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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-1970s contributed 0.6–0.8 percentage points to the average annual growth rate, which is equivalent to 48–58 percent and 35–45 percent of the labor productivity and total per-capita GDP growth rates, respectively, 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 0.1–0.3 percentage points. The range partly reflects uncertainty regarding the Ultra-Orthodox population's degree of integration in the effective education systems.

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1. INTRODUCTION

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.[2] 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.[3] 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 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

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

[3] 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).

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.[4] 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 productivity (GDP per hour) and 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.

The rest of the paper proceeds as follows: Section 2 presents the methodology for calculating the contribution of human capital to productivity 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 productivity 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. We conclude by summarizing the main results while discussing additional aspects of the level of human capital beyond that from years of schooling.

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

2. THE METHODOLOGY FOR CALCULATING THE CONTRIBUTION OF HUMAN CAPITAL TO PRODUCTIVITY AND GDP 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) $$Y_t = A_t K_t^{\alpha} (h_t L_t)^{1-\alpha}$$

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)[5], 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.[6]

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

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

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) $$h_t = e^{S_t r}$$

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.

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; Bassanini, Scarpetta 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)[7]; 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 approaches: The macroeconomic approach is based on 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.[8] 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 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 Sections 3.3 and 5, 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.

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

In order to calculate the Solow residual, we will assume a value of 1/3 for α, which reflects the average share of payments to capital in GDP.

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 labor productivity (GDP per hour), since it is a major determinant of improvements in the standard of living in Israel. In basic growth accounting practices, it is common to track the contribution to GDP of changes in physical capital stock—equal to $\alpha\,\Delta\log(k_t)$, and the contribution of human capital—equal to $(1-\alpha)\,\Delta\log(h_t)$, as indicated in equation (3). However, this is only partial equilibrium whereas in the long run some of the changes in physical capital are actually the equilibrium result of shifts originated in the labor input,

[7] 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.

[8] 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.

human capital or total factor productivity. In contrast, the ratio of the stock of physical capital to output, *K/Y*, is considered independent of the level of other components. The reason is that equilibrium conditions dictate that the marginal product of capital will be equal to the depreciation rate plus the interest rate (which are considered independent of the other inputs in the long run).[9] In order to account for this equilibrium condition, we 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). This way, our measure of contribution of changes in human capital to growth will account for two channels: the direct channel in which more human capital raises production capacity, and the indirect, where it raises the marginal product of capital and therefore stimulates more investment in capital. In addition, we will express the equation in terms of productivity as measured by output per hour ($y=Y/L$) as the dependent variable.

(4) $$\Delta\log(y_t) = \frac{1}{1-\alpha}\Delta\log(A_t) + \frac{\alpha}{1-\alpha}\Delta\log(K_t/Y_t) + \Delta\log(h_t)$$

In order to calculate the contribution of each component to growth, the coefficient of each variable is multiplied by its rate of change. A similar methodology of analysis for Israel was also conducted in Zeira (2018) for the years 1955–2011.[10] The main difference is that Zeira uses a return that decreases with the average years of schooling (from 13.5% at 6 years of schooling to 8.8% at 16 years). In addition, the return is operated on the distribution of years of schooling between three groups (0–8 years, 9–12 years and above 13 years) and not on the economy wide average.

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

[9] This is an acceptable result in neoclassical models that are used to explain long-term growth in which technological changes are disembodied of the capital stock. See Chapters 2 and 5 in Aghion and Howitt (2009).

[10] Chapter 2.

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.[11] 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

a. 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 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[12] men (of prime working age), their average years of schooling was 16.2 in 2011. We limited the number of

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

[12] Since Labor Force Surveys (prior to 2016) do not include direct identification of Ultra-Orthodox by self-definition, for the purpose of this research 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.

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, individually for men and for women, which were estimated using data from the 2011 Income Survey.[13] 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.[14 ,15] The regressions' observations were limited to individuals with 1 to 22 years of schooling. The 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 used in our analysis.[16] An analysis of column (1) reveals that the coefficient of the "ultra-orthodox * high years of schooling" 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 12^{th} year of schooling.

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

[14] 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.

