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FOR SOCIAL POLICY STUDIES IN ISRAEL

The Risk of Automation in the Israeli Labor Market

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Abstract

This research presents a current mapping of the Israeli labor market using data from the OECD's Survey of Adults Skills (PIAAC — Programme for the International Assessment of Adult Competencies) and based on a recent model that ranks different jobs according to the tasks required in the future labor market. The study focuses on identifying the population that is at highest risk of automation and further identifying their specific skill weaknesses that put them at higher risk of automation and less fit for the future labor market.

The results of the mapping show that the share of occupations at high risk in Israel stands at about 15 percent. A large portion of these positions are in the manufacturing and construction industries as well as clerking positions. The study also found that a central characteristic of work at risk of automation is that it does not require higher education, and a large portion of these jobs, in fact, do not require any formal education. Further, occupations at high risk are also characterized by low hourly wages and, often, less than full-time work hours. The data reveal the existence of gender gaps and indicate that women, and especially non-Haredi Jewish women, are at higher risk of computerization relative to their male peers, apparently mainly due to the fact that they make less use of the skills that will be required in the future labor market and not due to their choice of occupation. Another population at high risk of automation is the Arab Israeli population, and especially Arab Israeli men. A large share of these men are employed in positions characterized by low wages with minimal educational requirements, with little use of the skills that will be required in the future labor market and in digital platforms.

Proper preparation for the expected changes in the Israeli labor market is essential in order to train workers for the future and to narrow inequalities that are foreseen within the labor force. In this framework,

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it is important to consider how these essential skills are provided to workers and at what stage it is optimal to provide them. It is, of course, preferable to provide these skills early on, within the formal education system. The findings indicate the financial difficulties in gaining new skills particularly among this group of workers at high risk of automation, and underscore the advantages of a wider use of the training system run by the government. Nevertheless, the best way to enable the adaptability of workers to the future labor market is through appropriate long-term planning, including the collection of a wide range of data on an ongoing basis.

Introduction

The emergence of new technologies always impact the labor market, and it has captured the attention of researchers and experts, policy makers, international organizations, like the OECD, the ILO (the International Labor Organizations), and the WEF (the World Economic Forum) and, of course, employers and employees in the labor market.

Recent professional literature has devoted a great deal of attention to the effects of new technologies and are attempting to predict their impact on the labor market. So far, there is a broad consensus among researchers that technology will gradually displace humans from many tasks that they currently perform. Autor (2015), a leading researcher of the labor market, claims that the introduction of new technologies usually increases the importance of skills and tasks that do not yet have a technological replacement. He claims that machines are, in general, better than humans in repetitive tasks that can be coded into a set of clear rules. In contrast, humans are still better at tasks that require cognitive flexibility, creativity, and discretion. It appears that the question of whether an occupation will become automated is dependent on the extent to which it requires skills that computers do not as yet possess.

A ground-breaking model that predicts the effect of automation on the labor market was proposed by Frey and Osborne (2013). Their model maps occupations in the US labor market according to their risk of automation over the next twenty years. The mapping examines the tasks required for each occupation and their characterization as automatable or not at this time. The model assigns a probability between 0 and 1 to each occupation where 0 means a negligible chance of automation and 1 implies near certainty of automation, with the effect of making today's workers in a given occupation redundant or fundamentally changing the character of their job. They

predict that 47 percent of the jobs in the US are at high risk of automation (a probability of automation greater than 0.7). Based on this model, predictions for other countries such as Germany (Brzeski & Burk, 2015) and Finland (Pajarinen & Rouvinen, 2014) have also been made. In Israel, Madhala-Brik (2015) used this method and forecasted that about 40 percent of workers in Israel were at high risk of automation.

The publication of the OECD's Survey of Adult skills (PIAAC — Programme for the International Assessment of Adult Competencies) allows access to a great many variables that characterize workers and occupations, like the tasks that are required for particular jobs. Following its publication, additional studies have been conducted based on Frey and Osborne's original model making adjustments that increase the accuracy of the predictions using the data of required tasks and skills for specific jobs. In contrast to the basic approach of Frey and Osborne, where data used for mapping is at the occupation level, this newer method allows a differential ranking of workers in the same occupation where different tasks and demands are required by their specific jobs. Arntz, Gregory, and Zierahn (2016) conducted the first study using this approach and published their findings as an OECD working paper. Their study indicates that mapping according to this new approach predicts a much lower share of jobs at high risk of automation. Thus, for example, the forecasts for the US showed that only 9 percent of jobs are at high risk (as opposed to 47 percent according to the occupation-based model). They also show that there is variation in the tasks required of workers within the same occupation and that it is essential to account for this variation in any labor market mapping exercise. Nedelkoska and Quintini (2018) propose another improvement in the method of measurement according to this approach and, as of today, theirs is the most updated method.[1]

In recent years, other forecasts have been published based on various methodologies. For example, in 2018 the WEF published a forecast based on a survey of employers which indicated that 31 percent of existing jobs would not be needed in the future and would either disappear or fundamentally change and that this share would drop to 21 percent by 2022 (WEF, 2018). A report published by the McKinsey and Company consulting firm in 2017, examined a list of the activities required in 800 occupations and found that about one-half of the tasks carried out today in the global labor market could potentially be automated with the introduction of current technologies and that almost 5 percent of occupations are liable to become completely automated (Manyika et al., 2017).

1 The improvement was made possible by the use of a more detailed list of occupations in the 2015 PIAAC survey.

Preparing for these expected changes is critical for the future of employment in Israel, and it has serious implications for the training of future workers. It also impacts methods for reducing — or at least not increasing — labor market inequalities among population groups. The current research presents a mapping of the Israeli labor market according to the most up-to-date method using the Survey of Adult Skills (PIAAC), and identifies specific groups at high risk of being adversely affected by the introduction of new technologies and automation. In addition, it identifies worker's characteristics and their specific skill weaknesses that put them at higher risk of automation and make them less fit for the future labor market.

Automation in the Israeli and global labor markets

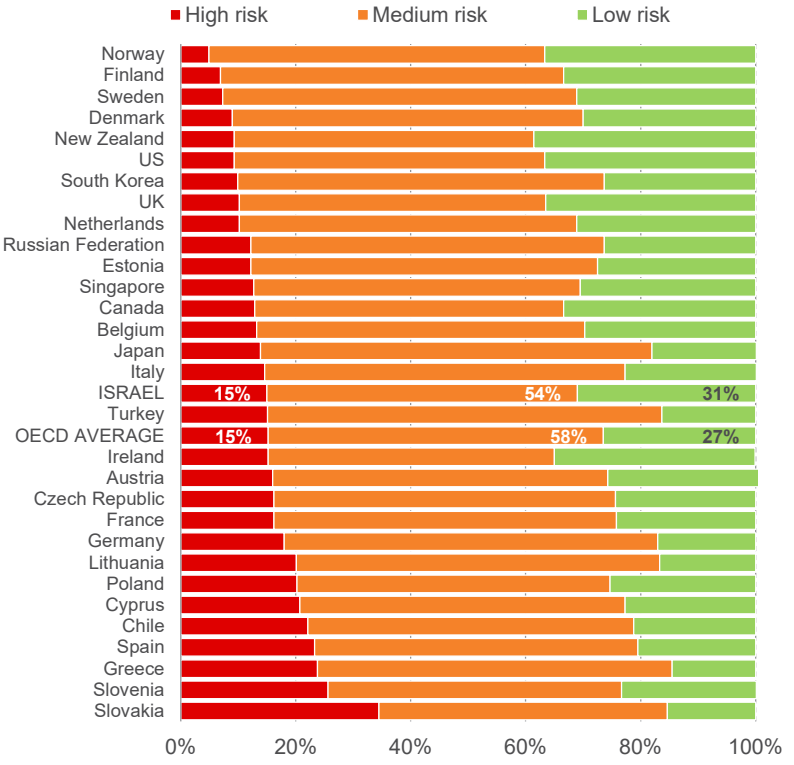
Nedelkoska and Quintini (2018) using the indices defined by Frey and Osborne (2013) describe bottlenecks to automation and they characterize the tasks which are currently difficult to automate. These include tasks that require an ability to perceive and manipulate (such as manual dexterity), creativity (originality), and social intelligence (such as the ability to manage negotiations and to persuade). Nine variables appearing in the PIAAC survey were modified in order to describe these tasks (see Appendix Table 1).[2] Following that, a logistic regression was run for 70 occupations that Frey and Osborne identified at very high risk of automation and those with a negligible risk for the next 20 years; risk/no risk was the dependent variable and the nine adjusted variables were the explanatory variables. The regression was based on data from Canada whose PIAAC survey was particularly large and, therefore, allowed for the optimal identification of the 70 occupations. The coefficients obtained for the nine variables using the Canadian data were used to predict the probability of automation for each of the countries participating in the survey (for information on the coefficients, see Nedelkoska & Quintini, 2018; Table 4.3). The predicted values for each observation are then used to map the labor market.

