TAUB CENTER
FOR SOCIAL POLICY STUDIES IN ISRAEL

How Much Can the Israeli Start-Up Nation Continue to Grow?

Gilad Brand

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Center address: 15 Ha'ari Street, Jerusalem, Israel
Telephone: 02 5671818 Fax: 02 5671919
Email: info@taubcenter.org.il Website: www.taubcenter.org.il

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Abstract

A national program to grow the skilled labor force to ready them for employment in the high tech sector has been initiated recently by the government of Israel. This chapter aims to evaluate the potential for success of this approach. The evaluation is through a comparison of the skill level of high tech and non high tech workers in Israel and in other developed countries as they are measured by the OECD's Survey of Adult Skills (PIAAC).

The data show that the skills and wages of high tech sector workers (as measured by the PIAAC survey) are very different from those in the other economic sectors, and that these disparities are exceptional when compared to other countries. These gaps lead to a weak connection between the sectors, and so it is difficult to expect that the anticipated widening of employment in this sector will lead to a significant spread of knowledge and innovative work methods from high tech to other industry sectors.

The findings also suggest that policies to encourage high tech employment are relevant for only a small share of the working age population (about 1 percent). This is for two reasons. The first is that, as of now, the share of workers in high tech is high relative to other developed countries. The second reason is that the skill level of workers outside of high tech are, in fact, substantially lower than the average skill level in the high tech sector.

It was also found that due to low proficiency in English and generally low skill levels (as measured by the PIAAC survey), the use of vocational retraining as a means of integrating Arab Israelis and Haredim into high tech is of limited potential value. The little as yet untapped potential lies in the non-Haredi Jewish population, to which the majority of high tech workers already belong.

* Gilad Brand, Researcher, Taub Center. The author wishes to thank Professor Benjamin Bental, Professor Gil Epstein, Professor Alex Weinreb, Professor Avi Weiss, and Dr. Assaf Zimring for their enlightening comments. The final result reflects the views of the author alone and are his sole responsibility.

Survey data show that the majority of workers in the non high tech industries are characterized by low skill levels, and this is possibly one of the reasons for low wages and low productivity in those industries. It is possible that focusing on raising skill levels of workers in those segments through appropriate retraining, as well as improving the education system (which will lead to higher skill levels in the next generation) is preferable to the effort to move additional high skilled workers to the high tech sector.

Introduction

Israel's reputation as the "Start-Up Nation" is well-earned given that high tech is such an important component of the Israeli economy. Although the sector's share of the Israeli worker population amounts to only about 8 percent (Figure 1), high tech accounts for a major portion of the added value of Israeli exports,[1] and provides a quarter of the country's income tax revenues.[2] Moreover, on average, high tech workers earn double the amount earned in other sectors.

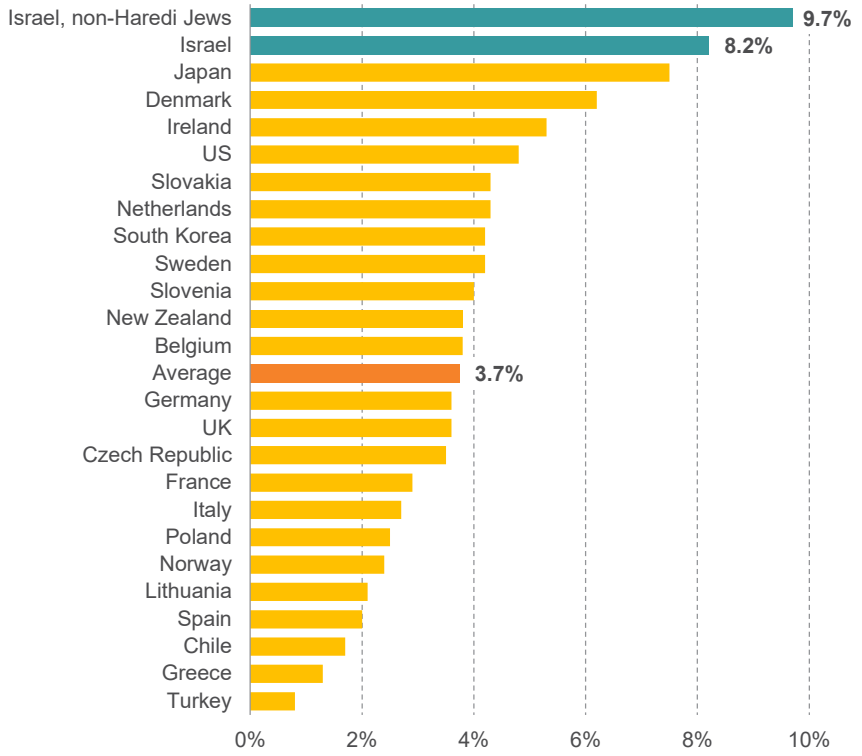
However, despite the high tech sector's high wage levels, its employment share has remained almost unchanged for over a decade, and there is evidence that employers are having difficulty filling positions. For instance, Central Bureau of Statistics (CBS) labor market supply and demand surveys have consistently shown that the number of available positions in the science, engineering, and information technology fields exceeds the number of job seekers in these fields.[3]

1 See the discussion in Bank of Israel (2011:274).

2 This estimate is calculated by multiplying the income tax payment distribution per decile by the prevalence of high tech workers in those deciles. Data on income tax payment distribution are shown in State Revenue Administration (2017:Chapter 5). The share of high tech workers in each decile was calculated by means of Central Bureau of Statistics administrative data.

3 Data for 2017 indicate that there are five software development positions available for every job seeker (CBS 2018). By contrast, Bental and Peled (2016) find no evidence of a comprehensive shortage of STEM graduates, but note that shortages may exist in specific fields. Deming and Noray (2017) argue that the difficulty in filling high tech positions is due to rapid technological change that renders some workers' skills obsolete and increases the demand for other workers with expertise in new fields.

Figure 1. Share of workers in the high tech sector
24 OECD countries, ages 25-65



Note: The high tech sector includes the following: pharmaceutical production; electronics and electronic equipment; aerospace manufacturing; computer programming; data analysis; research and development.
Source: Gilad Brand, Taub Center | Data: OECD, PIAAC

Recent years have witnessed the launch of several government programs aimed at increasing the supply of high tech workers. These include raising computer science student quotas, creating intensive career retraining programs with a specifically high tech orientation (coding boot camps), and instituting reforms to encourage higher level math study in high school.

Additionally, in January 2017, a comprehensive government program aimed at increasing the supply of skilled high tech personnel was approved (Prime Minister's Office 2017).[4] The program intends to encourage the return of Israeli expatriates and to offer incentives to potential immigrants (per the Law of Return) who possess the requisite skills needed in the high tech industry. It also streamlines the work permit process for foreign experts working in Israel. In order to improve the existing pool of human capital, the program proposes increasing the number of student grants allocated in technology fields, running programs aimed at exposing pupils to science and technology in informal education frameworks, and subsidizing retraining courses that will enable academic degree holders to enter high tech. The reform also proposes subsidizing extra-academic training (e.g., digital courses), expanding the tech course offerings at Haredi (Jewish ultra-Orthodox) women's seminaries, and developing a guidance system focused on populations that are currently under-represented in high tech — women, Arab Israelis, and Haredim.

The aim of this study is to assess the potential impact of government efforts for increasing employment in the high tech sector through vocational training, by means of the OECD's Survey of Adult Skills (conducted by the Programme for the International Assessment of Adult Competencies — PIAAC). The first section presents an international comparison of skill levels, illustrating, among other things, the importance of competencies in determining worker wages — and how Israel lags behind the comparison countries on this parameter. The second section compares the skills of high tech workers in Israel to those of workers in the other economic sectors. The findings suggest that disparities in favor of Israeli high tech workers are especially large relative to other OECD countries. In light of the skill differences, the third section discusses the potential for expanding employment in Israel's high tech sector, providing a simulated calculation of the percentage of workers currently employed in other fields who could transfer to high tech. The simulation indicates that only a negligible proportion of Israeli workers (around 1-2 percent) not already in the field could feasibly enter the high tech sector, meaning that growth potential from professional retraining programs is not large, and the government should seek other sources of future economic growth.

4 https://www.gov.il/he/departments/policies/2017_des2292; and *The Jerusalem Post* article (in English) from the same day, https://www.jpost.com/Business-and-Innovation/Government-approves-plan-to-boost-manpower-in-hi-tech-sector-478505.

What is the Survey of Adult Skills (PIAAC)?

The OECD's Survey of Adult Skills (PIAAC) evaluates the skill levels of people ages 16 to 65 in three basic areas: literacy, numeracy, and problem-solving in technology-rich environments. The survey also collects comprehensive information on a variety of background variables relating to education, the nature of employment and part- or full-time employment, age, gender, and more. The tests, and most of the background variables examined in the survey, are identical for all participating countries.[5]

Not surprisingly, people identified in the survey as having strong skills tend to earn higher wage levels. For example, Hanushek, Schwerdt, Wiederhold, and Woessmann (2015) show that the unexplained variation in wages diminishes greatly when employee achievements on the skills survey are taken into account.

A Bank of Israel study (2016) shows that, in sectors where Israeli workers have inferior skills relative to the OECD average, productivity is low as well (relative to other developed countries) — even when workers' formal education levels are no lower than those of their counterparts elsewhere. Moreover, Hanushek and Woessmann (2008; 2012) show that cognitive abilities measured on international exams explain economic growth to a greater degree than formal education as measured by years of schooling. These findings indicate that worker competencies are not determined solely by number of years of schooling, but also by the quality of education — alongside personal and environmental characteristics reflected in the PIAAC survey. Thus, the skill level measured by this survey, particularly among younger age cohorts, serve as an indicator of economic growth potential over the coming years (for a full list of the definitions, see the Appendix).

1. Basic worker skills: International comparisons

Figure 2 shows basic worker skill levels relative to the comparison-country average (for OECD countries with available data, as measured by the PIAAC survey). The data indicate that Israel's average skill levels are lower than those of most of the comparison countries. When the results are broken down by population group, Israel's poor showing can be traced to the Haredi population and, to an even greater extent, to the Arab Israeli population,

5 The survey was conducted in two stages. The first stage concluded in 2012, and the second stage in 2015. Israel participated only in the second stage.