[15] The robustness of the regressions was verified with respect to the intersection point in the variables "Low / High years of schooling" and the use of ranges for the number of years of schooling instead of a continuous variable.

[16] We should mention that Zeira (2018) included also the square of years of schooling in his regressions which received a negative coefficient in his estimations – leading to his use of decreasing return on schooling. In our regressions, once limiting the observations to individuals with up to 22 years of schooling, the years of schooling square coefficient does not turn out negative. Therefore we did not include this in our analysis.

Table 1

The factors affecting wages[a]

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	0.065***	0.065***	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***	-0.0311
Dummy for married	0.223***	0.105***	0.196***	0.147***
Years of schooling	0.088***	0.087***	0.083***	0.078***
Dummy for Ultra-Orthodox	-1.849*	1.302*	0.962	1.296
Ultra-Orthodox * low years of schooling[b]	0.142*	-0.114*	-0.097	-0.116
Ultra-Orthodox * high years of schooling[b]	-0.080***	-0.019	-0.043**	0.018
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

Significance level: * 10%, ** 5%, *** 1%.

[a] Based on the wage equations specified by Mincer (1974) and estimated using data from the Income Survey. The regression coefficients are based on weighted observations according to the observation weights of the population. The regressions do not include individuals with zero or above 22 years of schooling.

[b] "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.

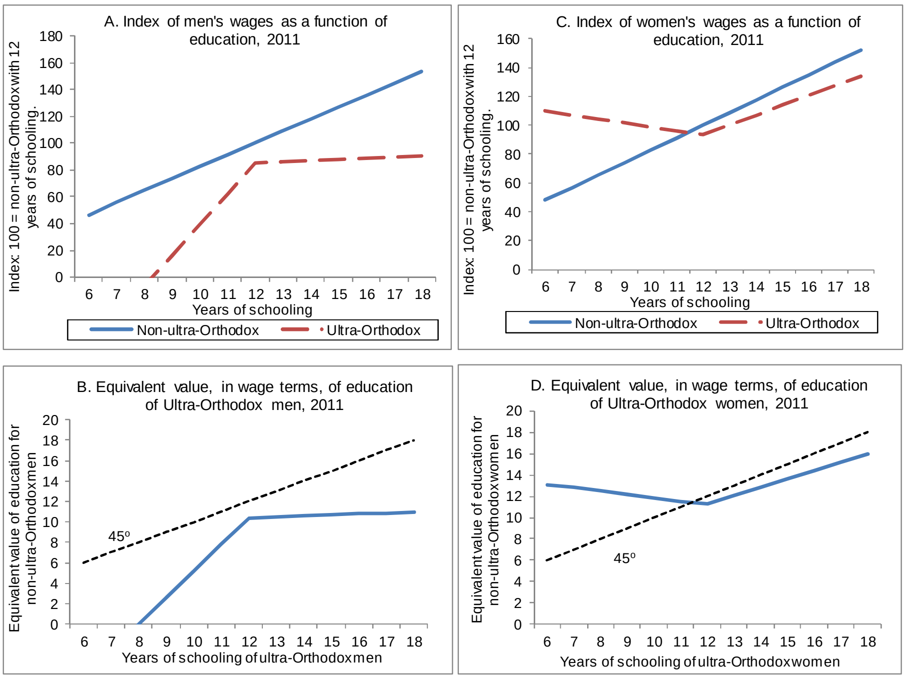
In this structure, the coefficient of "Ultra-Orthodox * Low years of schooling" reflects the return on a year of schooling up to the 12th year (relative to the general population), and the coefficient of "Ultra-Orthodox * High years of schooling" reflects the return on schooling beginning with the 12th year (relative to the general population).

Source: Based on Central Bureau of Statistics.

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.

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. Therefore for the rest of the analysis we used the years of schooling of Ultra-Orthodox women as they appear in the Survey without any adjustment.

