 1979), which was applied by Hall and Jones (1999) in a macroeconomic context. In accordance with this approach, we will use a function that links the stock of human capital to the average years of schooling in the economy:

$$(2) \qquad h_t = e^{S_t r}$$

where:

S = average years of schooling in the economy

r = return on schooling

With respect to the average years of schooling in the economy (S), most studies use the average for the prime working age population (ages 25–64). Although it can be claimed that using the years of schooling among the employed is more effective, international comparisons in general use the average for the population (working age or prime working age), since data for only the employed is less accessible. In this study, we present results for Israel according to the years of schooling of the employed and also based on years of schooling for the population as a whole. These data are based on the Labor Force Survey and the data for the population as a whole can be used for international comparison.

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[4] See, for example, Mankiw, Romer and Weil (1992).
[5] Hall and Jones (1999) also use this form.

When including human capital in an analysis, it is necessary to estimate the return on schooling (*r*), which can be measured using the microeconomic approach, the semi-macroeconomic approach or the full macroeconomic approach. In the microeconomic approach, the contribution of an individual's years of schooling to his labor productivity is estimated. In the absence of a measure of productivity on the level of the individual, wages are used. The generally used framework includes a Mincerian regression where the dependent variable is the logged wage of the individual and the explanatory variables are his characteristics, particularly years of schooling. Frisch (2007) used this approach and found that the return on schooling is 8–9.5 percent in Israel. In contrast, Zussman and Friedman (2009) found that the transition from 11–12 years of schooling to 13–15 years yields a return of 36 percent, and the transition to 16+ years yields a return of 65 percent (relative to 11–12 years). Psacharopoulos and Patrinos (2002) gathered the findings on return on schooling for a large number of countries, which had been estimated using the microeconomic approach. Morrison and Murtin (2010) used this international data to conclude that the return on schooling declines as the average years of schooling in the economy increases. This is the semi-macroeconomic approach. In the full macroeconomic approach, the return on schooling is estimated from cross-sections or panels on the country level. In other words, the dependent variable is GDP (or labor productivity) and the explanatory variables include average years of schooling in the economy. There is a high level of variance in the empirical findings for return on schooling on the macroeconomic level, even when one focuses on the advanced countries. To illustrate, Arnold, Bassanini and Scarpetta (2007) found that the return on schooling is 6–9 percent; Basssanini, Scrapetta and Hemmings (2001) found that it is about 10 percent; Barro and Lee (2010) found it to be about 12 percent (after taking into account the endogenous adjustment of the stock of physical capital)[6]; and Bouis, Duval and Murtin (2001) found it to be 8–15 percent. Bergman and Marom (2005) also used the macroeconomic approach and estimated the return on schooling using a panel regression for 32 industries in the Israeli economy, and arrived at a return of about 7 percent.

There is of course a tradeoff between the advantages and disadvantages of the two approaches: The macroeconomic approach yields a much smaller number of observations, and requires the assumption that different countries have the same return on schooling, while the microeconomic approach does not take into account the cross-effects among individuals.[7] Furthermore, it may be that the return on schooling for individuals is larger than the economy's return (the contribution to productivity), since the acquisition of education is also a signal of ability relative to other individuals and the measured microeconomic return is therefore biased upward. We will therefore assume in the basic

[6] In contrast to Morrison and Murtin (2010), they find that the return on schooling rises from zero percent for a year of primary education to 10 percent for a year of secondary education, and about 20 percent for a year of higher education.
[7] In other words, the approach does not take into account the way in which a change in the characteristics of one individual influences the productivity of other individuals.

analysis that the return on schooling is fixed at 8 percent, i.e. the lower bound of the microeconomic findings and within the bounds of the more reasonable findings according to the macroeconomic approach. Given a time series of average education and the assumed return on schooling, it is possible to build a measure of the stock of human capital using Equation (2) above. We would mention that in Section 6, we will examine the sensitivity of the results to alternative estimates of the return on schooling, and also the possibility that the return declines as the number of years of schooling increases according to the equation $r = 0.125 - 0.002 * S$, as claimed by Morrison and Murtin (2010).

With respect to the growth of TFP, it can be calculated as the Solow residual from Equation (1), using data for GDP, the stock of physical capital, the stock of human capital and labor input.

$$(3) \qquad \Delta \log(A_t) = \Delta \log(Y_t) - \alpha \Delta \log(K_t) - (1-\alpha)\left[\Delta \log(h_t) + \Delta \log(L_t)\right]$$

In order to calculate the Solow residual, we will assume that the share of capital in output, α, is 1/3.

In the final stage, we will seek to calculate how the rate of growth of each component (TFP, stock of human/physical capital and labor input) contributes to the rate of growth of per capita GDP, since it reflects the improvement in the standard of living in Israel. In order to capture the total contribution of these components to output as accurately as possible, we will deviate from the basic Growth Accounting methodology and will view the stock of physical capital, *K*, as an endogenous variable with respect to the long-term trends in the other components (since they affect output, which in turn affects the stock of capital). In the long term, in contrast, the ratio of the stock of physical capital to output, *K/Y*, is considered to be fixed and not dependent on the level of other components.[8] We will carry out some simple operations in Equation (3) in order to present growth in output as a function of the various components, particularly the change in the ratio of capital to output (as in Hall and Jones (1999) and others). In addition, we will express the equation in terms of output per capita ($y=Y/POP$) as the dependent variable, where the explanatory variables include the rate of population among the prime working ages ($pop'=POP^{25\text{-}64}/POP$) and the labor input per capita in the prime working ages ($l=L/POP^{25\text{-}64}$) (*POP* and $POP^{25\text{-}64}$ are the total population and the prime working age population, respectively). The first explanatory variable, *pop'*, captures demographic developments while the second, *l*, expresses the intensity of employment in the economy.

$$(4) \qquad \Delta\log(y_t) = \frac{1}{1-\alpha}\Delta\log(A_t) + \frac{\alpha}{1-\alpha}\Delta\log\left(K_t/Y_t\right) + \Delta\log(h_t) + \Delta\log(l_t) + \Delta\log(pop'_t)$$

[8] This is an acceptable result in neoclassical models that are used to explain long-term growth. See Chapters 2 and 5 in Aghion and Howitt (2009).

In order to calculate the contribution of each component to growth, the coefficient of each variable is multiplied by its rate of change. It is important to mention that the contribution of the stock of human capital (the third component), as it is estimated in this study, does not necessarily exhaust the contribution of education to growth. First, the amount of education can indirectly affect labor input. Thus, on the one hand, it reduces the number of employed since the period of schooling is lengthened, while on the other hand it delays the average age of retirement since more educated individuals tend to retire later. Furthermore, part of the empirical literature has found that the **level** of education also contributes to the **rate of growth** by way of total productivity (A). Various studies, such as Barro and Sala-i-Martin (1955a, ch. 13), Benhabib and Spiegel (1994), Kruger and Lindahl (2001) and Acost-Ormaecha and Morozumi (2013), carried out panel regressions and found positive correlations between the level of education and the rate of growth, although some of them found that the correlation was mostly due to the developing economies. In other words, the level of education is important to growth when the country is in a process of converging to the technological frontier. According to another hypothesis examined in various studies, the benefit of education to a country is dependent on both the type of education and the country's stage in the process of convergence. Thus, primary education is more beneficial in the **adoption** of technologies or their imitation, while tertiary education is more important for innovation. Therefore, countries who are more distant from the technological frontier should invest in primary education, while countries closer to it should invest in tertiary education.[9] Since the findings are not unambiguous, this article relates only to the effect of the level of education on the level of output rather than its rate of growth.

3. The average level of education and the contribution of human capital to growth between 1970 and 2011

3.1 The average years of schooling: method of calculation

In the first stage, we use the data from the Labor Force Survey and calculate the average years of schooling according to various cross-sections: among the working age population (15+), among the prime working age population (25–64), and among the employed. As part of the calculations, we made some adjustments to the Labor Force Survey data, with the goal of at least partially capturing effective education in the labor market. The following describes the main adjustments:

First adjustment: We omitted observations with zero years of schooling (which constituted 1.4 percent of the prime working age population in 2011). This was done because in 1995 there was a disjoint in the definition which led to a significant shift in the

[9] See Section 13 of Aghion and Howitt (2009); Vandenbussche, Aghion and Meghir (2006); and Aghion, Bouston, Hoxby and Vandenbussche (2005).

weight of the uneducated (from 0.4 percent in the 1994 Survey to 3.4 percent in the 1995 Survey).

Second Adjustment: We limited the years of effective schooling to 22, based on the assumption that from that point onward the additional schooling has no significant effect on productivity. In other words, we attributed 22 years of schooling also to workers who reported more than that in the Survey. In 2011, these observations constituted 1 percent of the prime working age population and this population segment had an average of 26 years of schooling.

Third Adjustment: According to the raw data for ultra-Orthodox men[10] (of prime working age), their average years of schooling was 16.2 in 2011. We limited the number of years to 10 since studies in a yeshiva appear in the Survey as regular years of schooling, even though they are not intended to increase human capital in the labor market, and also because the relative neglect of core subjects in ultra-Orthodox schools is reflected in limited work skills at the end of 12 years of schooling.

The calibration of the reduction was carried out on the basis of wage regressions that were estimated using data from the 2011 Income Survey.[11] The explanatory variables include the individual's years of schooling, a dummy variable for the ultra-Orthodox, and an interaction of the ultra-Orthodox with years of schooling, while distinguishing between individuals with 12 years of schooling or less and those with over 12 years of schooling.[12] The regression results appear in columns (1) and (2) of Table 1. The coefficient of "years of schooling" in the regressions is evidence that among the non-ultra-Orthodox (women and men) the return on schooling is about 9 percent, somewhat higher than the main estimate obtained in our analysis. An analysis of column (1) reveals that the coefficient of the "ultra-orthodox * years of higher education" interaction has a negative value and is of similar magnitude to that of the coefficient for general education. In other words, for ultra-Orthodox men, the return on schooling is equal to zero starting from the 12th year of schooling.

[10] A respondent is considered to be ultra-Orthodox if the last educational institution he attended or that one of his first-degree relatives (spouse or children) attended is a yeshiva.

[11] This was the last Survey available when the research was carried out. The results are not sensitive to the year of the Survey.

[12] Since the respondents are considered to be ultra-Orthodox when a yeshiva is their last educational institution attended, there were few observations that reflect a low number of years of schooling. Therefore, unreasonable results are obtained for ultra-Orthodox men and women who have less than 12 years of schooling. These results are reflected in a very negative coefficient (-1.8) for ultra-Orthodox men and in a very high return on schooling (23 percent) in the initial years. These two opposing variables offset each other when we get close to 12 years of schooling. Similar results were obtained for women.

Table 1: The factors affecting wages Explanatory variable - log of hourly wage from salaried work				
Column Year Gender	(1) 2011 Men	(2) 2011 Women	(3) 2004 Men	(4) 2004 Women
Dummy for 15–17 age group	-0.888	-0.984	-0.793	-0.751
Dummy for 18–24 age group	-0.323	-0.490	-0.381	-0.464
Dummy for 25–34 age group	-0.200	-0.179	-0.170	-0.125
Dummy for 45–54 age group	0.034	0.043	0.072	0.093
Dummy for 55–64 age group	0.066	0.066	0.054	0.096
Dummy for 65+ age group	-0.036	-0.070	-0.035	-0.004
Dummy for Arab	-0.251	-0.138	-0.172	-0.031
Dummy for married	0.223	0.105	0.196	0.147
Years of schooling	0.089	0.087	0.083	0.078
Dummy for ultra-Orthodox	-1.849	1.302	0.962	1.296
Ultra-Orthodox * low years of schooling	0.142	-0.114	-0.097	-0.116
Ultra-Orthodox * high years of schooling	-0.080	-0.019	-0.043	0.019
Dummy for an immigrant 0–3 years	-0.332	-0.362	-0.630	-0.540
Dummy for an immigrant 4–6 years	-0.311	-0.268	-0.563	-0.481
Dummy for an immigrant 7–9 years	-0.248	-0.243	-0.437	-0.398
Dummy for an immigrant 10–12 years	-0.210	-0.218	-0.370	-0.325
Dummy for an immigrant 13–14 years	-0.155	-0.125	-0.336	-0.268
Constant	2.528	2.420	2.467	2.342
Number of observations	8,272	8,497	7,728	7,531
R-square	0.330	0.289	0.319	0.289
Source: Based on Central Bureau of Statistics.				

[a] Based on the wage equations specified by Mincer (1974) and estimated using data from the Income Survey.

[b] All coefficients are statistically significant at the 1 percent level except for:

- Coefficients significant at the 5 percent level: "Dummy for age 55-64" in Regression (3); "Dummy for age 45-54" in Regression (2); "Ultra-Orthodox * High years of schooling" in Regression (3).
- Coefficients significant at the 10 percent level: "Ultra-Orthodox * Low years of schooling" and "Dummy for Ultra-Orthodox" in Regressions (1) and (2); and "Dummy for age 45-54" in Regression (1).
- Coefficients that are not significant at the 10 percent level: "Dummy for age 55-64" in all Regressions; "Dummy for Arab" in Regression (4); "Ultra-Orthodox * High years of schooling" in Regression (2); and "Ultra-Orthodox * Low years of schooling" and "Dummy for Ultra-Orthodox" in Regressions (3) and (4).

[c] The regression coefficients are based on weighted observations according to the observation weights of the population.

[d] "Ultra-Orthodox * Low years of schooling": Interaction of the dummy variable for ultra-Orthodox with $(S_i,12)$min, where S_i represents the original number of years of schooling obtained by the individual.

"Ultra-Orthodox * High years of schooling": Interaction of the dummy variable for ultra-Orthodox with $(S_i,12)$max, where S_i represents the original number of years of schooling obtained by the individual.
In this structure, the coefficient of "Ultra-Orthodox * Low years of schooling" reflects the return on a year of schooling up to the 12th year (relative to the general population), and the coefficient of "Ultra-Orthodox * High years of schooling" reflects the return on schooling beginning with the 12th year (relative to the general population).

[e] The base group for the dummy coefficients of the age groups includes those aged 35-44.

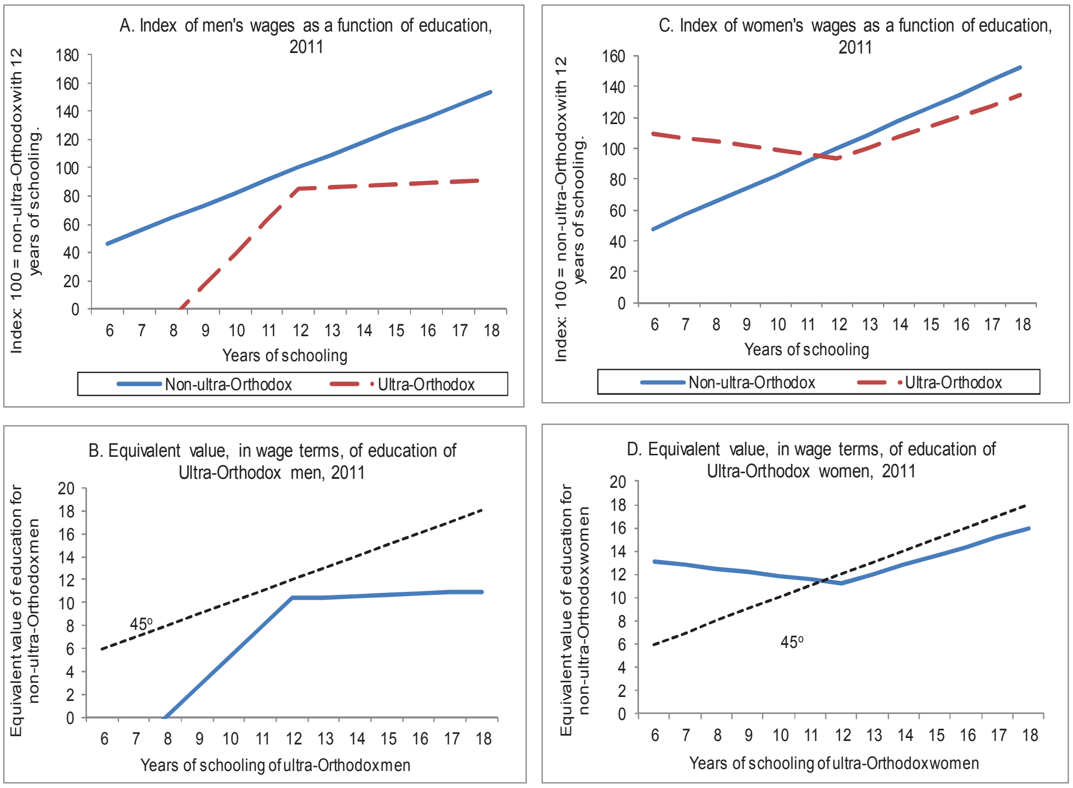
[f] The stability of the first equations was examined relative to the Income Survey year, the cut-off point in the low/high years of schooling, and the use of groups of years of schooling instead of the conescutive variable.

