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# THE INFORMATION TECHNOLOGY INDUSTRIES: EMPLOYEES, WAGES AND DEALING WITH SHOCKS

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Abstract

This paper describes and analyzes developments in employment, wages and profitability in the information technology industries between the years 1995 and 2010, and the uniqueness of the human capital among those working in these industries in Israel. Data on bachelor's degree recipients by profession indicate the large amount of time—more than five years—that passes from the time a positive shock in the industry is observed and demand for workers increases until the end of the period of adjustment between labor supply and demand. The increase in productivity and wages in the information technology industries during the second half of the 1990s led to a sharp increase in the quality of the workforce in these industries, emphasizing the uniqueness of the current aggregate human capital of those working in the information technology industries. Most of the electrical and electronics engineers and those with degrees in computer sciences in the economy are employed in the information technology industries, which are export-intensive industries. It is therefore reasonable to assume that the exchange rate and global demand (which affect the nominal product per employee in these industries) affect their wages. Contrary to the opinion that there is a high return for entrepreneurs in information technology, it seems that the high wages of those working in the industry, combined with the unique human capital, constitute the "buffer" for absorbing negative shocks.

## 1. FOREWORD

Between the years 1995 and 2010, the information technology [IT] industries have become a key component of the economy.[1] Their share of business output has hovered at about 13

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percent in recent years, and they account for more than 30 percent of the export of goods and services (excluding diamonds, ships and aircraft). As a key source of foreign exchange, the IT industries have a strong impact on all activity in the economy and in practice, since the mid-1990s, the changes and economic developments in the IT industries have been responsible for much of the development of the economy at the macro level.

Despite their considerable importance, developments in the IT industries over time with respect to employment, wages, and particularly their response to shocks, have not been widely covered or analyzed. Abuganim and Feldman (2002) studied wage increases in the high technology industries and characterized the development of manpower in these industries with respect to age, olim (new immigrants), gender and education between 1995 and 1999. Bank of Israel Annual Reports during the first decade of the 2000s periodically studied only current-year developments in the IT industries. Kirschberg (2012) studied the demographics of businesses regarding type and survivability in the R&D industries (a relatively small part of the IT industries) between 2003 and 2008. A comprehensive set of data for the high technology industries for 1995–2007, and for the IT industries for 1995–2006 is available in two relatively new Central Bureau of Statistics publications from 2008 and 2010, but by their nature they do not analyze or interpret the data. More recently, the IT industries were the subject of an extensive study in a report prepared by an interministerial task force which examined the shortage of skilled manpower in the IT industries and in other advanced industries (Prime Minister's Office, 2012). This report presents an interesting picture of the state of employment and training of employees in the IT industries, emphasizing the shortage of workers and recommendations for addressing the problem. The purpose of this paper is to fill in some of the blanks in the analysis of the IT industries, focusing on an analysis of the development of aggregate human capital in the IT industries and the response of wages to the major changes in productivity in these industries since they emerged on a large scale in the second half of the 1990s.

[1] In this paper, the definition of the Information and Communication Technology Industries (ICT) is similar to the accepted definition in Central Bureau of Statistics publications, with the exception of the Communications Services Industry (Code 66) which belongs to the generally accepted definition of the ICT industries, but due to its different nature and the difference in the education of those employed in this industry compared with the other IT industries, we chose not to include it in our analysis. The definition includes the following industries: manufacture of electronic components (Code 32), manufacture of telecommunications equipment (Code 33), manufacture of industrial control and supervision equipment (Code 340), manufacture of measuring and navigation devices (Code 342), and computer services and R&D (including start-ups, Codes 72 and 73). In some instances, due to the availability of data, the analysis of the developments also includes the medical and surgical devices industry (Code 341), and the optical devices and photographic equipment industry (Code 343), but it does not include manufacture of office machinery (Code 30). These are relatively small industries that employ less than 5 percent of all employees in the IT industries. It should also be noted that as generally accepted, all R&D industry activities (Code 73) are included here in the IT industries, despite the fact that some of the activity does not belong in this industry. The industry codes used in this footnote and throughout the paper are based on the Standard Industrial Classification of All Economic Activities, 1993.

Three significant shocks affected the IT industries between 1995 and 2010. In the second half of the 1990s, productivity in the IT industries surged, dramatically changing their profitability, output, exports, the composition of those working in the industry and the proportion of workers in the economy that they employ. Some of the changes were rapid while others were prolonged. The second shock to affect the IT industries was the dot-com crash of 2000 which culminated in a sharp decline in the demand for IT products and services in 2002. Between 2000 and 2002, the US Tech-Pulse Index dropped by more than 30 percent (average for the two years), and global trade in goods produced by the IT industries declined.[2] As a result of the crash, the output and exports of the IT industries dropped sharply and real wages paid to employees in these industries fell by almost 10 percent over a two-year period. Interestingly, wages dropped despite the increase in the proportion of engineers employed in these industries in the same period, an increase attributable to the positive shock that preceded the crisis.

The sharp real currency appreciation of a cumulative 15 percent that occurred between 2008 and 2010, and declining global trade in 2008–2009, form the third shock. In practice, these are two separate shocks, one the result of domestic developments and the other due to exogenic developments, but the parallel timing of these two shocks makes them difficult to separate. In 2010, these two shocks pulled in opposite directions: the continuing currency appreciation negatively affected exports whereas global demand recovered temporarily contributing to their success.

