Occupations at Risk: Computerization Trends in the Israeli Labor Market

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Abstract

In the past few years, there has been a rapid process of technological developments that is changing the face of the world of work. These changes raise several questions: what will the labor market look like in the future? Which occupations will disappear and which remain essential? What are the skills and aptitudes that will be required to succeed in the new labor market? This chapter maps out the risks faced by occupations in Israel from a process in which computerization will replace manpower; it is based on a similar mapping of the US labor market. Results indicate that workers who supply about 40 percent of the work hours in the Israeli market place are likely to be replaced by computers or machines in the coming two decades. Since the mid-1990s, there has been a decline in the relative share of work hours in such "high risk" occupations. A look at those occupations at high risk shows that they are characterized by requiring low levels of education and low wages and many of them employ non-Jewish men or young workers. These findings emphasize the need to prepare in advance for the expected changes in order to prevent a situation where willing labor market participants are forced out due to a lack of the required skills or aptitude. This preparation may require several steps, including widening the use of vocational training and targeting it to match the relevant characteristics of the workers in high-risk occupations while monitoring the needs of the future labor market.

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Introduction

The labor market is a dynamic market, one exposed to an array of influences, including technological developments, globalization and changing consumer preferences. Trends and changes in the labor force have been extensively discussed in the research literature. Goos, Manning and Salomons (2010) studied the employment structure of 16 European countries between 1993 and 2006, and determined that the employment share of prestigious occupations such as management and skilled work, as well as of low-wage personal care occupations, increased at the expense of production line and clerical jobs characterized by repetitive tasks performed according to a fixed routine. The authors conclude that declining employment in routine task jobs performed by workers of mid-range skill level is the main driver of polarization in the distribution of employment.

Kimhi and Shraberman (2014) found a similar phenomenon in the Israeli labor market. Between 1997 and 2011, workers in the central portion of the wage distribution were potentially adversely affected by changes in the labor market, due to decreases in both wages and work hours relative to workers at either end of the distribution.

Autor and Dorn (2013), who surveyed the American labor market from 1980 to 2005, determined that local labor markets characterized by routine task occupations had gradually adopted technologies to replace workers for these tasks.[1] Their study also finds polarizations within these markets in wages and employment rates of workers at different wage levels, as well as an increase in the employment of both high-skilled and low-skilled workers. Moreover, the authors find that increased employment rates and wages of low-skilled workers are mainly concentrated in a single broad occupational category – the service industry – and that this sphere expanded when wages declined in the routine task occupations, causing low-skilled workers to move into the service sector.

[1] For purposes of this chapter, routine tasks are defined as tasks for which automation has become possible and feasible in recent decades.

Computerization has been prevalent in the Israeli labor market for a long time: Israel Railways has replaced cashiers with an automated ticketing system; bank tellers are being increasingly supplanted by automated banking services, etc. (Varon, 2015; Frenkel, 2015). The labor market's dynamism and the changes taking place within it have given rise to uncertainty about its future: Which occupations will be replaced by technology, and which will continue to require human presence? What will be the labor market's leading occupations and what skills and capabilities will the market require?

This chapter aims to identify the trends and changes that can be expected for the future labor market vis-à-vis today's labor market and, in so doing, to offer a means of preparing in advance for these changes.

1. Likelihood of an Occupation's Computerization

Frey and Osborne (2013) developed a broad-based methodology for classifying occupations by the likelihood of their becoming computerized. The methodology was devised so that the computerization probability of occupations over the coming decade or two could be estimated, and along with it the likelihood of workers being replaced by automated technologies. The methodology is based on research in the field of labor economics, and especially findings on the historical impact of computerization on the labor market's occupational composition (Autor, Levy and Murnane, 2003; Goos et al., 2007; Autor and Dorn, 2013). The methodology was implemented using the O*NET occupational database for 2010.[2] This database contains detailed information on all occupations and on the

[2] O*NET was developed for the U.S. Department of Labor, and is a major source of American employment information. At the heart of the system is a database containing extensive information on hundreds of occupations and their attributes. The information is continually updated through surveys of workers in the various occupations and of relevant experts, so that the occupations' growth over time can be tracked.

abilities, skills, knowledge, and tasks they entail. Using the Frey and Osborne (2013) model, the probability of an occupation becoming computerized is a function of the kinds of tasks it is comprised of, which are assessed using measures of creative and social intelligence, perception complexity and manipulation, e.g., persuasion or negotiation. Using a model based on these parameters, the probability of a given occupation becoming computerized over the next two decades is rated using on a scale of 0 to 1: an occupation rated 1 is certain to be computerized within the next decade or two, and an occupation rated 0 will certainly not be computerized in the near future.

The model's analysis results, which relate to data for 2010 in the US labor market, show that 47 percent of those currently employed fall into the category of high computerization risk (probability greater than 0.7), 19 percent into the medium risk category (probability of 0.3-0.7), and 33 percent into the low risk category (probability lower than 0.3).

In this chapter a similar assessment was performed for the Israeli labor market based on the Frey and Osborne (2013) model. Israeli occupations were mapped in a comparable manner, and each individual occupation's risk of computerization was calculated in terms of the aforementioned criteria. Accordingly, Israeli workers were divided into 3 groups: high risk – occupations with a computerization probability of over 0.7; medium risk – occupations with a computerization probability of 0.3 to 0.7; and low risk – occupations with a computerization risk below 0.3.

This model is based on an assumption that occupations rated as at-risk according to Frey and Osborne's (2013) model will actually become automated within a decade or two at the level posited by the model. It is also important to consider that computer and machine capabilities are continually improving, making it safe to assume that even non-routine tasks, those that require creativity and emotional-social intelligence, may one day be easily performed by computers and machines. As an example, ten years ago, Autor et al. (2003) classified car navigation systems as a non-automatic task, while today computerized and automated navigation systems exist.

Another reservation worth noting is that the model's adaptation to the Israeli market conditions and the analysis that follows do not make allowances for unforeseeable changes, such as the removal of import barriers or changes to quotas or the production mix. These types of changes could affect the demand for certain occupations, or cause changes in certain sectors – and thereby affect the need for employees in those sectors. The Israeli textile industry underwent a change of this kind: the easing of import restrictions on textile products dealt it a fatal blow. Due to these kinds of occurrences, occupations that are expected to disappear from the labor market may not actually disappear but could potentially grow.

2. *Mapping Israel's Labor Market*

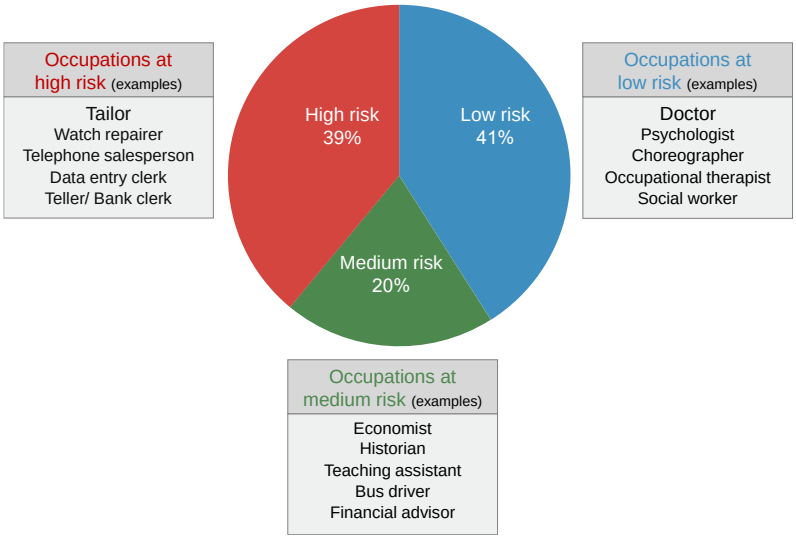
Figure 1 presents the work hours distribution of employees ages 25-64 in 2011 in Israel, according to the computerization probability definitions and risk group classifications noted above.[3] The figure shows that 39 percent of work hours are in occupations characterized by a high degree of computerization risk, 20 percent in medium risk occupations, and 41 percent in low risk occupations. Similar results are obtained when the distribution of employees are examined. This translates into a million Israeli workers in this age group who fall into the high-computerization-risk category. A similar number of workers are in the low risk category, while half a million are in the medium risk category. Figure 1 offers several examples of occupations in each of the risk categories.