From the results of these regressions, we can derive a measure for wages as a function of education, for both the ultra-Orthodox and the non-ultra-Orthodox (panels (a) and (c) in Figure 1). We can also determine the point at which the years of schooling of the ultra-Orthodox become equal in value (in terms of wages) to those of the non-ultra-Orthodox (panels (b) and (d) in Figure 1). The graphs make it clear that the wages of ultra-Orthodox men hardly increase at all after 11 years of schooling and their wages are on average equal to those of non-ultra-Orthodox men with 10 years of schooling.

In analyzing the wages of ultra-Orthodox women, we used the years of schooling that appear in the Survey, without any adjustment. The results of the regression in column (2) of Table 1 show that although for ultra-Orthodox women with 12 years of schooling or more the coefficient of interaction is negative (-2 percent), it is not significant. In other words, for educated ultra-Orthodox women, the return on schooling is certainly positive and is not significantly different from that of non-ultra-Orthodox women. Panel (d) of Figure 1 shows that the wages of ultra-Orthodox women (with 12 or more years of schooling) are equal in value to those of non-ultra-Orthodox women with 1.5 years less schooling, and the difference is not statistically significant.

Figure 1

Years of Schooling and Their Effect on the Ultra-Orthodox and Non-Ultra-Orthodox



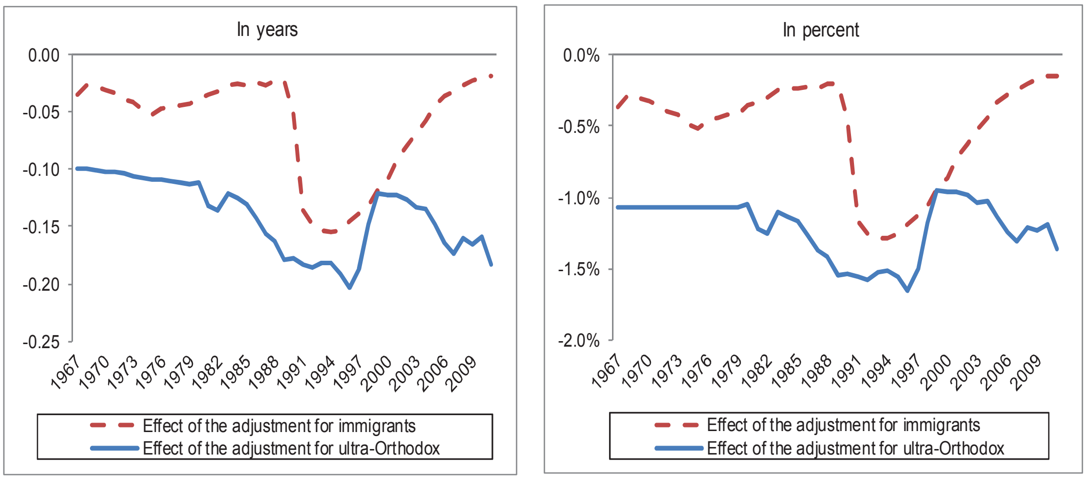
SOURCE: Based on Central Bureau of Statistics.

Fourth adjustment: We reduced the years of schooling of immigrants in the period following their arrival, on the assumption that the education they acquired in their country of origin becomes effective only after they have acclimatized in Israel. We assumed that in the year of their arrival the education of immigrants with more than 12 years of schooling is equal to the education of veteran Israelis with three years less of schooling. However, during the first 10 years in Israel, the education of an immigrant becomes fully effective (a technical explanation of the reduction appears in Appendix A). The calibration of the initial reduction is based on the wage regressions that were estimated using data from the Income Survey for 2004. We chose that year so that the Survey would include enough immigrants whose period after arrival ranged from 0 to 10 years. The results appear in columns (3) and (4) of Table 1. The coefficients of the regression for the dummy for immigrants who have been in the country for 0–3 years show that among male (female) immigrants wages in the year of arrival are about 63 percent (54 percent) lower than among veteran Israelis. In contrast, the dummy for an immigrant who has been in the country for 10–12 years shows that after about 10 years the wages of male (female) immigrants are only 37 percent (32 percent) lower. We assume that the gap that remains after 10 years is not a manifestation of lower productivity. Thus, in the year of arrival the component of productivity among male (female) immigrants is 26 percent (22 percent), and is equal to the marginal return on approximately 3.0 years of schooling.[13]

Figure 2 shows how the two aforementioned adjustments (in the education levels of the ultra-Orthodox and immigrants) affect the average education of the prime working age population. The graph shows that the adjustment for the ultra-Orthodox lowers the average education for the entire sample, and that the effect gradually intensifies from about 0.1 years of schooling in 1970 to about 0.2 years of schooling at the end of the sample. Since the decline is uniform over the period, the adjustment is not significant from the perspective of changes in education that determine to what extent increases in human capital contribute to growth. (When we calculated the forecast, we found that the adjustment for the ultra-Orthodox has a more significant effect on the long-term growth rate, due to the expected growth in their share of the population.) The adjustment for immigrants reduces the average education by 0.15 years at the beginning of the 1990s, but in the 2000s it already has no significant effect on the average level of education.

[13] Eckstein and Weiss (2004) and Cohen-Goldner and Eckstein (2008) showed that at the time of arrival the education that an immigrant acquired in his country of origin has a zero rate of return. In addition, the return rises over time and with the accumulation of local experience, but does not catch up to the return enjoyed by veteran Israelis.

Figure 2
Adjustment for the Education of the Ultra-Orthodox and Immigrants: Effect on the Average Years of Schooling of the Prime Working Age Population (25–64), 1967–2011



SOURCE: Based on Central Bureau of Statistics.

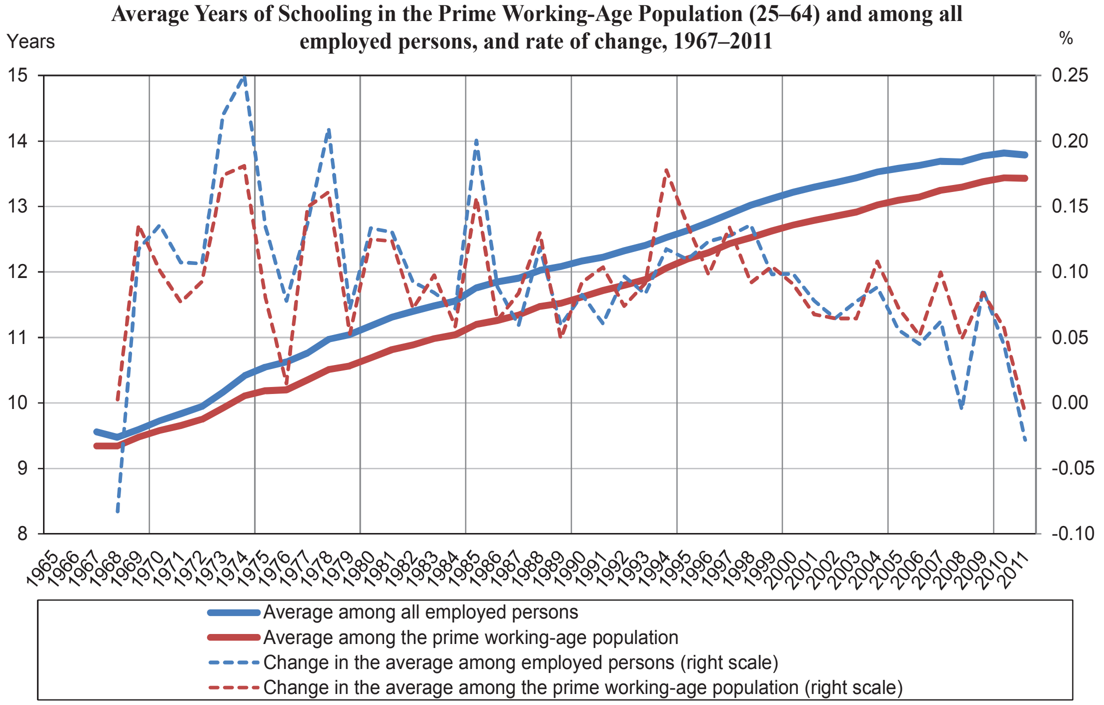
Clearly, these are only partial adjustments, since they do not include some of the components that explain the quality of education and that certainly affect the stock of human capital. To illustrate, we did not adjust for effective education in the case of the Arab population, even though according to the wage equations, their wages—which are an approximation for productivity on the level of the individual—are lower than those of the Jewish population. It is highly possible that the explanation is in part related to the fact that the education system in the Arab sector is less effective, which is reflected in the low skill levels of its graduates[14], or that their main language—Arabic—is not commonly used in the labor market, although other explanations are also possible. Similarly, we did not take into account the quality of primary or secondary education in Israel, as reflected in the country's ranking according to international tests (PISA), nor the fact that a significant portion of the growth in tertiary education during the last decade occurred in the colleges rather than the universities.[15] It would be difficult to integrate these factors into a measure of the past stock of human capital and even more so in the case of the expected stock of human capital. In Section 6, we will return to the aspects of education that may influence the stock of effective human capital.

[14] According to the analysis that appears in Bank of Israel (2016), 77 percent of the gap in hourly wages for Arab men is explained by a low level of basic skills, as measured by a survey of adult skills (PIAAC).
[15] Zussman et al. (2007) found that in many fields of study the return on schooling of graduates holding a bachelor's degree from the academic colleges was lower than that of university graduates.

3.2 The average years of schooling and their contribution to growth

Figure 3 relates to Israel during the period 1967–2011 and describes the trends in the average (effective) years of schooling for the prime working age population (25–64) and among the employed.[16] The figure shows that between 1970 and 1979, the average grew relatively quickly due, among other things, to the wave of educated immigrants from the FSU and the expanded application of the Free Compulsory Education Law during the 1970s (Karief, 2008). Between 1980 and 2000, the average rose fairly monotonically (except for a shallow trough at the peak of the wave of immigration during the early 1990s).

Figure 3
Average Years of Schooling in the Prime Working-Age Population (25–64) and among all employed persons, and rate of change, 1967–2011



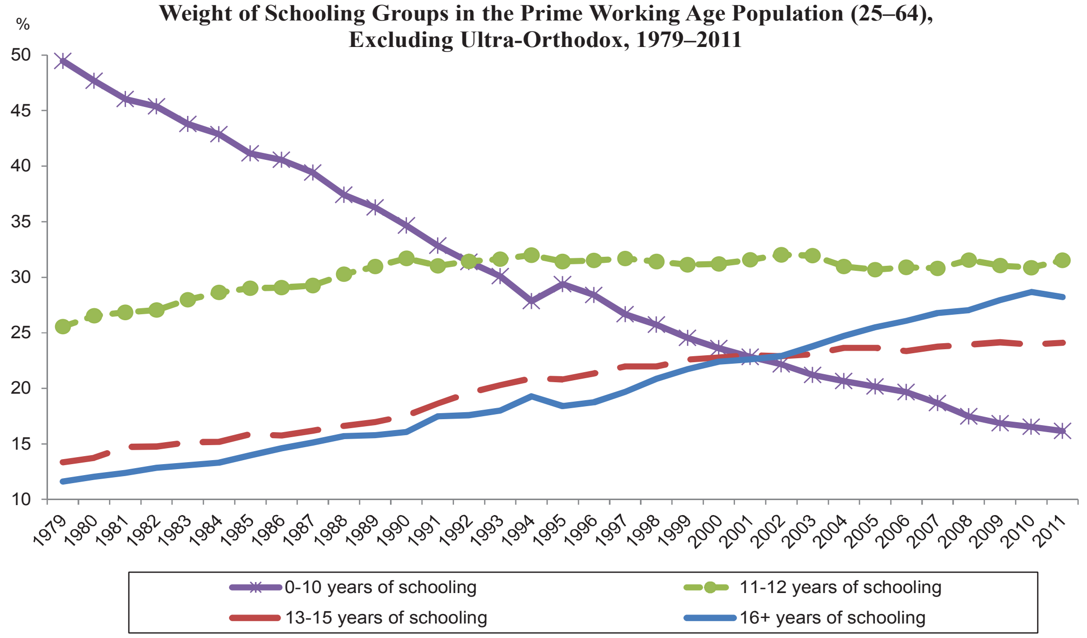
SOURCE: Based on Central Bureau of Statistics.

Figure 4 relates to the various categories of education (up to 10 years of schooling, 11–12 years, 13–15 years, and 16+ years) and shows their share of the working age population (without the ultra-Orthodox). The graph shows that the long-term growth in the average years of schooling reflects a continuing decline in the proportion of

[16] The data from the Labor Force Survey do not make it possible to identify the ultra-Orthodox prior to 1979. This is also the case for individuals over the age of 65. Therefore, we took the adjusted data for the prime working age population and chained it with the parallel data for the period 1967–79 for the whole working age population without the adjustment for the ultra-Orthodox, while preserving the rate of change between the years.

individuals lacking a secondary education (up to 10 years of schooling), simultaneous with an increase in the proportion of individuals possessing tertiary education (more than 13 years of schooling).[17] Starting in the 2000s, there was an uninterrupted decline in the rate of growth in average years of schooling. Meanwhile, the proportion of individuals with 13–15 years of schooling stabilized and the proportion of those who continued on to more advanced degrees (16+ years of schooling) increased.

Figure 4
Weight of Schooling Groups in the Prime Working Age Population (25–64), Excluding Ultra-Orthodox, 1979–2011

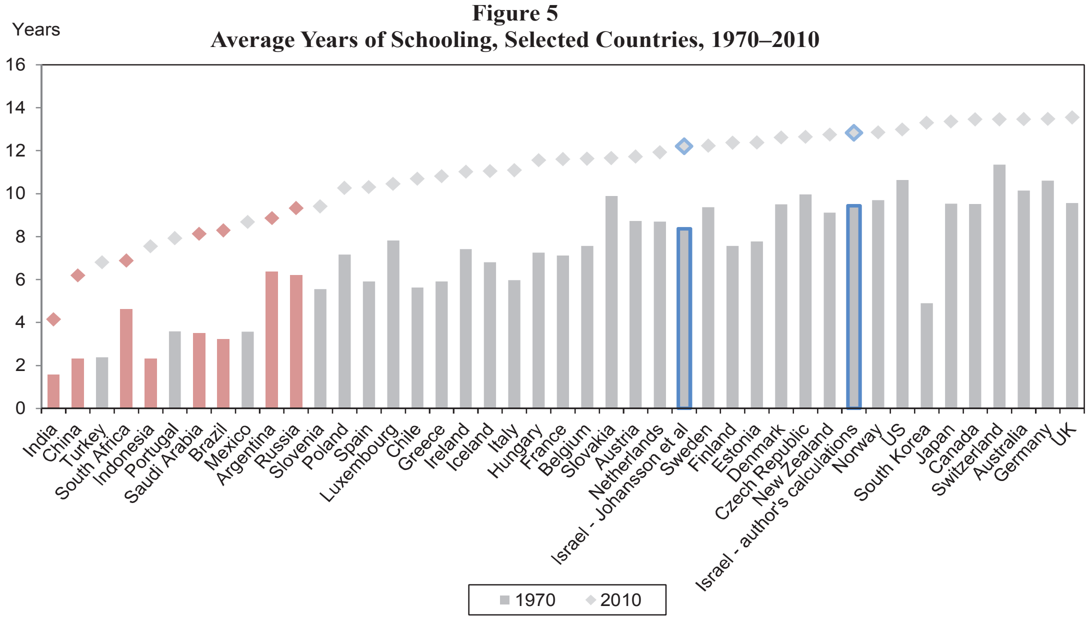


SOURCE: Based on Central Bureau of Statistics.

Figure 5 presents the average years of schooling in Israel and its trend relative to other advanced countries and the major developing countries. The data for all the countries is taken from Johansson et al. (2012), who primarily made use of population censuses (without any adjustment for effectiveness). The data for Israel are taken from two sources and therefore appear in two bars: one based on the findings obtained by Johansson et al. (2012) and the other based on the direct adjustment of Labor Force Survey data. The figure shows that in 2010, Israel is above the median in both cases: in 10th place according to our calculations and in 16th place according to Johansson et al. (2012).[18] The graph also shows that Israel has maintained its relative position since 1970.

[17] Until the beginning of the 1990s, there was also a noticeable rise in the proportion of high school graduates (11–12 years of schooling).
[18] According to a different database of education statistics, Israel is in 9th place among the advanced countries. See Barro and Lee (2013).

Figure 5
Average Years of Schooling, Selected Countries, 1970–2010



Grey - OECD countries; Red - Developing economies.
SOURCE: Johansson et al. (2012); Based on Central Bureau of Statistics.