This paper analyzes developments in the IT industries in light of the shocks that affected them between 1995 and 2010. Specifically, we will examine the speed at which the industry adjusted itself (with respect to employees and quality of the workforce) in response to the shocks. We will present the nature of the human capital employed in the industry and its increasingly unique characteristics throughout the 2000s, and we will examine how this uniqueness could affect the industry's response to future shocks. Contrary to the view that wages are almost totally independent of developments in the industry and that they are exogenic to the industry, we will posit that the high wages of those working in this industry serve as a potential "buffer" for absorbing negative shocks. Our study combines the collection of data with an attempt to explain the development of this data, using a variety of information sources: Labor Force Surveys, Income Surveys, Manufacturing Surveys and Surveys of Trade, Services, Transport, Communication and Construction conducted by the Central Bureau of Statistics, as well as data about students and college graduates by profession.

The paper is arranged as follows: Part 2 forms the background and describes developments in the IT industries between 1995 and 2010, emphasizing the shocks that have impacted these industries during this period. Part 3 discusses changes in the quality of

[2] The US Tech-Pulse Index is calculated on the basis of common trends of investments in IT products in the US, employment in the industry, production and shipments by the industry, and the consumption of computers and software. It is considered an index that summarizes developments in the industry in one set of data.

the workforce in the relevant period compared with developments in other industries. Part 4 addresses the unique aspects of the human capital in the IT industries and the intensification of this uniqueness in the last ten years. Part 5 discusses wages in the industry and their elasticity, and Part 6 is the summary.

## 2. EMPLOYEES, WAGES, PROFITABILITY AND SHOCKS IN THE IT INDUSTRIES, 1995–2010

The rapid growth of the IT industries began in the early 1990s.[3] From 1990 through 1995, the output of these industries expanded by more than 10 percent per annum with a corresponding rapid increase in the number of people employed in the industry. This process continued and even intensified from 1995 to 2000, despite the objective difficulty in recruiting workers with the necessary qualifications and know-how for the IT industries. In 1990, the number of people working in the IT industries accounted for just 4.3 percent of all employees in the business sector. By 1995, this figure had increased to 5.1 percent, and in 2000 they accounted for 8.1 percent. Overall, during the 1990s, the number of people employed in the IT industries increased by 180 percent while the number of employees in the entire business sector increased by only 50 percent.[4]

Although there was no significant difference between the rate of increase in the number of employees in the IT industries between 1990 and 1995 and between 1995 and 2000, the reasons for the accelerated increase in the number of employees in each of the two sub-periods were completely different. Whereas the growth of the IT industries in the first half of the 1990s was largely the result of general economic expansion thanks to the influx of olim from Russia who entered the workforce, in the second half of the 1990s the expansion of the IT industries was driven by the surge in productivity and in wages.[5] Between 1995 and 2000, productivity in the IT industries (excluding the electronic components industry) rose by 7 percent per annum, compared with 2.7 percent per annum in the rest of the business sector in the same period (Table 1).[6] Of course, the increase in labor productivity

[3] Due to changes in classification, it is difficult to track the growth of the IT industries before the early 1990s.

[4] Notably, the increase in the proportion of employees in the IT industries was driven by the computer services and R&D industries (including startups). Today, the computer services and R&D industries account for two-thirds of the workers employed in the IT industries.

[5] Among the additional factors that contributed to the growth of the IT industries in the 1990s, we note: (1) the cancellation of the Lavi aircraft project and reduction of defense expenditure that released experienced development engineers to the civilian market; (2) quality infrastructure of the defense establishment in training manpower for R&D projects, and the development of networking in the software industries and in R&D; (3) government support for R&D industries through the encouragement of venture capital companies and investment by the Chief Scientist in R&D. See discussion by Justman (2001).

[6] The opening of the Intel plant in Kiryat Gat in 1999, which is classified in the electronic components industry, contributed to an extraordinary surge in labor productivity in this industry, and it is therefore excluded here.

was certainly extraordinary in its intensity, and in part it reflected the dot-com bubble, but it was certainly a positive shock, the effects of which are still felt today. This is confirmed by the fact that in the past decade, the proportion of workers from the entire business sector who are employed in the IT industries and the average wage per employee post in the industries have remained above the 1999 level.

**Table 1**
**Annual change in labor productivity in the business sector and in the IT industries, 1991–2010**

| | 1996–2010 | 1991–1995 | 1996–2000 | 2001–2005 | 2006–2010 |
|---|---|---|---|---|---|
| | Labor productivity (percentage change in annual terms. Number of persons employed in the industry in thousands at end of period in parentheses) | | | | |
| Entire business sector | 1.5 | 1.5 (1,399) | 3.5 (1,559)* | 0.0 (1,742) | 1.2 (2,057) |
| Information technology industries | 3.4 | 1.1 (71) | 10.2 (126) | -1.4 (139) | 1.7 (176) |
| Information technology industries (excluding electronic components) | 2.7 | 0.5 (61) | 6.9 (109) | 0.8 (122) | 0.7 (155) |
| Information technology manufacturing (excluding electronic components) | 6.0 | 3.1 (35) | 11.6 (38) | 3.3 (38) | 3.3 (43) |
| Information technology services | 1.7 | -3.6 (26)** | 5.7 (71) | -0.2 (84) | -0.4 (112) |

* Estimated annual labor productivity excluding the IT industries for 1996–2000 is 2.7 percent.
** The negative labor productivity in the IT industries in a significant part of the period is probably due to a statistical error in calculating the industry's quantitative output. (For a discussion of the problems of measuring output in this industry, see Dar, 2001.)
For information about the industries, see footnote no. 1
**SOURCE**: Based on data from the Central Bureau of Statistics.