Figure 1 presents a division of the labor market in the OECD countries into three groups based on the method of Nedelkoska and Quintini: low risk — probability of automation up to 0.3; medium risk — probability of 0.3-0.7; and high risk — probability over 0.7 (jobs that are expected to change considerably or even to disappear).

2 The PIAAC survey does not include any questions relating to the care of others as part of a job and therefore the automatability of these jobs (such as, for example, those in the healthcare system) is liable to be overestimated.

The mapping shows that for the working-age group in the OECD countries, an average of about 15 percent of jobs are at high risk, namely that the job is expected to undergo substantial change in coming years. The mapping for Israel shows that the share of jobs at high risk is about 15 percent, which is similar to the OECD figure, and that 54 percent are at medium risk, and 31 percent are at low risk, which is higher than the OECD average.

Figure 1. Mapping the labor market by risk of automation
Workers ages 25-65



Source: Shavit Madhala, Taub Center | Data: OECD, PIAAC, 2012; 2015

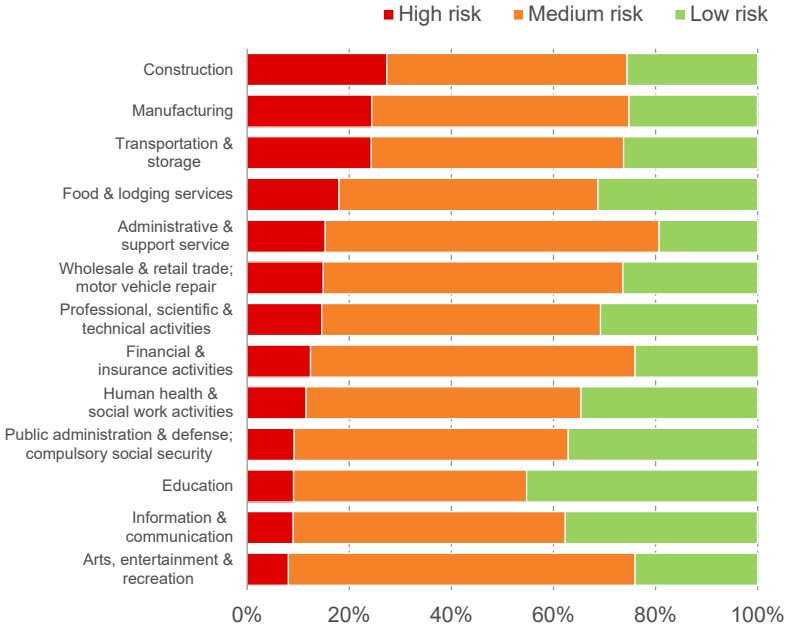
In order to characterize the type of jobs that are at risk of automation, industries and the distribution of jobs within them according to the predicted risk level are examined (Figure 2). The data show that the industries with the highest

share of high risk jobs are construction, manufacturing,transportation and storage services, and food and lodging services. In contrast, there is a low risk of automation in industries requiring skills such as creativity, complex problem-solving and social skills: art, entertainment and recreation; information and communication; education; and public administration and defense. An examination of the more detailed list of occupations (Appendix Figure 1)[3] shows that the occupations with a high share of jobs at risk are primarily those in manufacturing and construction and factory operators, jobs requiring interaction with machines, and clerical jobs, such as data entry. In contrast, occupations characterized by a low or even negligible risk of automation are primarily those requiring higher education or vocational training and also social intelligence, such as managers of various types and professionals, teaching professionals, or jobs in the legal professions.

3 The classification presented in Appendix Figure 1 is on the two-digit level. In general, the classification of occupations appears in the survey on four levels of detail: the most detailed level (four digits), which describes the worker's specific occupation; the subsequent levels gather occupations into subgroups (three digits), main groups (two digits), and domain (one digit). The occupations are grouped with emphasis on similarity among the occupational tasks.

Figure 2. Distribution of jobs in Israel by industry and risk of automation

Workers ages 25-65



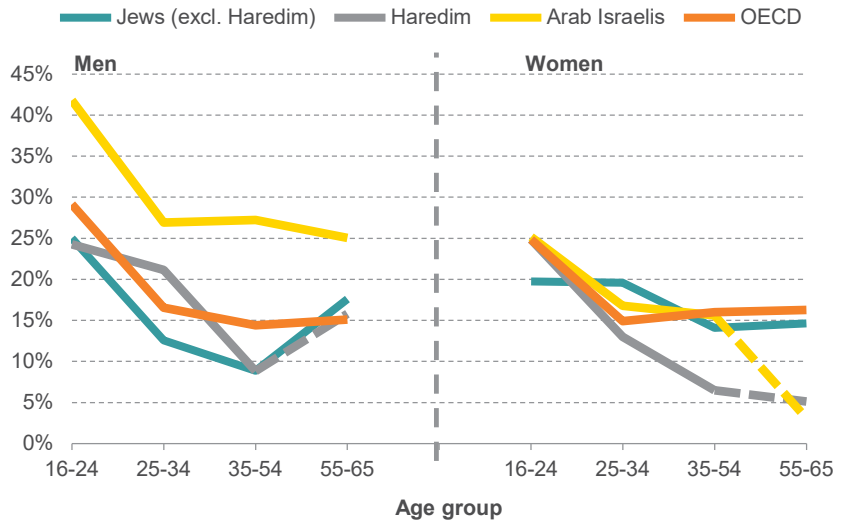
Source: Shavit Madhala, Taub Center | Data: OECD, PIAAC, 2015

A characterization of workers at risk of automation

One of the main research questions examined here is which workers at high risk of automation and which population groups are most vulnerable and should be given most consideration when setting policy? An examination of the rate of job positions at risk among the various population groups according to age group in Figure 3 leads to several insights. First, it appears that young workers (ages 16-24) have a higher risk of automation than workers in other age groups, except for non-Haredi Jewish women. This phenomenon is observed not only in Israel but also in the OECD countries. This finding is not surprising given the fact that most of this age group have not yet embarked on their career paths and are usually employed in temporary

jobs with no higher education or vocational training requirements. Among Jewish men, there is a drop in risk during the main working years, which then rises again prior to retirement.[4] The figure also shows major differences between Arab Israeli and Jewish men over all age groups, where among Arab Israeli men, there is a higher rate of job positions at high risk of automation. In contrast, among women, the gaps are not as wide. Among non-Haredi Jewish women in the prime working-age groups, there is a higher rate of occupations at high risk of automation than for men. In contrast, among Arab Israeli and Haredi populations, the gender differences are to the advantage of women.