On the basis of the graph for average years of schooling among the employed in Israel (Figure 3), we constructed an index for the stock of human capital using Equation (2) above. We derived total productivity from Equation (3) using annual data for GDP in fixed prices (according to the SNA2008 definitions), the gross stock of physical capital (Bank of Israel data, adjusted to SNA2008), and labor input (hours), as well as based on the assumption that the share of labor in output ($1–\alpha$) is 0.67. In order to present the proportion of the population in prime working ages and the number of workhours per capita (in the prime working ages), we used demographic data and data from the Labor Force Survey of the Central Bureau of Statistics (CBS).[19]

Table 2 summarizes the increase in each of the sources of per capita growth for sub-periods. The last column of the table presents the rate of increase in total productivity when the stock of human capital is not included in the production function. It is interesting that the drop in the rate of increase in average level of education is in line with the drop in the rate of per capita growth between the 1970s and the 1980s. This implies that during these two decades total productivity grew at a similar rate (0.7–1.1 percent). It is worth mentioning that when the 1970s are divided between the period prior to 1974 and the period subsequent to it (when a disjoint occurred in the rate of growth), the average increase in level of education is less correlated with changes in the growth rate.

[19] Since prior to 1980 the Labor Force Survey does not make it possible to separate the prime working age population from the total working age population, we assumed that both populations grew at the same rate.

However, it should be recalled that in the short term it is the business cycle that plays a dominant role in determining the growth rate. During the 1990s, inputs grew faster than GDP (thanks to the immigration during the 1990s and the investment that accompanied it), while the stock of human capital maintained the upward trend of the previous decade. As a result, the rate of increase in productivity slowed by a percentage point according to both calculations (that is, including and not including human capital). In the 2000s (2000–2011) the growth rate fell, and this was accompanied by an even more pronounced decline in the rate of increase in all inputs, including the stock of human capital. Thus, the increase in total productivity returned to a positive level similar to that which prevailed prior to the 1990s. In other words, apart from the 1990s, there is a significant increase of 0.7–1.1 percent in total productivity in each of the decades, when the calculation takes the stock of human capital into account.

Table 2: GDP growth and its sources, 1970–2011 (year groups) (percent)

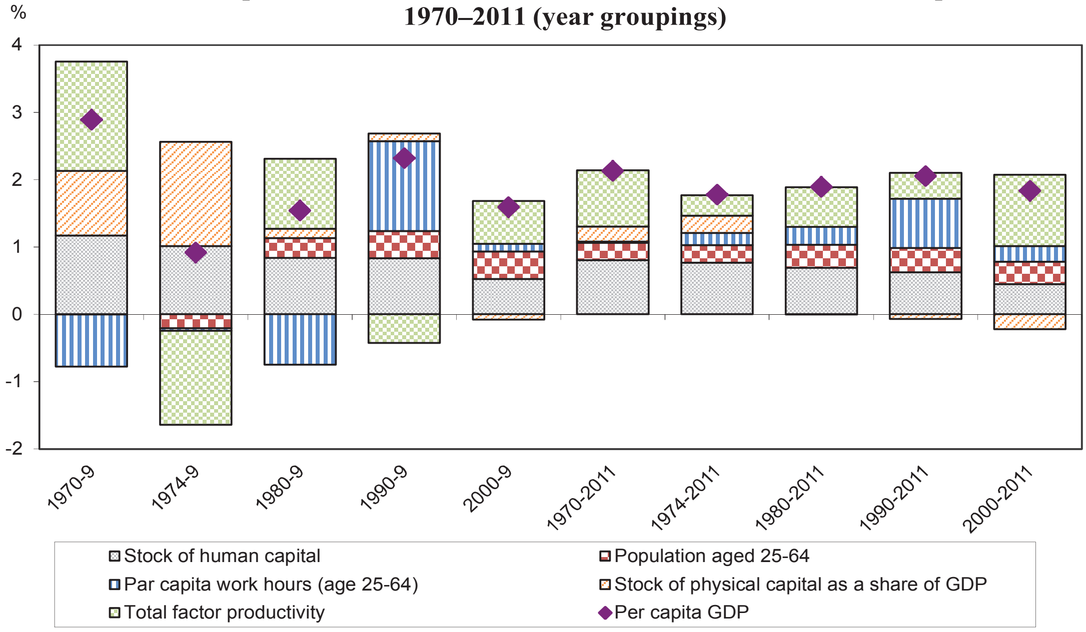
	GDP	Population	GDP per capita	Rate of population aged 25–64	Work hours per capita[1]	Stock of human capital	Stock of physical capital	Total factor productivity	Total factor productivity excl. stock of human capital
	Y	POP	y	pop'	l	h	K	A	
	(1)=(2)+(3)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1970–1979	5.7	2.8	2.9	0.0	-0.8	1.2	7.7	1.1	1.9
1974–1979	3.3	2.3	0.9	-0.2	0.0	1.0	6.4	-0.9	-0.3
1980–1989	3.4	1.8	1.5	0.3	-0.7	0.8	3.6	0.7	1.3
1990–1999	5.5	3.1	2.3	0.4	1.3	0.8	5.7	-0.3	0.3
2000–2009	3.7	2.0	1.6	0.4	0.1	0.5	3.5	0.4	0.8
1970–2011	4.6	2.4	2.1	0.3	0.0	0.8	5.0	0.6	1.1
1974–2011	4.1	2.3	1.8	0.3	0.2	0.8	4.6	0.2	0.7
1980–2011	4.2	2.3	1.9	0.3	0.3	0.7	4.2	0.4	0.9
1990–2011	4.6	2.5	2.1	0.4	0.7	0.6	4.5	0.3	0.7
2000–2011	3.9	2.0	1.8	0.3	0.2	0.4	3.4	0.7	1.0

[1] Total work hours in the economy relative to the prime working-age population.

SOURCE: Based on Central Bureau of Statistics

Figure 6 shows the contribution of each component to total per capita growth, and that the increase in average years of schooling from 1974 onward contributed a total of about 0.8 percentage points on average to annual growth, or about 40 percent of total growth. The rest of the growth is generated by the other components approximately equally: the proportion of the prime working age population, the labor input per capita (prime working ages), the intensity of the stock of physical capital (the stock of capital relative to output – *K/Y*) and TFP. The question arises as to how to relate to the finding that TFP makes such a low contribution to growth. For purposes of comparison, if we calculate total productivity without taking into account the stock of human capital, we would arrive at a significant contribution of 1.1 percentage points.[20] Does this imply that technology is not important to growth? We believe that there is no contradiction between technological progress and this analysis since the increase in level of education is what made it possible to invent or to adopt advanced technologies that contributed to growth.

Figure 6
Production Inputs and TFP, and Their Contribution to Growth of Per Capita GDP, 1970–2011 (year groupings)



SOURCE: Based on Central Bureau of Statistics.

Over the years, the rate of increase in the average level of education has slowed, which has led to a drop in its contribution to growth. Thus, in the 2000s, its contribution was only 0.4 percentage points (about 25 percent of total per capita growth). As we will see in the next section, this contribution is expected to continue to decline in coming decades.

Table 3 presents the estimated contribution of the stock of human capital to growth when the stock of human capital is calculated using various series for average education. It can be seen that the estimate is not particularly sensitive to the way in which the stock of human capital is calculated. Thus, it makes no difference whether the number of employed is used rather than the whole population, whether the prime working age population (25–64) or the working age population (15+) is considered, or whether or not the data for education among the ultra-Orthodox and immigrants is adjusted.

[20] Bergman and Marom (2005) estimated the contribution of the increase in human capital to growth during 1970–99. They found that human capital grew by 1.6 percent during this period and that its contribution to growth was equal to that of total productivity (in a calculation that does not include human capital).

Table 3: Contribution of the stock of human capital to growth in per capita GDP, by various education series (percentage points)						
Employed / population	Employed	Employed	Employed	Employed	Population	Population
Age	15+	15+	15+	15+	15+	25–64
Adjustment for education of ultra-Orthodox and immigrants	No adjustment	Adjustment for ultra-Orthodox only	Adjustment for immigrants only	Adjustment for ultra-Orthodox and immigrants	Adjustment for ultra-Orthodox and immigrants	Adjustment for ultra-Orthodox and immigrants
1970–1979	1.2	1.2	1.2	1.2	0.9	0.9
1980–1989	0.8	0.8	0.8	0.8	0.7	0.8
1990–1999	0.9	0.9	0.8	0.8	0.7	0.9
2000–2009	0.5	0.5	0.5	0.5	0.5	0.6
1974–2011	0.8	0.8	0.8	0.8	0.6	0.7
1980–2011	0.7	0.7	0.7	0.7	0.6	0.7
1990–2011	0.6	0.6	0.6	0.6	0.6	0.7
2000–2011	0.4	0.4	0.5	0.4	0.5	0.5
SOURCE: Based on Central Bureau of Statistics.						

4. Forecast of education and the stock of human capital, 2009–59

Since education has made a significant contribution to output during the last four decades, we are interested in estimating its expected contribution in coming decades. In this section, we will present a long-term forecast for the average level of education in the adult population and among the employed. The forecast is built bottom-up, i.e. for 84 cells of the population (or the employed) created by division according to gender, 14 age groups, and three ethnic/religious groups (ultra-Orthodox, Arabs and non-ultra-Orthodox Jews). We weight the education of each cell according to its expected share in the population/of the employed in order to arrive at an aggregate forecast. The forecast for the size of the population of each cell is based on the medium scenario of the demographic forecast made by the CBS for the period 2009–59 (Paltiel et al., 2012).[21] In order to estimate the share of each cell for the employed, assumptions were also made regarding the cell's participation rate and its rate of unemployment. We based ourselves on the detailed assumptions in Braude (2013).

The forecast for the level of education among the population is derived from the average level of education in each population cell in 2009[22], which is taken from the Labor Force Survey. Here as well we made the four adjustments described in Section 3.1. The average level of education in each cell develops according to the assumptions made regarding the long-term average and its rate of convergence. The following describes only the main assumptions. A full description appears in Appendix 2. We assume that among non-ultra-Orthodox Jews aged 25–34, years of schooling will close 1 percent of the gap each year relative to the situation in which, in the long term, 18 years of schooling are attained prior to age 30. To illustrate the implications of this assumption, it

[21] Section 8 will examine the sensitivity of the results to the demographic forecast scenarios.
[22] Which is the base year for the demographic forecast.

leads to a prediction that the average level of education among women aged 30–34 will reach 16 years in 2059 (as opposed to 14.8 today).[23] With regard to older age groups, we assume that each cohort closes the gap (at a very gradual rate of 0.5 percent per annum) between 18 years of schooling and the years of schooling that it accumulated by the ages 30–34. We assume that the younger Arab population (aged 15–29) will close 3–5 percent of the gap between it and the parallel Jewish non-ultra-Orthodox population. Based on these assumptions, by 2059, there will remain only negligible disparities between the Jewish non-ultra-Orthodox population and the young Arab population. In older age groups, disparities will remain.

For the ultra-Orthodox population, we considered two alternatives. In the first, there is no change in current years of schooling (after the adjustment for effective education) during the forecast period. In other words, the ultra-Orthodox population will not continue to progress in the long term with respect to years of schooling, nor will it acquire education that is more effective in the labor market. In the second alternative, we assume that there will be a convergence in the education level of the ultra-Orthodox population, such that for the 15–19 age group in 2009, the gap between the ultra-Orthodox population and the young Jewish non-ultra-Orthodox population (aged 30–34) will close by 10 percent each year. Under these assumptions, the average years of schooling among ultra-Orthodox men aged 30–34 will be 15.4 in 2059, only 0.3 years less than among Jewish non-ultra-Orthodox men (in comparison to the starting point where the average for ultra-Orthodox men is 10 years and for Jewish non-ultra-Orthodox men it is 14.3).

Arriving at the average education level for the employed requires somewhat more complicated calculations. For each cell, we assume that the level of education will develop and converge according to the assumptions for the population as a whole, until the rate of increase in the number of employed in the cell reaches the natural growth rate of the population. A more rapid increase in the number of employed within the cell (i.e. an increase in the employment rate within the cell) will be the result of the stock within the population, which will naturally have less years of schooling on average. To illustrate, a policy that is meant to integrate the ultra-Orthodox or Arabs within the workforce leads to a decline in the average years of schooling since the new workers have less education than the existing ones.

We mention that the aforementioned assumptions, and in particular those related to the trend in education levels among non-ultra-Orthodox Jews and the rate of convergence of the Arab population, are based on findings regarding the trend in education levels during the past decade by cell. We would also mention that these assumptions are similar in spirit to those of the OECD's long-term forecasts.

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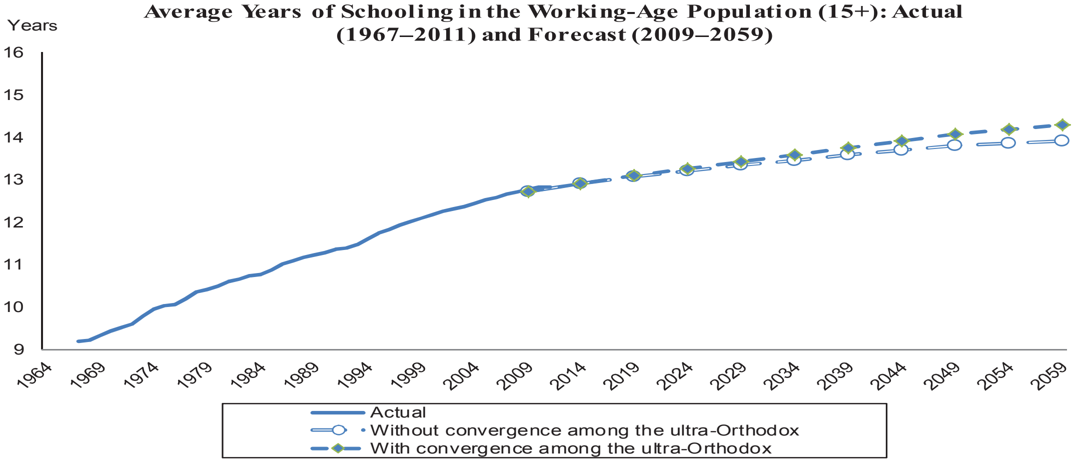
[23] The assumption that the average years of schooling will be 18 in the long term was also used in the OECD's forecasts for its members. This assumption makes it possible to compare the results of the forecast for Israel to those of the OECD for its other members.

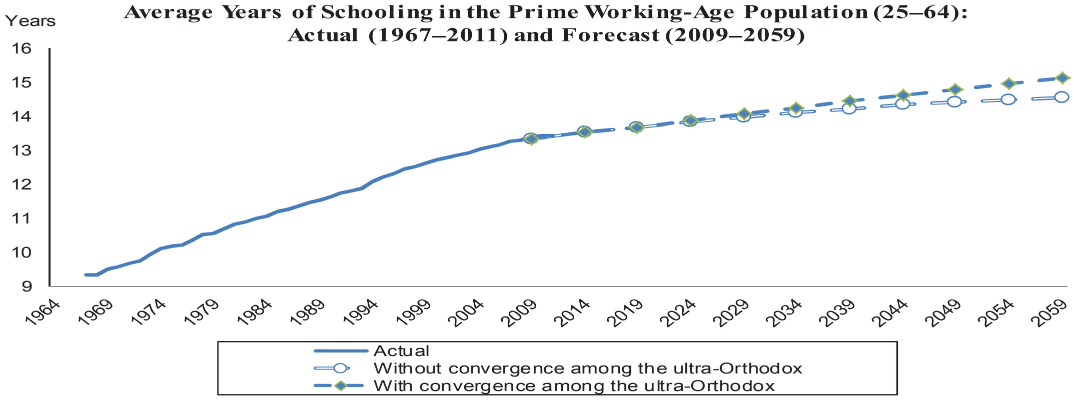
Figures 7–9 describe how the average years of schooling is expected to develop in the working age population (aged 15+), the prime working age population (aged 25–64), and among the employed (aged 15+).

Figure 7
Average Years of Schooling in the Working-Age Population (15+): Actual (1967–2011) and Forecast (2009–2059)



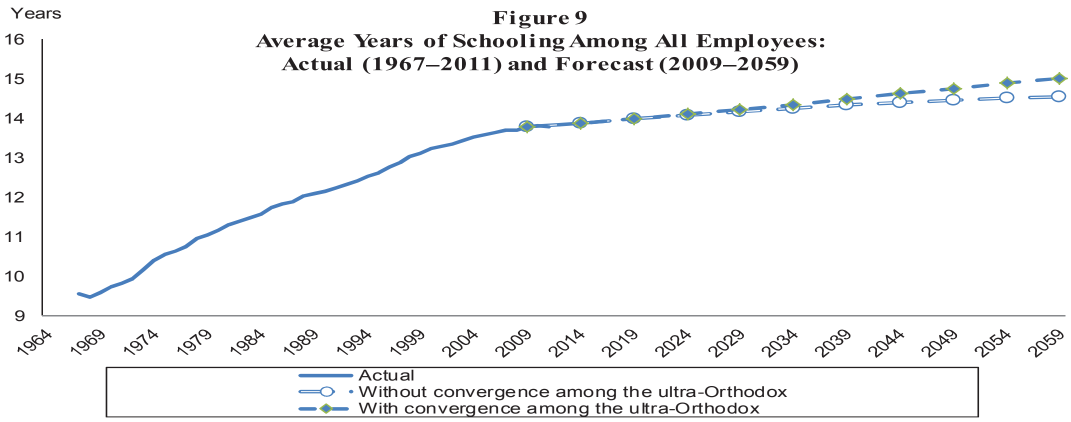
SOURCE: Based on Central Bureau of Statistics.