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, but rather other factors that require deeper investigation. Due to the moderate effect of the immigrants correction on the aggregate years of schooling (as will be shown), we leave this investigation for future research. 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.[17]

It is interesting to see in Table 1, that in the later regressions on 2011 data (columns 1 and 2) the negative coefficient of the immigrants at their arrival ("Dummy for an immigrant 0–3 years ") and its difference from the coefficient for 10 years after arrival ("Dummy for an immigrant 10–12 years ") are smaller in absolute terms. Thus, the negative immigrants wage impact during the immigration wave of the 1990s was more severe than for the immigrants of the 2000s. This may very well reflect decreasing returns to scale in the sense that it is hard to effectively absorb immigration waves of the 1990s magnitude.

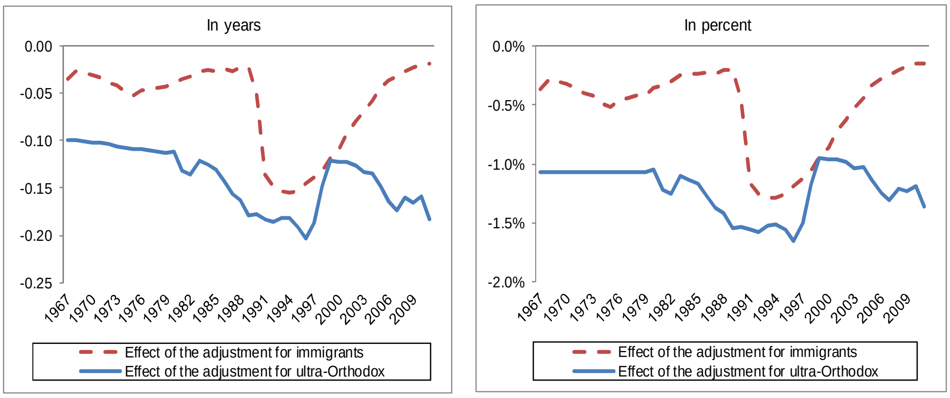
Figure 2 shows how the two aforementioned adjustments (in the education levels of the Ultra-Orthodox and immigrants) affect the average education of the prime working age population. The graph shows that the adjustment for the Ultra-Orthodox lowers the average education for the entire sample, and that 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

[17] 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.

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. Thus, only an immigration wave of the magnitude of the 1990s has macroeconomic impacts. This is all the more so if the calibration of the immigrants correction would have been based on parameters estimated in the latter years.

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[18], 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

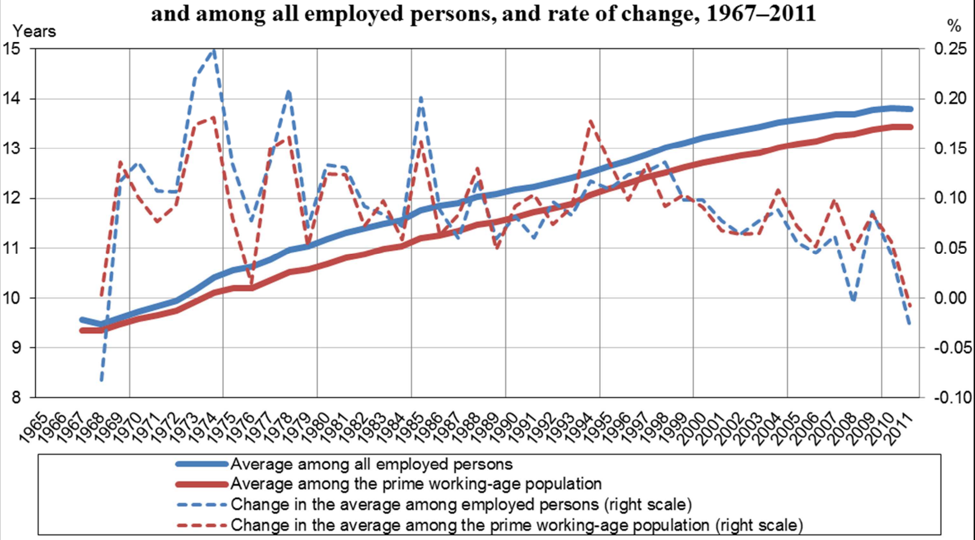
[18] According to the analysis that appears in Bank of Israel (2016), 77 percent of the gap in hourly wages for Arab men is explained by a low level of basic skills, as measured by a survey of adult skills (PIAAC).