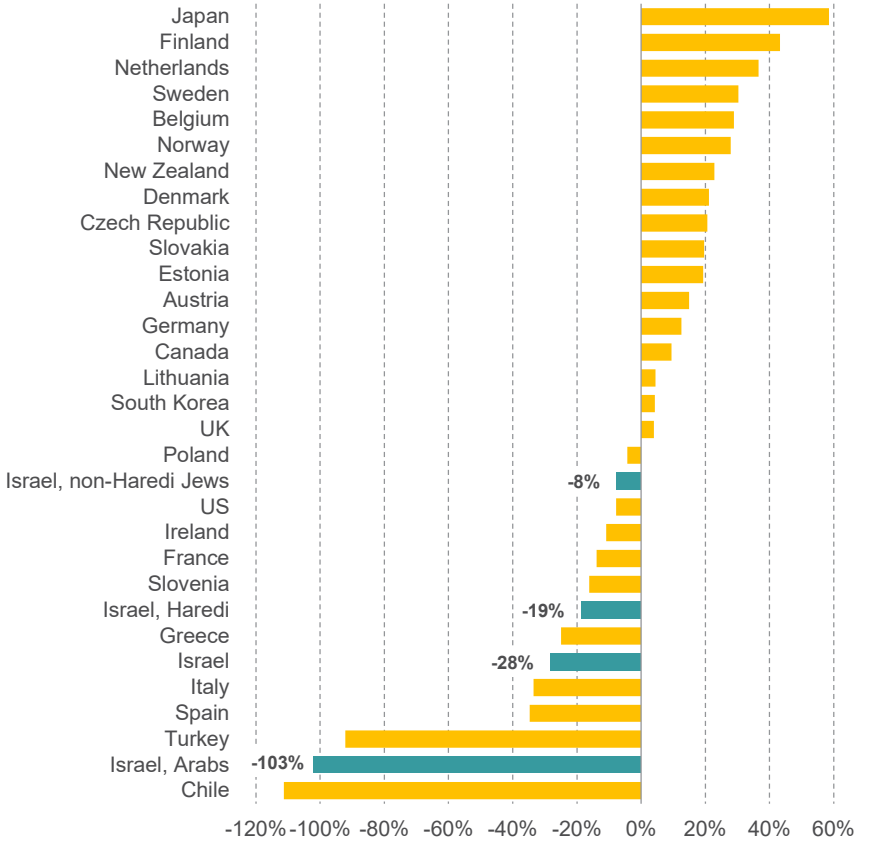
whose workers display exceptionally low competency levels. The negative gap between the average skill levels of the Arab Israeli population and the comparison-country average is very large, amounting to a full standard deviation (to illustrate how exceptional this is, note that the skill level of 68 percent of the survey participants are no more than a standard deviation from the average). Israel's non-Haredi Jewish population displays more encouraging results; the skill levels measured for this group are close to the OECD average.

A closer examination of skill levels by age group reveals an upward trend; the skills of the younger age groups surpass those of older workers in most Israeli population groups, except for the Haredi sector (Figure 3). For example, non-Haredi Jews ages 56-65 show a significant negative gap (0.3 standard deviations) relative to the comparison-country average; in the 46-55-year-old age group the gap narrows to 0.1 standard deviations; and the youngest age groups display skill levels no lower than the average for the comparison countries. A similar trend was found within the Arab Israeli population as well.[6]

6 Fuchs, Yanay, and Blass (2018) find a similar trend in the achievements of pupils in the Israeli school system.

Figure 2. The skill level as measured by the PIAAC survey relative to the OECD average

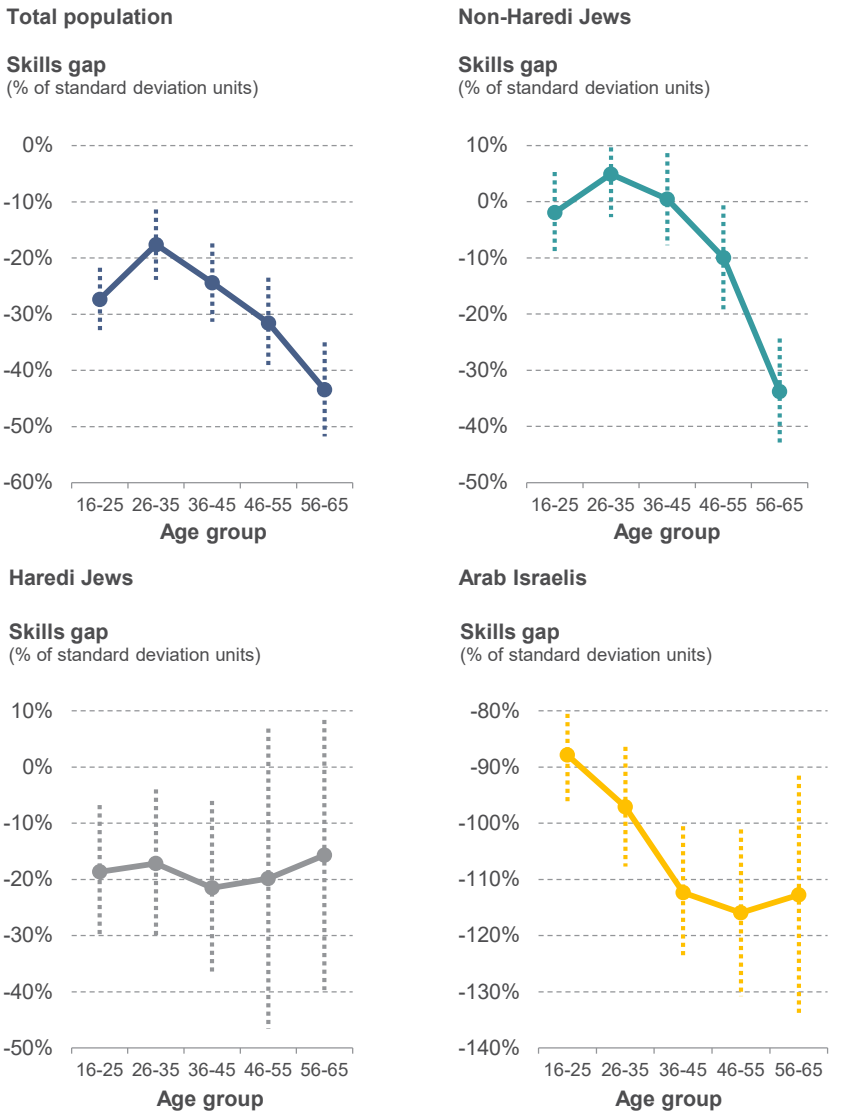
28 OECD countries, in standard deviation units, ages 16-65 (age group adjusted)



Source: Gilad Brand, Taub Center | Data: OECD, PIAAC

Figure 3. The gap between the average skill level in Israel and the OECD

28 OECD countries, in standard deviation units, by sector and age group

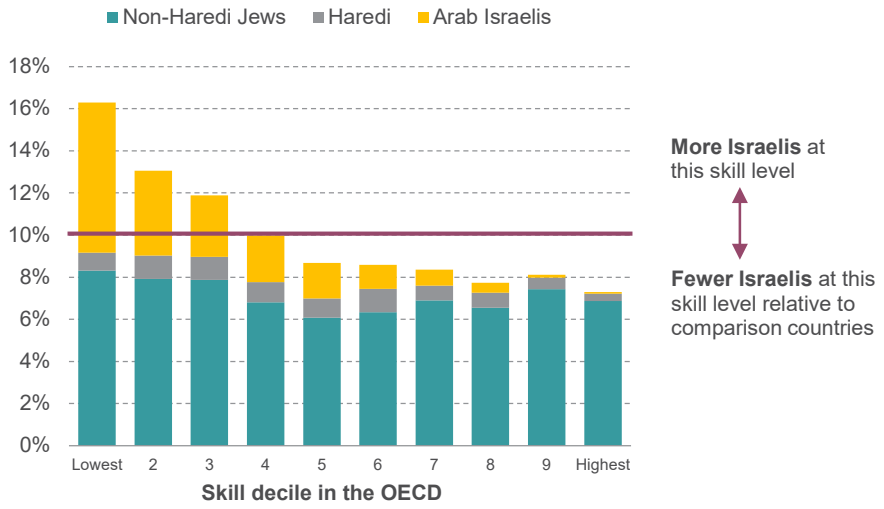


Note: The dotted lines represent the 95 percent confidence intervals.
Source: Gilad Brand, Taub Center | Data: OECD, PIAAC

The results also show that Israel's PIAAC survey score dispersion is among the OECD's highest, and that Israel is characterized by a high percentage of workers with low skill levels.[7] For the purpose of this comparison, the average achievements of the comparison countries were divided into deciles, and Israeli participants' achievements were compared to their OECD counterparts in each decile. The data show that 16 percent of the Israeli population is ranked in the lowest skill decile of the comparison countries; of these Israelis, 51 percent are non-Haredi Jews, 44 percent are Arab Israelis, and 5 percent are Haredi Jews. In addition to the 16 percent of the Israeli population in the lowest skill decile, another 13 percent place in the second-lowest skill decile. Only 7 percent of Israelis can be found in the highest skill decile (Figure 4). An analysis by population groups reveals a worrying picture: half of the Arab Israeli population is concentrated in the two lowest skill deciles, with just a negligible share placing in the highest deciles. As noted, Israel's non-Haredi Jewish population shows relatively encouraging scores, and we can see that the skills distribution for this group is fairly similar to the OECD average. From this comparison, we can conclude that Israel has a large share of workers with low skill levels relative to the OECD, and, subsequently, low earning ability. Thus, Israel's main challenge lies in the skill levels of the Arab Israeli and Haredi populations.

7 See the discussion in Ministry of Finance (2016). The authors show that individuals in Israel's highest skills decile have achievements similar to the OECD's highest decile. By contrast, the gaps are wider in the lower skill deciles. The authors conclude that there is no gap between high-skilled Israelis and their OECD counterparts, that the gap is relatively small at the moderate skills level, and that a large disparity exists between Israel and other developed countries at the lowest skill levels.