[3] 2011 is the last year for which relevant data are available.

Figure 1

Distribution of work hours by occupation risk of computerization*

workers aged 25-64, 2011



* Occupation risk level is based on Frey and Osborne (2013)

Source: Shavit Madhala-Brik, Taub Center for Social Policy Studies in Israel
Data: Central Bureau of Statistics, *Labor Force Survey*

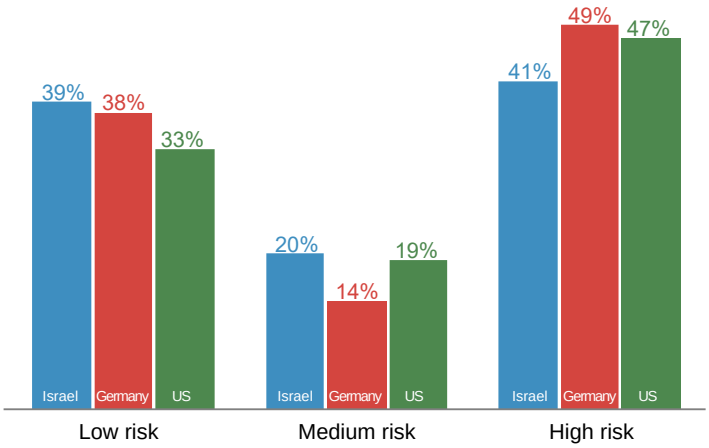
Figure 2 compares the distribution of employees in the labor market according to the three risk levels in Israel, Germany and the United States (the countries for which information is available in sufficient detail to conduct such a comparison). Overall, the 2010 data (the last year for which relevant data were available) show that the Israeli labor market distribution is similar to those in Germany and the US. This supports the assumption that a global or even a natural process is at play, one that may be expected to take place in all countries where new technologies are adopted. Alongside the similarity, there are a number of differences between Israel and the other two countries. In particular, a relatively large share of

employees in the Israeli labor market are engaged in occupations rated low risk for computerization, with a relatively small share, compared with the other countries, falling into the high risk category. This difference stems from structural differences in the markets and in the relevant industries.

Figure 2

Distribution of workers by occupation risk of computerization*

Israel, Germany and US, 2010



* Occupation risk level is based on Frey and Osborne (2013)

Source: Shavit Madhala-Brik, Taub Center for Social Policy Studies in Israel
Data: Central Bureau of Statistics; Luxembourg Income Study

A picture of the characteristics of occupations at high risk of computerization may be found in Figure 3, which presents the distribution of work hours for workers in these occupations, according to the Central Bureau of Statistics' occupational classification.[4] The occupation that stands out in this group is that of clerical work – 34 percent of all work hours in the high risk occupation group – despite the fact that the share of all forms of clerical work in the economy's total work hours is 15 percent. This occupation has a high percentage of female employees – 73 percent of all work hours – and few employees with academic degrees. The share of male academic degree holders in the occupation's total work hours is only 8 percent.

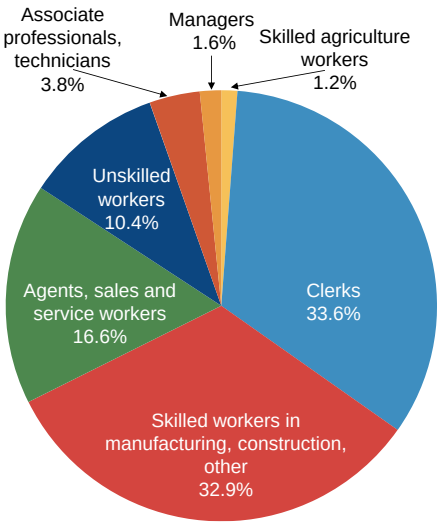
By contrast, the share of at-risk workers in the manager and associate professional/technician groups, which account for 9 percent and 15 percent respectively of the economy's total work hours, is very low – 1 percent and 4 percent out of the total work hours for workers in at risk jobs, respectively. The main reason for this is that these occupational groups encompass jobs that require a high degree of emotional intelligence and creativity. At the medium risk level as well, the relative share of the managerial occupations is 1 percent, and most managerial jobs are classified as "safe" with just a few managerial jobs, such as those in the supply sphere, at higher risk of computerization. Among academic professionals, no workers were found in occupations denoted as high risk.

[4] See the Central Bureau of Statistics occupational classification system in the Appendix.

Figure 3

Distribution of work hours for workers in occupations at high risk of computerization*

by occupation group, workers aged 25-64, 2011



* Occupation risk level is based on Frey and Osborne (2013)

Source: Shavit Madhala-Brik, Taub Center for Social Policy Studies in Israel
Data: Central Bureau of Statistics, *Labor Force Survey*

3. *The Effect of Worker Characteristics on Computerization Risk*

In order to characterize employees in the various risk groups, four areas were examined: education, hourly wages, gender, and sector. The relationship between these characteristics and occupational computerization probability was examined as well.

Education

Kimhi (2012) found a link between education level and exclusion from the labor market for Israeli males: the older they are, the more the less-educated among them tend to drop out of the labor market. Frey and Osborne (2013) found a close relationship between worker education in a given occupation and the probability of that occupation becoming computerized: occupations in which employees are less educated were found to be at higher risk. Figure 4 presents the correlation between percentage of academic degree holders in an occupation and the probability of that occupation becoming computerized.[5] As with the findings of Frey and Osborne (2013), an inverse relation was found between education and computerization probability: the higher the probability of an occupation being automated, the lower the share of academic degree holders among those employed in it. Nevertheless, in contrast to this trend, which is consistent through most of the distribution, there are two anomalies in the figure. The first is an increase in the share of academic employees in occupations classified as being at the highest risk for computerization (0.96-1). This jump occurred because the occupation group includes such jobs as insurance agent, secretary, bookkeeper, bank teller, and credit clerk – many of which are manned by academic degree holders. The second deviation is a decline in the rate of academics employed in occupations with a low risk rating. This decrease is due to the fact that there are some low risk occupations with only a few workers with higher education working in them (see details that follow).

Except for these occupations, the conclusion is that jobs whose computerization risk is great are ones that require less higher education. These findings are consistent with a 2013 occupational forecast of the US Bureau of Labor Statistics (Bureau of Labor Statistics, 2013), which states that occupations requiring higher education are expected, on average, to

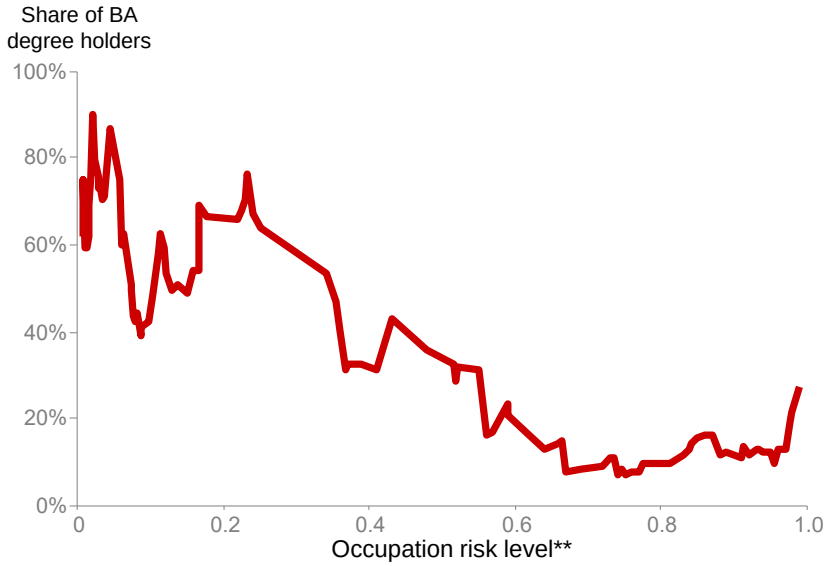
[5] Academic degree holders, for purposes of this chapter, are defined as people with at least 15 years of schooling, for whom the last institution at which they studied was an academic one.

grow more rapidly than those that do not demand post-secondary education.