Figure 8
Average Years of Schooling in the Prime Working-Age Population (25–64): Actual (1967–2011) and Forecast (2009–2059)



SOURCE: Based on Central Bureau of Statistics.

Figure 9
Average Years of Schooling Among All Employees: Actual (1967–2011) and Forecast (2009–2059)



SOURCE: Based on Central Bureau of Statistics.

The graphs reveal some interesting insights. First, the average education level is expected to rise at a slower rate during the next fifty years than during the previous forty, regardless of the scenario of ultra-Orthodox convergence. This is due to four main factors:

1. The level of education stood at 9.5 years on average forty years ago, which is less than a high school education. Therefore, there was room for a rapid increase in the average. In contrast, the average had already reached 13 years in 2009, which is between a high school education and a bachelor's degree, and the potential for a rapid increase has diminished.
2. The last forty years have witnessed the arrival of two waves of educated immigrants (at the beginning of the 1970s and in the early 1990s).
3. The demographic forecast foresees a relative increase in the number of the ultra-Orthodox and Arabs, populations that have a lower level of education at the starting point. In addition, an increase in the participation rate of these populations will lead to a greater increase in their share of the employed, which will on average reduce the level of education of the employed.
4. The demographic forecast predicts that the working age population will become older, i.e. the proportion of the 55+ category will increase, due to the slower rate of increase of the young population, among other things. Since this population tends to be more educated than older age groups, the rate of increase in the average education level of the population will slow.

It is worth noting that the last two factors—the increase in the proportion of Arabs and the ultra-Orthodox and the increase in the proportion of older workers—will reduce per capita output by way of labor input as well, since these populations are characterized by relatively low participation rates.[24]

Another interesting insight obtained from the graphs is related to the importance of ultra-Orthodox convergence. If convergence does not occur among the ultra-Orthodox, then the level of education will cease to grow during the second half of the forecast period. However, if convergence does occur, then the average education level will continue to grow throughout the forecast period and the aggregate education level will be higher by six to twelve months.

If we take the results of the simulations with respect to the expected <u>increase</u> in years of schooling in Israel and combine them with the OECD forecast, we find that without the convergence of the ultra-Orthodox, Israel's ranking among the OECD countries with respect to average education level of the population is expected to drop by 8 or 9 places.

[24] The ultra-Orthodox and older workers are also characterized by a relatively low number of work hours.

In other words, it is expected to drop to between 18th and 25th place depending on the starting point in 2010 (for an explanation of the differences in the starting point see the notes to Figure 5). In contrast, if the ultra-Orthodox education level converges according to our scenario, then Israel is expected to more or less maintain its current position.

Table 4 shows how the stock of human capital has contributed to Israel's growth in previous years and how it is expected to contribute in the future according to the forecast. The table shows that the contribution of the increase in education level to growth (in annual terms) has already declined—from 0.8 percentage points during the last forty years to 0.4 percentage points in the last decade (according to the education level among the employed). According to the forecast, this contribution is expected to continue to decline to only 0.1–0.2 percentage points if the convergence in the ultra-Orthodox education level does not occur. The expected contribution of education to growth will decline relative to the last decade primarily due to the exhaustion of the long-term growth in years of schooling to a great extent. However, it will also decline due to the increased proportion of groups with a low level of education (the composition of the population reduces the contribution of education to growth by about 0.1 percentage points), and to a lesser extent due to the expected change in the age structure of the population, whereby the proportion of the prime working age population (aged 25–64) is expected to drop from 47 percent currently to 42 percent in 2059. Gordon (2014) has presented similar results for the US, where the contribution of education to growth is expected to decline in coming decades by about 0.2 percentage points relative to previous decades as a result of the partial exhaustion of the long-term growth of education.

Table 4: Contribution of the stock of human gapital to GDP growth: actual (1974–2011) and forecast (2009–2059), percentage points

Employed / population	Population		Population		Employed	
Age	15+		25–64		15+	
Covergence among the ultra-Orthodox	No	Yes	No	Yes	No	Yes
1974–2011	0.6		0.7		0.8	
2000–2011	0.5		0.5		0.4	
2009–2034	0.2	0.3	0.2	0.3	0.2	0.2
2034–2059	0.1	0.2	0.1	0.3	0.1	0.2
2009–2059	0.2	0.3	0.2	0.3	0.1	0.2

SOURCE: Based on Central Bureau of Statistics.

The table also indicates that if the education level of the ultra-Orthodox population converges towards that of the Jewish non-ultra-Orthodox population, the contribution of education to growth will increase by about 0.1 percentage points relative to the scenario without convergence (though it will be still be lower than the estimated contribution in previous decades). Although the difference that is due to the convergence of the ultra-Orthodox education level appears to be small in terms of the growth rate, after fifty years the expected level of output in the scenario with convergence is 5 percent larger than in the scenario without convergence. In 2013 terms, this is equivalent to an addition of NIS 52 billion to the economy's annual income or to NIS 6500 per capita. Furthermore, a "back of the envelope" calculation shows that convergence will raise the income of the ultra-Orthodox population by NIS 16,700 per capita (in 2013 terms).[25] In other words, alongside the integration of the ultra-Orthodox in the labor market, their integration within the education system (i.e. increasing years of schooling that are effective in the labor market) is of major importance.

5. Sensitivity of the forecast to the assumptions

The model we have presented is based on a number of assumptions, and its results are therefore also based on those assumptions. In this section, we will examine the sensitivity of the results to some of them. In particular, we will test the dependency of the results on the assumption of convergence in the long term, on the demographic forecast of the CBS and on the assumptions with regard to the return on schooling. Figures 10 and 11 present the forecast of average education level under various assumptions, and Table 5 summarizes the estimated contributions (both historic and expected) of the stock of human capital to growth in the various scenarios. For the sake of brevity, we present only the forecast for average years of schooling (and the contribution to growth derived from it) for the prime working age population (aged 25–64), assuming convergence in the education level of the ultra-Orthodox population. The main findings with respect to the sensitivity of the model do not change if we instead consider the entire population or just the employed, or if we look at a scenario in which there is no convergence in the education level of the ultra-Orthodox.

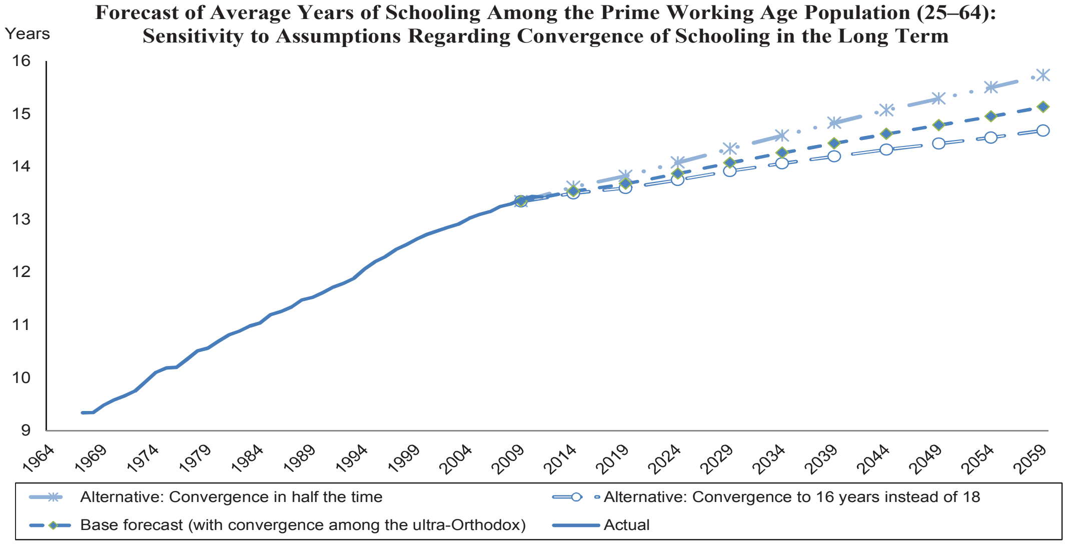
Sensitivity to the assumption of convergence in years of schooling in the long term: In order to forecast years of schooling, we assumed that the average years of schooling among young non-ultra-Orthodox Jews (aged 25–34) will increase over time toward 18 years by the age of 30. We assume the pace of increase will be that 1% of the existing gap (between the current average years of schooling and 18 years) will be closed in each year. With regard to older age groups, we assumed that each cohort would continue to close the gap between the years of schooling it had accumulated by age 30–34 and 18 years of schooling at a more gradual pace (0.5 percent per year). We will now examine how the forecast is affected by each of the following changes in assumptions:

1. Years of schooling converge in the long term to only 16 years.

[25] We have assumed that wages accounts for a 2/3 share of GDP, and that the increase in wage payments as a result of an increase in the human capital of the ultra-Orthodox will be channeled into the wages of the ultra-Orthodox. The remaining additional GDP will be channeled to payments to capital, and for the purposes of the calculation we have assumed that capital is not owned by the ultra-Orthodox.

2. Convergence in the long term occurs at double the rate. In other words, the average years of schooling in the young age group will close the gap relative to the long term situation at a rate of 2 percent per year, and each cohort in the older age groups will continue to close the gap between 18 years of schooling and the years of schooling that it had accumulated up to age 30–34 at a rate of 1 percent per year.

Figure 10
Forecast of Average Years of Schooling Among the Prime Working Age Population (25–64): Sensitivity to Assumptions Regarding Convergence of Schooling in the Long Term



SORCE: Based on Central Bureau of Statistics.

Figure 10 shows that each of the alternatives changes the average years of schooling at the end of the forecast period by about six months. Table 5 shows that in terms of the contribution to the growth rate, the level of sensitivity is not particularly high. The assumption that education converges to a lower average reduces the annual growth rate by 0.06–0.08 percentage points, while doubling the rate of convergence contributes about 0.1 percentage points to the growth rate during the forecast period.

Table 5: Estimated contribution of the stock of human capital to GDP growth: its sensitivity to the assumptions underpinning the model (percentage points)

	Base scenario	Convergence to 16 years of schooling	Convergence twice as fast	Demographic scenario		Return on schooling		
				Low	High	Declining	6%	12%
1974–2011	**0.7**	0.7	0.7	0.7	0.7	0.7	0.6	1.1
2000–2011	**0.5**	0.5	0.5	0.5	0.5	0.5	0.4	0.8
2009–2034	**0.3**	0.2	0.4	0.3	0.3	0.3	0.2	0.4
2034–2059	**0.3**	0.2	0.4	0.3	0.3	0.2	0.2	0.4
2009–2059	**0.3**	0.2	0.4	0.3	0.3	0.2	0.2	0.4

SOURCE: Based on Central Bureau of Statistics.

Sensitivity to the demographic forecast: In order to construct our basic forecast, we used the medium scenario of the CBS demographic forecast for the period 2009–59 (Paltiel et al., 2012). In order to test whether the forecast of education and its contribution are sensitive to demographic assumptions, we will use the high and low scenarios. In order to get an idea of the significance of the various scenarios, we will look at the expected rate of increase in the population and the expected proportion of the ultra-Orthodox and Arabs in 2059, in each of the demographic scenarios (Table 6). The table shows that the scenarios certainly differ in the total rate of population growth. Although the expected proportions of the minority groups vary from one scenario to the next, their growth trends are not dependent on the scenario.

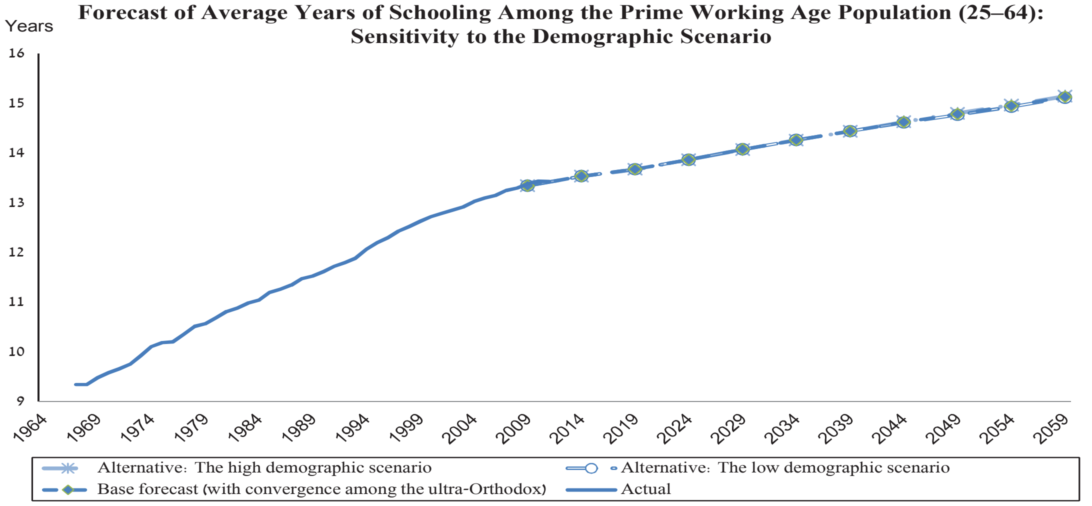
Table 6: The expected demographic parameters of the prime working-age population, by various demographic scenarios (percent)

	Demographic scenario		
	Low	Medium	High
Population growth rate, 2009–59	1.0	1.3	1.5
Ultra-Orthodox as a share of the population, 2059 (2009 = 6.5%)	22.5	23.1	23.6
Arabs as a share of the population, 2059 (2009 = 17.3%)	26.1	25.6	25.1

SOURCE: Author's calculations based on data from Paltiel et al. (2012).

Figure 11 clearly shows that the forecasted average years of schooling is not at all sensitive to the demographic scenario. This is because the forecast of education itself is not dependent on the expected size of the total population, but rather on changes in its composition. As we saw above, the differences in composition between the scenarios are negligible relative to the expected changes over time. Therefore, the contribution of human capital to growth (Table 5) is not sensitive to the demographic scenario.

Figure 11
Forecast of Average Years of Schooling Among the Prime Working Age Population (25–64): Sensitivity to the Demographic Scenario



SOURCE: Based on Central Bureau of Statistics.

Sensitivity to the estimate of return on schooling: For the basic forecast, we assumed that the return on schooling is fixed and equal to 8 percent. In other words, an increase of one year in the average years of schooling increases GDP by 8 percent, independent of the level of schooling. In Section 2, we surveyed the variance that exists in the estimates of the return on schooling (also when they are estimated using the macroeconomic approach). Here we will examine three alternative scenarios with regard to the estimated return on schooling:

1. A return on schooling of 6 percent: the lower bound in Arnold, Bassanini and Scarpetta (2007).
2. A return on schooling of 12 percent: the finding of Barro and Lee (2010).
3. The return on schooling declines according to the function estimated by Morrison and Murtin (2010): r=0.125-0.002*S, where S represents the average years of schooling in the economy.

The estimate of the return on schooling does not influence the forecast of the average years of schooling, but only the estimate of the contribution of education to output and growth. However, in contrast to previous sensitivity tests, changing the assumption regarding return on schooling also affects the estimate of the historical contribution of human capital to growth. Table 5 summarizes the effect of the various scenarios. In the case of a declining function for return on schooling (alternative 3), the results obtained with respect to the contribution of human capital to growth are basically similar to those of the basic scenario. This is because in the vicinity of the levels of education that prevailed in Israel in the past and are expected to prevail in the future (according to the forecast), the return on schooling derived from the function (6.5–9.0 percent) is not very different from our basic assumption (i.e. 8 percent) and is not very volatile. In contrast, alternatives 1 and 2 (a lower and higher return, respectively)—and alternative 2 in particular—alter the results to a greater extent. Thus, the estimated historical contribution to growth changes by 0.1 to 0.4 percentage points, depending on the alternative. With regard to the forecast, the higher return raises the estimated expected contribution by 0.15 percentage points, while the lower return reduces it by 0.07 percentage points.

In summary, it appears that the trends surveyed in previous sections, with regard to the past and future contributions of human capital to growth, are not particularly sensitive to reasonable changes in the assumptions. In particular, the following conclusions remain valid in all of the alternatives:

1. The increase in human capital has contributed significantly to growth since the 1970s, but this contribution has declined during the last decade.
2. The rate of increase in average education and its contribution to growth are expected to continue to decline in coming decades.
3. Without convergence of the ultra-Orthodox level of education, the contribution of human capital to growth will be lower by 0.1 percentage points.