The increase in profitability of the IT industries led to increased demand for workers and a sharp increase in wages, with the latter also affected by the fact that the supply of labor was unable to keep pace with demand. Between 1995 and 2000, real wages per employee post in the IT industries rose 50 percent, compared with 20 percent in the rest of the business sector.

The bursting of the dot-com bubble led to lower profitability in the IT industries, the employment of fewer workers in the field and a sharp decline in real wages. In 2001, profitability (equity as a share of output) in the IT industries fell to 9 percent from an average of more than 20 percent between 1998 and 2000. One of the factors that helped restore profitability to pre-crisis levels by 2002 (Table 2) was the relatively rapid adjustment of the wages of those employed in the industry to the new situation. Real wages per employee post in the IT industries continued to increase slightly in 2001, but in the subsequent two years (2002–2003) they fell by almost 10 percent. Likewise, from 2001 to

2003, the number of salaried positions in the IT industries declined by more than 10 percent, compared with stability in the number of jobs in the rest of the business sector. Consequently, the number of employees in the IT industries as a percentage of all employees in the business sector declined by one percentage point, from 8.3 percent to 7.2 percent (Figure 1). Notably, given the events of the Second Intifada at about the same time, the negative macro data for the IT industries for those years are less severe than for the rest of the economy.

**Table 2**
**Inequity as a share of output ("profitability") in the business sector, in the information technology industries, in manufacturing and in services (percent)**

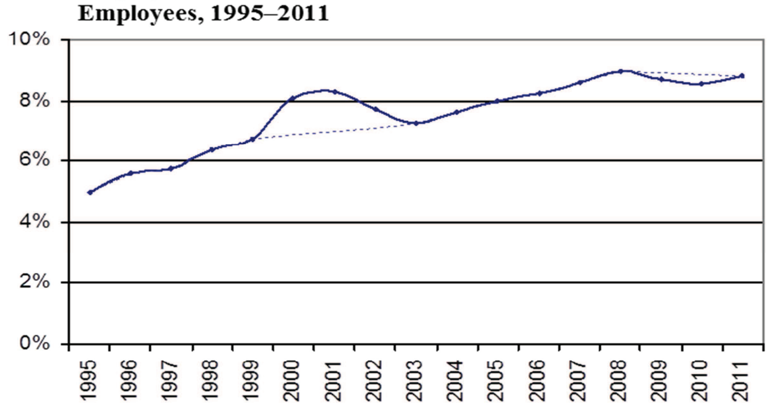
| | 1995–1997 | 1998–2000 | 2001 | 2002–2003 | 2004–2007 | 2008–2009 | 2010–2011 |
|---|---|---|---|---|---|---|---|
| Entire business sector | 29 | 29 | 26.9 | 28.7 | 32 | 31 | 32 |
| Information technology industries | 22.6 | 28.4 | 18.1 | 26.3 | 24.0 | 26.3 | 25.1 |
| Information technology industries (excluding electronic components) | 17.1 | 21.0 | 9.3 | 22.1 | 22.3 | 23.9 | 23.0 |
| Information technology manufacturing | 27.6 | 35.3 | 25.8 | 25.3 | 27.6 | 22.2 | 19.0 |
| Information technology manufacturing (excluding electronic components) | 19.8 | 20.9 | 3.6 | 12.9 | 23.6 | 10.9 | 7.4 |
| Information technology services | 12.9 | 21.0 | 12.2 | 26.7 | 21.6 | 28.4 | 28.0 |
| Manufacturing excluding the information technology industries * | 35 | 36 | 34.9 | 38.3 | 45 | 44 | - |
| Service industries excluding the information technology services ** | 42 | 43 | 40.2 | 36.9 | 44 | 48 | - |

* And excluding the medical and surgical devices industry (Code 341) and the optical devices and photographic equipment industry (Code 343). For information about the different industries, see Footnote 1.
** The IT services here include computer services and R&D (including startups, industry codes 72 and 73).
**SOURCE**: Industry survey data, Trade and Services survey data, national accounting, and Central Bureau of Statistics publications on the Information Technology Industries.

The crisis of 2001–2003 was particularly severe, and during this time dollar exports from Israel's IT industries plummeted by almost 30 percent (about half of the decline can be attributed to a sudden cessation of sales of start-up companies to foreign investors). The crisis dampened the widespread feeling that hi-tech workers were on the fast track to prosperity, and underscored the risk entailed in choosing a profession suited to employment in a highly volatile industry. This volatility was reinforced in the slowdown of 2008–2009, and in this respect it is reasonable to assume that the combination of the crisis of the early 2000s and the slowdown of 2008–2009 have had a long-term impact on young people joining the industry.