universities.[19] 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 the summary section, we will return to the aspects of education that may influence the stock of effective human capital (beyond years of schooling).

b. 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.[20] 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 (Krief, 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



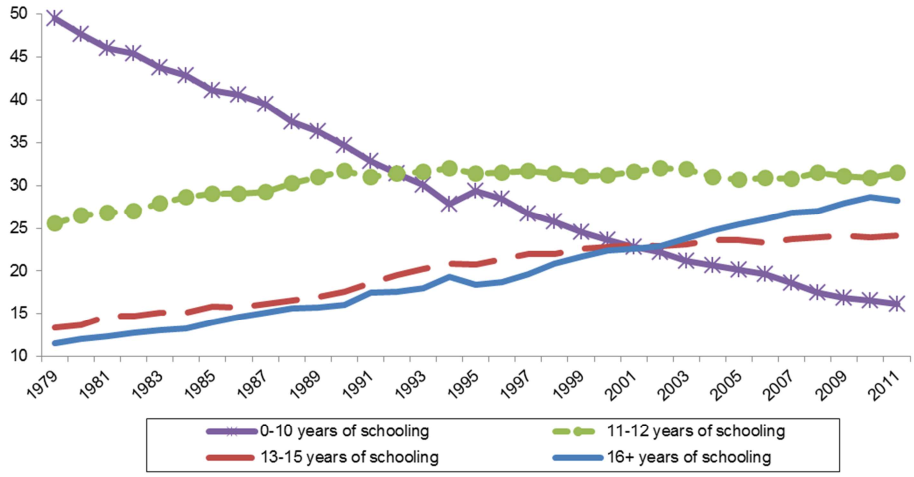
SOURCE: Based on Central Bureau of Statistics.

[19] 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.

[20] 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.

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 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).[21] 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 (percent)



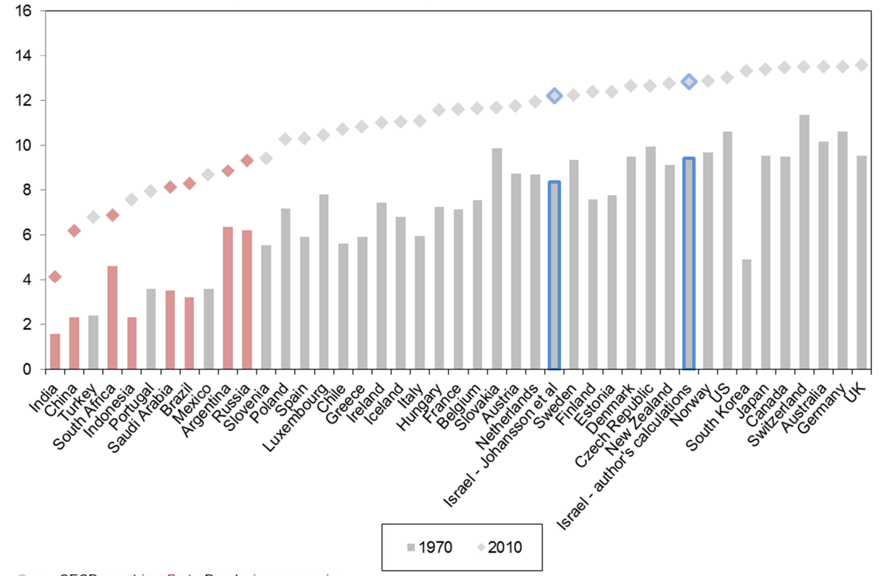
SOURCE: Based on Central Bureau of Statistics.

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

[21] Until the beginning of the 1990s, there was also a noticeable rise in the proportion of high school graduates (11–12 years of schooling).

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).[22] The graph also shows that Israel has maintained its relative position since 1970.

Figure 5
Average Years of Schooling, Selected Countries, 1970 and 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 factor 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.

Table 2 summarizes the increase in each of the sources of GDP and labor productivity growth for sub-periods. The last column of the table presents the rate of increase in total factor 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 labor productivity growth between the 1970s and the 1980s. This implies that during these two decades total factor productivity grew at a similar

[22] According to a different database of education statistics, Israel is in 9th place among the advanced economies. See Barro and Lee (2013).