Figure 3. Share of jobs at high risk of automation among different population groups



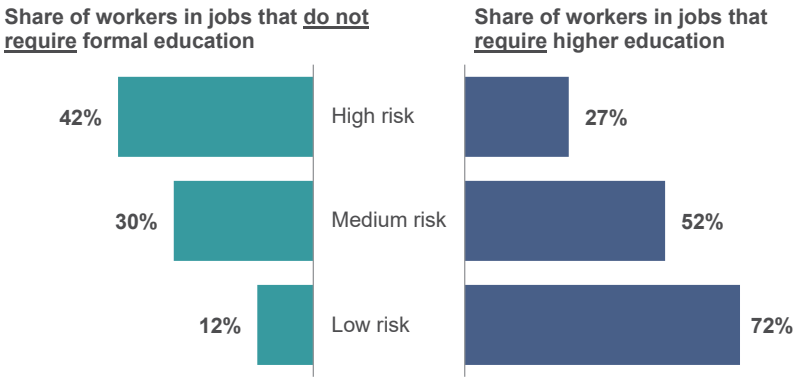
Note: The data for Haredi men and women and Arab Israeli women ages 55-65 are based on a small number of observations.
Source: Shavit Madhala, Taub Center | Data: OECD, PIAAC, 2012; 2015

4 These differences were found to be statistically significant.

One of the main correlates of risk of automation is level of education. The link between this characteristic and the occupational degree of risk has also been found in previous studies (Frey & Osborne, 2013; Madhala-Brik, 2015). Figure 4 clearly shows the connection between a job's risk of automation and its educational requirements according to the self-reporting of respondents to the PIAAC survey. It can be seen that the majority of workers in low risk jobs (72 percent) are employed in jobs requiring higher education, in contrast to about 42 percent of workers in high risk jobs who are employed in jobs not requiring any formal education at all.

Figure 4. Educational requirements of jobs at risk

Workers ages 25-65



Source: Shavit Madhala, Taub Center | Data: OECD, PIAAC, 2015

In order to identify more precisely the characteristics of those workers who are most likely to hold jobs at high risk, a regression estimating the effect of sociodemographic characteristics on the risk of automation was performed. The characteristics included: gender, age, sector, education and mathematical proficiency level (PIAAC's numeracy score). In Models 2 and 3, controls were added for residential district and occupation (see Appendix Table 2 for the results). It can be seen that the aforementioned gender gaps are also seen in the regression results, and the jobs held by women have a risk of automation that is about 3 percentage points higher. Surprisingly, when occupation is added as a control variable, the gender gap does not narrow but, in fact, widens to about 4 percentage points. This may be an indication

that among men and women employed in the same occupation, women are more vulnerable and make less use of those skills that reduce risk and that are required in the future labor market relative to their male counterparts. It can also be seen that risk decreases with age up until about age 40 and then starts to climb. With respect to the differences between population groups, jobs held by Arab Israelis are at higher risk than those held by Jews and the difference is statistically significant when only age and gender are used as controls (not presented in the table). When controlling for education, the difference is no longer significant. In contrast, the risk of automation among workers in the Haredi sector is lower than among non-Haredi Jews even after controlling for educational level; however, if occupation is controlled, the difference is not significant. It appears, therefore, that the differences seen in the average level of risk among the various population groups is connected to gaps in education level and the choice of occupation. As noted, there is a negative relationship between education and automation, where an increase in education is accompanied by a lower risk of automation. Thus, for example, a high school education reduces the risk of automation by about 5 percentage points relative to a less than high school education (the omitted group) and having a master's degree or higher reduces the risk by about 15 percentage points. This negative relationship continues to exist even when controlling for occupation. A test of residential district shows that in the Tel Aviv and the Southern districts there is a higher possibility of being employed in a job with a high risk of automation relative to the Center district, although the level of statistical significance is relatively low. Controlling for occupation leaves the difference statistically significant only for the South relative to the Center.

Appendix Table 2 shows the estimation presented for all populations groups combined. Regression estimates that are identical to what appear in Appendix Table 2 but broken down by population group (Arab Israelis, Haredi, and non-Haredi Jews) show that the gender gap exists in all the groups but is statistically significant only among non-Haredi Jews. Similarly, a statistically significant variation in the risk of automation according to age can be seen only in the estimation for the non-Haredi Jewish population.

Regression results show that differences among population groups are apparently related to differences in education level and the choice of occupation (which are interrelated). The occupational distribution in the labor market shows large gaps between Arab Israeli men and Jewish men (both Haredi and non-Haredi, see Figure 5). About one-half of Arab Israeli men are employed in manufacturing, construction, and the operation of

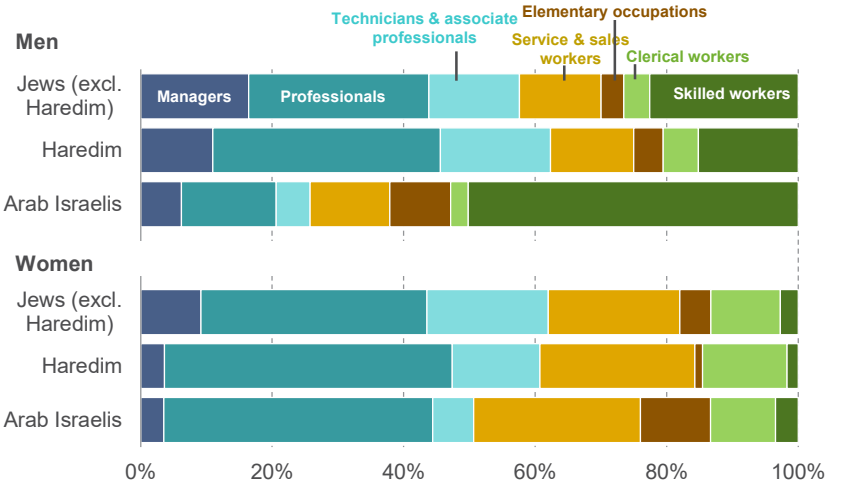
factories and machines (skilled workers in the figure). These industries are characterized by a high share of jobs that are at risk of automation and a low educational threshold. A relatively low share of the Arab Israeli workers are employed in academic (professionals) or managerial positions which are characterized by lower risk. In contrast, between Haredi and non-Haredi men, the differences do not appear to be as substantial as they are relative to Arab Israeli men in the distribution of occupational groups. This is also the case for Arab Israeli women relative to women in the other groups.[5]

Professionals are a major occupational group among Haredi men and women. A closer look at the jobs within this group shows that a large share of the Haredi adults work in the field of education, a category characterized by jobs with a low risk of automation. It is interesting to note that among Arab Israelis — both men and women — there is a relatively high rate of employment in unskilled occupations involving simple and routine tasks usually requiring physical effort and the use of manual tools and not requiring a high level of skills or training. Nonetheless, this occupational group is — surprisingly — characterized by a medium share of high risk jobs. It is also interesting that in the occupational distribution of non-Haredi women and men, the men have higher rates of employment in occupations characterized by high risk levels. This is consistent with regression results showing that gaps among groups are primarily the result of differences in skills (skills that are required in the future labor market) and not necessarily in the choice of occupation itself.