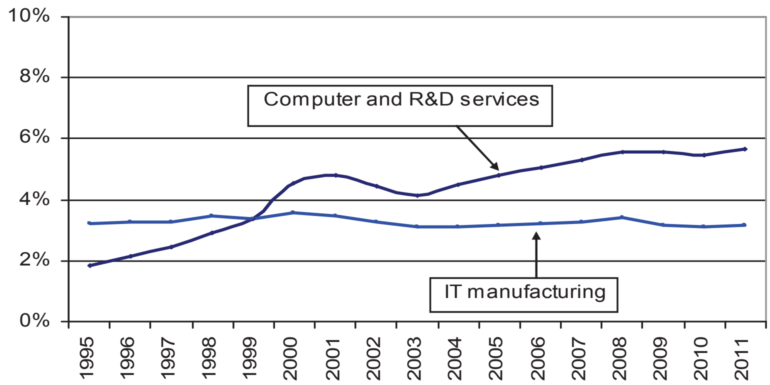
In the wake of the 2001–2003 crisis, the upsurge in the number of students applying to study computer science, electrical engineering and electronic engineering came to a halt, but there were still noticeable past effects on the stream of college graduates, which continued to increase. With the recovery of the IT industries from 2004, the increase in the proportion of workers employed in the IT industries resumed, but since 2008 their proportion of the total business sector has not increased, a fact which might indicate the end of the era.

**Figure 1**
**Employees in the IT Industries as a Share of Business Sector Employees, 1995–2011**



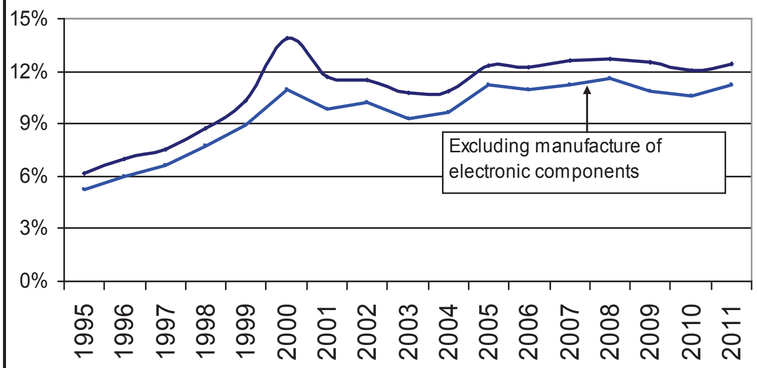

SOURCE: Central Bureau of Statistics Labor Force Surveys.

**Figure 2**
**Employees in the IT Industries as a Share of Total Business Sector Employees, Divided into Manufacturing and Services, 1995–2011**



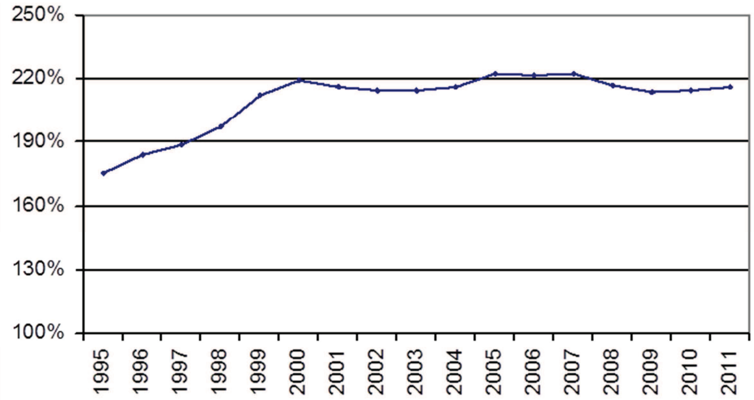

SOURCE: Central Bureau of Statistics Labor Force Surveys.

**Figure 3**
**Output of IT Industries as a Share of Total Business Sector Output, 1995–2011** (percent, at current base prices*)




* Manufacturer's price minus taxes and plus support payments.
SOURCE: National Accounting, Central Bureau of Statistics.

**Figure 4**
**Average Wage per Employee Post in the IT Industries as a Share of the Average Wage in the Business Sector, 1995–2011**




SOURCE: Central Bureau of Statistics.

The sharp real currency appreciation of 2008 was a further shock to activity in the IT industries. About two-thirds of the output of the IT industries is directed to exports so that the appreciation which began in 2008 and continued in 2010 directly affected the nominal output per worker and the profitability of these industries. The 2008 appreciation followed a depreciation of the exchange rate from 2002 through 2004 and stability in the subsequent three years. It also came after a surplus had accumulated in the current count, reaching a record level of almost 5 percent of GDP in 2006. Nevertheless, the intensity of the appreciation and the speed at which it occurred raised the question of whether exports were capable of coping with the damage to their profitability.

Several studies conducted empirical reviews of the effect of the real exchange rate on Israel's exports. These papers, as well as articles on the subject that appeared in Bank of Israel Annual Reports, generally found a weak relationship between the real exchange rate and exports, and particularly with respect to exports that are technologically intensive.[7] The findings regarding the limited effect of the real exchange rate on exports were not exceptional in the literature (for example, Baxter and Stockman, 1989; Deckle et al. 2010), and were therefore accepted by most economists, who analyzed the response of exports in general, and of the IT industries in particular, to appreciation. Nevertheless, a sharp appreciation could be expected to affect exports, and it would certainly affect profitability.[8,9] In this respect, policymakers were surprised by the minimal effect of the 2008 appreciation on the goods and services account (and on activity in the IT industries) in 2008 and in subsequent years.