Figure 4. The skill level of the Israeli population
By skill deciles, 28 OECD countries, ages 16-65 (age adjusted)



Source: Gilad Brand, Taub Center | Data: OECD, PIAAC

Another question that can be addressed through the PIAAC survey is that of the degree to which basic skill levels correlate with wages, and whether the return on skills is similar to the return on formal education. The data in Figures 5 and 6 show that, while the skills premium in Israel is noticeably high in an international comparison, the return on formal education in Israel is similar to the average for the sample countries.[8] A possible explanation for this is that in Israel skilled workers are more of a rare phenomenon.[9] By contrast, Israel's relatively high share of college graduates has, to a certain degree, eroded the return on academic education.[10]

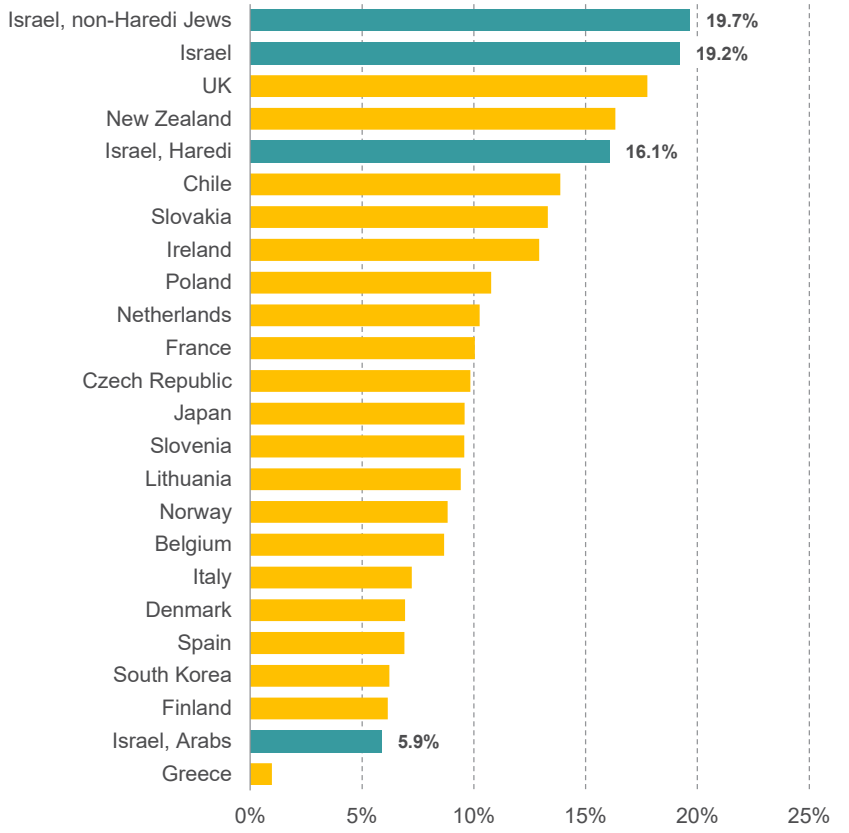
8 This finding is also noted in Ministry of Finance (2016). Mazar (2018) demonstrates that Israel's high return on skills is due to relatively high returns in the business sector, while the return on skills in the public sector is similar to the average for other developed countries.

9 Bank of Israel (2016) finds a negative relationship between a country's skill levels and its return on skills, and concludes that, the rarer a skill is, the higher its price in the labor market.

10 Israel's share of people with an academic education is higher than that of most developed countries, and is surpassed only by that of Canada (Katz 2017).

Figure 5. Skills premium

Increase in hourly wage as a result of a rise of 1-standard deviation in skill level, 21 OECD countries, ages 25-65, business sector, controlling for formal education and other observable characteristics



Note: Return is calculated using a standard Mincer equation where hourly wage is regressed on gender, marital status, and dummy variables for native-born workers, 10 age groups, and 5 categories of formal education (self-reported). Results are significant at the $p < 0.01$ level for all countries except Greece and Israeli Arabs where the results are not significant. The estimate for the Israel, Haredi sector is significant at the $p < 0.05$ level.

Source: Gilad Brand, Taub Center | Data: OECD, PIAAC

A breakdown of the data by population groups reveals a more complex picture. Particularly notable is that the Arab Israeli population displays a low return on skills but a relatively high return on formal education.[11, 12] Since the skills premium is calculated while controlling for formal education, this means that the market offers similar remuneration to Arab Israelis whose education levels are identical, but whose cognitive abilities as measured in the PIAAC survey differ.[13] The question as to why the return on skills is relatively low among the Arab Israeli population is beyond the scope of this work, but merits future in-depth study.

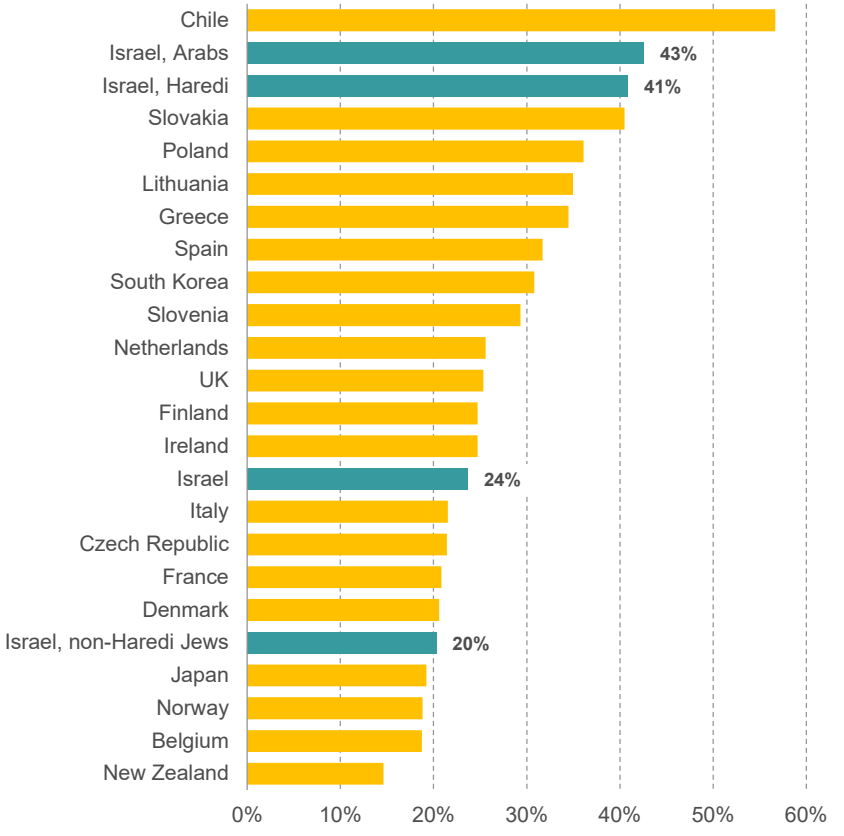
11 This figure is consistent with the findings of Melzer (2014). Melzer's article employs several different methods in order to address typical problems that arise when calculating a wage equation, and shows that the excess return is lower for Arab Israeli men and higher for Arab Israeli women when taking these problems into account.

12 This result remained also when a Quantile regression analysis was performed.

13 The calculation we performed does not control for fields of study, as some of the return on skills is relevant to this choice. Adding this variable to the calculation does not alter the results.

Figure 6. College wage premium: The hourly wage gap between workers with an academic education and those without

21 OECD countries, ages 25-65, business sector, controlling for skill level (PIAAC) and other observable characteristics



Note: Return is calculated using a standard Mincer equation where hourly wage is regressed on gender, marital status, results on the verbal and quantitative portions of the PIAAC survey, parents' schooling, and dummy variables for 10 age groups and native-born. Results are significant at the $p < 0.01$ level for all countries except for the Israel, Haredi population, where results are significant at the $p < 0.05$ level. Data for the UK do not allow identification of post-secondary school studies alone; the value presented represents return on post-secondary schooling and not necessarily academic education.
Source: Gilad Brand, Taub Center | Data: OECD, PIAAC

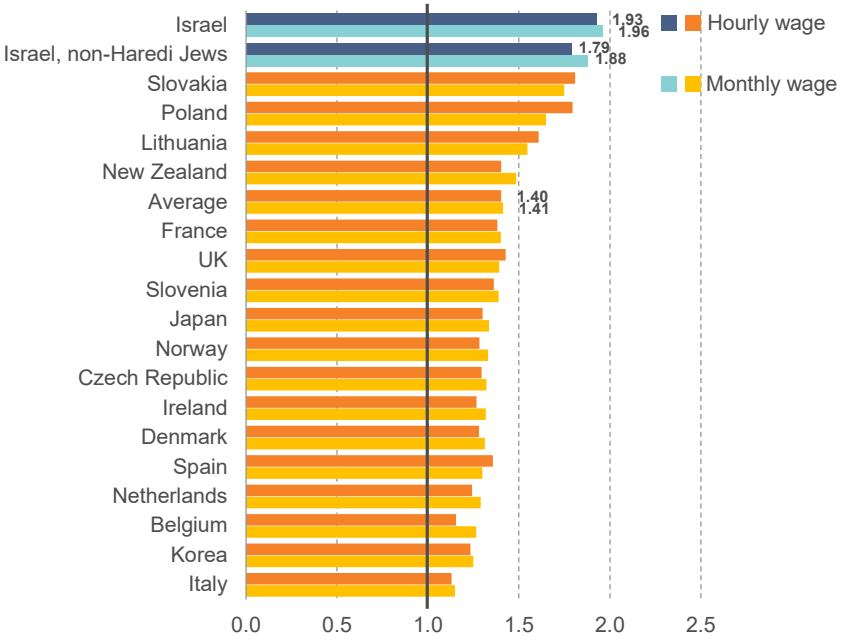
2. The Start-Up Nation: High tech versus the rest of the labor market

As noted, on average, workers in Israel's high tech industry enjoy salaries that are double the wages in other sectors of the economy, with Israel showing the largest inter-sector disparity of all OECD countries (Figure 7).[14] Additionally, in recent years, the large high tech companies (such as Elbit and Google) have been regularly ranked among Israel's most desirable workplaces (*The Marker* 2018), and it seems reasonable to assume that the negative characteristics of high tech employment (such as long work hours and the absence of long-term security) are compensated for by more than just high wages. Thus, there would appear to be major incentives for workers to acquire the necessary high tech skills. The question then arises: Why has the share of high tech workers remained unchanged for over a decade?

As detailed in Brand (2017), a possible explanation for the rigidity in the supply of workers in the high tech sector is that the unique character of high tech human capital in Israel constitutes a barrier to entry for workers from other sectors. However, this is not the only possible explanation. It is also possible that this rigidity stems from the workers themselves — not all of whom are interested in working in the high tech sector at the given wages and employment conditions. It is possible that systemic factors, or other adjustments in the labor market, prevent the creation of an efficient labor market where suitable employers and employees find each other. Among other possibilities is that high taxes influence workers' decisions in choosing a profession. The recently conducted PIAAC survey in the OECD creates an opportunity to examine how important an obstacle the level of human capital is to entry into the high tech sector. If, indeed, the need for high-level skills presents an obstacle to workers transferring into high tech, we would expect that those workers who are not currently in high tech have far lower skill levels than workers employed in the high tech sector.

14 Brand, Weiss, and Zimring (2017) find a larger (2.5 times greater) wage gap when comparing high tech to the other sectors. One reason for the differing findings is that the comparison presented here includes only full-time employees and workers from the entire economy, not just from the business sector. The data source and the comparison-country sample differ as well. A calculation of the premium on high tech employment (by means of a standard Mincer equation in which such characteristics as skills and fields of study are controlled for) also indicates that the Israeli premium exceeds that of any other comparison country.