6. Additional aspects of education and the stock of human capital

Thus far, we have focused on only one indicator of human capital: the average years of schooling in the economy. This is also the most commonly used indicator in the literature on the connection between economic growth and the stock of human capital, which is to a large extent due to the accessibility of data and the possibility of international comparison. However, the stock of human capital is also affected by other factors, some of which are unrelated to education (for example, the health of the population and years of work experience) while others are related to education but are not reflected in the average years of schooling, which is simply the total quantity of education. In this section, we will examine these two aspects: We will first look at the way in which education is distributed among individuals in the economy and then at the quality of education, while differentiating between the quantity of inputs invested in education and the results of the education system. We do not claim to be providing a comprehensive analysis of these factors. Rather, it is our intention to present alternative approaches, and to show how Israel is ranked according to the various indices relative to other advanced countries, and which factors can be exploited in order to moderate the decline in the contribution of the average education level to growth.

The distribution of education level

Figure 5 shows the ranking of OECD countries according to the stock of human capital (average years of schooling).[26] Israel is ranked within the second quarter of the distribution. In contrast, Figure 12 presents the proportion of individuals with higher education in the population[27], and shows that Israel is in third place in the case of the prime working age population. Among the young (aged 30–34) as well, Israel is highly ranked (in 4th place). It therefore cannot be claimed that Israel's ranking in this index is undergoing change.[28] These data shed a positive light with respect to the number of individuals with higher education in Israel, but because Israel's ranking is lower in the distribution of average years of schooling, this data may also be an indication that Israel is an outlier in the distribution of education in the population, since individuals without a higher education study for only a few years, thus creating a high degree of inequality in the distribution of the population according to education level. An alternative explanation involves the possibility that individuals with higher education in Israel study for relatively fewer years (due to the prevalence of short degree programs).

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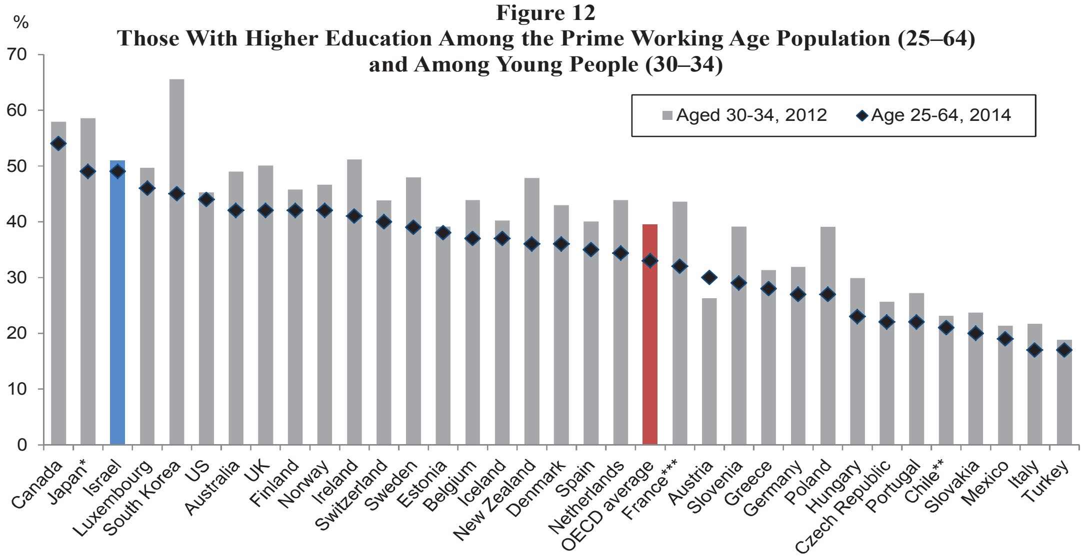
[26] In 2010, Israel was ranked between 10th and 16th place out of 34.

[27] The data are taken from "Education at a Glance", OECD (2014).

[28] If we look at the gap between the proportion of those with higher education among the young and the same proportion for the prime working age population, we find that it is somewhat less than the OECD average. However, it may be that this is due to the long period of military service in Israel (as a result of which the young enter higher education at a later age than in other countries) and not because there is some change occurring in the proportion of students.

Several empirical studies point to the negative relationship between the Gini index of inequality in the distribution of education and an economy's long-term growth rate. Thus, for example, Castello and Domenech (2002) estimated a cross-section regression using data on 108 countries for the period 1960–90 and found that an increase of 0.1 in the Gini index reduced the annual growth rate by 0.15–0.3 percent. Castello-Climent (2010) found greater elasticity (0.55 percent) and showed that initial inequality in education leads to an increase in the birthrate and a drop in life expectancy, which together account for a decline in the future investment in human capital and in growth.

Figure 12
Those With Higher Education Among the Prime Working Age Population (25–64) and Among Young People (30–34)



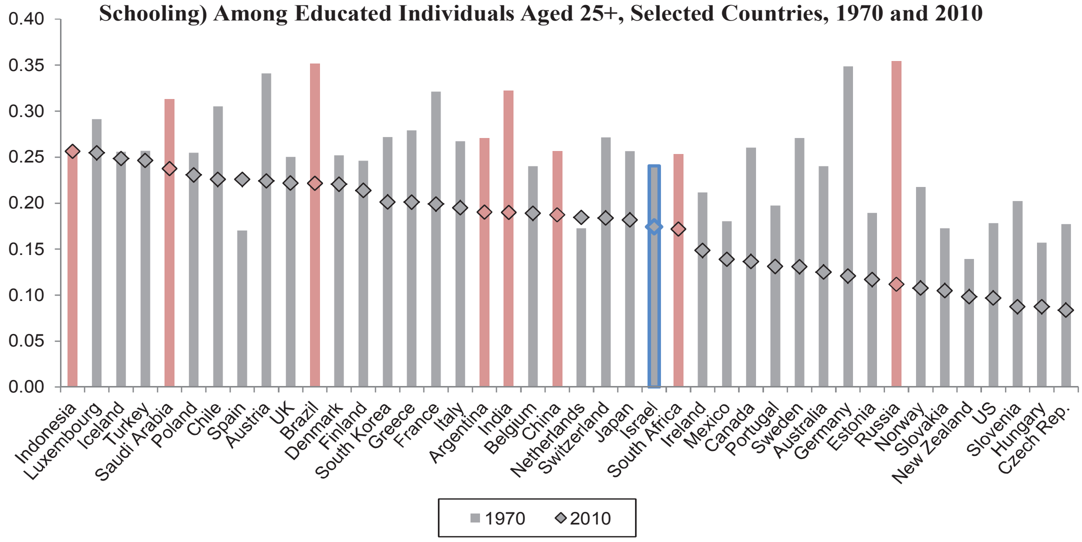
* Due to lack of data, the figure relates to those aged 25-34 instead of 30-34.
** The data on those aged 25-64 and those aged 30-34 were obtained for 2013 and 2011, respectively.
*** The data on those aged 25-64 were obtained for 2013.
SOURCE: Education at a Glance, 2014; and Education at a Glance, 2015.

Figure 13 presents an estimate of the Gini index for years of schooling among the 25+ age group in Israel and the other advanced countries.[29] The index relates to equality only among those with some education (those with more than zero years of schooling). The figure shows that, as of 2010, Israel was near the center of the distribution and therefore not an outlier with respect to inequality in the distribution of education. The graph also shows that inequality in education has diminished since 1970 both in Israel and in most of the advanced countries. Morrison and Murtin (2010) show that this is a global phenomenon that began in the advanced countries as early as 1870, primarily due to the

[29] The calculation is based on the data of Barro and Lee (2013), who include the proportions of 7 subgroups within the population according to education level: no education, primary education (partial and full), secondary education (partial and full) and tertiary education (partial and full). The data also include the average years of schooling in primary, secondary and tertiary education. A similar calculation, based on the same data, appears in Castello-Climent and Domenech. Appendix 3 presents complete details of the calculation.

drop in the proportion of those with no education. Since we have omitted observations with zero years of schooling, this decline goes beyond that resulting from the reduction in the proportion of those with no education. It indicates that the increase in education among those with few years of schooling exceeded the increase in years of schooling among those at the upper end of the distribution of education.

Figure 13
The Gini Index of Inequality in the Distribution of Human Capital (Years of Schooling) Among Educated Individuals Aged 25+, Selected Countries, 1970 and 2010

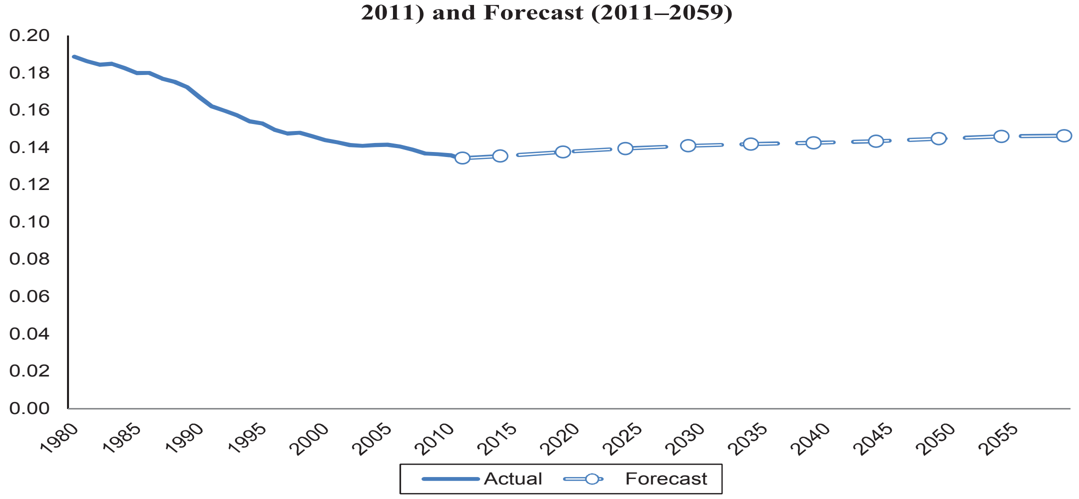


Grey - OECD countries; **Red** - Developing economies.
SOURCE: Author's calculations based on Barro and Lee (2013).

An examination of inequality in education from an international perspective shows that it is not consistent with the possibility that there exists an exceptionally large gap in the average years of schooling between those with higher education and those with no education at all in Israel. On the other hand, it is consistent with the possibility that a large portion of those with higher education in Israel have acquired degrees that require relatively fewer years of study.

Is Israel's relative ranking with respect to inequality expected to change? Building a comprehensive forecast of inequality in education, as we did for average years of schooling, is a more complex process since it requires assumptions on the level of the individual. Nonetheless, it is possible to determine whether expected demographic changes are likely to bring about a change in inequality in education. To this end, we first calculated the Gini index for inequality in education using the data for individuals taken from the Labor Force Survey. We calculated the years of schooling of each individual according to the method described in Section 3.1 (omitting zeroes, restricting years of schooling to 22 and adjusting the years of schooling of ultra-Orthodox men and immigrants). Each observation in the Survey was given a weight according to the number of individuals that it represented in that year (this information appears in every Labor Force Survey). The solid line in Figure 14 relates to Israel and represents the Gini index for years of schooling among the prime working age population (aged 25–64) from 1980 to 2011. As in the international calculation presented in Figure 13, here as well there has been a downward trend in inequality in the distribution of education (among those with at least some education) in recent decades. It is worth mentioning that throughout this period there is a gap of 0.04 between the data in Figure 13, which are based on Barro-Lee, and the data in Figure 14, which are calculated according to the Labor Force Survey. About one-third of the gap is a result of the difference in cohort (25+ as opposed to 25–64) and the rest is the result of the difference in data source. The restriction of years of schooling to 22 and the adjustment to the education level of ultra-Orthodox men and immigrants (in the case of the Labor Force Survey data only) do not affect the index significantly.

Figure 14
The Gini Index of Inequality in Years of Schooling of the Prime Working-Age Population (25–64), Including Adjustment for Ultra-Orthodox and Immigrants: Actual Index (1980–2011) and Forecast (2011–2059)



The forecast is based on demographic changes only.
SOURCE: Based on Labor Force Survey data.

After calculating the historical time series of the Gini index, we calculated how the demographic developments are expected to affect inequality in education up until 2059. To this end, we used the reported years of schooling for each individual in the 2011 Labor Force Survey (after adjustment), although we weighted them by the expected future weight of the representative individual in the Survey. For that, we moved the weight of each individual in the 2011 Labor Force Survey forward in time according to the following two steps:

1. We attributed each individual to one of the 84 cells for which there exists a demographic prediction[30] (according to the division by gender, age group and ethnic group).

[30] The detailed demographic forecast prepared by the CBS for the period 2009–59 (Paltiel, 2012).

2. We multiplied the weight of the individual in the 2011 Labor Force Survey by the gross rate of increase (according to the medium scenario of the demographic forecast) expected for that cell, where the initial size of the cell is equal to the average of its size in 2009 and in 2014, and its final size is equal to that in the year of the forecast.

The forecast obtained in this way for the Gini index is only affected by expected demographic changes (and not by other factors such as the expected increase in years of schooling, the convergence of education level in particular populations to the education level in other populations, etc.). Figure 14 shows that the demographic changes are expected to bring about only a moderate increase of 0.011 in the Gini index by 2059 (half of the increase occurs in the next 15 years).[31] This calculation, as simple as it may be, primarily shows that the demographic developments do not predict a future problem of inequality in the distribution of education. Even when we use the upper bound of the elasticity of growth with respect to inequality in the distribution of education (Castello-Climent, 2010), we find that long-term growth is expected to decline by at most 0.05 percentage points.

Quality of education

The basic analysis views the average years of schooling as an indicator of the stock of human capital. This approach essentially assumes that each year of education provides an identical return, which is not dependent on the material learned or the quality of teaching. This is course a simplifying assumption. There are two main approaches to measuring the quality of education. The first is based on the inputs invested in the education system (total expenditure per student, average class size, etc.). The main problem with this approach is that increasing inputs does not ensure higher quality. The second approach measures quality according to the output of the education system, such as scores on standard international tests in subjects such as math and science. The main problem with this approach is that these tests are not standardized over time. In other words, it is difficult to compare results from different years, and therefore difficult to determine whether the quality of education has changed over time. The tests are also limited to several parameters, and it is unclear whether they reflect the overall output of the education system. Nonetheless, empirical studies have shown that despite these problems, the indices explain the gaps between countries in growth rate or income level. Some of the studies of growth even claim that only the quality of education, and not its quantity, has an effect on long-term growth.

Islam et al. (2014) tested regressions for growth using the data for about 60 countries during the period 1970–2010 and showed that when one adjusts the level of human

[31] The estimate is not sensitive to adjustments in the education level of immigrants and the ultra-Orthodox. If we focus on the general working age population (15+), we find that the increase in the Gini index is expected to reach between 0.015 and 0.018 by 2059.

capital (the average years of schooling) for quality, the result is a positive and very statistically significant ability to explain the average rate of growth in total productivity and the rate of convergence to the technological frontier. These researchers adjusted human capital for quality by using measures of both output and inputs. With respect to output, the researchers weighted five indicators using the First Principal Component Method[32]: the extent to which there is no need to repeat a grade in primary and secondary education; the results on international tests in math, science and reading that are administered in primary and secondary schools; and the number of universities that are among the 500 top-ranked universities according to the Shanghai ranking relative to number of employed. With respect to inputs, the researchers weighted two indicators: the student-teacher ratio in primary and secondary schools and public expenditure on education per student relative to per capita GDP. They also showed that if no adjustment is made for quality (in other words, if just the average years of schooling are used), then the quantity of human capital has less statistically significant ability to explain growth.

Hanushek and Woessmann (2012) examined the way in which the quality of education affects growth and measured quality using education's outputs. To this end, they built a measure of education quality for each country using the scores on twelve international tests in math and science for 9–15 year olds during the period 1964–2003 (not every test was given in every country). The researchers normalized the scores on all the tests to the PISA scale (average of 500 and standard deviation of 100) and the measure of education quality of each country was obtained from its average score (divided by 100). Growth regressions for 50 countries (both advanced and developing) showed a significant and stable relationship between the measure of education quality and the rate of growth during the period 1960–2000. Thus, an increase of one standard deviation in the index (100 points on the PISA scale) contributes about two percentage points to the annual long-term growth rate. Without the interaction between them, the coefficient for years of schooling was not significant.[33] It should be mentioned that though they found no relationship between growth and years of schooling, there was a positive relationship between years of schooling and the index of education quality that they used.