[7] In a paper that examined the relationship between exports, imports and the real exchange rate between 1973 and 2004, Lavi and Friedman (2006) found that the effect of the real exchange rate on exports has weakened considerably since the stabilization program, and that, in practice, in the "short term" it did not exist. In the long term, researchers found elasticity of 0.2 between the real exchange rate and exports, although Lavi and Friedman believe that this relationship was also weakened after the 1985 stabilization program. An elasticity of between 0.1 and 0.2 was also found in Lavi's paper (1997), which addressed the period between 1961 and 1996. In the Annual Report for 1999 (Box 6.1, pp. 181–182), elasticity of 0.25 was found between the real exchange rate and exports in the long term. In the Annual Report for 2008 (Box 2.3, pp. 79–83), no clear causal relationship was identified between the real exchange rate and total manufacturing exports, but the real exchange rate was found to affect the manufacturing industries at the level of "mixed" technology. This finding is consistent with the work of Sofer (2005) which identified a relationship between the real exchange rate and the export of goods only after removing the export of hi-tech industries from the sample.

[8] For example, the Bank of Israel Annual Report for 2009 states that: "Although several studies examined the effect of the exchange rate on export volume and found it to be small, their estimates were flawed by simultaneity that made the causal relation hard to detect. Another problem with the estimates is that the effect of the exchange rate on exports is probably not linear: the main effect of slight appreciation should be on the level of export profitability, not on volume; however, it is hard to estimate quantitatively the effect of steep appreciation of the sort that occurred in 2008, especially when it coincided with abruptly falling demand". This argument is repeated in the Bank of Israel Annual Report for 2010 as well (footnote no. 15 on page 43). With hindsight, it transpired (profitability data by industry is published with a lag) that the profitability data for 2008 and 2009 for the IT industries were actually good, thanks to high profitability in the computer services and R&D industries. The profitability of the IT manufacturing industries suffered badly in those years. A similar development also occurred in 2002.

[9] One of the explanations for the weak relationship between the real exchange rate and export volume is that companies may choose to absorb some of the exchange rate changes by changing their markup so that the price of the product in foreign currency changes more moderately than the real exchange rate, with the result that the effect on export volume is also moderate. In this case, in response to currency appreciation, export volume declines moderately while profitability falls more sharply. For a discussion of this subject, see Goldberg and Knetter (1997). This approach is supported by the recent results obtained by Berman, Martin and Mayer (2012).

In this context, it is worth noting that in the long term, it is inherently difficult to identify the relationship between the real exchange rate and exports due to the conflicting causality of these two variables: a real depreciation is expected to help increase exports, whereas an increase in exports is expected to contribute towards a real appreciation. As we have noted, in this respect, it is reasonable to assume that part of the real appreciation of 2008 and 2010 was not an exogenic shock but a response by macroeconomic variables to the positive developments in the IT industries in the years preceding 2008.

The negative impact on export industries in general, and on the IT industries in particular, intensified greatly when the global crisis erupted and global trade fell sharply from the fourth quarter of 2008. However, the IT industries seem to have been quite successful in coping with the crisis. In 2009, the export of goods and services from the IT industries declined much more moderately than the level of global trade, and in 2010, it increased more rapidly than global trade. In all probability, the 7 percent decline in real wages between 2007 and 2009 helped mitigate the impact on profitability.

Despite the crises of 2001–2003 and 2008–2009, employees in the IT industries accounted for a higher proportion of all business sector employees in 2011 than in 2000, before the bursting of the dot-com bubble. Compared with 1995, the number of workers employed in the IT industries as a percentage of the entire business sector rose by 4 percentage points, and the output of these industries as a percentage of total business output rose by almost 5 percentage points. These increases are pronounced when compared with the other advanced economies and they reflect the success of the IT industries during the reviewed period (Figures 5 and 6).