Figure 7. Wage premium for employment in high tech, 2012-2015
Ratio of high tech sector wages to those in the other sectors, 18 OECD countries, ages 25-65, full-time employment



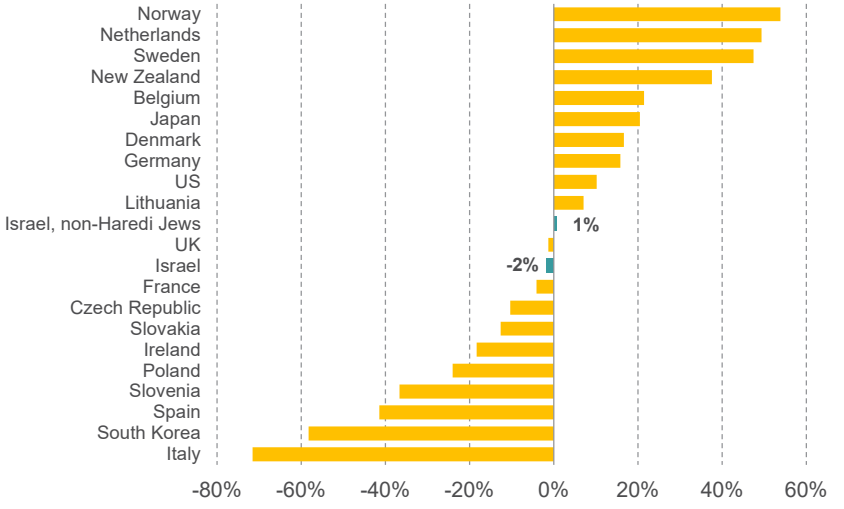
Note: The PIAAC survey was conducted in two rounds between 2012 and 2015; data for each country is between these dates depending on when the survey was conducted.
Source: Gilad Brand, Taub Center | Data: OECD, PIAAC

Indeed, the survey results point to stark differences between the skill levels of high tech workers and those of workers in other fields. Israeli high tech worker skills are rated higher than those of other workers by a large margin (nearly a full standard deviation). In international comparison, while the skills of Israel's high tech workers are similar to those of their peers in other countries, the skills of Israeli workers in other industries are inferior to those of workers in most of the comparison countries (Figure 8). As a result, the skill gaps between Israeli high tech workers and Israeli workers in other sectors are the largest of all of the comparison countries (Figure 9).

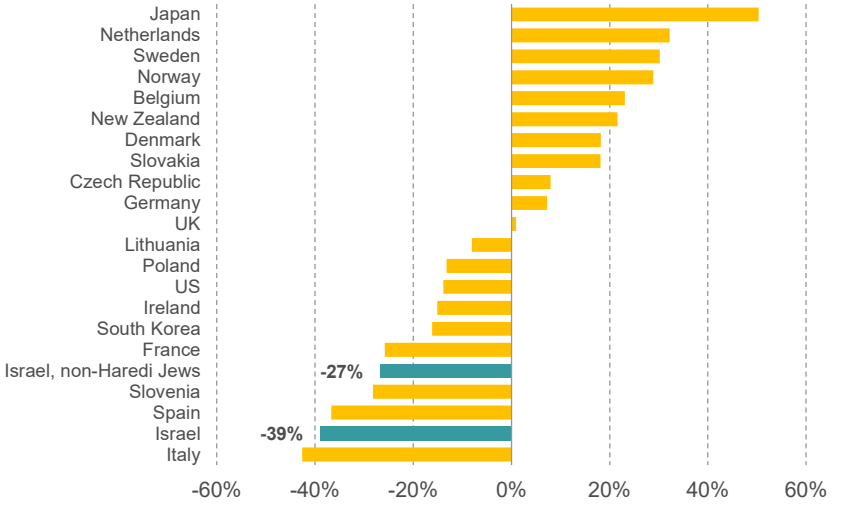
Figures 8. The skill level of workers compared to the OECD average

21 OECD countries, in standard deviation units, ages 16-65 (age group adjusted)

High tech workers



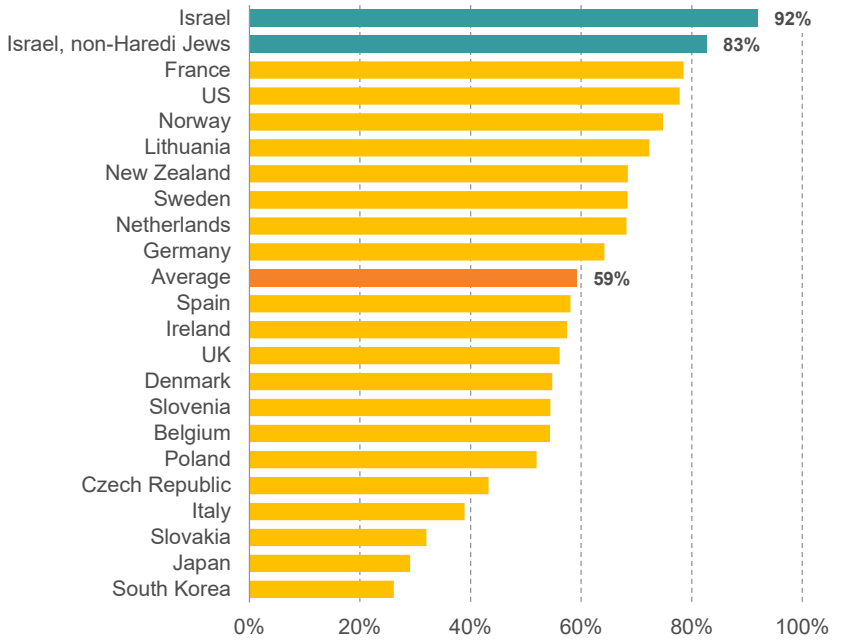
Non high tech workers



Source: Gilad Brand, Taub Center | Data: OECD, PIAAC

Figure 9. The skill level gap between workers in the high tech and the non high tech sectors

21 OECD countries, in standard deviation units, ages 16-65 (age group adjusted)



Source: Gilad Brand, Taub Center | Data: OECD, PIAAC

Another finding from the survey is that a large portion of the most highly-skilled workers as measured by PIAAC survey are already in high tech. The share of employed persons in the high tech sector among Israeli workers ranked in the highest skills quintile is 22 percent — the highest percentage of all the comparison countries. Ireland has the second-highest share at 14 percent, trailing Israel by a large margin (Figure 10a). The skill distribution of workers in the high tech sector illustrates the sector's great reliance on the country's most highly-skilled workers: 60 percent of those working in the sector are ranked in the highest skills quintile (Figure 10b).[15]

15 Chile, Turkey, and Greece were omitted from these comparisons due to the low number of observations of high tech workers (n<50). In several other countries there are no data that allow high tech workers to be identified.

Figure 10a. Share of employees in high tech out of the highest skill quintile

21 OECD countries, ages 25-65 (age group adjusted)

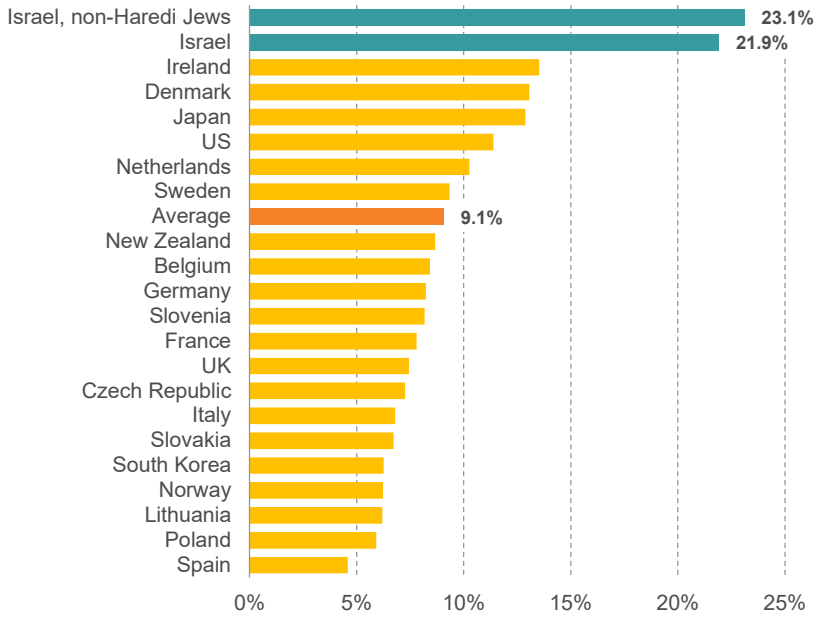
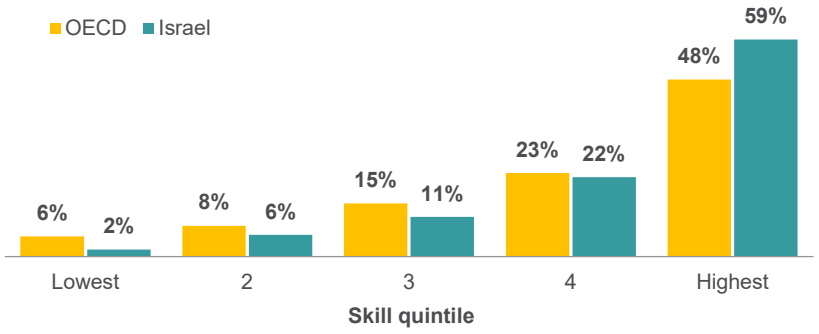


Figure 10b. The composition of employees in high tech by skill quintile

21 OECD countries, ages 25-65



Source for both figures: Gilad Brand, Taub Center | Data: OECD, PIAAC

Thus, the Survey of Adult Skills data effectively offer a good explanation for the difficulties high tech employers face in filling positions, despite the relatively high wages that they offer. There are major differences between the worker skills required in high tech and those required by the other business sectors, meaning that high tech's higher wages are not sparking worker mobility or substantially changing the composition of workers across sectors. Moreover, the high-skilled population as measured by PIAAC survey is already well-represented in the various high tech fields, meaning that the potential for enlarging the scope of high tech employment is likely approaching its upper limit.

3. The potential for expanding the high tech sector through Israeli labor

The previous sections noted the advantages of high tech employment and the high skill levels required of those working in the sector. This section will try, by means of PIAAC survey results, to assess the potential for other workers to enter the high tech sector.

What skills are necessary to work in high tech?

The Survey of Adult Skills enables an assessment of worker employment attributes relevant to the high tech sector or, in other words, the likelihood that workers at various skill levels will be employed in high tech. As can be seen in Figure 11, the probability of employment in the high tech sector, as measured by the PIAAC survey standard score ranking, is close to zero for workers at the lower skill levels, and increases as the skill levels rise.