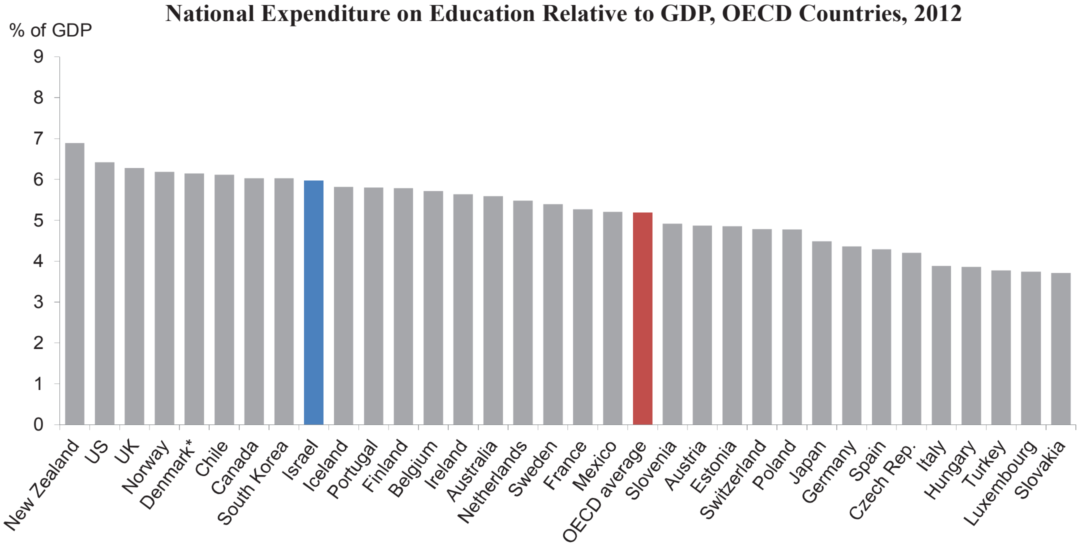
[32] A statistical method that derives the linear combination of indicators that explains the maximum covariance between them. It produces a single series that characterizes the movements in all of the indicators.

[33] Hanushek and Woessmann carried out several indirect econometric tests in order to rule out the possibility that the relationship between quality of education and growth is a result of reverse causality or an omitted variable. First, they estimated regressions that tested whether in countries that improved the quality of education there was a noticeable acceleration in the growth trend of per capita GDP. Second, they tested whether on the level of the individual there is a relationship between the salaries of immigrants in the US who had been educated in their country of origin and the index of education quality in their country of origin. The results of the two approaches supported the hypothesis that quality of education (according to international test scores) has a positive ability to explain the long-term growth rate.

Bouis, Duval and Murtin (2011) used a panel of about 40 countries (most of them advanced) and carried out regressions for long-term growth for the period 1970–2005. They found that the index for education quality of Hanushek and Woessmann (2012) has a statistically significant effect on the long-term level of total productivity. In particular, an increase of one percentage point in the index of education quality (i.e. an improvement of 100 points on the PISA scale in international test scores) raises the level of long-term productivity by 90 percent, and this result is in line with the elasticities found by Hanushek and Woessmann.[34,35] However, they also found, in contrast to Hanushek and Woessmann, that when quality of education is included in the regressions, the coefficient of quantity of education (average years of schooling) remains significant, although it is reduced (the macroeconomic return on a year of schooling drops from 10 percent in regressions that do not include quality to 5 percent in regressions that do).

The quality of education is therefore important to the long-term performance of an economy. Below, we present Israel's ranking according to several widely used measures of this variable. We begin with the inputs approach. Figure 15 presents the national expenditure on education relative to GDP in 2012. The figure shows that the rate of

Figure 15
National Expenditure on Education Relative to GDP, OECD Countries, 2012



* Data are for 2011.
SOURCE: Education at a Glance, 2015.

[34] The elasticities in the two articles are similar for small numbers: according to Hanushek and Woessmann (2012), an increase of 10 points in PISA scores leads to an increase of 0.2 percentage points in the annual rate of growth. The cumulative effect on growth over forty years (the length of Hanushek and Woessmann's sample) reaches $(1+0.002)^{40}-1=8.3$ percent. According to Bouis, Duval and Murtin (2011), the same improvement in the index is expected to lead to an increase of 9.0 percent in the level of total productivity.
[35] Regressions that control for the economy's level of income show that in a comparison between only the developed countries, the elasticity is only 56 percent, though still statistically significant.

expenditure in Israel (6.0 percent) is among the highest in the OECD. Expenditure on education is high in Israel because of the high proportion of children in the population, who of course are the ones that consume inputs in the education system.

However, the picture changes when we examine expenditure per student. Figure 16 describes the relationship in the OECD countries between per capita GDP and expenditure per student, according to the level of education (primary, secondary and tertiary). The following observations can be made:

1. Expenditure per student in Israel, at all levels of education, is lower than in most of the OECD countries and lower than the OECD average. In other words, even though expenditure on education as a share of GDP is high, it is not sufficient to reach the average expenditure per student in the advanced countries. The government's increase of public expenditure on education by about 0.2 percent of GDP since 2012 has succeeded in closing only a small portion of the gap.

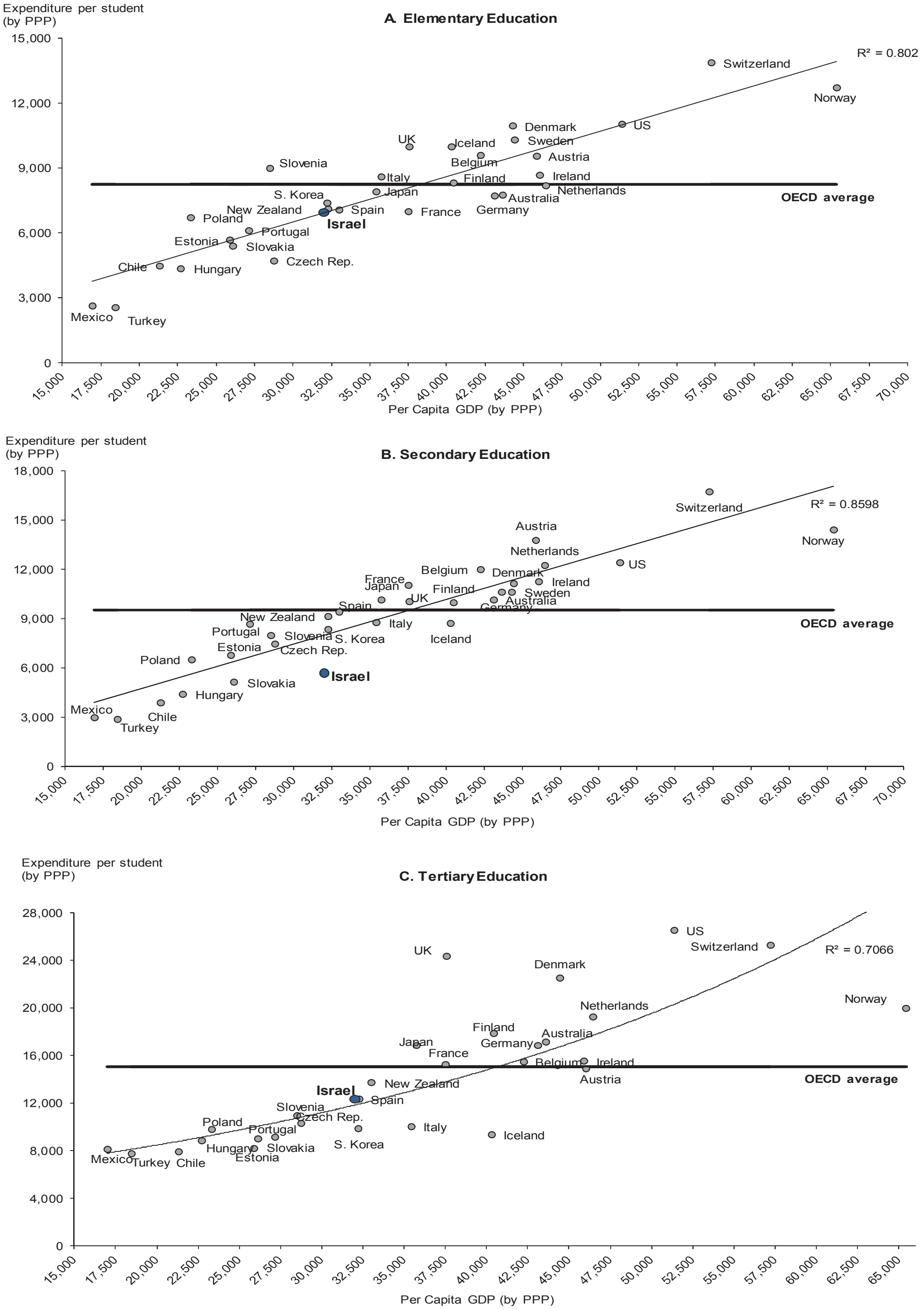
2. There is a clear positive correlation between the economy's income and expenditure per student at all levels of education. It is important to stress that the correlation may reflect two-way causality, i.e. expenditure on education per student contributes to per capita GDP, but rich countries also tend to spend more on education (both because education is a normal good—its consumption increases with income—and because its relative cost increases with level of income since it is a non-tradable good, a phenomenon known as the Balassa-Samuelson effect).

3. Israel is located on the regression line for primary and tertiary education but is well below the line for secondary education. In other words, relative to per capita GDP, less is being spent on students in secondary education.[36] Apparently, only part of the gap has been closed since 2012, when the government increased public expenditure on secondary education as part of the "Oz le'Temurah" program.[37]

[36] The gap between Israel's ranking and the regression line is not due to the fact that there is less vocational education in Israel—which is characterized by high expenditure per student—than in other OECD countries. Although Israel ranks low with respect to the proportion of students in vocational education at the secondary level (22nd place among the OECD countries), the proportion in Israel (39 percent) is not drastically lower than the OECD average (44 percent). Furthermore, in a multivariate regression in which both per capita GDP and the proportion of students in vocational education are included as explanatory variables for expenditure per student in secondary education, the coefficient of the proportion of students in vocational education is not significant.

[37] The finding regarding Israel's low ranking relative to the regression line does not change significantly when using the data for 2013. Furthermore, the analysis appearing in OECD (2016) found that in 2014 as well, the data for Israel show no change in the country's ranking according to the index of expenditure per student (at all levels of education) relative to per capita GDP.

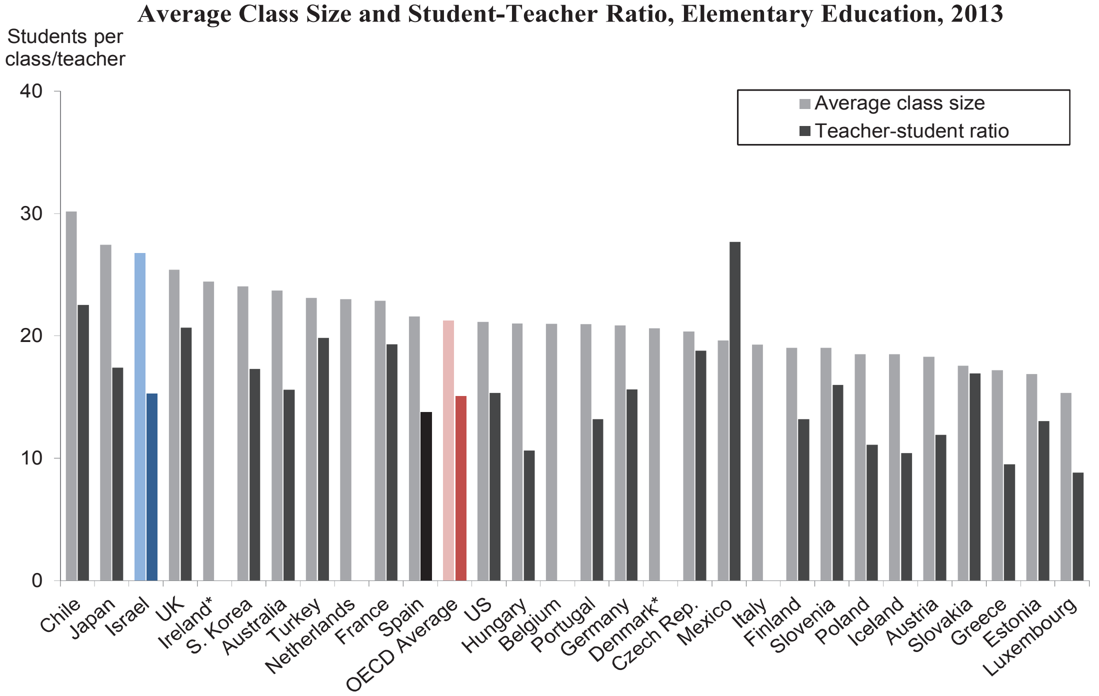
Figure 16
Annual National Expenditure per Student at Educational Institutions, by Per Capita GDP, by Educational Level, OECD Countries, 2012



SOURCE: Education at a Glance, 2015.

The two aforementioned indices focused on financial expenditure on education, but it is also important to examine how the funds are spent. Figure 17 shows the average class size and the student-teacher ratio in primary education in the advanced countries. The figure shows that classes in Israel are among the largest in the OECD. On the other hand, Israel does not lag in the student-teacher ratio. These findings are in line with the hypothesis that although classes are larger in Israel, they are allocated a larger teaching staff. We leave the testing of this hypothesis to future research, together with the question of whether the additional teaching staff is indeed allocated to the larger classes.

Figure 17
Average Class Size and Student-Teacher Ratio, Elementary Education, 2013

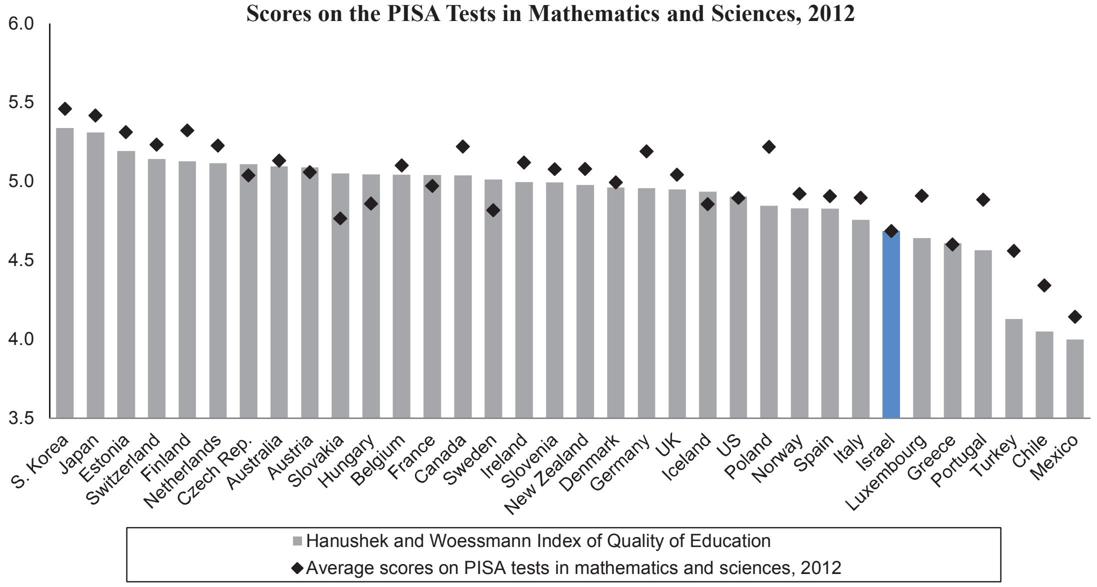


* Data on class size obtained in 2012; from Education at a Glance, 2014.
SOURCE: Education at a Glance, 2015.

As mentioned, the quality of education can also be observed by way of the education system's results. The most common way of doing so is based on international test scores. Figure 18 presents two such indices. The columns present an index calculated by Hanushek and Woessmann (2012), which shows that Israel ranks low (seventh from the bottom) among the OECD countries, with a score of 4.7 while that of New Zealand—the median country—is 5.0. The use of the elasticities estimated by Hanushek and Woessmann (2012) and Bouis, Duval and Murtin (2011) shows that the extent to which Israel lags behind New Zealand reduces its long-term growth rate by 0.6 percentage points and its long-term total productivity level by about 27 percent. (As mentioned, when the elasticity of only the advanced countries is considered, the size of the effect is about two-thirds of the estimate appearing here.)

The situation is even less favorable when we consider Israel's position according to recent scores on the PISA tests in math and science (results for 2012, which are represented by the diamonds in Figure 18)[38]: Israel drops two additional places (to fifth from the bottom).[39] In addition, it is reasonable to assume that Israel's ranking on the PISA test is biased upward, since few ultra-Orthodox schools participate and the scores they would achieve in math and science would likely be lower than the average for the rest of the population.[40] Therefore, it can be said that the international tests administered in junior high and high schools indicate that Israel lags behind in the quality of education and that the lag may be getting larger.

Figure 18
The Hanushek and Woessmann Index on the Quality of Education, and the Average Scores on the PISA Tests in Mathematics and Sciences, 2012



SOURCE: Hanushek and Woessmann, 2012; PISA, 2012.