**Figure 5a**
**Employees in the IT Industries as a Share of Total Business Sector Employees, 2009**

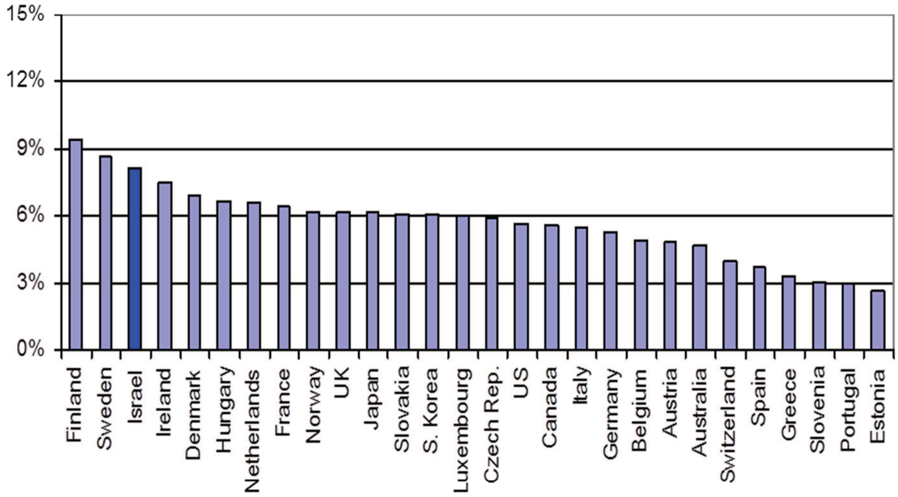
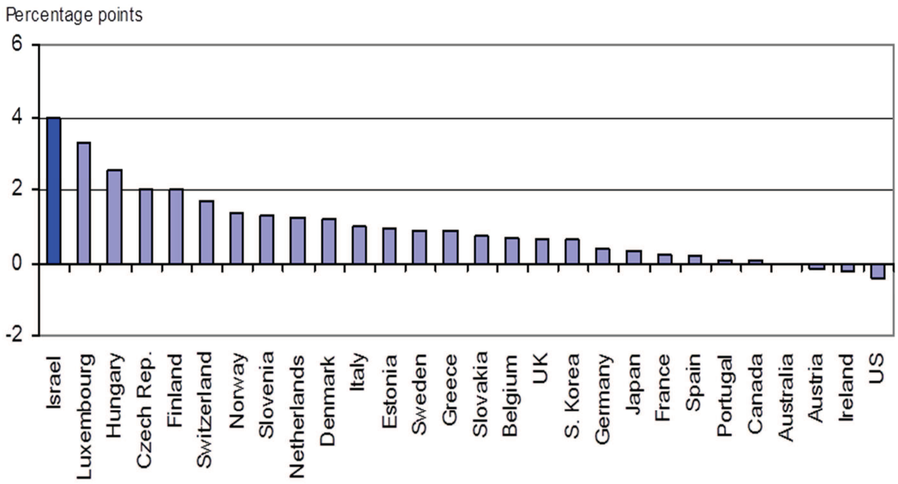



**Figure 5b**
**Change in the Proportion of IT Employees in the Business Sector, 1995–2009**




The figures include the communications industry, and do not include the electronic components industry or the R&D industry. Due to data restrictions, the definition of IT industries is not identical in all countries. Data for Australia is from 2008 and data from Portugal is from 2007. High variance is possible in the level of human capital among employees of the IT industries in various countries.

SOURCE: OECD Internet Economy, 2012; Israel—Central Bureau of Statistics.

**Figure 6a:**
**Output of IT Industries as a Share of Business Sector Output, 2009**

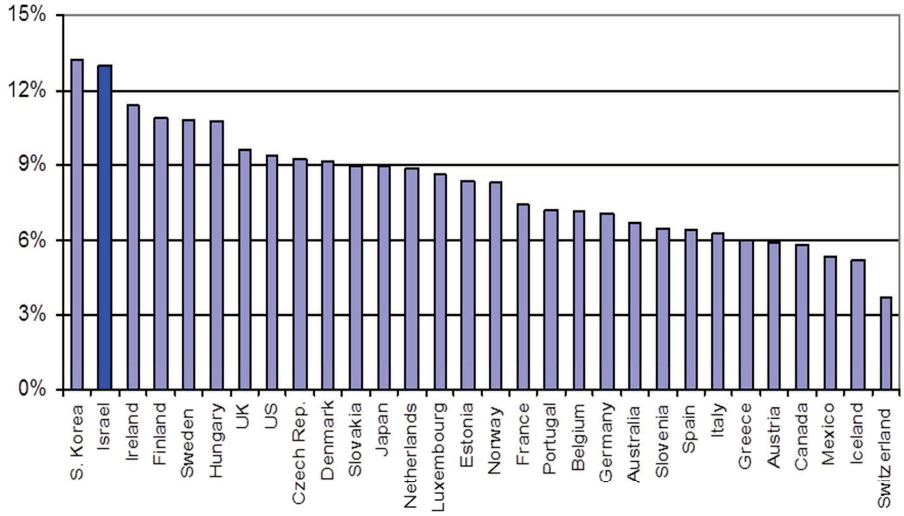
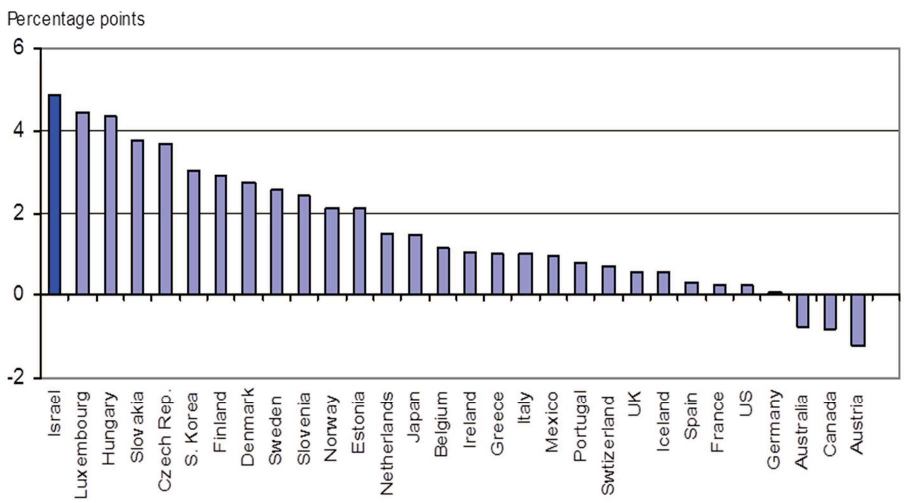



**Figure 6b**
**Change in the Proportion of IT Industry Output in Total Business Sector Output, 1995–2009**




The figures include the communications industry and do not include the electronic components industry or the R&D industry.