5 The distribution shown is on the simplest, most aggregated level (one digit) and accordingly each group includes a diverse range of occupations. Therefore, the lack of differences in this distribution does not indicate their absence in the occupations on a more detailed level within each category.

Figure 5. Distribution of employment among populations groups by occupation

Workers ages 25-64



Note: Skilled workers includes those in manufacturing and construction, craft and related trade workers, as well as other skilled workers in agriculture, forestry, and fishery.
Source: Shavit Madhala, Taub Center | Data: CBS, *Labor Force Survey 2017*

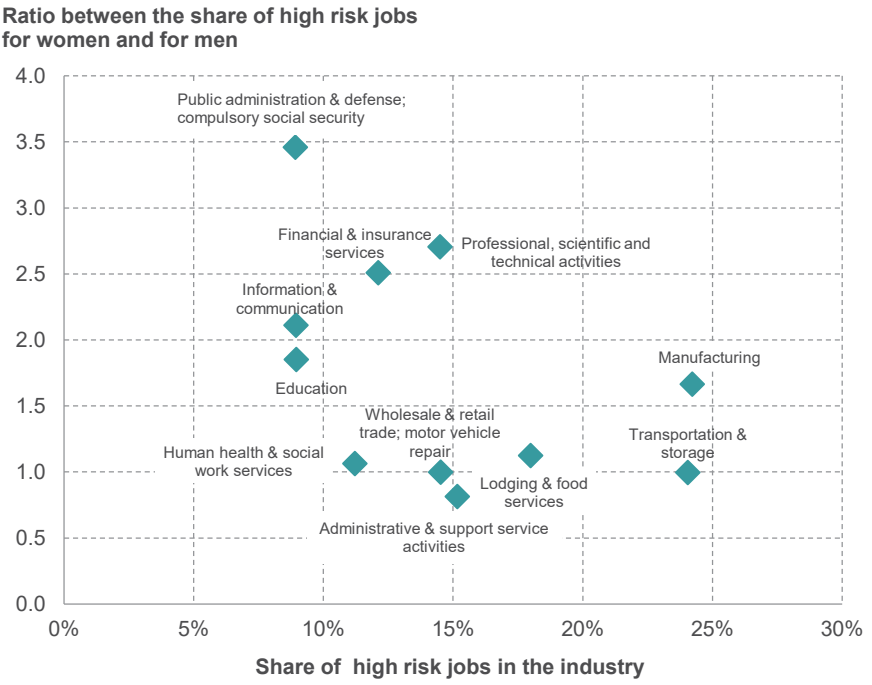
As indicated by the regression analysis presented above, women, and in particular prime working-age Jewish women, face a higher risk of automation in their jobs than do men. Despite the gender gaps that were identified, these disparities are not necessarily the same across the various industries. An examination of the ratio between the share of women in jobs at high risk of automation and the share of men at this level of risk in the various industries is shown in Figure 6. It shows that only in the administrative and support service activities industry is the share of women at high risk lower than the share of men at high risk (a ratio of less than 1).[6] This industry is relatively egalitarian with respect to the employment of men and women and does not have a particularly high rate of jobs at high risk. In other industries, such as transportation and storage, wholesale and retail trade, and human

6 Among the industries that appear in Figure 6. Industries with only a few observations for women were not included.

health and social work services, the share of women at risk is similar to that for men. In contrast, there are industries where women's exposure to risk is increased: in fact, within the same industry, the share of women at high risk is double or more than the share of men. These include information and communication, financial and insurance services, professional, scientific and technical activities, public administration and defense. Financial and insurance services are in general characterized by a high share of women but not a high rate of jobs at risk while public administration and defense, and information and communication have relatively low rates of jobs at risk.

Figure 6. Ratio between the share of women in high risk jobs relative to the share of men in high risk jobs

Workers ages 25-64



Source: Shavit Madhala, Taub Center | Data: OECD, PIAAC 2015

In order to complete the picture of workers in roles at high risk of automation, there are two important labor market parameters — work hours and wages. Weekly work hours for those at the various levels of risk show that workers in jobs at low risk work more hours on average than workers in jobs at medium or high risk (44 weekly hours versus 39). About 31 percent of the workers in medium risk and about 28 percent of those in high risk jobs work in part-time jobs, as opposed to about 22 percent of those in low risk jobs.[7]

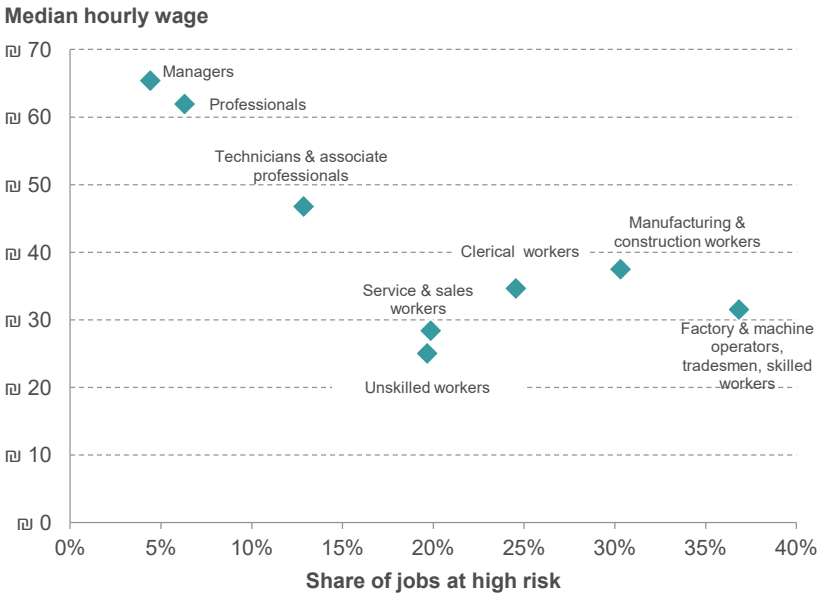
Appendix Table 3 presents a test of weekly work hours as a function of the risk of automation, age, gender, hourly wage, sector, education level, residence in the Center or Tel Aviv districts (as opposed to the rest of the country), and the addition of a control for occupation. The results of the estimation show that the difference in weekly work hours between a worker in a job at medium risk (probability in the range of 0.3-0.7) and a worker in a job at low risk (probability in the range of 0.0-0.3) is about 3 weekly work hours (the coefficient of medium risk) and about 2.7 weekly work hours when controlling for occupation. For workers in jobs at high risk (probability above 0.7) relative to workers at low risk, the gap relative to workers at low risk increases to 3.4 work hours and to about 4 work hours when controlling for occupation.[8]

Previous studies that have examined the relation between wages and automation have shown that workers in occupations at risk are characterized by lower wages (Frey & Osborne, 2013; Madhala-Brik, 2015; Nedelkoska & Quintini, 2018). An examination by occupation (Figure 7) shows that managers and professionals, who are characterized by a low share of jobs at risk, also earn higher wages. In contrast, in occupations such as factory and machine operators and tradesmen in manufacturing and construction, in which there are higher rates of jobs at high risk of automation, the median hourly wage is relatively low.

7 The figure presented in the text applies to a worker in a part-time job defined as working up to 35 work hours per week. According to self-reporting of part-time employment in the survey, about 21 percent of the workers in jobs at medium risk and about 20 percent of those in jobs at high risk work in part-time jobs, in contrast to 13 percent of workers in jobs at low risk.