Similarly, we can assess the probability of science and technology graduates at various skill levels finding employment related to their fields of study. The results indicate that even among graduates in fields relevant to high tech, workers with low skill levels are less likely to be employed in occupations in those fields (Figure 12).

Compared with other countries, the data show that Israel's high tech sector has an exceptionally large concentration of workers at the highest skill levels.[16]

16 The causal relationship between skills and high tech employment can work in two directions. In one direction, a high skill level increases the probability of relevant studies at in-demand institutions, and also raises the individual's status in the eyes of employers. In the other direction, it is likely that high tech employment, especially in science and engineering, improves worker performance on the PIAAC survey, especially on the quantitative portion. Since there is a close relationship between scores on the quantitative and verbal portions ($\rho = 0.91$), in this section the assessment was based on the verbal portion only. Including the score on the quantitative portion only sharpens the findings based on verbal scores.

Figure 11. Probability of employment in high tech by skill level

21 OECD countries, ages 25-65

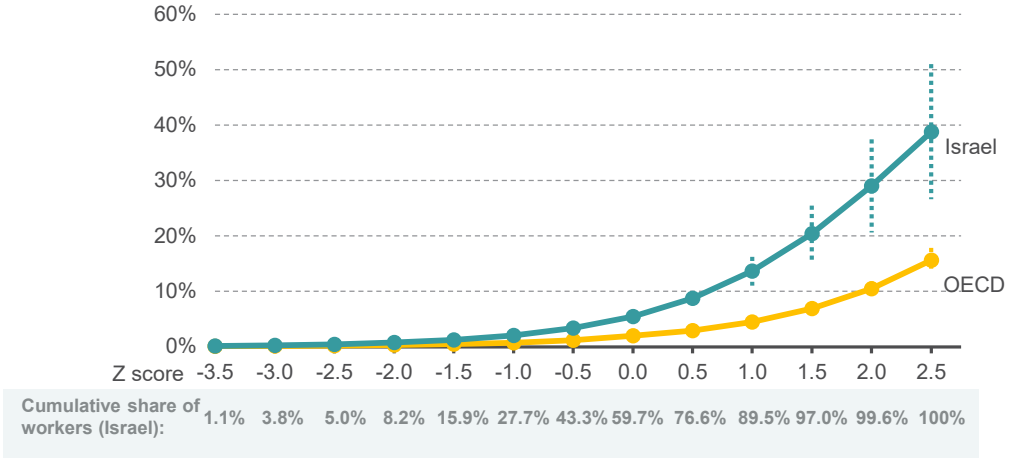
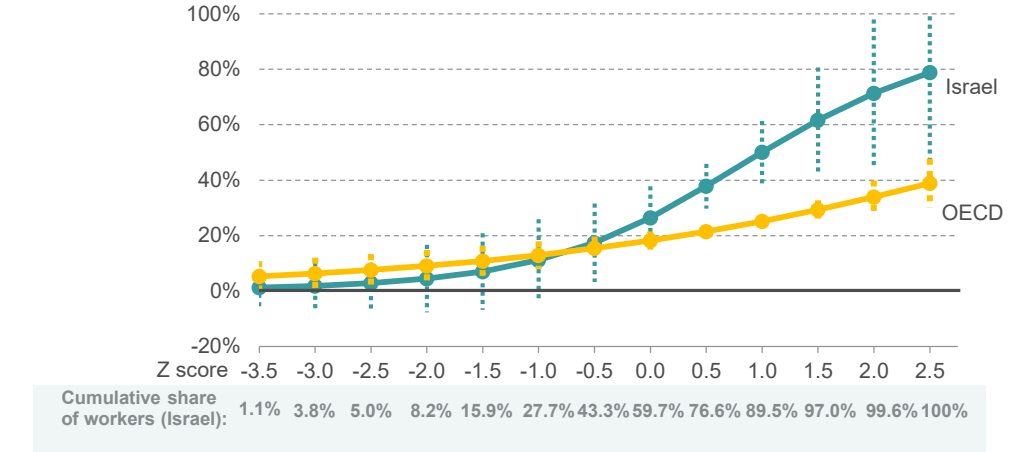


Figure 12. Probability of employment in the science-engineering professions for academic graduates in those majors

21 OECD countries

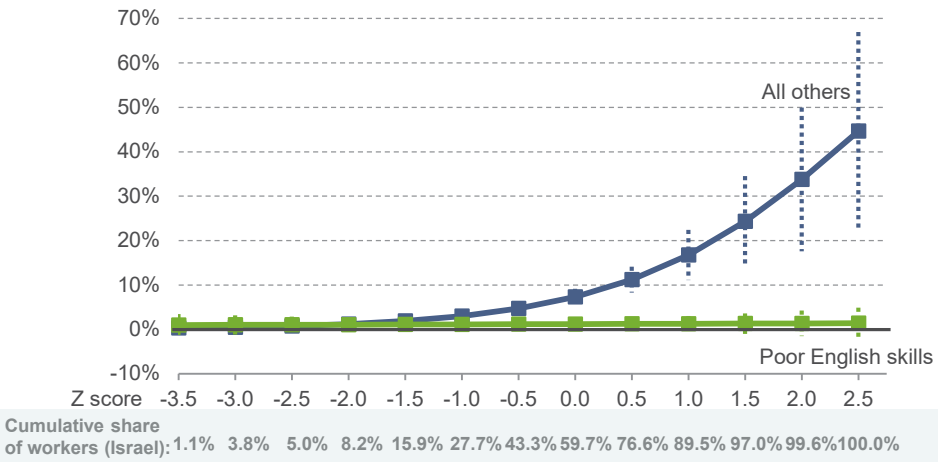


Note for both figures: Probability is calculated using a logistic regression. Explanatory variables are a cubic function of verbal skill level and the interaction with gender and English proficiency (written). The estimation is based on the measured skill level in the verbal section only and does not include the quantitative portion of the survey in order to eliminate as much as possible a reverse causality. The dotted lines represent the 95 percent confidence intervals.
Source for both figures: Gilad Brand, Taub Center | Data: OECD, PIAAC

Mastery of English is another skill connected with high tech employment. The PIAAC survey conducted in Israel includes a special section in which participants are asked to rate their English proficiency level. The results show that individuals who reported low levels of English had almost no likelihood of being employed in the high tech sector, regardless of their skill levels in other areas (Figure 13).[17]

Figure 13. Probability of employment in Israel in the high tech sector by skill level and English proficiency

Ages 25-65



Note: Probability is calculated using a logistic regression. Explanatory variables are a cubic function of verbal skill level and the interaction with gender and English proficiency (written). The estimation is based on the measured skill level in the verbal section only and does not include the quantitative portion of the survey in order to eliminate as much as possible a reverse causality. The dotted lines represent the 95 percent confidence intervals.
Source: Gilad Brand, Taub Center | Data: OECD, PIAAC

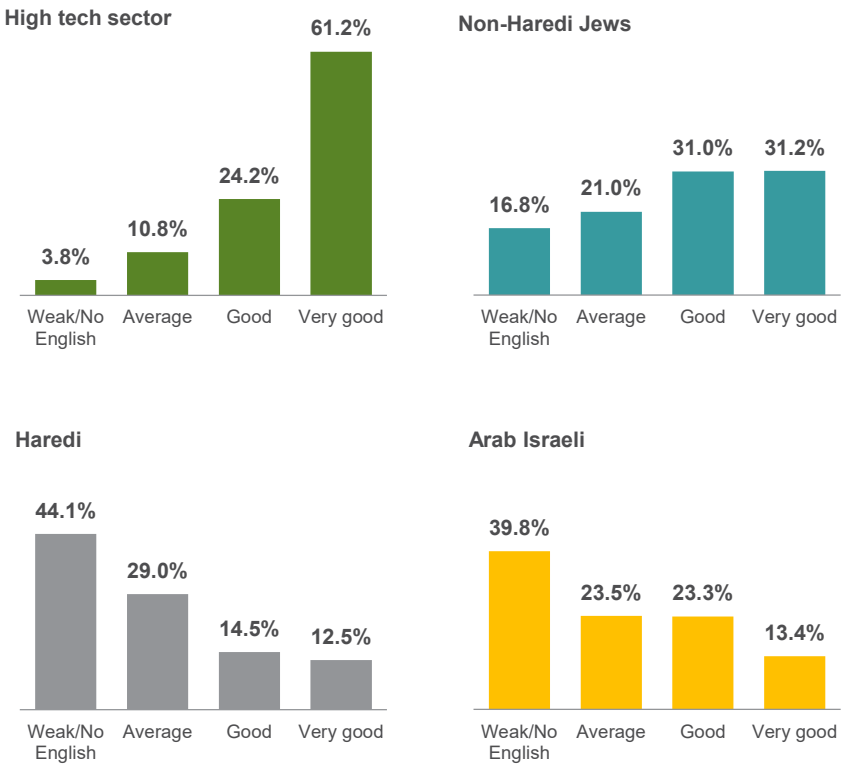
The importance of English proficiency for working in high tech also has major implications regarding the composition of the high tech worker population. Currently, the decisive majority of those employed in high tech (over 95 percent) are non-Haredi Jews. As such, the potential for expanding high tech employment lies in the Haredi and Arab Israeli populations, which are not currently integrated into this sector. However, English proficiency in these populations is poor which is a serious barrier to integration into the high tech sector.

17 In general, level of English knowledge is positively correlated with high tech employment. This analysis, in particular, focuses on individuals reporting poor or no knowledge of English.

As shown in Figure 14, almost half of the Haredi population and about 40 percent of the Arab Israeli population sampled in the survey (ages 26-45) report that they have no proficiency in English. About 85 percent of those working in the high tech sector report that their knowledge of English is good, while only 37 percent of the Arab Israeli and 27 percent of the Haredi populations report this level of proficiency. One conclusion that arises from this is that improved English instruction in the Arab Israeli and Haredi education systems is a necessary step for making the high tech world accessible to these populations.