SOURCE: OECD Factbook, 2013; Israel for 1995—Central Bureau of Statistics.

## 3. DEVELOPMENT OF THE SUPPLY OF WORKERS AND CHANGES IN THE QUALITY OF THE WORKFORCE IN THE IT INDUSTRIES

In terms of education, the quality of the workforce in the IT industries is among the highest in the economy. A third of the workers employed in these industries in 2011 have academic professions; another third have professions that require post-secondary education and a further 10 percent are managers with an academic degree. This picture of high-quality manpower is not new to the IT industries, but it became more pronounced largely as a result of the changes that occurred in the industry in the second half of the 1990s.

The increase in labor productivity and the demand for goods and services produced by the IT industries in the second half of the 1990s led to a rapid increase in the demand for workers in these industries. However, the highly specialized human capital that the IT industries require made it difficult to recruit workers and to strike the correct balance between demand and supply. Clearly, the demand for workers in that period was forced to compromise with supply that was not an optimum match for the nature of the work in the IT industries, and in practice the process of adjustment between the demand for and supply of human capital in this industry continued well into the 2000s.

The demand for workers was initially met mainly by young bachelor's degree recipients (generally in the natural sciences) who applied for the relevant professional retraining, and by young people who decided not to pursue academic studies and instead chose to study specific professions suited to work in the IT industries (such as computer programming, or practical computer or electronic engineering). In other cases, workers who specialized in relevant fields and had previously been employed in other industries were diverted to the IT industries, although the potential for such movement was small, given that by 1995, more half of the college graduates in computer science, computer engineering and electrical and electronic engineering were already employed in the IT industries.[10]

Subsequently, it was those young people who were in the process of deciding what academic degree to pursue with a view to entering the labor market with relevant professions 4–6 years later on—after completing their bachelor's degree—who met the demand for workers. It is noteworthy that the development of employment and professions in the IT industries among young olim from the Former Soviet Union (FSU) did not differ significantly from those of the native-born Israelis. Generally, the percentage of workers from the FSU out of all employees employed in the IT industries was 2–3 percentage points higher than the corresponding figure among veteran Israelis.

The standard bachelor's degree programs in computer science and engineering, which are the relevant disciplines for working in the IT industries, are 3 and 4 years respectively. This is the minimum period for expanding the supply of workers with human capital in these disciplines. To this, some would add the time required for applying for studies

[10] Recipients of academic degrees in one of these three professions who work in another occupation are not included in this figure.

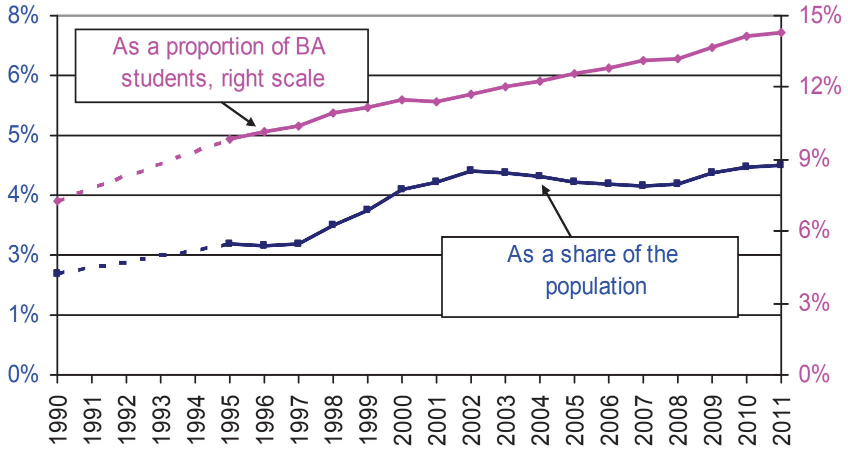
(usually six months) and the time between the period in which the demand for workers grows and the stage at which the supply begins to respond to this demand.[11]

Figure 7 shows the total number of bachelor's degree students and the number of students in engineering, architecture, the natural sciences and math, as well as bachelor's degree candidates as a percentage of the young population (ages 25 through 34) from 1990 to 2010. Figure 8 presents corresponding data on students who have completed their bachelor's degree. The rapid rate of growth in the percentage of all bachelor's degree students was recorded throughout the 1990s and reflects the higher education revolution in that period. However, this revolution was not in line with the human capital needed for work in the IT industries.[12] The increase in the proportion of undergraduates studying for a bachelor's degree in engineering, architecture and the natural sciences and math was completely different from the development in the total number of undergraduate students. At the beginning of the period, the number of students of engineering, architecture and natural sciences and math increased more slowly than the total number of bachelor's degree students, reflecting the fact that the higher education revolution was felt less strongly in these disciplines. After the sharp increase in the return on studying engineering and computer science, in the second half of the 1990s, there was a steep increase in the number of students in these disciplines, as reflected in the number of students who earned a degree in engineering, architecture and computers in 2001–2005.

[11] At the macro level, the limited number of available places in institutions of higher education for the relevant professions may further delay the process of adjustment between supply and demand for workers.