Figure 4

Share of BA degree holders in occupations at high risk of computerization*

out of all workers in occupations at all risk levels, workers aged 25-64, 2011



* Moving average

** Occupation risk level is based on Frey and Osborne (2013)

Source: Shavit Madhala-Brik, Taub Center for Social Policy Studies in Israel
Data: Central Bureau of Statistics, *Labor Force Surveys*

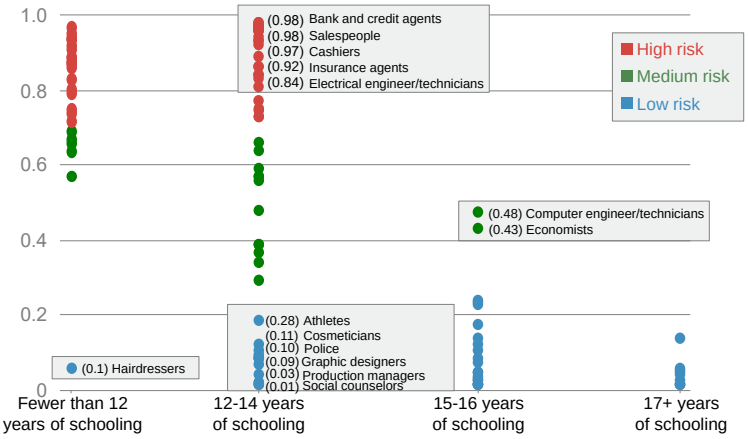
Figure 5 also shows the inverse relationship between education level and computerization probability, by breaking down occupations by the average number of years of schooling of those employed in them (each dot on the figure represents an occupation). As may be seen, occupations at high risk are located in the two groups with the smallest number of years

of schooling. In the 15-16 years of schooling group, most of the occupations are low risk, while in the 17 years and over group, all of the occupations are low risk. Even in this figure, there are exceptions: jobs such as hairdresser, athlete, cosmetician, and police officer are held by people with relatively few years of schooling, yet are at low risk of computerization. There are also occupations, such as economist, computer engineer and computer technician, that are at medium risk of computerization, even though they require many years of schooling.

Figure 5

Occupation by risk of computerization* and number of years of schooling**

workers ages 25-64, 2011



* Occupation risk level is based on Frey and Osborne (2013)

** Average number of years of schooling for all employed people in the occupation group

Source: Shavit Madhala-Brik, Taub Center for Social Policy Studies in Israel

Data: Central Bureau of Statistics, *Labor Force Survey*; Frey and Osborne (2013)

Wages

Another interesting link is between wage and computerization probability. Frey and Osborne (2013) found an inverse relationship between an occupations' wages and its likelihood of being computerized. Figure 6 presents the same correlation by average hourly wage of salaried employees in the Israeli economy. As with the education variable, hourly wage is also negatively correlated with computerization probability in Israel. The figure shows that the link is most evident in the higher computerization probabilities – from 0.4 on. The positive relationship between education and wage is clear and well-known, making the emergence of an indirect relationship between hourly wage and probability of computerization unsurprising. However, there are deviations from this trend at both ends of the wage distribution: on the one hand there are occupations at low risk of computerization whose average hourly wage is low, e.g., clergy, teachers (primary and pre-primary) and security workers (police officers and firefighters). On the other hand, there are occupations at high risk of computerization with high average wages relative to the other high risk jobs – auditors, bookkeepers and postal clerks.

Figure 6

Average wage per work hour* by occupation risk of computerization**

workers aged 25-64, 2011

* Moving average

** Occupation risk level is based on Frey and Osborne (2013)

Source: Shavit Madhala-Brik, Taub Center for Social Policy Studies in Israel
Data: Central Bureau of Statistics, *Income Surveys*

Gender and Sector

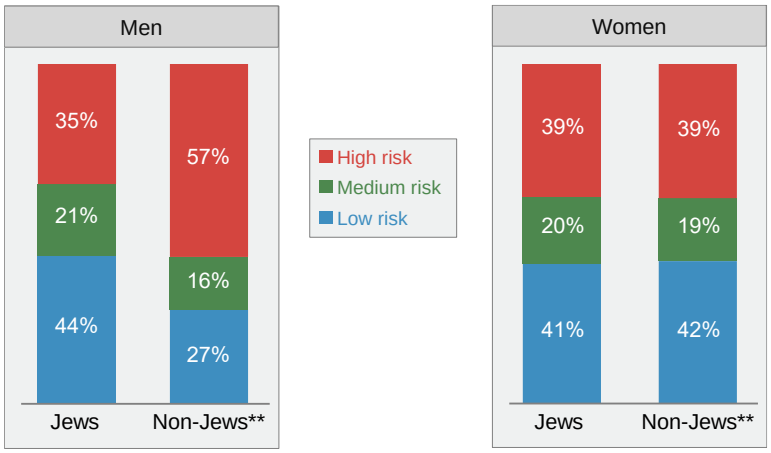
The distribution of work hours in the economy by computerization risk level broken down by gender and sector is presented in Figure 7. Non-Jewish males stand out for their high representation in high risk occupations. They are followed by women – both Jewish and non-Jewish – with similar distributions, with Jewish men at the lower end of the scale, demonstrating a relatively low rate of employment in occupations with high computerization risk. The sector variable does not seem to be meaningful in the work hours distribution by risk level for women. For men, though, the difference between Jews and non-Jews is clearly visible

in the distribution, and is due to the differing occupations in which the members of each sector are employed.

Figure 7

Distribution of work hours by occupation risk of computerization*

by gender and ethnic group, workers aged 25-64, 2011



* Occupation risk level is based on Frey and Osborne (2013)

** Muslims, Christians, Druze, and others

Source: Shavit Madhala-Brik, Taub Center for Social Policy Studies in Israel

Data: Central Bureau of Statistics, *Labor Force Surveys*

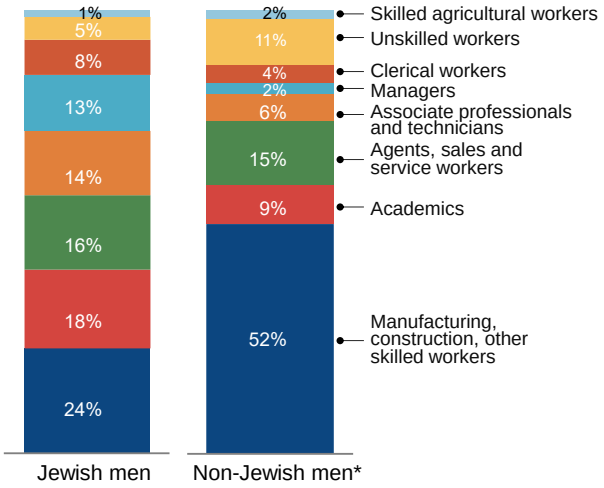
This is demonstrated in Figure 8 which focuses on the distribution of work hours among non-Jewish men by occupation. Over 50 percent of this group's work hours are in skilled jobs in industry, construction and other sectors – a particularly high percentage compared with the work hours of Jewish men in those same occupations. These professions are characterized by a proliferation of occupations that are considered at high risk of computerization. A review of the occupations with high employment of non-Jewish men shows that many of these jobs are as construction workers, drivers, tinsmiths, welders, metalworkers, and mechanics. Fuchs (2015)

shows that there is a decline in the employment rate of young Arab Israeli men (ages 18-34) between 1995 and 2011. This decline is at least partly explained as the first signs of the effect of technological changes on the main employment areas for this population.