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. 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.

Table 2
GDP and productivity growth and their sources, 1970–2011 (year groups) (percent)

	GDP Y (1)	GDP per capita Y/POP (2)	Productivity: GDP per hour worked y (3)	Stock of human capital h (4)	Stock of physical capital K (5)	Total factor productivity A (6)	Total factor productivity excl. stock of human capital (7)
1970–1979	5.7	2.9	3.7	1.2	7.7	1.1	1.9
1974–1979	3.3	0.9	1.2	1.0	6.4	-0.9	-0.3
1980–1989	3.4	1.5	2.0	0.8	3.6	0.7	1.3
1990–1999	5.5	2.3	0.6	0.8	5.7	-0.3	0.3
2000–2009	3.7	1.6	1.1	0.5	3.5	0.4	0.8
1970–2011	4.6	2.1	1.9	0.8	5.0	0.6	1.1
1974–2011	4.1	1.8	1.3	0.8	4.6	0.2	0.7
1980–2011	4.2	1.9	1.3	0.7	4.2	0.4	0.9
1990–2011	4.6	2.1	1.0	0.6	4.5	0.3	0.7
2000–2011	3.9	1.8	1.3	0.4	3.4	0.7	1.0

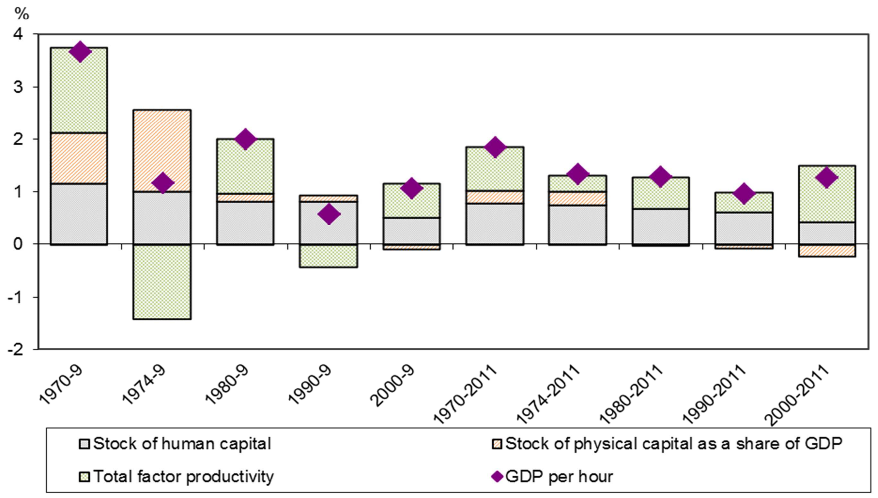
SOURCE: Based on Central Bureau of Statistics

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 total factor productivity slowed by a percentage point according to both calculations (that is, including and not including human capital). In the 2000s (2000–2011) the GDP growth rate declined, 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 factor 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.

Figure 6 shows the contribution of each component to labor productivity 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. This amounts to approximately

57 percent of total labor productivity growth and 43 percent of GDP per capita growth. Not very surprisingly, Zeira (2018) reaches similar results. He reports an increase of 0.8 percent per year in the human capital. He calculates that this increase accounted for approximately 45 percent of the growth rate in GDP per worker. Turning back to our analysis, the rest of the growth is generated, equally, by 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.[23] 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 Productivity Growth, 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 35 percent of labor productivity growth). As we will see in the next section, this contribution is expected to continue to decline in coming decades.

[23] 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).

c. The sensitivity of the contribution estimate of human capital to growth

The sensitivity to the education series: for the basic analysis above we used the average education among the employed persons to calculate the stock of human capital, while conducting corrections for the education of Ultra-Orthodox men and immigrants. 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 employed are 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.

Table 3
Contribution of the stock of human capital to productivity growth, 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.

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 labor productivity 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 the sensitivity of the contribution estimate with respect to three alternative values of the 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.

Table 4 summarizes the effect of the various assumptions. 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, the return on schooling derived from the function (7.5–9.0 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 0.5 percentage points, depending on the alternative and time period. Like in the basic analysis in all three alternatives with respect to the return, we arrive at the conclusion that the growth of human capital had a major contribution to growth, and that the contribution moderated in the last decade.