Figure 14. English proficiency level by sector and population group, self-reported levels of proficiency

Ages 25-44



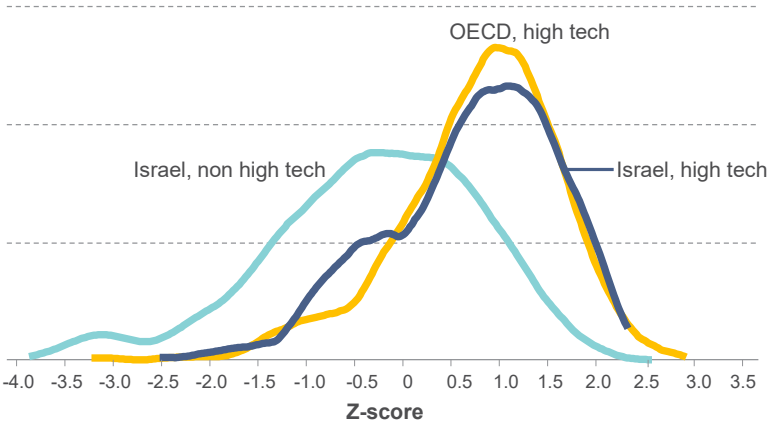
Source: Gilad Brand, Taub Center | Data: OECD, PIAAC

The potential for expanding the high tech sector: Quantitative assessment

Having examined the skills necessary for employment in high tech compared with the skill levels in other sectors, it is possible to assess the potential for increasing high tech employment in Israel. As shown earlier in other contexts, the skills of Israeli high tech workers are much higher than the skills of other workers in the labor force. This finding is clearly depicted in Figure 15, which shows only partial overlap between the distribution of skills in high tech and the distribution of skills of workers in other sectors. Thus, many workers in the labor force lack the ability required for employment in the high tech field.

Figure 15. Skill distribution in high tech and non high tech sectors

21 OECD countries, ages 25-44, Kernel distribution



Source: Gilad Brand, Taub Center | Data: OECD, PIAAC

For the purposes of assessing potential employment growth in the sector, the relevant portion of the graph is the area of overlap between the distributions, which represents those workers whose skill levels match at least some of the workers in the high tech sector, but who are not currently employed in high tech. The overlapping area is examined by dividing the

skill distribution of the OECD high tech sector into percentiles.[18] This allows a determination of the percentage of workers above a certain skill threshold who are not currently employed in high tech.

The comparison focuses on ages 25-44, when the likelihood and feasibility of career retraining are relatively high. From the group of workers not employed in high tech, subjects who report in the survey that they are currently studying disciplines relevant to high tech employment are excluded.

Figure 16 presents the results of the comparison. The horizontal axis shows the skill percentiles based on the OECD high tech sector skill distribution, while the vertical axis displays the percentage of workers in other sectors who fall below the skill threshold. For example, half the population of Israeli workers employed outside of high tech fall into the lowest skill decile in high tech, and, therefore, the probability that they will be able to work in high tech is low.[19] By contrast, the skill level of 12 percent of the non high tech workers is higher than the high tech skill median, making them more likely candidates for successful high tech employment.

An international comparison of these two reference points (Figure 17) reveals that Israel has a high share of workers whose skills are low relative to those of high tech workers, while its share of workers whose skills are high is relatively small. The share of the Haredi sector and, to a great degree, the Arab Israeli sector, with the skills to successfully integrate into high tech, also appears to be particularly low.[20] This means that the potential for

18 The decision to use the skills distribution in the OECD high tech sector stems from the assumption that increasing Israeli high tech employment would likely also involve diversifying the types of high tech activity, meaning that the skills distribution of Israeli high tech workers could potentially change. As noted, the average skills distribution in the comparison countries' high tech sector is similar to that of Israel; thus, the results are not sensitive to this choice.

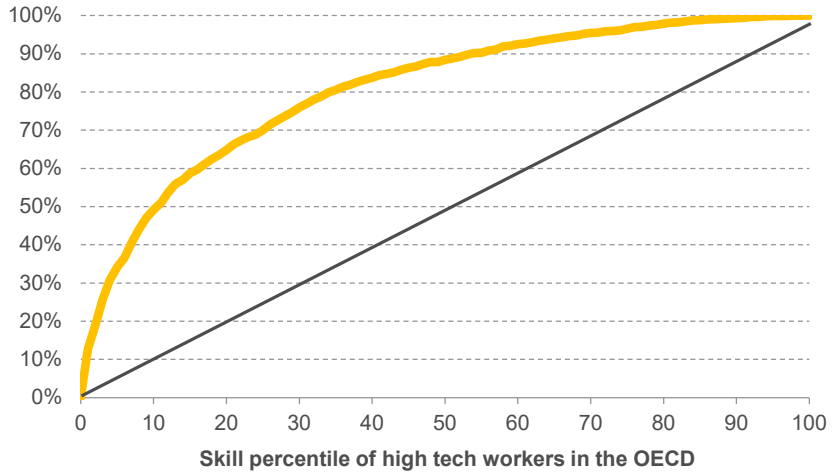
19 There are several possible explanations for why the share of unskilled workers in high tech cannot expand beyond its current level. For example, it is reasonable to assume that high tech export is based on a certain share of unskilled workers but it may not behoove high tech companies to increase this share. An alternate explanation is that unskilled workers in high tech may be high on other skills that are not measured by the PIAAC survey and it is reasonable to assume that they are unique within the labor pool.

20 The Ministry of Finance (2017b) finds that the dropout rate of Arab Israeli students in programs relevant to high tech employment is high compared with that of Jewish students, and that, even among those who complete their degrees, the presence of Arab Israelis in the industry is relatively small. It was also found that those Arab Israeli graduates in the relevant fields who do find work in high tech earn very high salaries, and that the percentage of those pursuing studies in these fields has increased substantially in recent years.

expanding the high tech worker population in Israel is low in general, and this potential is concentrated in the non-Haredi Jewish sector, the sector which already supplies most of the high tech workers.

Figure 16. Cumulative distribution of the skill level in high tech in the OECD versus the skill level of Israeli workers in non high tech

21 OECD countries, ages 25-44, Lorenz curve



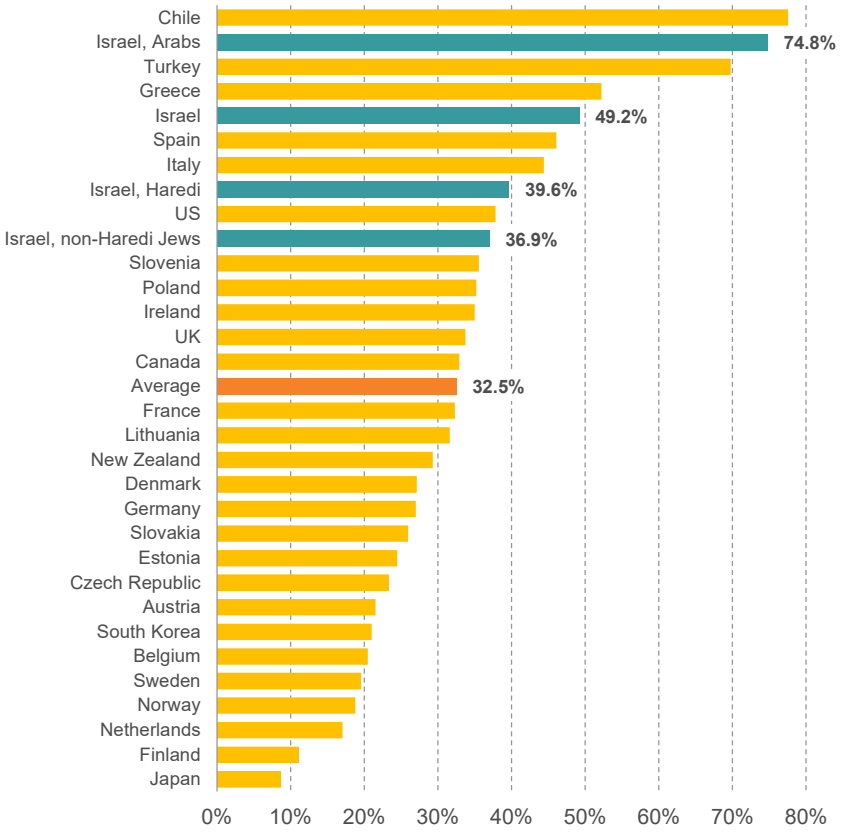
Source: Gilad Brand, Taub Center | Data: OECD, PIAAC

Figures 17a and 17b are based on two randomly selected reference points, but this type of comparison can also be done for the entire distribution. The Gini coefficient calculation method enables an assessment of the degree of equality between the skill level of high tech workers and those from other sectors. The lower the coefficient, the higher the degree of equality, meaning the higher the potential for workers to join the high tech field. As shown in Figure 18, there is a relatively high level of inequality in Israel, translating into low high tech employment growth potential compared with other countries. This result is due to a combination of Israel's already high share of workers in high tech, and the low skill level of its workers in other sectors.

Figure 17a. Skill level of non high tech workers relative to high tech workers in the OECD

21 OECD countries, ages 25-44

Share of non high tech workers that match the skill level of the lowest skill decile in the high tech sector in the OECD

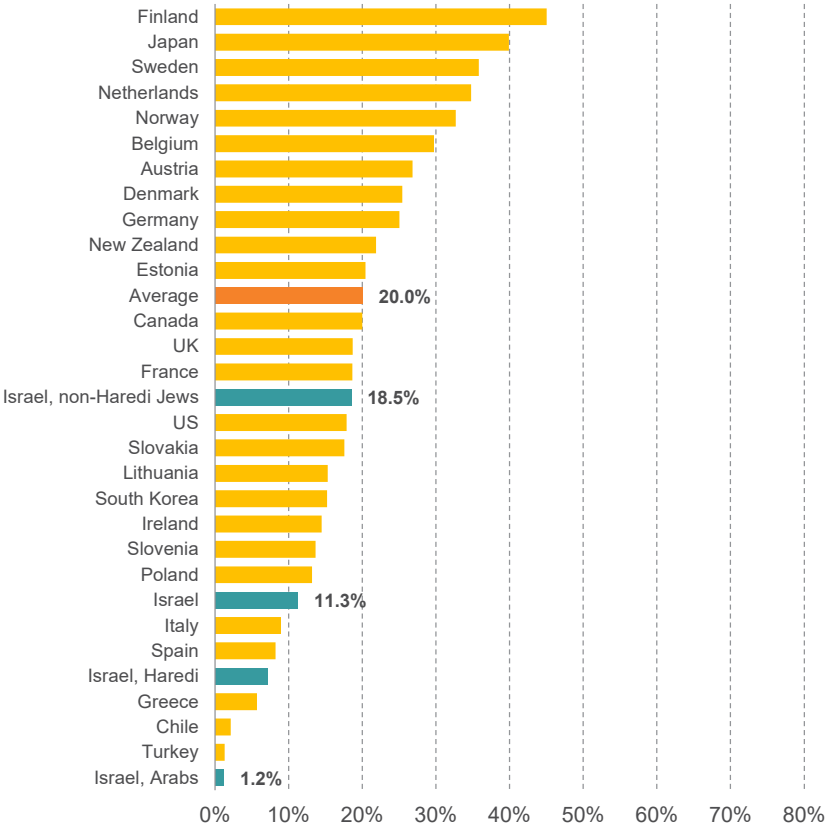


Source: Gilad Brand, Taub Center | Data: OECD, PIAAC

Figure 17b. Skill level of non high tech workers relative to high tech workers in the OECD