Figure 8

Distribution of work hours of men by occupation group

by ethnic group, aged 25-64, 2011



* Muslims, Christians, Druze, and others

Source: Shavit Madhala-Brik, Taub Center for Social Policy Studies in Israel
Data: Central Bureau of Statistics, *Labor Force Survey*

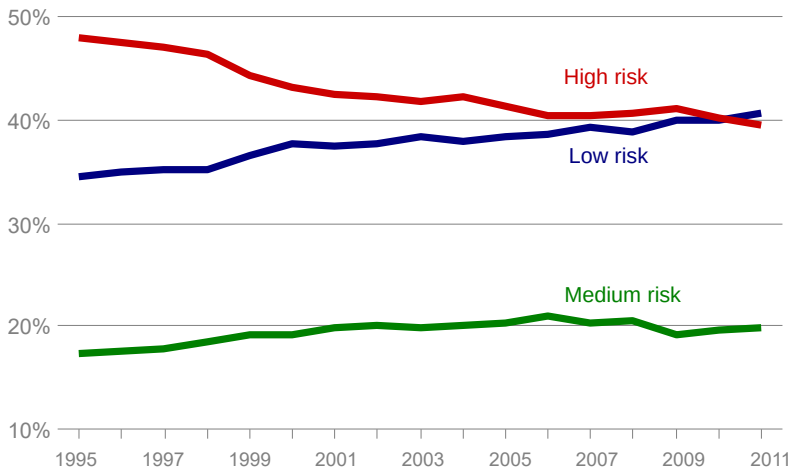
4. Employment Trends by Computerization Risk Level: 1995-2011

After examining current computerization risk levels, this section looks at developments in this area over time. A review of Israeli labor market trends from 1995 to 2011, presented in Figure 9, reveals that the relative share of occupations rated high risk for computerization in the work hour total has declined over the years, along with a rise in the relative share of occupations rated low risk. This trend indicates that a drop in the relative share of occupations considered to be at high risk of computerization is an ongoing process that has been underway for the past two decades.

Figure 9

Distribution of work hours by occupation risk of computerization,* 1995-2011

workers ages 25-64



* Occupation risk level is based on Frey and Osborne (2013)

Source: Shavit Madhala-Brik, Taub Center for Social Policy Studies in Israel
Data: Central Bureau of Statistics, *Labor Force Surveys*

Table 1 presents the employment characteristics of the main occupations rated as high risk for computerization.[6] The picture obtained is one in which the total employment share of most of these occupations declined between 1995 and 2011. These data also reflect the negative correlation observed between education and occupation computerization risk (Figure 3). Apart from insurance agents, bank tellers and credit clerks, 46 percent of whom hold academic degrees, the percentage of academic degree holders among all those employed in the major high risk of computerization fields is low.

[6] Occupations characterized by a relatively high rate of labor market participation and ranked as high risk for computerization.

Table 1. **Main occupations at high risk of computerization***

Occupation	Relative share of labor force, 2011 (%)	Relative share of labor force, 1995 (%)	Rate of change, 1995-2011 (%)	Share of workers in the occupation with an academic degree (%)	Weekly work hours (average)
Salespeople/shop assistants	4.80	5.62	-15	12	38
Drivers (private, taxi, commercial, truck)	3.16	3.54	-11	4	45
Secretaries	2.55	2.82	-9	20	34
Metal workers (welders, blacksmiths, tinsmiths)	2.22	3.61	-38	10	45
Bookkeepers	2.09	2.03	3	24	37
Stock keepers**	1.29	1.23	5	16	42
Bank clerks and credit agents	0.82	1.01	-19	47	39
Woodworkers/ carpenters	0.70	1.30	-43	7	43
Cashiers	0.67	0.63	6	14	34
Insurance agents	0.37	0.38	-3	46	41

* Occupation risk level is based on Frey and Osborne (2013)

** Although stock keepers are ranked at a risk level of 0.64, which is on the borderline of high risk, they appear here because of their relative high share in the labor force.

Source: Shavit Madhala-Brik, Taub Center for Social Policy Studies in Israel

Data: Central Bureau of Statistics, *Labor Force Surveys*

Table 2 presents the main occupations rated as low risk for computerization and their attributes.[7] In contrast to the list of major high computerization risk jobs, the list in Table 2 is characterized by high rates of workers with higher education. The change rate in employment for most of these occupations is positive, and even in those where a decline in the employment rate is seen, the decline is relatively small except for medicine, which showed a 24 percent drop in relative employment share, though this appears to be unrelated to computerization).

[7] Jobs characterized by a relatively high rate of labor market participation that are rated low for computerization risk.

Table 2. **Main occupations at low risk of computerization***

Occupation	Relative share of labor force, 2011 (%)	Relative share of labor force, 1995 (%)	Rate of change, 1995-2011 (%)	Share of workers in the occupation with an academic degree (%)	Weekly work hours (average)
Architects/engineers**	3.41	2.62	30	96	44
Primary school, special education teachers and others	2.87	2.34	23	66	30
Security workers (police, detectives, firefighters)	2.22	1.65	34	24	41
Company directors and private sector CEOs	1.82	1.71	6	56	47
Systems analysts and academic professionals in computer sciences	1.77	0.69	158	91	44
Secondary school teachers	1.46	1.51	-3	90	30
Certified nurses	1.13	1.01	11	67	37
Physicians	0.95	1.24	-24	100	45
Preschool teachers	0.84	0.57	48	48	32
Lecturers in higher education institutions	0.60	0.47	27	97	31

* Occupation risk level is based on Frey and Osborne (2013)

** Engineers are not included in the computer science group

Source: Shavit Madhala-Brik, Taub Center for Social Policy Studies in Israel

Data: Central Bureau of Statistics, *Labor Force Surveys*

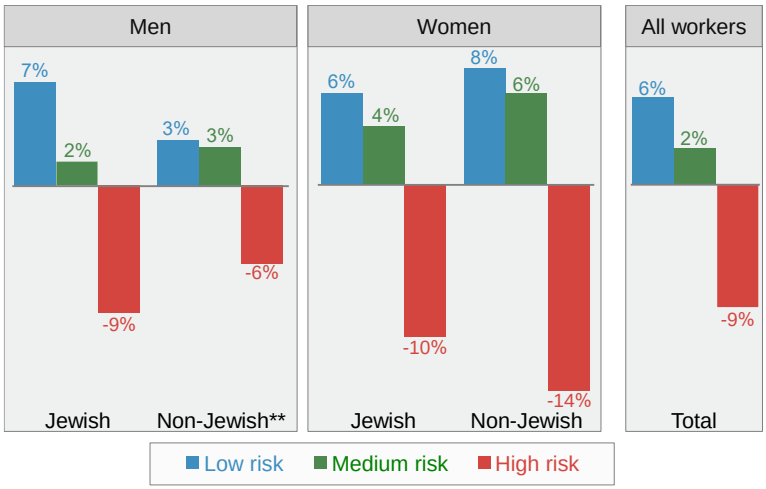
Developments in the Labor Market by Level of Computerization Risk and Worker Characteristics

Figure 10 presents the changes in the relative share of work hours of different types of worker between 1995 and 2011 by level of computerization risk and broken down by gender and sector. The figure shows a trend toward switching from employment in high risk occupations to employment in low and medium risk occupations, for both women and men. However, women – especially non-Jewish women – showed a steeper decline in the relative share of work hours in high computerization risk occupations. For Jewish men, most of the increase was found in jobs at low risk of being computerized.