These results raise the question of the extent to which government policy to increase inputs or to improve the education system (such as, for example, by changing the structure of incentives) will improve educational outcomes. The empirical literature does not suggest a clear answer. In a basic survey article, Hanushek (2006) showed that the data do not indicate a connection between the resources invested in educational institutions, particularly with the goal of reducing class size, and test scores. However, at

[38] The PISA tests are given to 15 year olds.
[39] It is worth mentioning that Israel achieved an impressive relative improvement in the 2012 PISA tests compared to previous tests (2000, 2003 and 2006). However, it appears that Israel's ranking is still low relative to its achievements on older tests included in the index of Hanushek and Woessmann (2012).
[40] We do not possess information on the degree of selection in other countries, i.e. which populations, if any, are not included.

the same time, he shows that an efficient incentives system in educational institutions can indeed improve student achievement. In contrast to Hanushek (2006), later articles showed a relationship between inputs and achievement. Dolton and Marcenaro-Gutierrex (2011) analyzed a panel of advanced countries and found that higher teacher salaries, and in some cases also a higher teacher-student ratio, leads to an improvement in student achievement. As to research based on microeconomic data on the level of the individual, Holmlund et al. (2010) showed that in Britain, expenditure per student has a positive effect on student achievement. Fredriksson (2013) investigated the education system in Sweden and found that larger class size in primary education is expected to reduce student achievement in secondary school and salaries at ages 24–42. Jackson et al. (2015) investigated the effect of education expenditure on the future productivity of students. Their estimations indicated that an increase of 10 percent in expenditure per student (during 12 years of schooling) is expected to increase a student's future salary by 7.25 percent. The increase in expenditure was channeled to improving the teacher-student ratio and an increase in teachers' salaries.

It is also possible to examine the relative quality of higher education in Israel. Although there are no uniform international tests for graduates of higher education, it is possible to use the international rankings that exist. One of them is published by *Times Higher Education*, which rates 400 leading universities worldwide[41] according to a weighted average of 13 indicators in the following categories: teaching (30 percent), research (30 percent), citations (30 percent), income from industry (2.5 percent) and international outlook (7.5 percent).[42,43] Figure 19 presents, for each OECD country, the

$$M200^{i} = \frac{\sum_{j=1}^{200}\left(INDi_{j} * Score_{j} * Stud_{j}\right)}{Pop^{i}}$$

number of universities appearing within the top 200 (diamonds) and the weighted sum of their scores (columns). We weighted the sum by the number of students studying at each university and, in order to normalize it, we divided it by the total population aged 20–39. The following is the formula for the calculation:
where:

$M200^{i}$ is the weighted sum of the scores of the universities in country i that appear in the top 200.

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[41] The last ranking published, for 2015–16, rated 800 leading universities.

[42] International outlook – the volume of research collaboration with other universities and the ratio of number of students and faculty members from abroad to the number of other students and faculty members.

[43] There are two other widely recognized ratings: the Shanghai Ranking and the QS (Quackquarelli Symonds) Ranking. *Times Higher Education* gives greater weight to the quality of teaching and less to the academic achievements of the faculty.

INDi$_{j,}$ is a dichotomous indicator that receives the value 1 if university j is in country i and the value 0 if it is not.

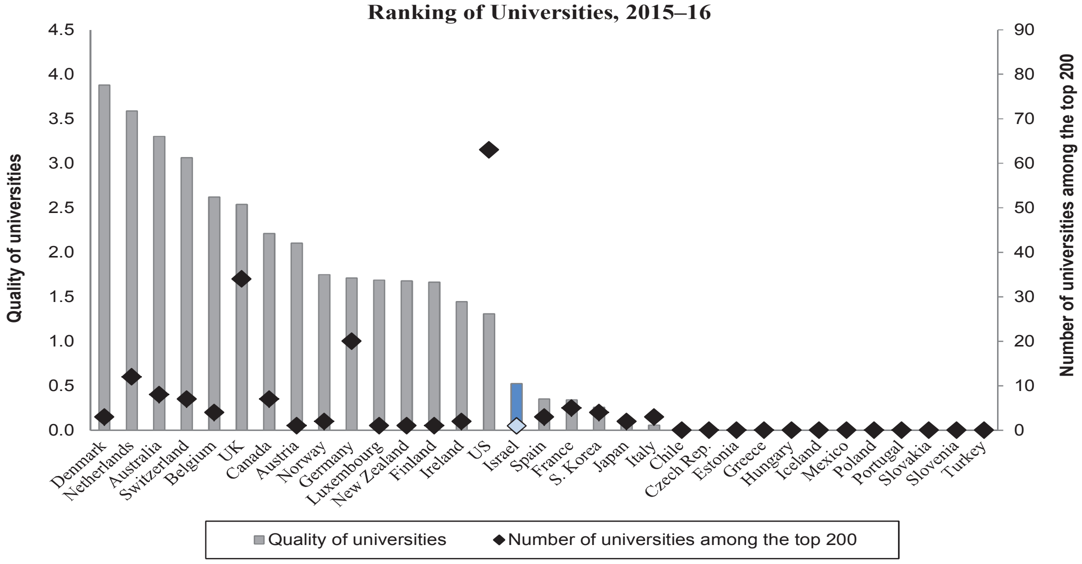
Score$_j$ is the general score of university j in the *Times Higher Education* World University Rankings for 2015–6.

Stud$_j$ is the number of students studying at university j. Source: *Times Higher Education* World University Rankings for 2013/14, 2014/15 and 2015/16, and the university websites.

Pop^i is the population aged 20–39 in country i (2012). Source: OECD database.

In other words, in addition to the number of universities appearing in the top 200, our index also takes into account their ranking (according to the score), the number of students studying in each university (an indicator of the relative weight of the university in the country's higher education) and also the absolute size of the age group that includes most students (20–39). The figure shows that the US and Britain have the largest number of universities rated in the top 200. However, when the size of the economies (according to the population aged 20–39) and the fact that the leading universities are relatively small (with respect to number of students) are taken into account, the US and Britain receive a lower ranking. The weighted index is similar in nature to the one that Islam et al. (2014) found explains long-term growth.

Figure 19
Quality of Higher Education* According to the Times Higher Education Global Ranking of Universities, 2015–16



* In order to calculate the quality of the higher education system in each country, we focused on the universities that appear in the top 200. We multiplied the university scores by their number of students, totaled the results, and divided that by the population aged 20–39.
SOURCE: Based on OECD stat; Times Higher Education Ranking, 2015–16; university websites; and Wikipedia.

In the case of Israel, only the Hebrew University appears in the top 200 (178th place) in the most recent rankings (2015–16). This is due to its high scores in citations and international outlook. We note that in some of the rankings in recent years Tel Aviv University also appeared in the top 200, due to its high scores in research, as did the Technion, due to its high scores in international outlook. However, in the most recent ranking, these universities do not appear in the top 200. Taking into account the other parameters of the weighted sum of scores, this result places Israel in 17th place out of the advanced countries, which is in the center of the distribution (in the lower part of the range of Israel's location according to average years of schooling, which ranged from 10th to 16th; see Figure 1).[44] Israel's position dropped somewhat relative to its ranking for 2011–12, when it was ranked between 13th and 15th place. In the first ranking carried out, in 2010–11, there were no Israeli universities in the top 200.

It is worth mentioning that we examined several alternatives to the index, primarily the use of alternative ranking systems, examining the top 100 or top 400 universities (instead of the top 200), and normalization of results by dividing by the number of students in the country or the number of employed instead of the population aged 20–39. We can say that there is a high positive correlation between the rankings that produce most of the various possibilities. There is a relatively low correlation of 0.2–0.3 between the *Times* index and the others (i.e. Shanghai and QS) when we focus on the top 400 universities. We note that university scores are available only up to the 200th place; using the 400 top universities without taking the score into consideration appears to be problematic since it provides the same weight to a university that is ranked first and to the one that is ranked 400th. Israel's ranking among the OECD countries is not sensitive to the other parameters mentioned, including the use of the top 400 universities.

In summary, based on the results regarding the quality of education, the most prominent factors appear to be class size in primary education, low expenditure per Israeli secondary school student, and the lag in student achievement in secondary school. However, if we look at the quality of education as reflected in expenditure per student in higher education and the ranking of universities, we find a reasonable level of quality, given Israel's size and its relative income. It is quite possible that the low quality of education up to and including secondary school explains the finding that the skill level of workers in Israel (in reading, math and problem solving in a computerized environment) is lower than the average of the advanced countries, despite the high proportion of university graduates in Israel.[45]

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[44] According to the number of universities in the top 200, Israel is between 18th and 22th place, together with four other countries that have one university in the top 200. If we take into consideration other parameters, such as size of population, size of the universities and their global ranking, then Israel rises somewhat, to 17th position.

[45] This finding is based on the results of a survey of adult skills (PIAAC) carried out among most of the OECD countries. Israel participated in the survey in 2014 and 2015. For further details, see Bank of Israel (2016).

7. Conclusion

In this article, we have examined the contribution of human capital, as measured by average years of schooling, to long-term growth. The paper makes several important contributions: First, several annual time series were constructed for years of schooling and inequality (Gini) for various cross-sections of the population. As part of this process, we adjusted the individual data in order to better reflect education that contributes to productivity in the labor market. The calculations showed that average years of schooling in the prime working age population (25–64) rose from 9.5 years at the end of the 1960s to 13.5 in 2011. In an international comparison, Israel is ranked above the center of the distribution of advanced countries (a position that has been maintained since the 1970s). When these calculations are combined with quantitative estimates of the economy's return on schooling, it is found that the increase in education has contributed 0.6 to 0.8 percentage points, on average, to the growth rate, which constitutes between 33 and 45 percent of the average growth in per capita GDP since the 1970s. At the same time, the effect of education already started to exhaust itself in the previous decade, and its annual contribution to growth dropped to between 0.4 and 0.5 percentage points.

Second, a forecast was constructed for the future trend in years of schooling during the next 50 years. According to the forecast, the long-term expansion in years of schooling will continue to weaken, which is expected to cause additional erosion of education's contribution to growth. This development leads to the prediction that during the next 50 years the contribution of the increase in education to per capita GDP will decline to between 0.1 and 0.3 percentage points.[46] This process is expected to occur in most of the advanced countries, although our position according to average years of schooling is dependent on local factors, particularly the education patterns of the ultra-Orthodox, a group whose proportion of the population is expected to increase significantly. The scenarios examined showed that if this population integrates within the job market without acquiring an appropriate education, Israel will drop in the ranking by 8 to 9 places to the lower portion of the distribution. Furthermore, future annual growth in these scenarios is about 0.1 percentage points lower than in scenarios which assume convergence of the ultra-Orthodox level of education. A sensitivity analysis showed that these findings are not sensitive to most of the forecast's basic assumptions.

In the final part of the article, we expanded the discussion to additional facets of human capital. Despite the fact that the proportion of university graduates in Israel is among the highest in the world (while the average years of schooling is within the second quarter of the distribution), we did not find that inequality in education, as measured by the Gini index, was outside the range for the advanced countries. Although demographic trends are expected to contribute to an increase in the index of inequality during the

[46] To this should be added additional factors that predict changes in future growth, particularly the effect of demographic changes on the slowing of growth in labor input.

coming 50 years, this contribution is small, particularly when translated into lost growth as a result of inequality in education.

With regard to the quality of education, as opposed to its quantity, we find that there is room for concern (though there is also potential for improvement). Various measures of the quality of education in primary and secondary education, primarily expenditure per student (especially in secondary education), class size in primary education and the results of international test scores in math and science, show that Israel is ranked low among to the advanced countries. This finding should be of concern since empirical studies provide evidence that there is a close relationship between these measures and long-term economic growth. It is important to emphasize that Israel allocates a relatively large proportion of GDP to education (it is in fourth place among the advanced countries). However, since it has a large population of children, the expenditure per student is small relative to that in the developed countries.

With regard to tertiary education, if one measures the quality of the university system in Israel using international ratings, Israel is located in the center of the distribution of advanced countries. The scope of tertiary education has expanded in recent years and a large part of that growth is due to the colleges, which in the 2012–13 academic year accounted for about 60 percent of undergraduate students. However, Zussman et al. (2007) found that on the level of the individual the return on a degree obtained from a college is about 16 percentage points lower on average than for a university degree (when controlling for characteristics of the individuals, particularly ability as measured by the psychotechnic exams administered by the army).

In this context, it is worth mentioning the finding that at the end of the last decade the gap closed between the proportion of high school graduates whose matriculation scores were sufficient to begin academic studies[47] and the proportion of individuals actually starting academic studies.[48] Our analysis indicates that if the quality of primary and secondary education does not change, i.e. if the school system does not prepare more individuals for tertiary education and with a higher level of quality, the level of education will continue to increase only if individuals in tertiary education choose to extend the duration of their studies or if a non-academic education system is created for the adult population. In contrast, a real change in the quality of primary and secondary education will increase the proportion of high school graduates that meet the requirements for acceptance to university, and this will make it possible to increase the average years of

[47] CBS data indicate that, as of 2012, 48 percent of high school graduates "met the criteria for acceptance to university", i.e. a full matriculation certificate that includes a passing grade in math at a level of three units, in English at a level of four units and in one reinforced subject apart from English.

[48] See Box 5.1 ("The Effect of Education on of the Labor Force Participation Rate in Israel") in Bank of Israel (2013), *Bank of Israel Annual Report, 2012*.

schooling by increasing the proportion of individuals who have acquired a higher education in the universities.

In conclusion, in order to preserve the contribution of the stock of human capital to growth at the rate that we have seen during the last decade (and to improve Israel's relative position according to average years of schooling among the population), greater investment must be made in education.[49]

1. Efforts should be made to integrate the ultra-Orthodox population into education and the job market.
2. The level of education among non-ultra-Orthodox younger age groups should be raised and at a more rapid rate than in recent years (due the aging of the population). To this end, the investment in secondary education should be increased with the goal of raising the proportion of high school graduates who meet the university entrance requirements and improving the outcomes of secondary education relative to other countries.
3. Efforts should be made to expand the scope of higher education in the universities, since it was found that their quality is at least equal to the international average. Alternatively, the quality of studies in the colleges should be improved in order to bring their return closer to that of studying in university.

As an illustration, if by 2059 Israel has increased the average years of schooling by two years (and thus succeeded in catching up to South Korea and reaching the top of the list of advanced countries according to the index based on average years of schooling), then the average growth rate during those years will rise by 0.4 percentage points relative to the scenarios presented, and the level of per capita GDP in 2059 will be 19 percent higher. If the proportion of high school graduates with matriculation scores that are sufficient to enter university increases from 48 to 58 percent—thanks to an improvement in the education system—the level of long-term per capita GDP will increase by between 2.5 and 4.0 percent.[50] Since the proportion of high school graduates whose matriculation scores are sufficient to begin academic studies was 39 percent in 1996 and has increased uninterruptedly to 48 percent in 2012, it appears that raising the proportion by 10 percentage points is an ambitious though feasible goal. Alternatively, if investment in the education system improves the quality of education by a rate that corresponds to an increase of 10 points on the PISA tests, this will increase long-term per capita GDP by between 6 and 9 percent.

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[49] These are the overall recommendations coming out of this article. They do not purport to suggest specific policy programs.

[50] These calculations are based on several assumptions, the most important of which are the following: (1) the additional high school graduates who meet the entrance requirements for higher education will indeed spend three years in academic studies; (2) the average return on three years of higher education is 36 percent (Zussman and Friedman, 2009); and (3) the gap between the return on a university degree and that on a college degree is 16 percentage points (Zussman et al., 2007). The simulation range reflects the extent to which additional students are channeled to the universities/colleges.

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Appendix A – Adjustment of education level for immigrants

In order to calculate the effective years of schooling of immigrants, we used the following formula:

$$(A\text{-}1)\ S^{eff} = w^{*}\ S^{orig} + (1\text{-}w)S^{0}$$

$$(A\text{-}2)\ w = MIN(1,\ y/10)$$

$$(A\text{-}3)\ S^{0} = MIN\{S^{orig},\ MAX[S^{orig}\text{-}3,12]\}$$

where:

S^{eff} – effective years of schooling of an immigrant.

S^{orig} – actual years of education of an immigrant (according to the Labor Force Survey).

S^{0} – effective years of schooling at the time of arrival.

w – weight calculated according to the number of years the immigrant has been in Israel.

y – number of years since arrival in Israel.

Equation (A-3) describes effective years of schooling of an immigrant in the year of his arrival (S^{0}). In general, we subtract three years from his reported years of schooling in the Labor Force Survey (S^{orig}). However, we do not reduce his education to below 12 years of schooling, since we assume that until high school the educational institution is of less importance. If the reported years of schooling are less than 12 then we do not make the adjustment.

Equation (A-2) calculates a weight (w) for each immigrant on the basis of the number of years he has been in Israel (y). If the immigrant has been in the country more than 10 years, he is given a weight of 1 and if he has been in Israel less than 10 years the weight is the number of years in Israel divided by 10.

Equation (A-1) calculates the effective years of schooling of an immigrant (S^{eff}), which is the weighted average of actual average years of schooling (S^{orig}) (weighted by w as calculated from Equation (A-2)) and effective years of schooling on arrival (S^{0}). In other words, there is no adjustment for an immigrant who has been in Israel for 10 years or longer.