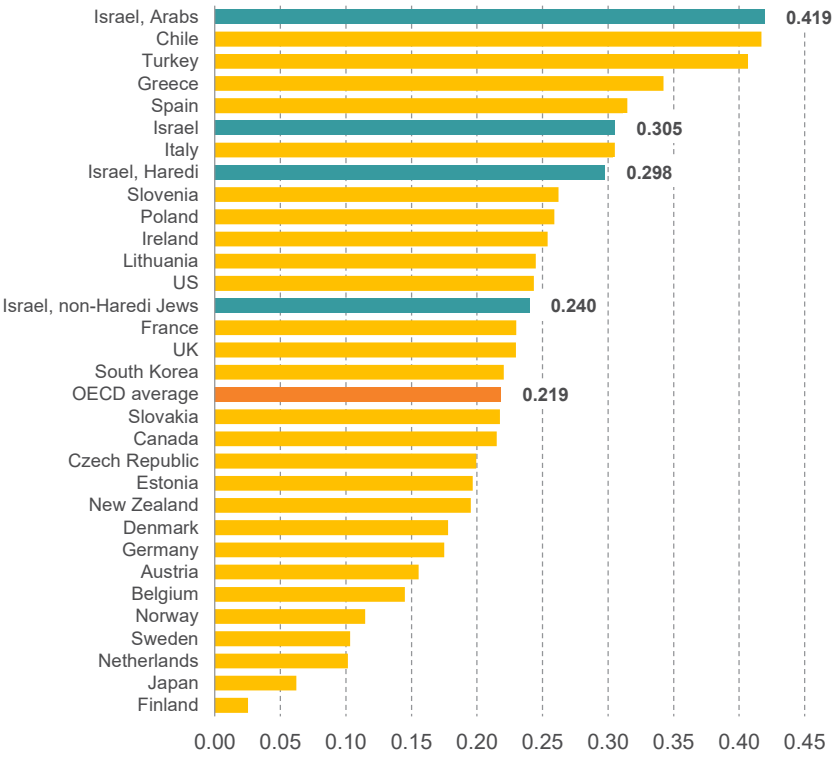
21 OECD countries, ages 25-44

Share of non high tech workers that match the skill level of the upper half of the skill distribution in the high tech sector in the OECD



Source: Gilad Brand, Taub Center | Data: OECD, PIAAC

Figure 18. Gini index of inequality between high tech worker skill levels and workers in the other sectors
Ages 25-44



Source: Gilad Brand, Taub Center | Data: OECD, PIAAC

The potential for increased high tech employment can also be evaluated by means of a quantitative estimate. For this purpose, we will look only at workers with the following three characteristics:

1. Ages 25-44;

2. Not currently employed in high tech; and,

3. Not currently engaged in science and technology studies (STEM).

The estimation is carried out under three scenarios: expanded, intermediate, and narrow. In the expanded scenario, the assumption is that workers ranked above the 34th percentile have the potential to switch to high tech; that is, workers in the upper 66 percentiles of the high tech skills distribution (in the OECD countries). The intermediate scenario assumes that only workers ranking above the skills median have the potential to move into high tech, while the narrow scenario includes only workers in the upper 34 percentiles.

The results suggest that the potential for expanding employment in the Israeli high tech sector is between 3 to 10 percent of the working-age population ages 16-64 (Table 1). Consistent with the findings from earlier sections, the potential is particularly low in the Arab Israeli population and higher in the Jewish population, especially for non-Haredi Jews.

Table 1. Share of those with the appropriate skills to move to the high tech sector

Out of the working-age population, ages 16-64

	Narrow scenario Workers over the 66th percentile in high tech	Intermediate scenario Workers over the 50th percentile in high tech	Expanded scenario Workers over the 34th percentile in high tech
Arab Israeli	0.40%	0.51%	1.74%
Haredi	1.33%	4.17%	11.06%
Non-Haredi Jews	3.62%	6.80%	11.87%
Israel total	2.79%	5.32%	9.77%

Note: Subject to the following assumptions: individuals who are not currently employed in the high tech sector and are not currently engaged in science and technology studies (STEM).
Source: Gilad Brand, Taub Center

For a more realistic assessment, two additional characteristics of workers are added for those workers who could potentially switch to high tech are included in the model:

1. Earning less than 80 percent of the average high tech salary (standardized for age group). The purpose of this assumption is to test these workers' motivation to move to high tech.

2. Knowledge of basic-level English.

Table 2. Share of those with the appropriate skills to move to the high tech sector

Out of the working-age population, ages 16-64

	Narrow scenario Workers over the 66th percentile in high tech	Intermediate scenario Workers over the 50th percentile in high tech	Expanded scenario Workers over the 34th percentile in high tech
Arab Israeli	0.3%	0.5%	1.6%
Haredi	1.3%	2.8%	6.5%
Non-Haredi Jews	3.1%	6.0%	10.3%
Israel total	2.0%	3.8%	7.0%

Note: Subject to the following assumptions: individuals who are not currently employed in the high tech sector, are not currently engaged in science and technology studies (STEM), are earning less than 80 percent of the average wage in the high tech sector (age adjusted), and have at least a basic proficiency in English.
Source: Gilad Brand, Taub Center

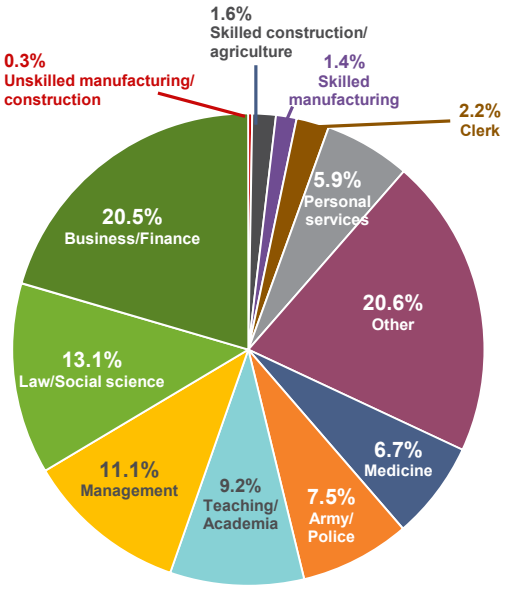
As shown in the table, the intermediate scenario shows the high tech employment growth potential to be about 4 percent of the working-age population not currently employed in high tech. For Haredim, the figure is about 3 percent, while for Arab Israelis, the potential amounts to just half a percent of the target population.

An important element in determining the scope of the potential is worker motivation to make the switch into high tech. In order to more accurately assess this element, the occupational characteristics of workers identified as suitable in the intermediate scenario (about 4 percent of the total target population) are examined in light of the five characteristics discussed above. This group's occupational distribution shows that the majority, 68 percent, are already employed in occupations either characterized by relatively high salaries or characterized by secure long-term employment trajectories that compensate for lower wages — such as teaching, the military, or the police (Figure 19). The rest of the group, 32 percent, are employed in occupations characterized by relatively low wages. This group constitutes 1 percent of the total working-age population not already employed in high tech (32 percent * 3.8 percent = 1.22 percent). That is, the percentage of workers who may expect to improve substantially their employment status by retraining for high tech (of all those with the appropriate skills) is very little. Furthermore, it is reasonable that these workers have not integrated into high tech as of now because of different priorities, like professional interest. This being the

case, it appears that the efforts to grow high tech employment is relevant for an extremely small share of the labor force in the short term — at least, until the population's skill level improves.

Figure 19. Occupational distribution of workers whose skill levels are appropriate for the high tech sector

Ages 25-44, according to the simulation, intermediate scenario



Note: Subject to the following assumptions: individuals who are not currently employed in the high tech sector, are not currently engaged in science and technology studies (STEM), are earning less than 80 percent of the average wage in the high tech sector (age adjusted), and have at least a basic proficiency in English.
Source: Gilad Brand, Taub Center | Data: OECD, PIAAC

Conclusion and discussion

Although, the high tech sector in Israel accounts for only about 8 percent of total employment, the sector is very important to the economy as a whole. It produces about one-fourth of income tax payments in Israel and accounts for a major portion of the added value of Israeli exports. From its inception, Israel's high tech sector has enjoyed support and incentives from policy

makers. Most recently, a comprehensive government program to encourage high tech employment was approved by the government.

Using the OECD's Survey of Adult Skills Survey (PIAAC), this study evaluates the potential for integrating additional workers from the adult population in Israel into the high tech sector. The findings suggest that the share of additional workers who can successfully integrate into high tech on the basis of their skill level is quite small. The potential narrows even more when considering that among the pool of potential workers are those who have had the opportunity, yet, for one reason or another, chose not to pursue a career in this field.

The conclusion that encouraging high tech employment is relevant for only a small share of workers is supported by other findings as well. First, the average skill level in the working age population is low relative to the OECD average, especially among Haredim and Arab Israelis. Second, skill level disparities between high tech workers and non high tech workers are particularly large in Israel relative to other developed countries. While the skill level of Israeli high tech workers are quite similar to those of their peers in the OECD countries, skill levels in the other Israeli industry sectors are substantially lower. Evidence of this is that despite the particularly high wage levels in high tech, the employment rate in the sector has remained largely unchanged for over a decade. One conclusion is that the specialized and unique human capital required in the high tech field presents obstacles to workers from other sectors making the shift to high tech. In addition, it seems that the sector has already absorbed the majority of those who can work in it. The data show that more than 20 percent of workers in the top skill quintile are already employed in high tech — the highest share in any of the comparison countries.

A simulation conducted as part of the study shows that the combination of the high share of highly skilled workers who are already employed in high tech and the low skill level of workers in the other sectors means that the potential for increasing high tech employment is low relative to that in other countries, at least in the short term.

It was also found that due to generally low skill levels and poor English language skills among the Haredi and Arab Israeli population, the possibility of improving their employment possibilities in high tech through retraining programs is limited. The best but small potential is concentrated in the non-Haredi Jewish population, from which the majority of high tech workers are already drawn. The effectiveness of vocational training in high tech as a tool to narrow income gaps across population groups seems dubious.

An additional factor that indicates that widening employment in high tech will not narrow gaps is the wage disparities between workers in the sector. Although the average high tech worker has higher wages than workers in other sectors, compensation varies widely depending on skill level: while the high-tech wage premium is substantial for workers with high measured ability levels, the premium falls as ability levels decline (see the second analysis in the Appendix). The study also finds that science and engineering graduates identified in the survey as not having high ability levels have difficulty finding work in occupations related to their fields of study (both in Israel and in the OECD countries). Therefore, providing high tech retraining for workers with a more diversified skill set will not yield the current wage premium measured for high tech employment.