Table 4
Estimated contribution of the stock of human capital to productivity growth: its sensitivity to the return on schooling assumption (average of annual contributions, percentage points)[a]

	Base scenario (8%)	Declining	6%	12%
1970-1979	**1.2**	1.2	0.9	1.8
1980-1989	**0.8**	0.8	0.6	1.3
1990-1999	**0.8**	0.8	0.6	1.3
2000-2009	**0.5**	0.5	0.4	0.8
1974–2011	**0.8**	0.7	0.6	1.2
1980–2011	**0.7**	0.6	0.5	1.0
1990–2011	**0.6**	0.6	0.5	0.9
2000–2011	**0.4**	0.4	0.3	0.7

[a] All alternatives are computed based on the education among employed at age 15+, including Ultra-Orthodox and immigrant corrections.
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). 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[24], 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 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).[25] 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

[24] Which is the base year for the demographic forecast.

[25] 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.

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 Ultra-Orthodox cohorts as of that aged 15–19 in 2009, so that the gap between the Ultra-Orthodox population and the young Jewish non-Ultra-Orthodox population (up to age 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.

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.

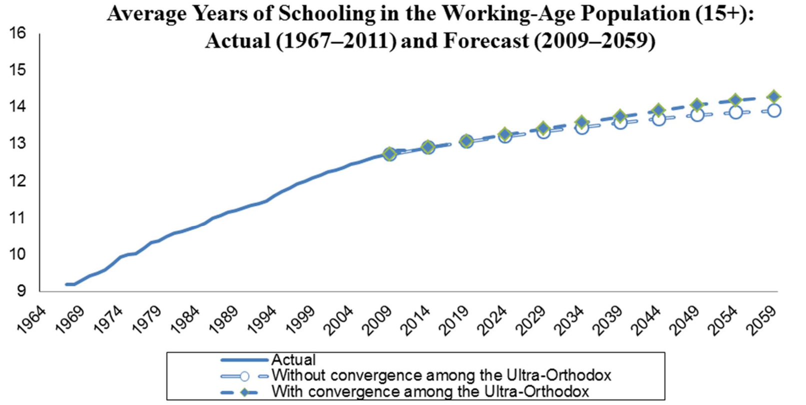
Figures 7–9 describe how the average years of schooling is expected to develop in the working age population (aged 15+), the prime working age population (aged 25–64), and among the employed (aged 15+).

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 exhaustion of the long-term growth in years of schooling. 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 proportion of the young among the working-age population will decrease, due to the slower rate of increase of the young population,

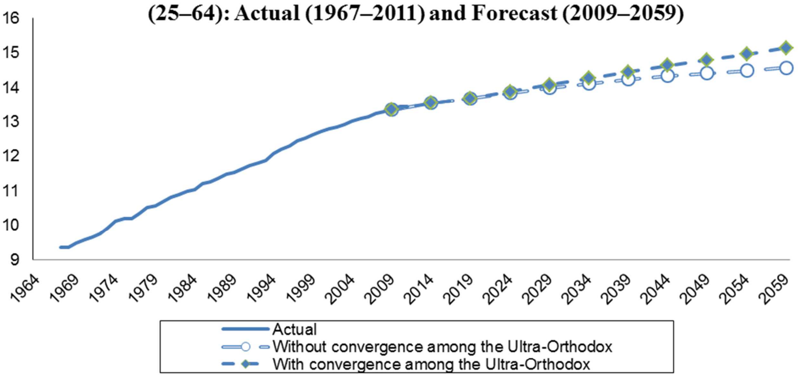
among other things. Since this population tends to be more educated than older age groups, the rate of increase in the average education level of the population will slow.