8 The gap between a worker at high risk and one at medium risk is not statistically significant.

Figure 7. Median hourly wage and the share of high risk jobs by occupation
Workers ages 25-65



Source: Shavit Madhala, Taub Center | Data: OECD, PIAAC 2015

This relationship was tested by estimating the log of hourly wages as a function of the probability of automation and other explanatory variables, as in the previous estimation of work hours (Appendix Table 4).[9] As in earlier studies, a negative relationship was found between the two variables. Thus, the hourly wage of a worker in a job with medium risk was lower by about 16 percent than that of a worker in a job at low risk and by about 14 percent when controlling for occupation. The gaps between a worker in a job at high risk and one in a job at low risk is about 27 percent and drops to 21 percent when controlling for occupation.[10]

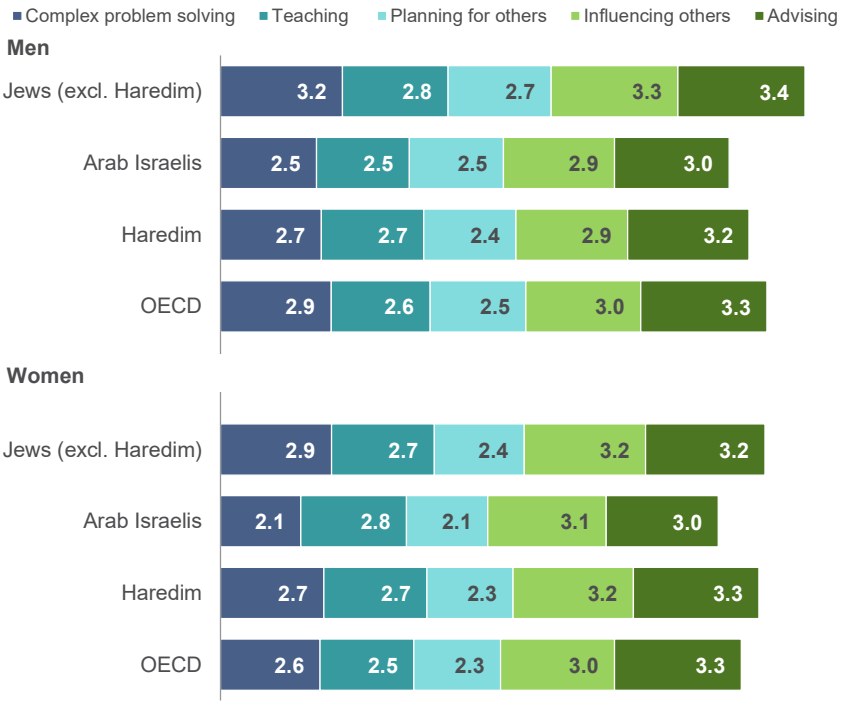
9 The models in Appendix Table 4 were also estimated using the Tobit model in order to rule out the possibility of bias in the coefficients as a result of the effect of selection on wages. The resulting coefficients were identical to those in the table.

10 The gaps between a worker in a job at high risk and one in a job at medium risk are statistically significant only in the estimates in Model 1.

The degree to which a worker utilizes a certain set of job skills is crucial in determining the risk of automation. As explained previously, a worker's risk of automation is dependent on the frequency with which he carries out tasks that call for those skills identified as required in the future labor market: consulting, persuasion or influencing other people, planning the activities of others, teaching or training others, and complex problem solving.[11] Figure 8 shows the frequency of use of these skills among men and women in various population groups. Particularly notable is the low frequency of use of these skills among Arab Israeli men and women relative to Jewish men and women (including the Haredi), and also relative to the average frequency of use among workers in the OECD countries. Furthermore, it appears that non-Haredi men use these job skills more than workers in all the other groups — whether men or women — and more than the average for the OECD countries. Also of note is the high rate of use of complex problem solving among non-Haredi Jewish men relative to the other groups. In fact, only about 15 percent of non-Haredi Jewish men report not using this skill in their job, as opposed to 31 percent of Arab Israeli men and about 42 percent of Arab Israeli women. There were also relatively large gaps in the use of the planning for others skill between men and women and even more so between Arab Israeli women and the other groups. About 63 percent of Arab Israeli women reported that they do not use this skill at all, as opposed to about 44 percent of non-Haredi Jewish men.

11 Skills that were identified in the detailed process by Nedelkoska and Quintini (2018) based on the research of Frey and Osborne (2013).

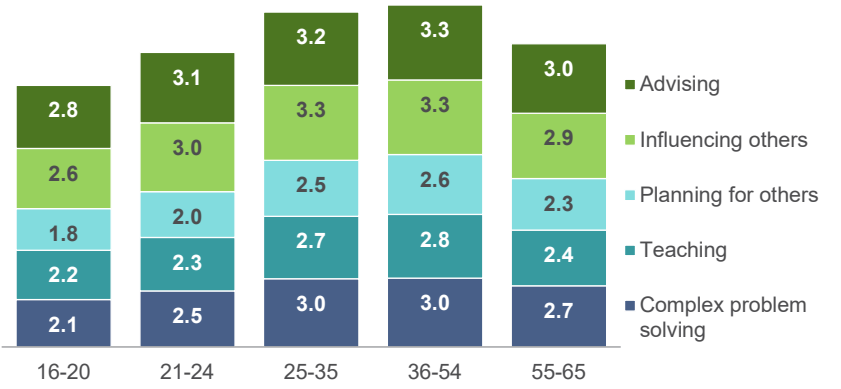
Figure 8. Frequency of selected skills required in the future labor market used on the job by population groups
Workers ages 25-65



Note: Frequency of each task is measured on a scale of 1 to 5, where 1 represents "never" and 5 represents "daily." The values in the figure are the average frequency for each group.
Source: Shavit Madhala, Taub Center | Data: OECD, PIAAC 2012; 2015

An examination of the risk of automation according to age group reveals differences in the frequency of use of the aforementioned skills across the age groups. As can be seen in Figure 9, the frequency of use of these skills in a job increases with age and reaches a peak in the 36-54 age group, after which it declines (in the 54-65 age group).

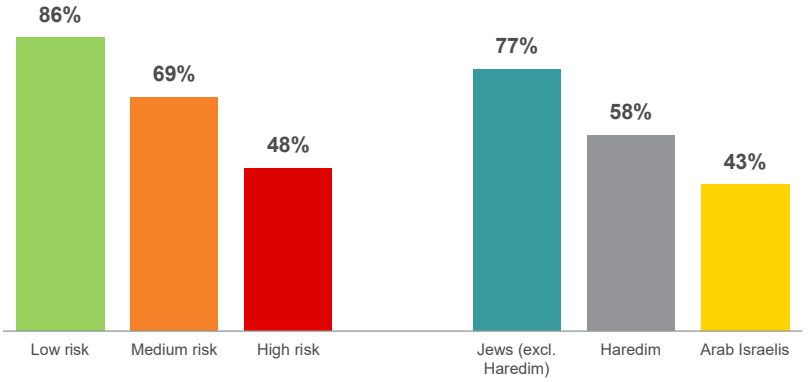
Figure 9. Frequency of current use on the job of selected skills required in the future labor market by age group



Note: Frequency of each task is measured on a scale of 1 to 5, where 1 represents "never" and 5 represents "daily." The values in the figure are the average frequency for each group.
Source: Shavit Madhala, Taub Center | Data: OECD, PIAAC, 2015

Other than the skills identified in the model on which the analysis is based, another important skill in the future labor market is the ability to use a computer. Figure 10 shows that workers in jobs at low risk of automation use a computer in their jobs much more than workers in jobs at high risk. The variation in the use of a computer across population groups also points to substantial gaps, with Arab Israeli workers making far less use of a computer than Jewish workers in their jobs.