Appendix B – The assumptions underlying the forecast of education

The construction of the forecast for average years of schooling of the population and of the employed is made up of two main parts and involves specific assumptions:

1. Construction of a forecast of the size (number of individuals and number of employed) of each cell. Each cell represents an age group, gender and sector (Arabs, ultra-Orthodox, and non-ultra-Orthodox Jews) with a total of 84 cells.

2. Construction of a forecast for the trend in average years of schooling for each of the cells, for both the entire population and only the employed.

The forecast relates to the period 2009–59 with jumps of five years. Each age group covers five years (15–19, 20–24,…, 75–79, 80+) with a total of 14 groups.

In the last stage, the average years of schooling in each cell is weighted by the cell's share of the population or of the employed, in order to arrive at an aggregate forecast.

B-1: Construction of the forecast for the size of each cell

The forecast for the size of each cell is taken directly from the medium scenario of the long-term forecast of the CBS (Paltiel et al., 2012).

In order to derive the number of employed in each cell, a forecast is added for the employment rate in the cell at each point in time. The employment rate can be broken down as: (1-unemployment rate)*participation rate = employment rate.

The data for the trend in the participation and unemployment rates in each cell are taken from the forecast made by Braude (2013) for the long-term trends in growth and labor in Israel. Some adjustments were required since Braude grouped the cells into age groups of 10 years while our cells cover only five years.

B-2: Constructing the forecast of average years of schooling for each cell

We define the following:

$S_t^{i,pop}$ – the average years of schooling in cell i (age, gender and sector) of the population in year t .

S_t^{i,em_nat} – average years of schooling in cell i (age, gender and sector) of the employed in year t, on the assumption that the increase in employment is natural (i.e. that there is no change in the employment rate).

$S_t^{i,em}$– average years of schooling in cell i (age, gender and sector) of the employed in year t.

In order to calculate average education among the employed in a cell ($S_t^{i,em}$) we will use the following equations:

$$S_t^{i,em} = w^i * S_t^{i,em\_nat} + (1-w^i) * S_t^{i,pop}$$

$$w^i = [L_{t-5}^i * (POP_t^i / POP_{t-5}^i)] / L_t^i$$

where:

POP_t^i –size of the population in cell i in year t.

L_t^i– number of employed in cell i in year t.

Explanation: When the rate of growth in the number of employed in a cell is similar to the rate of growth of the population (i.e. when the employment rate is stable), then w=1 and the education of the employed will develop according to the assumptions for the development of S_t^{i,em_nat} (assumptions will be listed below). However, we wish to relate to a situation in which the employment rate in the cell rises (w<1), due to, for example, a policy to integrate additional participants in the labor market. In this case, we would expect that the new participants will be characterized by a lower level of education than those already in the labor market. We will assume that the education of new participants is equal to the average for the population in the cell (which can be expected to be lower than the average for the employed within the cell).

The following are the assumptions regarding the development of the average years of schooling in each cell, among the total population of the cell and among only the employed in the cell, under the assumption of natural growth. When it is not specified whether we are talking about the population or the employed under the assumption of natural growth, then the same assumption or rules apply to both groups. When the equations do not include the index that differentiates between the population and the employed under the assumption of natural growth (pop, em+nat), that equation applies to both groups.

<u>Non-ultra-Orthodox Jews</u>

1. Individuals aged 15–19 and 20–24 will maintain their average years of schooling according to the 2009 data, both for the population and for only the employed under the assumption of natural growth.

2. Individuals aged 25–29 and 30–34 will each close *g* percent of the gap relative to the long-term average years of schooling. "Long term" indicates a situation in which women begin studying towards a degree at age 22 and men at age 23, and both groups study continuously to complete 18 years of schooling. The average years of schooling in age group *i* (S^i) in year *t* is:

$$S^i_t = S^i_{t-5} + [1-(1-g)^5]*(S^* - S^i_{t-5})$$

   where S^i_{t-5} is the average years of schooling in an age group five years earlier and S* is the average long-term years of schooling. We will assume that g=1% for both the population and for the employed under the assumption of natural growth. Table A-1 describes the current average years of schooling (2009), the expected years of schooling at the end of the period (2059) and the long-term years of schooling:

Table A-1: Years of schooling of young non-ultra-Orthodox Jews						
	Men			Women		
Age group	2009	2059	"Long-term"	2009	2059	"Long-term"
			Population			
25–29	13.7	14.6	16.0	14.4	15.3	16.8
30–34	14.2	15.7	18.0	14.7	16.0	18.0
			Employed[1]			
25–29	13.7	14.6	16.0	14.5	15.4	16.8
30–34	14.3	15.8	18.0	14.9	16.1	18.0

[1] The forecast of employed persons also depends on assumptions regarding the participation and unemployment rates.

SOURCE: Based on Central Bureau of Statistics.

3. With regard to the age group 35–64 (for the population and for only the employed under the assumption of natural growth), we will assume that part of the population continues to acquire education at an older age as well, and each cohort therefore reduces the gap between its actual level of education and the "long-term" level by 0.5 percent each year. The average years of schooling in cohort *j* (S^j) in year *t* is:

$$S^j_t = S^j_{t\text{-}5} + [1\text{-}(1\text{-}0.005)^5]*(S^*\text{-}\ S^j_{t\text{-}5})$$

   where $S^j_{t\text{-}5}$ is the cohort's years of schooling 5 years earlier and S* is the "long-term" years of schooling, i.e. 18.

4. With respect to the 64+ age group (for the population and for only the employed under the assumption of natural growth): each cohort maintains the average years of schooling it achieved while aged 60–64.

Arabs

1. Arabs aged 15–19 will each year close *g* percent of the gap between them and non-ultra-Orthodox Jews of the same age:

$$S_t = S_{t\text{-}5} + [1\text{-}(1\text{-}g)^5]*(S_{t\text{-}5}^*\text{-}\ S_{t\text{-}5})$$

   where $S_{t\text{-}5}^*$ is the years of schooling of non-ultra-Orthodox Jews aged 15–19 (while differentiating according to gender and inclusion in the population/employed).

2. Those aged 20–24 and 25–29 will each year close *g* percent of the gap between them and non-ultra-Orthodox Jews in the same age group and in the previous age group (in terms of the above equation, $S_{t\text{-}5}^*$ is the average of years of schooling in the same age group and in the previous age group). We take the previous age group into account since the Arab population does not serve in the army, which enables it to complete its education at an earlier age. Table A-2 relates to Arabs and describes the assumption regarding *g*, the current average years of schooling (2009), and the expected years of schooling at the end of the forecast period (2059).

Table A-2: Assumptions regarding convergence in the schooling of young Arabs, and results derived from those assumptions, 2009–59[1]						
	Men			Women		
Age group	g[2]	2009	2059	g[2]	2009	2059
			Population			
15–19	3%	10.8	11.0	3%	11.0	11.2
		(-0.3)	(-0.1)		(-0.2)	(-0.1)
20–24	5%	12.0	13.2	5%	12.6	13.8
		(-1.0)	(-0.2)		(-1.0)	(-0.3)
25–29	5%	12.0	14.6	5%	12.5	15.1
		(-1.9)	(-0.6)		(-2.0)	(-0.6)
			Employed			
15–19	3%	11.0	11.3	10%	11.5	11.7
		(-0.4)	(-0.1)		(-0.1)	(0.0)
20–24	5%	11.6	13.2	50%	13.4	14.1
		(-1.4)	(-0.3)		(-0.3)	(0.0)
25–29	5%	12.3	14.6	100%	14.6	15.7
		(-1.7)	(-0.6)		(-0.1)	(-0.1)

[1] The numbers in parentheses show the gap between Arabs and the parallel non-ultra-Orthodox Jewish population (S*)
[2] The rate of convergence to non-ultra-Orthodox Jews.
SOURCE: Based on Central Bureau of Statistics.

We calibrated the assumption regarding *g* in the population and among the employed men under the assumption of natural growth on the basis of the rate of convergence that was observed during the past decade. With regard to employed women, since we found that at the starting point there is no gap between them and Jewish women, we assumed that the rate of convergence is very high in order to prevent the creation of gaps in the forecast over time.

3. Each older cohort maintains the average years of schooling that it achieved at ages 25–29.

The ultra-Orthodox

Scenario A – without convergence in ultra-Orthodox education: The average years of schooling among the ultra-Orthodox, after adjustment, does not change during the forecast period.

Scenario B – convergence in ultra-Orthodox education: The initial years of schooling (in 2009) are equal to the number in Scenario A, and they converge to the years of schooling among non-ultra-Orthodox Jews:

1. Those in the 15–19, 20–24, 25–29 and 30–34 age groups will each year close 10 percent of the gap between them and non-ultra-Orthodox Jews of the same age:

$$S_t = S_{t-5} + [1-(1-0.1)^5]*(S_{t-5}^* - S_{t-5})$$

where S_{t-5}^* is the average years of schooling among non-ultra-Orthodox Jews in the same group (with respect to age, gender and employment). Table A-3 relates to the ultra-Orthodox and describes the current years of schooling (2009) and the expected years of schooling at the end of the forecast period (2059).

Convergence will occur only starting from the cohort of individuals who in 2009 were already in the 15–19 age group, and will not occur for cohorts older than that.

2. All older cohorts maintain the average years of schooling they attained at ages 30–34.

Table A-3: Assumptions regarding convergence in the schooling of young ultra-Orthodox Jews, and results derived from those assumptions, 2009–59[1]

	Men			Women		
Age group	g[2]	2009	2059	g[2]	2009	2059
			Population			
15–19	10%	9.8	11.1	10%	11.4	11.2
		(-1.3)	(0.0)		(0.2)	(0.0)
20–24	10%	9.9	12.3	10%	13.8	12.8
		(-2.3)	(0.0)		(1.1)	(0.0)
25–29	10%	10.0	14.4	10%	14.4	15.1
		(-3.7)	(-0.2)		(0.1)	(-0.2)
30–34	10%	10.0	15.4	10%	14.2	15.7
		(-4.3)	(-0.3)		(-0.5)	(-0.3)
			Employed			
15–19	10%	10.0	11.4	10%	12.5	11.7
		(-1.4)	(0.0)		(0.8)	(0.0)
20–24	10%	10.0	12.3	10%	14.0	12.8
		(-2.3)	(0.0)		(1.2)	(0.0)
25–29	10%	10.0	14.4	10%	15.2	15.2
		(-3.7)	(-0.2)		(0.7)	(-0.2)
30–34	10%	9.9	15.4	10%	14.7	15.9
		(-4.4)	(-0.3)		(-0.2)	(-0.3)

[1] The numbers in parentheses show the gap between the ultra-Orthodox and the parallel non-ultra-Orthodox Jewish population (S*)

[2] The rate of convergence to non-ultra-Orthodox Jews.

SOURCE: Based on Central Bureau of Statistics.

Appendix C – Gini index of inequality in average level of education

This appendix presents the method used to calculate the Gini index of inequality in education in the developed countries (data for Figure 13). The data are taken from the database built by Barro and Lee (2013) for the level of education among the 25+ age group in the general population. This database includes, for each country, a time series of the proportion of the population (n_i) for seven education groups i:

1. Uneducated (zero years of schooling)
2. Partial primary education
3. Full primary education
4. Partial secondary education
5. Full secondary education
6. Partial tertiary education
7. Full tertiary education

The database also includes data on average years of primary education ($x_{2,3}$), secondary education ($x_{4,5}$) and higher education ($x_{6,7}$) for the country as a whole (i.e. the average years of primary/secondary/tertiary education divided by the entire population), as well as the average total years of schooling in the population (for the 25+ age group) – $\overline{S}$.

The Gini index (which includes those with no education) is calculated according to the following equation:

$$(C.1) \quad G^s = \frac{1}{2\overline{S}} \sum_{i=1}^{7} \sum_{j=1}^{7} n_i \left| s_i - s_j \right| n_j$$

where n_i is the weight of education group i in the population and s_i is the average total years of schooling in education group i. The data for s_i is not found in Barro and Lee, and must be derived from the data on x (the average years of schooling according to type of education) based on assumptions regarding the years spent at each level of education in each country, or the average number of years those with partial education spent studying. We will assume that, on average, those with a partial education completed half of the full curriculum. Based on this assumption, it is possible to calculate s_i as follows:

$$(C.2) \quad s_1 = 0$$

$$(C.3) \quad s_2 = 0.5 s_3$$

$$(C.4) \quad s_3 = \frac{x_{2,3}}{0.5 n_2 + n_3 + \cdots + n_7}$$

$$(C.5) \quad s_4 = s_3 + 0.5(s_5 - s_3)$$

$$(C.6)\quad s_5 = s_3 + \frac{x_{4,5}}{0.5n_4 + n_5 + \cdots + n_7}$$

$$(C.7)\quad s_6 = s_5 + 0.5(s_7 - s_5)$$

$$(C.8)\quad s_7 = s_5 + \frac{x_{6,7}}{0.5n_6 + n_7}$$

Finally, we will use the equation appearing in Morrison and Murtin (2010) and Castello-Climent (2014) to derive the Gini index for inequality only among the educated (G^{s+}):

$$(C.8)\quad G^s = n_1 + (1 - n_1)G^{s+}$$

Appendix D – University rankings

There are three main university ranking systems. The following is a review of the parameters that are used to calculate each of them.

1. ***Times Higher Education* World University Rankings**[51]

This is an annual ranking by the weekly magazine *Times Higher Education* since 2010. The ranking includes the 400 leading universities worldwide[52], and relates to universities that meet the following criteria:

1. It has an undergraduate program.
2. Students can study more than one narrow subject.
3. It has published at least 200 research articles annually.

The ranking is based on the university's performance according to 13 parameters in five different categories:

a. Teaching (30 percent):

   1. Ratio of academic staff to students.
   2. Ratio of doctorates to bachelors.
   3. Ratio of doctorates who were awarded a prize by some institution to number of academic staff.
   4. The university's income divided by the size of the academic staff.
   5. An international survey of academics regarding the university's research and teaching.

[51] Taken from the site: www.timeshighereducation.co.uk
[52] The most recent ranking, for 2015–16, ranked 800 leading universities.

b. Research (30 percent):

1. The university's reputation in research.
2. Research income of the university relative to the size of the academic staff.
3. Number of research articles published (normalized to the size of the university and the subject of the research).

c. Citations (30 percent)

Number of times that a publication of the academic staff is cited in articles published during 2007–12.

d. Industry income (2.5 percent)

Amount of income earned by the university from industry (in order to carry out research) divided by the size of the academic staff.

e. International outlook (7.5 percent)

The scope of research collaboration between the university's students and staff and other universities, and the ratio of foreign students and staff to the rest of the students and staff.

After gathering the data, the scores are standardized for each parameter and category and translated into a probability score that creates a common denominator for all of the parameters.

2. Shanghai Ranking – Academic Ranking of World Universities (ARWU)[53]

Shanghai University has carried out this annual ranking since 2003. The ranking includes 500 leading universities worldwide and relates to universities that fulfill the following criteria:

1. A member of the staff has won a Nobel Prize or Fields Medal
2. Researchers are cited frequently in the research articles of other universities.
3. The university publishes articles in the Exact Sciences or in the Natural Sciences.

This methodology also includes universities that have a large number of articles in SCIE (Science Citation Index Expanded) and in SSCI (Social Science Citation Index).

The ranking is carried out according to the following indicators:

a. Quality of teaching (10 percent):

[53] Taken from the site: www.shanghairanking.com

Number of alumni who have been awarded a Nobel Prize or a Fields Medal.

b. Quality of the faculty (20 percent):

Number of faculty members who have been awarded a Fields Medal or Nobel Prize in Chemistry, Physics, Medicine or Economics while working at the university.

c. Citations (20 percent):

Number of highly cited researchers in 21 subjects.

d. Number of papers published in the Natural Sciences and the Exact Sciences by faculty members during 2008–12.

e. Number of papers in important catalogues (20 percent):

Number of papers in Science Citation Index Expanded and the Social Science Citation Index for 2012.

f. Adjustment for size of institution (10 percent):

Division of the abovementioned indicators (with the relevant weights) by the number of fulltime academic staff.

After calculating the indices, the university with the highest original score is given a score of 100 and the rest of the universities are given a score relative to it.

3. QS world University Rankings[54]

This is an annual ranking carried out by the QS Intelligence Unit since 2004. The ranking includes 400 leading universities worldwide.

The universities are ranked according to the following indicators:

a. Academic reputation (40 percent):

Measured by means of a universal survey of academics. The survey is meant to determine where the most professional work is being done in the respondent's field.

b. Reputation among employers (10 percent):

Measured by means of a universal survey of employers. The survey is meant to determine which university has the best graduates in the opinion of employers.

[54] Summarized from the site: www.topuniversities.com

c. Teaching (20 percent):

The ratio of number of academic staff members to number of students.

d. Citations (20 percent):

Number of times that the university's research articles have been cited in other research articles during the past five years, relative to the number of academic staff members.

e. International component (10 percent):

Proportion of foreign students in the total student body, and the proportion of foreign staff members within the total university staff.