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



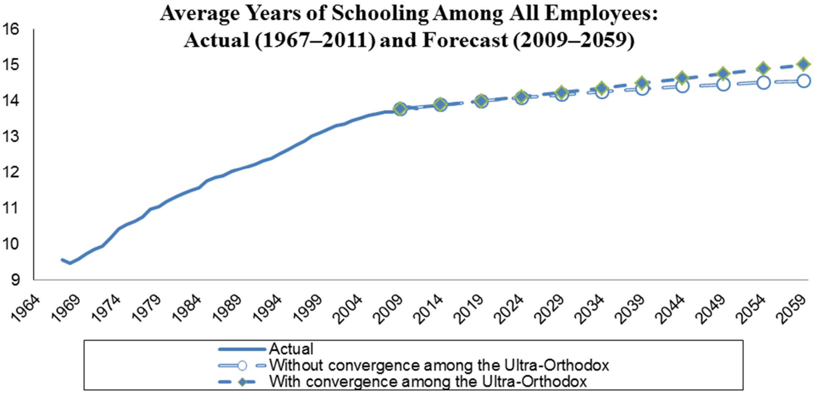
SOURCE: Based on Central Bureau of Statistics.

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.

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.[26]

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 increase 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. 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 5 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. 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.

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

Table 5
Contribution of the stock of human capital to productivity growth: actual (1974–2011) and forecast (2009–2059), percentage points

Employed / population Age Convergence among the Ultra-Orthodox	Population 15+ No	Population 15+ Yes	Population 25–64 No	Population 25–64 Yes	Employed 15+ No	Employed 15+ 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 6,500 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).[27] 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.

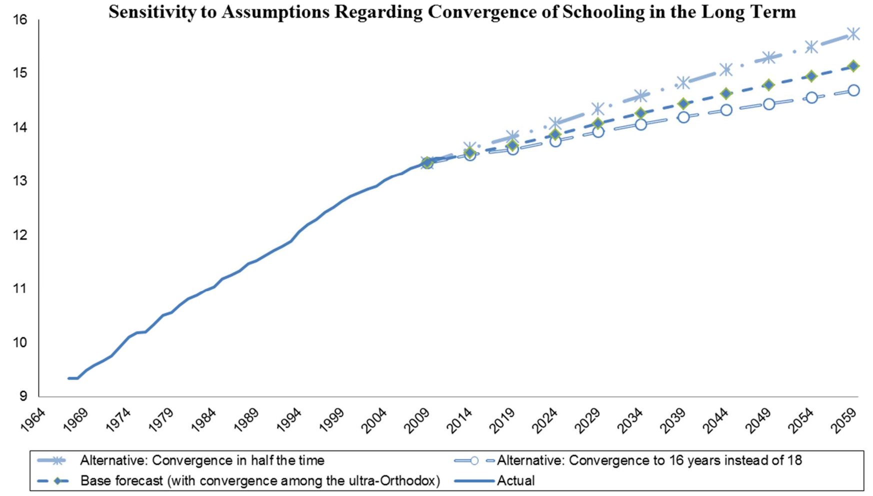
5. SENSITIVITY OF THE FORECAST TO THE ASSUMPTIONS

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 and on the assumptions with regard to the

[27] 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.

return on schooling. Figure 10 presents the forecast of average education level under various assumptions, and Table 6 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. In addition, the forecast of the average years of schooling and its contribution to growth is not sensitive to the choice of each of the three demographic scenarios given by the CBS (Paltiel et al., 2012).

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



SOURCE: Based on Central Bureau of Statistics.

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.
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 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.

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. Table 6 summarizes the effect of various assumptions regarding the return on schooling: a return that declines with the level of schooling, a lower return of 6% and a higher return of 12% (for details see Section 3.3) In the case of a declining function for return on schooling, the results obtained with respect to the expected contribution of human capital to growth are basically similar to those of the basic scenario. However, the higher return raises the estimated expected contribution by 0.15 percentage points, while the lower return reduces it by 0.07 percentage points.

Table 6
Estimated contribution of the stock of human capital to productivity growth: its sensitivity to the assumptions underpinning the model (percentage points)

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

SOURCE: Based on Central Bureau of Statistics.

In summary, it appears that the trends surveyed in the previous section, with regard to the future contribution of human capital to growth, are not particularly sensitive to reasonable changes in the assumptions. Particularly, in all of the alternatives the rate of increase in average education and its contribution to growth are expected to continue to decline in coming decades; and 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. 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 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 productivity growth rate, which constitutes between 35 and 45 percent of the average growth in per capita GDP since the 1970s, and 48 to 58 percent of labor productivity growth. 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 labor productivity will decline to between 0.1 and 0.3 percentage points.[28] 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.