Figure 10. Share of workers who use a computer in their work
Workers ages 25-65



Source: Shavit Madhala, Taub Center | Data: OECD, PIAAC, 2015

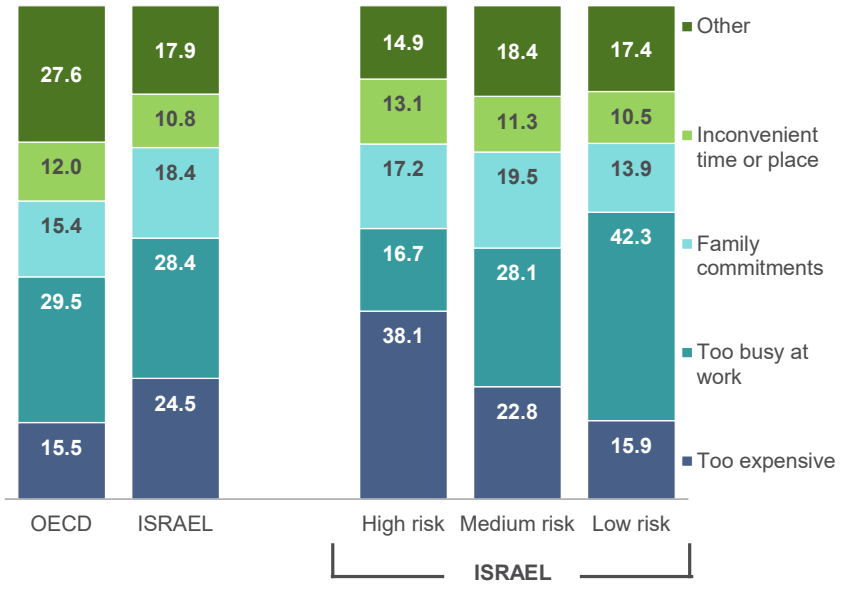
Tools for dealing with the expected changes

The expected trends and changes in the labor market underscore the value of efforts to adapt the work force to the future labor market. As discussed previously, the expected changes represent a risk to the employment of the most vulnerable groups in the economy, which are characterized by low education levels, low wages, residence in the South (geographic periphery), and tend to be women and Arab Israelis. The weaker socioeconomic status of these groups is further reason to provide them with assistance in adapting to the changing labor market by acquiring the necessary skills throughout the work-life cycle. Aside from identifying the vulnerable populations as socioeconomically weak groups, it is also important to look at the reasons that workers do not seek the education or training that would give them greater future job security. Looking at the main reason for the failure to participate in further education or training among those interested in doing so reveals that, in contrast to the OECD, in Israel, there is a higher share of non-participation due to the cost of the training (Figure 11). About 24 percent of the respondents gave this as the main reason, in contrast to about 16 percent on average in the OECD countries. A comparison by risk group shows that among workers in Israel in jobs at high risk of automation, the main reason for not seeking additional education or training is the high cost, although among workers in jobs at medium risk of automation, and, in

particular among workers in jobs at low risk, the main reason is lack of time due to job pressures.

Figure 11. Distribution of the main reason for not participating in studies or vocational training

Workers ages 25-65



Note: The distribution of the main reason given by those who were interested in participating in studies or vocational training in the last 12 months but did not do so.
Source: Shavit Madhala, Taub Center | Data: OECD, PIAAC, 2012; 2015

One of the main policy tools to encourage the acquisition of skills, particularly among vulnerable populations, is vocational training programs operated by the state. Although there has been an upward trend in the budget allocated for this purpose in recent years, the expenditure is still at a low level relative to other OECD countries (Gal & Madhala, 2019).

Alongside the amount of training required to respond to frequent changes in the labor market, it is important to ensure the quality of vocational training and that it is in line with the needs of the future labor market. In order to plan an efficient vocational training system, reliable information is needed on those skills that are in demand and that will continue to be in demand in the future. The findings in this study show that certain groups lack skills that are considered in the literature to be essential in the future labor market. These findings can provide a basis for decision making in the planning of vocational training programs. At the same time, it should be recalled that the Survey of Adult Skills was used here to formulate a picture of the current situation from the perspective of workers. In order to complete the picture, it is desirable that the data be based also on the perspective of the other main player in the labor market, namely the employers. A full picture that reflects the needs of employers and the existing supply of employee skills will provide the state with a solid foundation for building effective vocational training programs. Many countries have already understood this and have begun to take steps that will assist in the long-term planning for the future labor market. Britain, for example, carries out surveys of sought-after skills among employers, which include information on the skills they are looking for, on the existing shortages, and on the character of the training that is needed (Gov.uk, 2017). In France, the government employment service is carrying out an evaluation of vocational training needs based on a survey that provides information on expected hiring, and there is also an agency responsible for coordination between the various players in the labor market in order to maintain dialog and create joint projects (OECD, 2017). In Italy, the central bureau of statistics has recently invested efforts in order to combine various sources of information on skills needed in the labor market, with the goal of providing policy makers with precise information on the labor market at the occupational level (ibid).

Due to the continual changes in the labor market, learning new skills is important at every stage of life; however, there is added importance in acquiring skills at early stages, namely within the education system. Thus, the education system serves as another important component in the implementation of policy to adapt human capital to the needs of the future labor market. A comprehensive study of the Israeli education system concluded that, for the most part, it has not managed to keep up with the pace of change and it is not preparing the next generation to deal with the challenges of the 21st century (Eisenberg & Zelivneski, 2018). The study also found that one of the most important steps needed in the education system is to include studies in digital applications within the curriculum. Indeed,

some measures seem to indicate the need for further implementation of computing in the Israeli education system. For example, the number of computers per pupil in Israeli schools is 0.43 which is lower than the OECD average of 0.77 (OECD, 2016). Also, the share of pupils who make use of a computer at school is low relative to the OECD — 55 percent as compared to 72 percent (OECD, 2015). These figures, alongside the findings on the disparities between various population groups with respect to the use of digital platforms in the labor market (Figure 10), emphasize the need for acquisition of digital skills prior to entering the labor market, particularly in the case of socioeconomically weaker populations.

Conclusion

In view of the technological changes and the processes taking place in the labor market, there is no doubt that changes will occur in the composition of the task and skill set required of workers. This will involve a shift from repetitive tasks to tasks that are difficult for a computer to carry out. As an extension of the 2015 Taub Center study which mapped the labor market according to occupations (Madhala-Brik, 2015), this study has produced a more up-to-date mapping of the labor market in Israel. The mapping, based on the model presented by Nedelkoska and Quintini (2018), ranks jobs (even within the same occupation) according to their use of tasks required in the future labor market. The result of the mapping relative to other countries shows that the share of jobs in Israel at high risk of automation is about 15 percent, which is similar to the OECD average, and in contrast to the figure of 40 percent arrived at in Madhala-Brik, 2015, which relied on a less up-to-date mapping methodology.) A large share of these jobs are in manufacturing and construction and factory operation, and even in clerical work.

The research indicates that a main characteristic of jobs at risk of automation is that they do not require higher education and many of them do not even require formal education. Additional characteristics of the labor market (which are also connected to education level), such as wages and number of weekly work hours, were also found to be negatively correlated with risk of automation. Thus, jobs at risk of automation are characterized by low hourly wages and fewer weekly work hours. These findings emphasize the importance of integrating socioeconomically weaker populations that are more exposed to risk into academia and promoting the acquisition of higher education among these groups.