Figure 10

Changes in the relative portion in work hours, 2011 compared to 1995

by ethnic group, gender and occupation risk of computerization,* workers ages 25-64



* Occupation risk level is based on Frey and Osborne (2013)

** Muslims, Christians, Druze, and others

Source: Shavit Madhala-Brik, Taub Center for Social Policy Studies in Israel

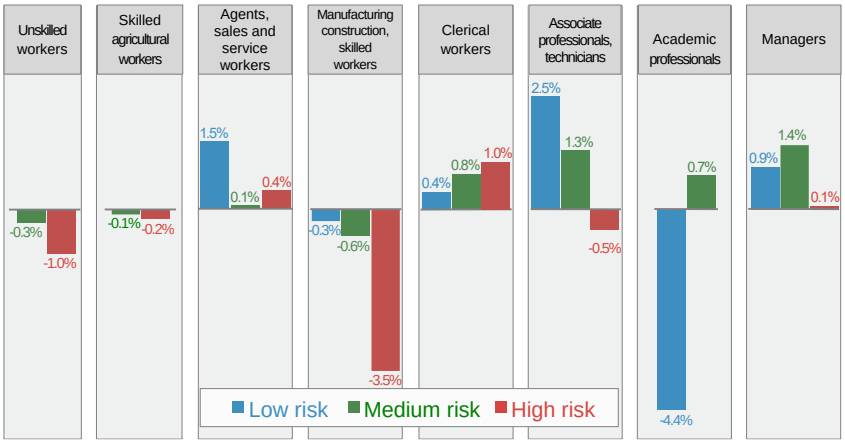
Data: Central Bureau of Statistics, *Labor Force Surveys*

Figures 11A and 11B present the change in relative share of work hours among employed persons with and without academic degrees, respectively, from 1995 to 2011. Academic degree holders appear to have transitioned from employment in jobs belonging to skilled and unskilled occupations, especially those rated as high risk, to employment in the associate professional/technician, management, and clerical occupations – particularly those fields rated as low and medium risk for computerization. The rise in work hours among academic degree holders occurred mainly in the fields of primary and pre-primary school teaching, laboratory technician/nursing, senior management, computer engineering, engineering and architecture. In the figure, the declining relative share of low risk of computerization jobs among academic occupations stands out. An examination of changes in work hours for jobs in this occupational group found that most of the decline can be explained by a drop in the relative share of physicians.

Figure 11A

Change in the relative portion of work hours of employed academic degree holders,* 2011 versus 1995

as percent of all work hours of academic degree holders, by occupation and occupation risk of computerization,** workers ages 25-64



* Occupations are arranged from left to right in order of ascending wage per work hour in 2011 prices

** Occupation risk level is based on Frey and Osborne (2013)

Source: Shavit Madhala-Brik, Taub Center for Social Policy Studies in Israel

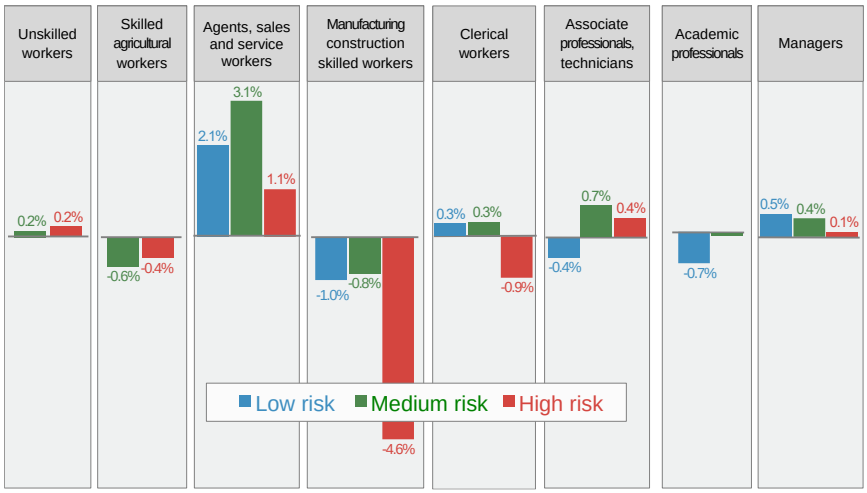
Data: Central Bureau of Statistics, *Labor Force Surveys*

Figure 11B shows that, as with the trends found in the American labor market (Autor and Dorn, 2013), the rise of service occupations in the Israeli labor market has been especially great among non-academic degree holders, and particularly for service jobs rated at medium risk for computerization.

Figure 11B

Change in the relative portion of work hours of employed workers without academic degrees,* 2011 versus 1995

as percent of all work hours of workers without academic degrees, by occupation and occupation risk of computerization,** workers ages 25-64



* Occupations are arranged from left to right in order of ascending wage per work hour in 2011 prices

** Occupation risk level is based on Frey and Osborne (2013)

Source: Shavit Madhala-Brik, Taub Center for Social Policy Studies in Israel

Data: Central Bureau of Statistics, *Labor Force Surveys*

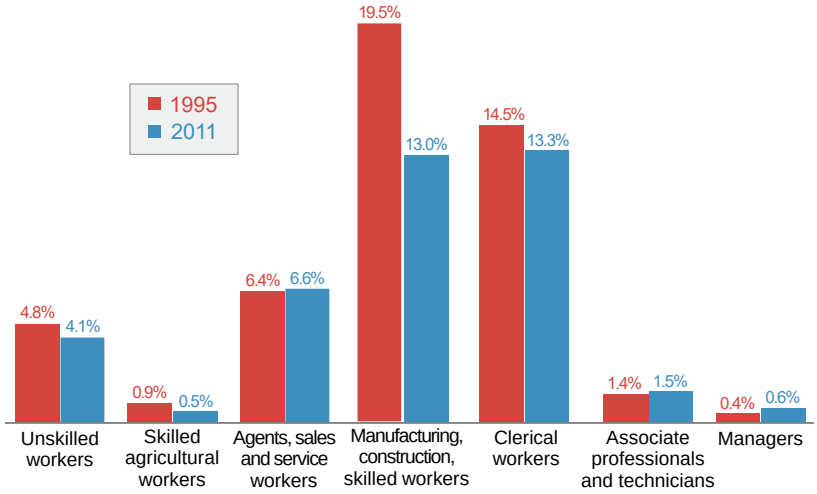
The two figures highlight the decline in the relative share of jobs belonging to the skilled workers in industry, construction and other skilled workers group. This decline is also seen in jobs not considered to be at high risk of computerization, such as foremen in the machinery and mechanic field.

Figure 12 presents the distribution of work hours in jobs at high risk of computerization as a share of all work hours in the economy. It can be seen that many work hours are concentrated in the category of skilled workers in industry, construction and other skilled workers, and in clerical jobs. By contrast, in the associate professional/technician occupations and among managers and skilled agricultural workers, the figures are low to nonexistent. It should be noted that skilled agricultural workers' share in the economy's total work hours, at all computerization risk levels, is low, amounting to about 1 percent.

Figure 12

Distribution of work hours in occupations at high risk of computerization*

by occupation group,** as percent of all work hours, workers aged 25-64



* Occupation risk level is based on Frey and Osborne (2013)

** Occupations are arranged from left to right in order of ascending wage per work hour in 2011 prices

Source: Shavit Madhala-Brik, Taub Center for Social Policy Studies in Israel

Data: Central Bureau of Statistics, *Labor Force Surveys*

Regarding the changes in work hour distribution that took place between 1995 and 2011, most of the decline occurred in the category of skilled workers in industry, construction and other skilled workers. An in-depth look at work hour rates in high computerization risk in this category shows an especially sharp decline among tinsmiths, welders and metalworkers, as well as floorers, painters/whitewashers and tailors. A small decline was also seen in clerical jobs. In occupations characterized by a low concentration of work hours on the part of workers at high risk, like managers, the changes are very small.