Alongside this, it should be said that there is a notable shortage of women in high tech, and it seems highly likely that a majority of workers with the suitable skills and talents lie within this group. Encouraging women to study technology and science from a young age and creating high tech employment environments that allow for an appropriate work-life balance — like, flexible working hours — can also help grow the supply of workers with appropriate skills from this population pool.

Beyond the question of the extent to which it is possible to grow the high tech sector, there is also room to examine whether this is a worthwhile pursuit. It is possible to justify these efforts on the basis that high tech employment has a positive external effect on the economy's other sectors, through the spread of innovative work methods to other fields. As noted, the unique composition of Israel's high tech sector's human capital means that worker mobility between sectors is minimal. This and the large technology gaps raise doubts regarding the extent of high tech's positive impact on other economic sectors.[21]

In fact, the lack of skilled workers in other industry sectors — which is likely to widen even more if incentives bring about their integration into high tech — may hamper development of the Israeli economy's comparative advantages in other fields, and distort the allocation of resources. For example, high tech has a direct impact on the rest of the economy through the exchange rate: an increase in revenue from high tech exports appreciates the exchange rate and, as a result, reduces the competitiveness of the economy's other exporters. Brand (2017) shows that the share of those employed in export industries other than high tech has been trending downward. Since

21 Brand (2017) shows that high tech's success in recent decades has not created wage pressure in the rest of the economy.

Israeli exporting is relatively centralized in terms of its areas of activity and the composition of its human capital, it might actually be better to curtail the country's high tech-oriented incentives policy.[22]

Additionally, as noted, the PIAAC survey data indicate that a large portion of Israel's working-age population is characterized by low skill levels and consequently low earning ability. The availability of cheap labor makes it less worthwhile for employers to adopt cutting-edge technologies and restricts the potential for economic growth.[23] Focusing on improving the skills of this worker group might yield a higher return than would the investment necessary to move better-skilled workers into high tech.

On a positive note, the data indicate an upward trend in the non-Haredi Jewish population's skill level, and to an even more substantial improvement in the skills of the Arab Israeli population. Within these populations, the younger age groups outperform the older ones on the PIAAC surveys (compared with the analogous age groups in the OECD countries). Thus, the potential for increasing the share of those employed in high-wage employment sectors, such as high tech, will grow over time. There are indications that, in contrast to other population groups, Israel's Arab population may be generating a lower skills premium. This matter lies beyond the scope of this chapter, but merits in-depth attention in the future.

22 Bank of Israel (2012:274) shows that, relative to other developed countries, Israeli exporting is concentrated in a small number of tech-intensive industries. A similar conclusion also emerges from Ministry of Finance (2017a).

23 Israel's capital output ratio is only 74 percent of the OECD average, while the local investment rate is lower than that of most developed countries. See Brand (2017).

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Appendix

Definitions

This section sets forth the methodology used for the international comparison of the PIAAC survey participants' skills.

Defining the basic skill S for individual i is a simple mean of the individual's achievements on the quantitative and verbal portions of the survey.[24]

$$1.\ S_i = \frac{numeracy_i + literacy_i}{2}$$

Since there is a negative correlation between the skills measured by the survey and participant age, and since Israel's age structure differs from that of other developed nations, we recalibrate the basic skill S_i for age group n of individual i, for ten age groups (ranging from 16-65) is standardized as follows:[25]

$$2.\ \hat{S}_{in} = \frac{S_{in}}{\overline{S}_n},$$

Where $\overline{S}_n$ denotes the mean of the scores of the OECD countries in the sample, in the relevant age group. Hence the standard score Z_{in} for a defined individual i is:

$$3.\ Z_{in} = \frac{(\hat{S}_{in} - \overline{S}_n)}{\sigma_n},$$

Where σ_n denotes the standard deviation of the OECD country scores, in the relevant age group. Similarly, the mean basic skills in country j, standardized for age, relative to all of the sample OECD countries in standard deviation terms is defined as follows:

$$4.\ Z_{jn} = \frac{\overline{S}_{jn} - \overline{S}_n}{\sigma_n}.$$

24 The survey also contains a section on problem solving in a technology-rich environment, aimed at measuring computerized technology utilization skills. Since there are countries for which this portion is not included in the survey, we refer to the verbal and quantitative sections only. The results are not sensitive to the omission of this part of the survey.

25 In several countries the age variable is not sequential, but rather divided into five-year age groups.

The definition of high tech sector is based on the Standard Industrial Classification of All Economic Activities 2011 and per the accepted definition,[26] includes the following industries: Manufacture of pharmaceutical products (21), Manufacture of computer, electronic and optical products (26), Manufacture of air and spacecraft and related machinery (303), Computer programming (62), Data processing (631), and Scientific research and development (72). Although the definition also includes Telecommunications (61), the latter sector is not included in this study because it does not resemble the other high tech fields in terms of export volume and worker education and wages.

High tech employment premium

High tech workers earn, on average, higher salaries than workers in other economic sectors, but the premium on high tech employment varies depending on worker skill levels. This section presents a comparison of the premium on high tech employment at different skill levels, by means of a standard Mincer equation. The comparison is shown in the top graph in Appendix Figure 1, in which the vertical axis displays the wage difference (in percentages) between the high tech and non high tech sectors for workers identical to each other in terms of gender, age, family status, skill level as measured by the survey, formal education, and occupation (at a two-digit level of detail). The horizontal axis shows different skill levels divided into quintiles. The lower figure offers a similar comparison, but without controlling for occupation.

The comparison suggests that compensation in high tech is higher for workers in the upper portion of the skill distribution, while the premium is not significantly different from zero for less skilled workers. The figure shows that Israel's skilled workers enjoy a particularly high premium on high tech employment.[27]

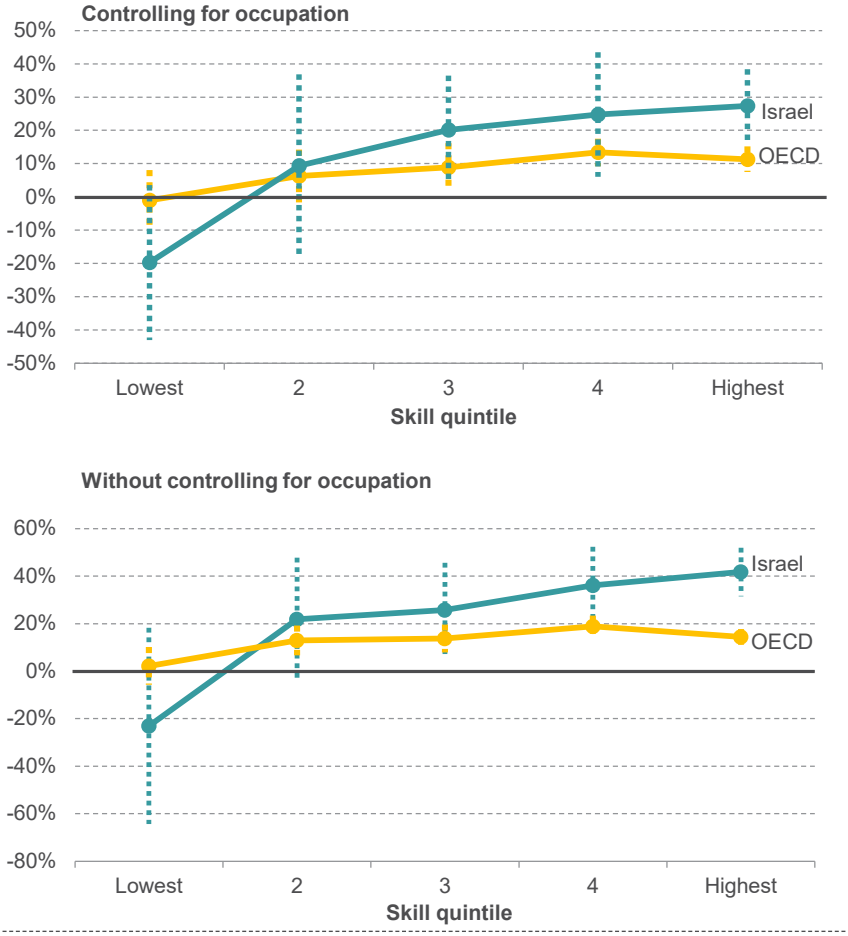
26 A detailed discussion of the definitions can be found in Central Bureau of Statistics (2017:41).

27 Ministry of Finance (2018) shows that the premium on a degree from an institution with stringent admission standards in terms of psychometric exam scores is higher for computer science and engineering than for other fields of study. Krill, Aloni, and Geva (2016) demonstrate that, in computer science, graduates of Israel's state-budgeted colleges earned, on average, 40 percent less than did graduates of the country's more selective universities. CBS (2012) also finds major differences in the salaries of college as opposed to university graduates in computer science and the exact sciences.

This indicates that, while the compensation for high tech employment is high and meaningful for those workers identified as possessing strong skills, the premium is lower for the rest of the worker population, and appears not to be positive at all at the low skill levels.

Appendix Figure 1. Wage premium for employment in high tech

The difference between the predicted wage in high tech and other sectors for workers with the same characteristics, 18 OECD countries, ages 25-65



Note: Return is calculated using a standard Mincer equation where hourly wage is regressed on gender, marital status, skill level on the verbal and quantitative portions of the exams, dummy variables for 10 age groups and fixed effects for occupation (at the two-digit level). The figure presents the coefficient for the intervening variables between hourly wage and employment in high tech. The dotted lines represent the 95 percent confidence intervals. | Source: Gilad Brand, Taub Center | Data: OECD, PIAAC

Appendix Table 1. Countries participating in the PIAAC survey and the additional data available

	Skills data	Wage data	Identification of high tech sector	Identification of high tech sector and wages
Austria	√	X	X	X
Belgium	√	√	√	√
Canada	√	X	X	X
Chile	√	√	n<50	√
Czech Republic	√	√	√	√
Denmark	√	√	√	√
Estonia	√	√	X	√
Finland	√	√	X	X
France	√	√	√	√
Germany	√	X	√	X
Greece	√	√	n<50	√
Ireland	√	√	√	√
Israel	√	√	√	√
Italy	√	√	√	√
Japan	√	√	√	√
Lithuania	√	√	√	√
Netherlands	√	√	√	√
New Zealand	√	√	√	√
Norway	√	√	√	√
Poland	√	√	√	√
Slovakia	√	√	√	√
Slovenia	√	√	√	√
South Korea	√	√	√	√
Spain	√	√	√	√
Sweden	√	X	√	X
Turkey	√	X	n<50	X
UK	√	√	√	√
US	√	X	√	X
All country total	28	22	21	20

Source: Gilad Brand, Taub Center | Data: OECD