The characterization of workers in jobs at risk reveals the existence of gender gaps in this context, where non-Haredi Jewish women have job roles that are characterized by a higher risk of automation compared to their male peers in the same group, most likely due to less use of skills required in the future labor market rather than their occupational choice. Another population group that is characterized by a relatively high risk of automation is the Arab Israeli sector, and in particular Arab Israeli men. A high share of Arab Israeli men are employed in low-paid jobs and in jobs with low education requirements, which require less use of the skills that are needed in the future labor market, such as the ability to use digital platforms. Moreover, this group is primarily employed in manufacturing and construction, which, for the most part, are physically demanding occupations that often lead to their leaving the labor force at earlier ages (Yashiv & Kasir, 2018). Another characteristic of Arab Israeli workers is the relatively high share of households with a single wage earner (although this phenomenon has been characterized by a downward trend in recent years due to the increased labor force participation of Arab Israeli women). The employment rates of this population do not, however, indicate a significant problem in their integration in the labor market, particularly relative to Arab Israeli women and Haredi men who currently are attracting more attention among labor market policy makers. However, all of the characteristics listed above indicate that the Arab Israeli men is exposed to increased risk in the future labor market. Therefore, this population is in need of greater attention and intervention by policy makers in order to reduce the threats to their future employment rates.

The effect of technology on jobs is dependent on the ability of employers and workers to adjust to changes in the labor market, such as the training of workers to function in a technological environment. In the case of prestigious industries and workers with a medium or high socioeconomic status, it can be assumed that they will make the necessary adjustments and will acquire the needed skills over their lifetimes, thus enabling them to maintain a continuum in the labor market despite the technological changes. In contrast, it is doubtful whether populations from weaker socioeconomic backgrounds will be able to keep up with the changing labor market without intervention by the state, whether because of an inferior starting point or a lack of information and the means to acquire the relevant skills. A policy to reduce these gaps should involve an early intervention through the education system. The acquisition of skills that are essential in the future labor market is important for all groups in the population and in particular it can reduce existing disparities among various population groups prior

to their entry into the labor market. A later stage of intervention involves workers already in the labor market. In view of the data on the difficulty in financing the acquisition of skills among workers at risk, there is a clear benefit in expanding state-run vocational training programs. In order to facilitate the efficient use of this platform and the optimal acquisition of skills in general, including on the individual level, a policy of long-term planning in the labor market is necessary, which will include the gathering of information on the needed employment skills and which will facilitate access to that information.

It appears that despite the high level of uncertainty involved, and even if there is no way of predicting the extent of the impact technological change will have, in view of past trends and the employment trends in Israel there is little ground for fears of mass unemployment due to these changes. However, it can be assumed that certain jobs will disappear or will be changed substantially, although new jobs will simultaneously appear. Nonetheless, the largest impact on employment will apparently be among weaker populations which will likely find it difficult to acquire the skills needed to integrate into the new jobs that will emerge. Such a situation is likely to exacerbate the already existing inequalities between these groups and the rest of the population. Therefore, it appears that the true challenge is to ensure that these groups successfully adjust to the changes in the labor market and that they are able to exploit the new opportunities that technological change will bring.

References

English

Autor, D. H. (2015). Why are there still so many jobs? The history and the future of workplace automation. *Journal of Economic Perspectives, 29*(3), 3-30.

Arntz, M., Gregory T., & Zierahn U. (2016). *The risk of automation for jobs in OECD countries: A comparative analysis*. OECD social, employment and migration working papers No. 189. Paris: OECD Publishing.

Brzeski, C., & Burk, I. (2015). *Die Roboter kommen. Folgen der Automatisierung für den deutschen Arbeitsmarkt*. INGDiBa Economic Research.

Frey, C., & Osborne, M. (2013). *The future of employment: How susceptible are jobs to computerisation?* Oxford: Oxford Martin School, University of Oxford.

Gal, J., & Madhala, S. (2018). Israel's social welfare system: An overview. In A. Weiss (Ed.), *State of the nation report: Society, economy and policy in Israel 2018* (pp. 313-334). Jerusalem: Taub Center for Social Policy Studies in Israel.

GOV.UK (2017). *Employer skills survey 2017: UK findings*, https://www.gov.uk/government/publications/employer-skills-survey-2017-uk-report

Madhala-Brik, S. (2015). Occupations at risk: Computerization trends in the Israeli labor market. In D. Chernichovsky & A. Weiss (Eds.), *State of the nation report: Society, economy and policy in Israel 2015* (pp. 53-96). Jerusalem: Taub Center for Social Policy Studies in Israel.

Manyika, J., Chui, M., Miremadi, M., Bughin, J., George, K., Willmott, P., & Dewhurst, M. (2017). *A future that works: Automation, employment, and productivity*. McKinsey Global Institute.

Nedelkoska, L., & Quintini, G. (2018). *Automation, skills use and training*. OECD social, employment and migration working papers, No. 202. Paris: OECD Publishing.

OECD (2015). *Students, computers and learning: Making the connection, PISA*. Paris: OECD Publishing.

OECD (2016). *PISA 2015 results (Volume II): Policies and practices for successful schools, PISA*. Paris: OECD Publishing.

OECD (2017). *Getting skills right: Good practice in adapting to changing skill needs*. Paris: OECD Publishing,

Pajarinen, M., & Rouvinen, P. (2014). *Computerization threatens one third of Finnish employment*. ETLA Brief, 22.

PIAAC (2012). *OECD Survey of Adult Skills 2012*.

PIAAC (2015). *OECD Survey of Adult Skills 2015*.

WEF (2018). *The future of jobs report 2018*. World Economic Forum, http://www3.weforum.org/docs/WEF_Future_of_Jobs_2018.pdf

Hebrew

Eisenberg, E., & Selivansky, O. (2018). *Adjusting the education system to the 21st century*. Jerusalem: The Israel Democracy Institute.

Yashiv, E., & Kasir, N. (2018). *The Arab economy in Israel*. Jerusalem: The Haredi Institute for Policy Research.

Appendix

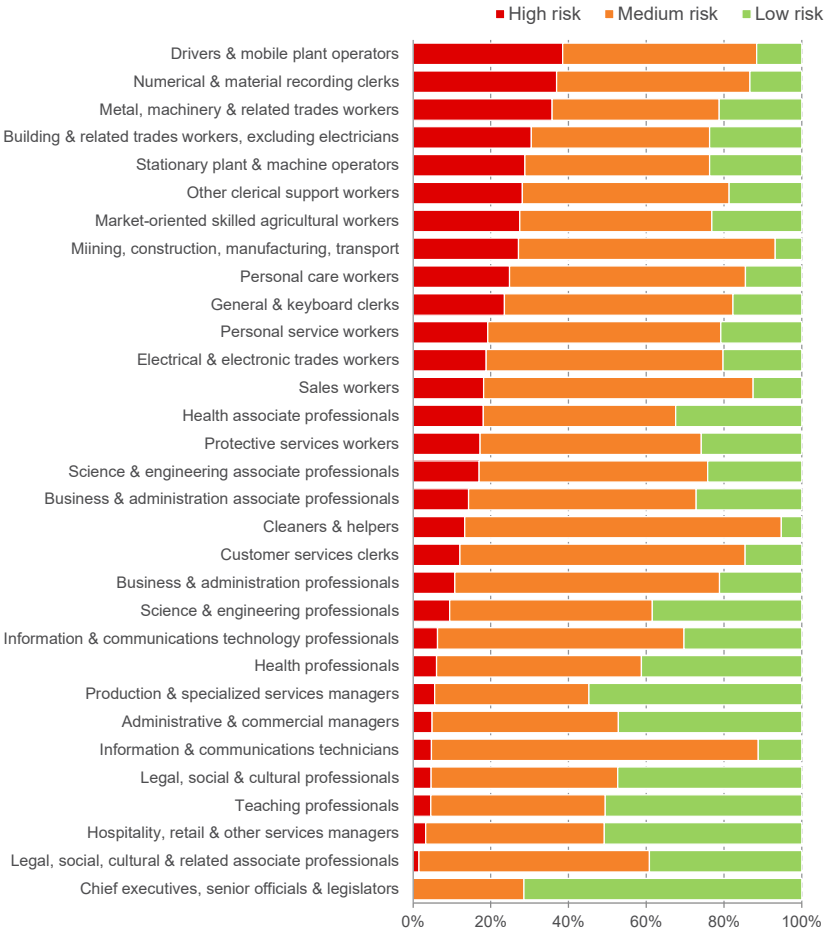
Appendix Table 1. Matching Frey & Osborne's measures to the PIAAC survey