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. In the context of this study, we did not attempt to estimate the contribution of these factors to growth in Israel or to predict their future contribution. Some of them are unrelated to education (such as the

[28] 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.

health of the population and work experience), while others are related to education, though they are not reflected in the number schooling years, which only measures quantity. For example, the return on schooling or even the amount of schooling in the economy may depend on the individuals' abilities that enable them to advance in the level of schooling and extract skills that contribute to their future working productivity.

The return may also be influenced by the quality of the education system at its various levels. 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 such as Islam (2014) and Boius, Duval and Murtin (2011) 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 (Hanushek and Woessmann, 2012).

With regard to the quality of education, as opposed to its quantity, we find that there is greater potential for improvement (Argov, 2016). 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 the advanced economies. In contrast, the quality of Israel's universities is reasonable, when considering its size and relative income. It may very well be that the low quality of education in the various levels up to secondary education explains the finding that the basic working skills of the workers in Israel (in terms of reading, mathematics and problem solving) is below the average among advanced economies despite its high rate of higher educational attainment.[29]

Beyond the quality of education, the empirical research of Castello and Domenech (2002) and Castello-Climent (2010) found a negative relation between inequality in the distribution of educational years and long term income growth. Despite the fact that the proportion of highly educated individuals in Israel is among the highest in the world (while the average years of schooling is within the second quarter of the distribution), Argov

[29] This finding is based on the results from the adult skills survey (PIAAC) which was conducted in most OECD countries. Israel joined the survey in 2014-2015. For details see Bank of Israel (2016).

(2016) did not find that inequality in education, as measured by the Gini index, was outside the range for the advanced countries.

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 in order to:[30]

1. Integrate the Ultra-Orthodox population into education that is relevant to the job market.
2. Accelerate the expansion of education among young non-Ultra-Orthodox to a more rapid rate than in past 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[31] and improving the outcomes of secondary education relative to other countries.
3. 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 or additionally, the quality of studies in the colleges should be improved in order to bring their return closer to that of studying in a university.[32]

As an illustration, if by 2059 Israel will increase its average years of schooling by two additional years (and thus succeed 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 productivity and per capita GDP in 2059 will be 19 percent higher.

[30] These are general recommendations coming out of this article. They do not pretend to suggest specific policy programs.

[31] 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 and the proportion of individuals actually starting academic studies. 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*.

[32] 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.

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

(A-2) $w = MIN(1, y/10)$

(A-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) <u>of the population</u> in year *t* .

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

$S_t^{i,em}$– average years of schooling in cell *i* (age, gender and sector) <u>of the employed</u> 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), the equation applies to both groups.

Non-Ultra-Orthodox Jews

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:

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

   where $S^i_{t\text{-}5}$ 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[a]			
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

[a] 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).

Table A-2
Assumptions regarding convergence in the schooling of young Arabs, and results derived from those assumptions, 2009–2059[a]

Age group	Men			Women		
	g[b]	2009	2059	g[b]	2009	2059
	Population					
15–19	3%	10.8 (-0.3)	11.0 (-0.1)	3%	11.0 (-0.2)	11.2 (-0.1)
20–24	5%	12.0 (-1.0)	13.2 (-0.2)	5%	12.6 (-1.0)	13.8 (-0.3)
25–29	5%	12.0 (-1.9)	14.6 (-0.6)	5%	12.5 (-2.0)	15.1 (-0.6)
	Employed					
15–19	3%	11.0 (-0.4)	11.3 (-0.1)	10%	11.5 (-0.1)	11.7 (0.0)
20–24	5%	11.6 (-1.4)	13.2 (-0.3)	50%	13.4 (-0.3)	14.1 (0.0)
25–29	5%	12.3 (-1.7)	14.6 (-0.6)	100%	14.6 (-0.1)	15.7 (-0.1)

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

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).

   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:

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

   where $S_{t\text{-}5}*$ 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, 2009–2059[a]

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

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

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