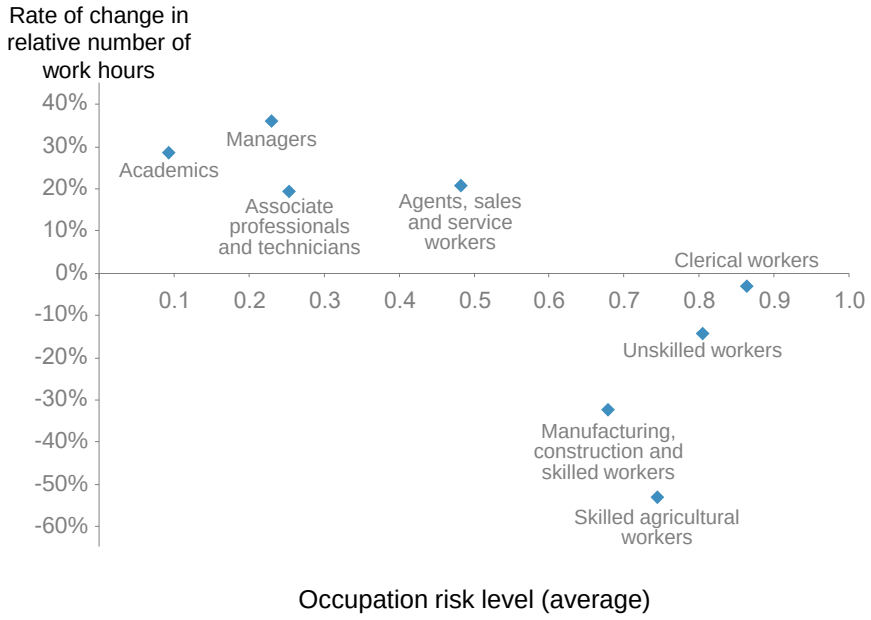
Figure 13 shows the relationship between the change in employment by occupation over the past few years and the average probability of computerization. The figure shows the change in each occupation's relative share of the total work hours, by the average computerization probability for each occupation (from 0 to 1). Academic degree holders, managers and associate professionals/technicians – fields characterized by few workers in high computerization risk jobs – appear to exhibit the largest employment increase from 1995 to 2011. Clerical work, an occupation characterized by high computerization risk, shows a relatively small decline in its share of total work hours in the labor market. It is interesting that occupations characterized by an average (medium to high) degree of risk show a decline in their relative employment share, while occupations with a high degree of risk actually exhibit quite small changes in their relative share of work hours. It should be remembered that each occupation carries a different weight in the labor market, meaning that the trends described here do not contradict the change trends by computerization risk level in the labor market as a whole (Figure 9). For agents and sales/service workers, a rise in the relative share of work hours is found. Regarding the occupation's internal distribution, a decline in the relative share of jobs belonging to the sales area is found and, by contrast, there is a rise in the relative share of jobs in the service sphere.

Figure 13 combined with the findings of Figures 11A and 11B leads to a conclusion similar to that indicated by Figure: the period 1995 to 2011 saw a transition to occupations whose computerization risk is medium or low – service jobs, associate professional/technician occupations, management and academic professions.

Figure 13

Change in relative share of occupations out of all work hours, 2011 compared to 1995

by occupation risk of computerization,* workers aged 25-64



* Occupation risk level is based on Frey and Osborne (2013)

Source: Shavit Madhala-Brik, Taub Center for Social Policy Studies in Israel
Data: Central Bureau of Statistics, *Labor Force Surveys*

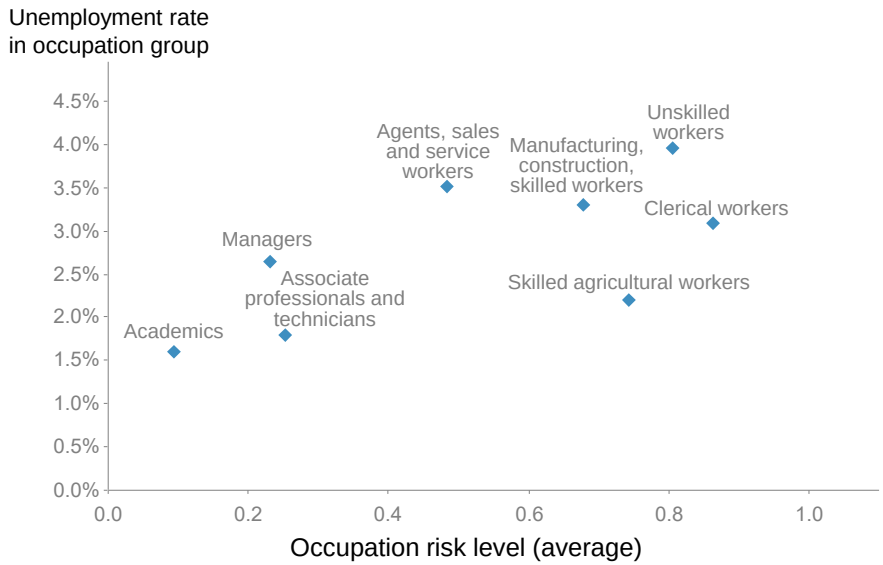
Unemployed Individuals

The data for unemployed individuals supplements the picture of the status of employed persons in the labor market.[8] Figure 14 shows the share of unemployed individuals in the various occupations by average probability of computerization. Like the trends observed for employed persons, the percent of unemployed individuals is relatively high in occupations with a high average computerization probability, especially among unskilled workers and skilled workers in the industry, construction and other skilled workers category. The opposite is also seen: few unemployed people belong to occupations whose average probability of computerization is low.

Figure 14

Unemployment rate by average occupation risk of computerization*

in occupation groups, workers aged 25-64, 2010-2011



* Occupation risk level is based on Frey and Osborne (2013)

Source: Shavit Madhala-Brik, Taub Center for Social Policy Studies in Israel

Data: Central Bureau of Statistics, *Labor Force Surveys*

[8] "Unemployed" is defined as people actively seeking work who have worked during the past 12 months.

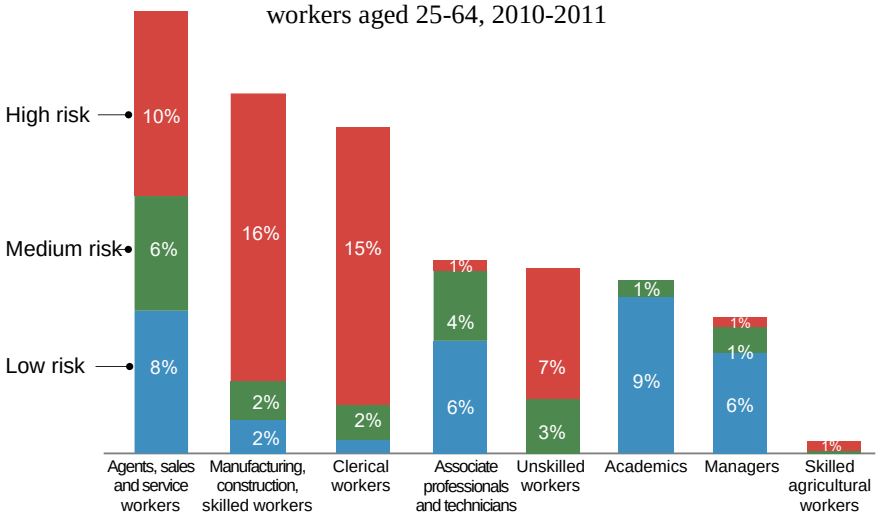
A look at the kinds of work in which unemployed individuals are engaged in shows that 50 percent belong to occupations at high risk for computerization. To obtain an in-depth picture of this group's occupational composition, Figure 15 presents the distribution of unemployed individuals across the various occupations by computerization risk level. It can be seen that among those who were in unskilled work, as well as clerical workers and skilled workers in industry, a large proportion of the unemployed belong to occupations rated as at high risk for computerization.

Regarding unemployed persons who have given up looking for work from 2010 to 2011 31 percent stated that the reason they abandoned their job search was that no work existed in their occupation. A look at these individuals' occupations indicates that, during this period, 60 percent of these individuals belonged to occupations rated as at high risk for computerization. This finding constitutes a warning sign for people engaged in high risk occupations: they could ultimately find themselves unemployed despite their wish to remain in the labor force.