Frey & Osborne bottlenecks to automation	Variable in PIAAC	Variable description
Perception manipulation	Fingers (dexterity)	How often — using skill or accuracy with your hands or fingers?
Creative intelligence	Problem-solving, simple	How often — relatively simple problems that take no more than 5 minutes to find a good solution?
	Problem-solving, complex	Problem solving — complex problems that take at least 30 minutes thinking time to find a good solution?
Social intelligence	Teaching	How often — instructing, training or teaching people, individually or in groups?
	Advise	How often — advising people?
	Plan for others	How often — planning the activities of others?
	Communication	How often — sharing work-related information with co-workers?
	Negotiate	How often — negotiating with people either inside or outside your firm or organization?
	Influence	How often — persuading or influencing people?
	Sell	How often — selling a product or selling a service?

Source: Shavit Madhala, Taub Center based on Nedelkoska and Quintini, 2018

Appendix Figure 1. Distribution of jobs in Israel by level of risk of automation and by occupation

Workers ages 25-65



Source: Shavit Madhala, Taub Center | Data: OECD, PIAAC, 2015

Appendix Table 2. Estimates of the worker's job risk of automation

Workers ages 25-64

	Model 1	Model 2	Model 3
Female	0.033***	0.032***	0.043***
	(-0.008)	(-0.008)	(-0.01)
Age	-0.011***	-0.011***	-0.008**
	(-0.003)	(-0.003)	(-0.003)
Age squared	1.20E-04***	1.17e-0.4***	9.01E-05**
	(0.000)	(0.000)	(0.000)
Population group			
Arab Israeli	0.001	0.005	0.009
	(-0.01)	(-0.012)	(-0.012)
Haredi	-0.034**	-0.038**	0.001
	(-0.012)	(-0.013)	(-0.013)
Education level			
High school	-0.046***	-0.045**	-0.025
	(-0.014)	(-0.014)	(-0.014)
Above high school	-0.077***	-0.077***	-0.031
	(-0.016)	(-0.016)	(-0.016)
BA degree	-0.136***	-0.135***	-0.047**
	(-0.016)	(-0.016)	(-0.016)
MA degree or higher	-0.153***	-0.152***	-0.059**
	(-0.017)	(-0.017)	(-0.018)
Numeracy	-0.054***	-0.055***	-0.040***
	(-0.008)	(-0.008)	(-0.008)
District			
North district		0.001	-0.001
		(-0.012)	(-0.012)
Haifa district		0.004	-0.003
		(-0.013)	(-0.012)

Appendix Table 2 (continued). Estimates of the worker's job risk of automation

Workers ages 25-64

	Model 1	Model 2	Model 3
Jerusalem district		0.026	0.025
		(-0.016)	(-0.015)
Tel Aviv district		0.024*	0.015
		(-0.011)	(-0.011)
South district		0.031*	0.032*
		(-0.014)	(-0.014)
Judea/Samaria district		-1.07E-04	0.007
		(-0.02)	(-0.02)
Occupation dummies	no	no	yes
Constant	0.903***	0.886***	0.527***
	(-0.063)	(-0.064)	(-0.067)
R^2	0.123	0.127	0.358
No of observations	3,025	3,025	3,025

Note: Results from OLS regression. Robust standard errors in parentheses.
Significant at: *p<0.05; **p<0.015; ***p<0.001.

Source: Shavit Madhala, Taub Center | Data: OECD, PIAAC, 2012; 2015

Appendix Table 3. Weekly work hours as a function of level of automatability

Workers ages 25-64

	Model 1	Model 2
Automatability level		
Medium risk	-3.009***	-2.726***
	(-0.649)	(-0.649)
High risk	-3.408***	-3.979***
	(-0.908)	(-0.974)
Age	1.052***	0.804***
	(-0.221)	(-0.216)
Age squared	-0.012***	-0.008***
	(-0.003)	(-0.002)
Female	-10.004***	-3.998***
	(-0.594)	(-0.737)
Hourly wage (log)	-2.140**	-5.077***
	(-0.701)	(-0.760)
Population group		
Arab Israeli	-2.600***	-2.382**
	(-0.761)	(-0.756)
Haredi	-7.921***	-4.437***
	(-1.011)	(-1.024)
Education level		
High school	2.537*	1.954
	(-1.113)	(-1.135)
Above high school	2.864*	2.202
	(-1.253)	(-1.270)
BA degree	3.296**	3.351**
	(-1.218)	(-1.263)
MA degree or higher	3.647*	4.883***
	(-1.420)	(-1.396)
Center & Tel Aviv district	-1.213*	-0.877
	(-0.590)	(-0.565)

Appendix Table 3 (continued). Weekly work hours as a function of level of automatability

Workers ages 25-64

	Model 1	Model 2
Occupation dummies	no	yes
Constant	33.730***	48.127***
	(-5.026)	(-4.785)
R^2	0.19	0.481
No of observations	2,023	2,023

Note: Results from OLS regression. Robust standard errors in parentheses.
Significant at: *p<0.05; **p<0.01; ***p<0.001.
Source: Shavit Madhala, Taub Center | Data: OECD, PIAAC, 2012; 2015

Appendix Table 4. Hourly wage as a function of level of automatability

Workers ages 25-65

	Model 1	Model 2
Automatability level		
Medium risk	-0.161***	-0.136***
	(-0.027)	(-0.026)
High risk	-0.274***	-0.207***
	(-0.040)	(-0.042)
Age	0.056***	0.045***
	(-0.009)	(-0.009)
Age squared	-0.001***	-3.99E-04***
	(0.000)	(0.000)
Female	-0.253***	-0.104***
	(-0.026)	(-0.029)
Hourly wage (log)	-0.004**	-0.009***
	(-0.001)	(-0.001)
Population group		
Arab Israeli	-0.245***	-0.170***
	(-0.030)	(-0.034)
Haredi	-0.04	-0.044
	(-0.044)	(-0.046)
Education level		
High school	0.125*	0.028
	(-0.051)	(-0.059)
Above high school	0.210***	0.024
	(-0.055)	(-0.064)
BA degree	0.459***	0.150*
	(-0.054)	(-0.065)
MA degree or higher	0.569***	0.242***
	(-0.063)	(-0.073)
Center & Tel Aviv district	-0.150***	-0.080***
	(-0.024)	(-0.023)

Appendix Table 4 (continued). Hourly wage as a function of level of automatability

Workers ages 25-65

	Model 1	Model 2
Occupation dummies	no	yes
Constant	2.799***	3.868***
	(-0.186)	(-0.172)
R^2	0.287	0.564
No of observations	2,023	2,023

Note: Results from OLS regression. Robust standard errors in parentheses.
Significant at: *p<0.05; **p<0.01; ***p<0.001.
Source: Shavit Madhala, Taub Center | Data: OECD, PIAAC, 2012; 2015