Figure 15

Distribution of unemployed individuals

by occupation risk of computerization* and occupation group, workers aged 25-64, 2010-2011



* Occupation risk level is based on Frey and Osborne (2013)

Source: Shavit Madhala-Brik, Taub Center for Social Policy Studies in Israel
Data: Central Bureau of Statistics, *Labor Force Surveys*

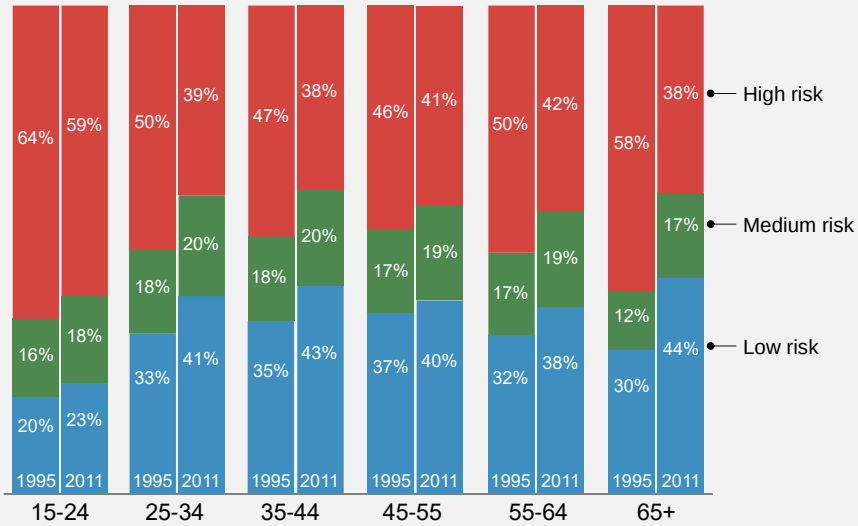
Spotlight: *Employment Characteristics by Age Groups*

A look at the distribution of work hours by computerization risk and by age group (Figure 16) reveals that in the youngest age group (15-24) a substantial proportion of work hours is supplied by workers in high computerization risk occupations. This is not surprising, given that employed persons in this age range have generally not yet embarked on their career path and for the most part may work at temporary jobs that do not require education or training.

Figure 16

Distribution of work hours by age group and occupation risk of computerization*

1995 and 2011



* Occupation risk level is based on Frey and Osborne (2013)

Source: Shavit Madhala-Brik, Taub Center for Social Policy Studies in Israel

Data: Central Bureau of Statistics, *Labor Force Surveys*

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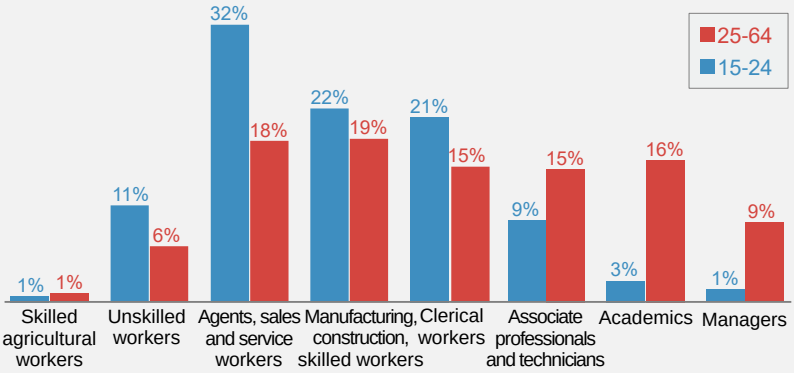
Moreover, compared with employed persons in the other age groups, those in the 15-24-year-old age group exhibit the smallest decline (5 percent) in the share of work hours in occupations at high risk of computerization. By contrast, the largest decline in share of work hours in high computerization risk occupations was found among those aged 65 and over – 19 percent, compared with more moderate declines of 5-10 percent in the other age groups. The decline among those aged 65 and over is reflected primarily in sales, tailoring, accounting, and cashier jobs. A similar distribution is found when employee numbers are looked at.

According to 2011 data, employed persons aged 15-24 account for 8 percent of work hours in the Israeli economy. About 30 percent of work hours in this age group are in agent, sales and service occupations – a relatively high percent compared with that of the prime working age range (Figure 17).

Figure 17

Distribution of work hours by occupation* and age group, 2011



* Occupation are arranged from left to right in ascending order of wage per work hour in 2011 prices

Source: Shavit Madhala-Brik, Taub Center for Social Policy Studies in Israel
Data: Central Bureau of Statistics, *Labor Force Surveys*

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Overall, it appears that occupations considered to be high wage have a low proportion of young employees, as these occupations require education, skills and experience. By contrast, occupations in the skilled workers in industry, construction and other skilled workers category exhibit a relatively high proportion of young employees – despite the fact that these jobs generally require training and job-specific skills. A closer look at the young people working in skilled industry jobs shows that most are employed in positions at high risk for computerization, especially metalworkers, electrician/electronics workers, auto mechanics, and truck drivers.

The high computerization risk jobs in which workers aged 15-24 are employed are mainly sales and office jobs, wait staff jobs, and shop assistant/department store jobs. The main areas that employ people in this age group and that are not at high risk of computerization are childcare, computer technician and technical agent jobs, and security.[9]

5. *Implications and Recommendations*

The data presented here point to a feasible scenario in which, within the span of two decades, employed persons who currently supply 40 percent of work hours in the Israeli economy will be replaced by computers and automated devices. The current trend, which is expected to continue, indicates a transition from routine-task occupations at high risk of computerization to occupations whose computerization risk is moderate or low. Additionally, there are jobs which, though their definitions may remain the same, will nevertheless change radically in terms of the nature

[9] For a more detailed discussion of young adult employment in Israel, see Fuchs (2015).

of the work and the skills that those doing the work will be expected to have.

Beyond the obvious impact of anticipated changes in the labor market – the likelihood that many of those employed today will find themselves in occupations destined to disappear or due to change drastically – it must be acknowledged that the unemployment risk will affect those belonging to the most vulnerable groups in Israeli society. As shown in this study, worker attributes such as lack of academic education and low wage, as well as non-Jewish status (for males) and young age (15-24), are strongly correlated with occupations at high risk of computerization. The needs of these worker populations should therefore be addressed in advance, so that a lack of skills and abilities required by the new labor market will not doom them to unemployment.

Vocational Training Tailored to Existing Needs

A policy tool that can be used to address and prepare for anticipated labor market changes is vocational training. This measure should be tailored to the needs of those who are forced out of the labor market due to technological development, taking into account their occupational background and skills and oriented toward the future labor market – the careers of the future, as well as the attributes and the skills that will be required. Accordingly, the current training programs funded by the state must be examined and assessed as to how well they serve their population, as well as their suitability for the future labor market.

At present the government operates, through the Israeli Employment Service framework, two vocational training tracks: (1) government courses offered by the Ministry of Economy's Manpower Training and Development Bureau; and (2) a voucher system for subsidizing vocational training, in which an unemployed person can choose a desired course and

educational/vocational institution.[10,11] Upon successful completion of the course, the government provides partial funding for participation (Ministry of Economy, 2015). Although these tools could help many unemployed people, Israeli Employment Service data (2014) show that of the half-million jobless citizens who visit the country's employment bureaus each year, fewer than 1 percent are referred to these training frameworks – only 1,649 to the voucher program, and 2,276 to government courses operated through the Manpower Training and Development Bureau (personal communication from the Israeli Employment Service, 2015). This being the case, it would be both appropriate and worthwhile to increase the enrollment of unemployed people in vocational training courses by tens of percentage points.

A comprehensive Israeli Employment Service survey of voucher recipients during the years 2008 to 2013 attempted to identify the main voucher-recipient populations, and to determine whether the courses they took had been useful to them.[12] The survey found that the voucher recipients' median wage was just NIS 4,500, and that most of them were unable to pay for the training on their own.

Survey data regarding the main vocational training courses offered in the voucher framework (Appendix) indicate that the most prevalent jobs for which training is provided include ones rated high risk for computerization, such as bookkeeper, payroll controller and payroll clerk. However, graduates of these courses do appear to be finding work in these fields, as are most of those who complete courses in occupations rated medium risk for computerization. By contrast, most graduates of courses offered in areas classified as low risk for computerization, such as academic

[10] There are other agencies that refer clients to existing training courses. In the present study the focus is on the Israeli Employment Service, as it is the largest service for unemployed Israelis.

[11] Courses that meet specific criteria, and educational institutions from a list of recognized institutions.

[12] The survey encompassed 53 percent of the voucher recipients for the period 2008-2013. A survey response bias was found in favor of stronger populations.

occupations, hairdressing, and management, are not finding work in their fields of study. The fact that graduates of courses in high computerization risk occupations are managing to find their way into the labor market is not surprising, since – it should be recalled – the scenario foreseeing the demise of these occupations is forward looking, referring to a period of ten or twenty years from now. In addition, as noted, structural changes in certain sectors may affect the demand for workers and actually lead to increased employment in these sectors, even if the nature of the work is changing. The real question is why graduates of courses in low-computerization-risk fields are failing to find work. There are several plausible explanations for this: voucher recipients might be unsuited to the occupations for which they are trained; there could be a glut of workers in some of the occupations; and the training provided by the educational institutions offering the courses might be inadequate, which in turn would hurt the course graduates' placement chances.

Another tool that could prove useful in addressing the anticipated changes is that of continuously updating the continuing education programs offered by schools and academic institutions, to ensure that the training provided is in line with technological development in the relevant fields and in the labor market.

In order to facilitate coordination between all of the relevant entities, a government unit should be established to manage this area in an ongoing way. The unit could work together with the training and academic institutions, the schools, the employment authority, and the Israeli army training units, as well as with the National Labor Federation, other labor unions, and employers. The unit would see to coordination and continuous updating of all involved agencies regarding anticipated changes in the labor market.

6. Conclusion

This chapter aims to identify technology driven trends and changes likely to affect Israel's labor market. The importance of these developments lies in their potentially broad and far-reaching consequences for the Israeli economy as a whole.

The chapter provided a glimpse of the current distribution of employment in Israel's labor market in terms of three levels of computerization risk: low (less than 0.3), medium (0.3-0.7), and high (over 0.7). The expected scenario is that employed persons now accounting for 40 percent of work hours in Israel's labor market will be at high risk for replacement by computers and machines over the next two decades. An international comparison shows that the trend discernible in Israel is prevalent in other countries as well, and the share of workers in high computerization risk occupations in the Israeli labor market is even relatively small.

Alongside this finding, it may be expected that some occupations will remain unaffected by technological development. According to Autor and Dorn (2013), though technological development lowers the cost of executing routine, codifiable tasks of the kind that can be performed by computers, it has a marginal impact on the cost of service tasks that require human presence.

It is important to note that, although technological development causes some occupations to disappear from the labor market, it can also be expected to produce new ones. A British-Welsh study found that new technologies had created more jobs over the years than it had eliminated, and that, on the whole, it had led to an increased proportion of workers in caregiver and nursing jobs, at the expense of physical labor jobs (Stewart, Debapratim and Cole, 2015).

It has also been shown in this chapter that the main occupations at high risk of computerization are those that involve routine tasks and manual labor in a fixed procedural framework, such as secretarial work, accounting and insurance agent jobs. By contrast, occupations found to be at low risk of computerization require creativity, persuasiveness and emotional-social

intelligence – e.g., teachers, engineers, security workers, and physicians. Higher education is another widely shared attribute of people employed in low computerization risk occupations, and the reverse is true as well: low education levels are correlated with high computerization risk. High computerization risk also characterizes areas in which young people, non-Jewish men and low wage workers are disproportionately employed. The trends observed for the period 1995 to 2011 are aligned with predictions for declining employment in jobs categorized as high risk for computerization. A decline in the relative share of work hours was found for these occupations, alongside a rise in the relative share of occupations rated medium and low risk for computerization. This increase is due mainly to a shift on the part of employed persons who are not academic degree holders to these occupations – especially to service jobs, which fall into the medium risk category.

The status report and forecast presented in this chapter were supplemented by policy options for addressing the anticipated changes: creating appropriate vocational training frameworks and expanding the use of such frameworks, continually updating study programs in the schools and in academic institutions, and establishing an agency to coordinate activity in this area.

Appendix

Classification of Jobs by Occupation by the Central Bureau of Statistics

The Central Bureau of Statistics developed its *Standard Classification of Occupations, 1994* based on the recommendations of the International Labor Organization, as set forth in the International Standard Classification of Occupations, ISCO-88, and adapted to reflect local Israeli conditions.

"Occupation" as defined in the *Standard Classification of Occupations*: "Occupation includes all the activities the worker actually does at his workplace. However, the level of education required for filling a specific occupation became the main principle for classification. This principle is already expressed in the division of occupations into 'major groups' by descending ranking of educational level. The major group 'Managers' (Major Group 2) is an exception which does not follow the principle of education."

Description of the Contents of the Major Groups

Major Group 0 - Academic Professionals: Academic Professionals who work in life sciences and natural sciences, engineering, computers, medicine, law, humanities and social sciences and education in academic and secondary education institutions. Professionals in this major group deal mainly with conducting research and applying scientific methods to find solutions to various problems in fields listed above. These workers require a high level of education which is usually acquired at universities or at other recognized academic institutions.

Major Group 1 - Associate Professionals and Technicians includes workers who perform tasks of technical assistance in research, in scientific development and in applying scientific knowledge, as assistants to academics in the fields specified in Major Group 0. Also included are associate professionals such as: athletes, designers and religious associate professionals, and those whose occupations are in teaching, medicine and

other fields, which require a post-secondary school education but not an academic one.

Major Group 2 - Managers includes workers who participate in determining policy, laws, regulations, decision making on a governmental or non-governmental plane, in managing and organizing factories and institutions and in carrying out policies that have been decided upon. This order is not related to level of education […] In this major group a distinction has been made between a manager whose position is mainly administrative, who is classified in this major group, and a manager whose work is mainly in the field of his specialization and is classified in the appropriate major group (for example - a manager of a medical division in a hospital will be classified among doctors).

Major Group 3 - Clerical Workers includes occupations whose main tasks are filing, storing material, calculations and supplying information. The workers perform secretarial work, type, operate office machinery and perform clerical tasks connected to mail services, handling money and managing meeting schedules. This major group also includes clerks who supervise these workers. These are supervisory clerks equal in authority to department managers, according to the accepted terminology of the Civil Service Authority.

Major Group 4 - Agents, Sales Workers and Service Workers includes workers who deal in wholesale and retail trade. They purchase and sell various goods and services or serve as agents between buyers and sellers. Also included are workers who provide services related to the daily needs of the community and the family such as accommodation and food, personal care and other services.

Major Group 5 - Skilled Agricultural Workers includes workers who perform skilled work in agriculture: field and vegetable crops, plantations, animals and mixed farming; forestry and maintenance, fishing and fish raising.

Major Group 6-8 - Skilled Workers in Industry, Construction and Other Skilled Workers includes workers having professional knowledge and training who deal in production processes in industry and workshops using sophisticated equipment and industrial machinery or using manual equipment or hand tools. Also included are sailors, drivers, construction workers and mining and quarry workers.

Major Group 9 - Unskilled Workers includes workers who have occupations requiring primary school education or not requiring any education at all. They usually perform work that requires more physical strength than training and knowledge.

Twenty Leading Courses in the Voucher System

Occupation of the course	Number of students	Shortage of professionals in the market	Integrate into work in the profession	Occupation risk level
Accountants	315		Yes	High
Other academic occupations	210		No	Low
Cosmetician	199		Partial	Low
Programmers	191	✓	Partial	Medium
Associate professions and technicians	147		Partial	Low
Bookkeepers	145		Yes	High
Skilled agriculture, manufacturing, construction workers	144		Yes	High
Medical secretaries	138		Yes	High
Graphic designer	126	✓	Partial	Low
Website designer, computer communications	111	✓	Partial	Low
Bus drivers	81	✓	Yes	Medium
Machine operator and other drivers	81	✓	Yes	Medium
Agents and service workers	77		Partial	Medium
Personal trainers	71		Partial	Low
Hairdressers	66		No	Low
Stock keepers	59		Yes	Medium
Travel agents	58		Partial	Medium
Childcare workers	57		Partial	Low
Other managerial professionals	40		No	Low
Production workers and the like	39		Yes	Medium

Source: Shavit Madhala-Brik, Taub Center
Data: Employment Service, *Survey of Professional Vouchers*, June 2014; Frey and Osborne (2013)

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