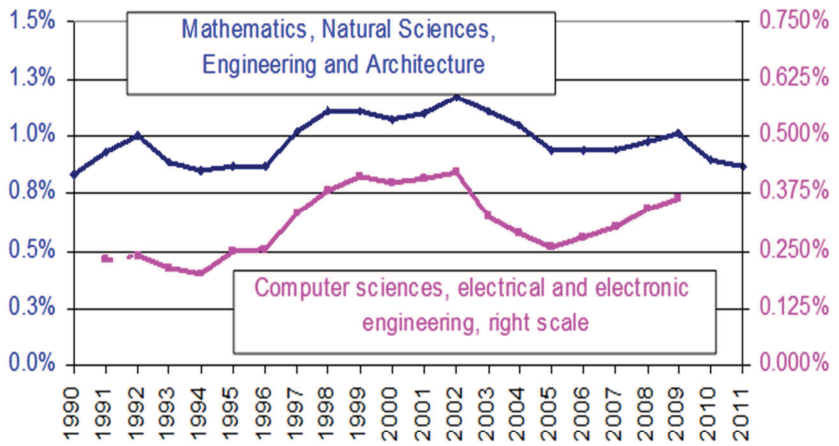
[12] For a description of the change in accessibility to higher education in Israel in the early 1990s and the change in the number of students pursuing an academic degree in this period, see for example Kirsch (2010).

**Figure 7a:**
**BA Students in Engineering, Architecture, Natural Sciences and Mathematics as a Share of the Population Aged 25–34 ***




* Excluding students in Colleges of Education.
SOURCE: Central Bureau of Statistics publications on higher education.

**Figure 7b:**
**Applicants for studies in Mathematics, Natural Sciences, Engineering and Architecture at Universities as a Share of the Population Aged 25–34**

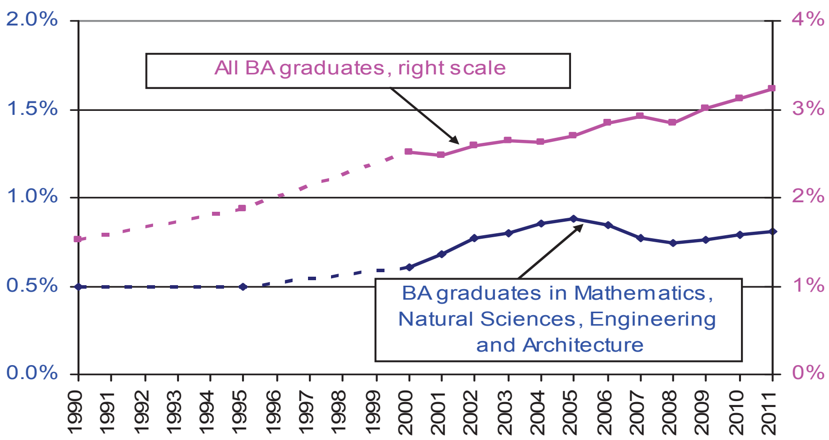



* Preferred area of study by academic year. Candidates submitted their candidacies the previous year.
SOURCE: Central Bureau of Statistics.

Given that engineering studies include academic disciplines such as industrial and management engineering that are not specific to employment in the IT industries, we present a separate graph which shows the number of students who completed a degree in computer science, computer engineering and electronic engineering. Figure 9 shows that the number of graduates in the professions relevant for working in the IT industries peaked in 2004, more than 5 years after the return on the study of these professions jumped, and three years after the bursting of the dot-com bubble. The increase in the flow of graduates in the relevant professions certainly helped cool the rate of increase of real wages in these industries from 2004 through 2007.

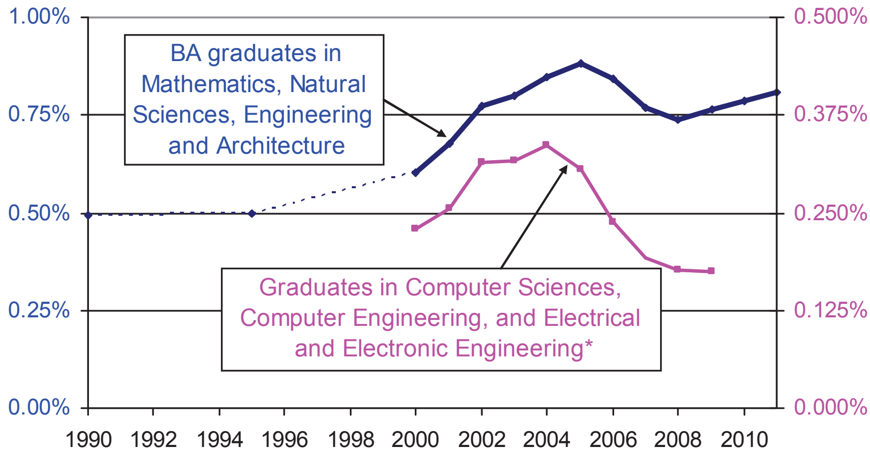
The number of students completing a bachelor's degree in the professions relevant for employment in the IT industries began to diminish in 2006, with a marked decline in the number of recipients of a bachelor's degree in computer science. We can assume that this decline is attributable to the dot-com crisis and the decline in the attractiveness of the computer science profession as perceived during the crisis. We can therefore assume that the negative shock that affected the IT industries in 2008–2009 and the present decline in global demand will be reflected in a slow-down in the number of students completing a bachelor's degree in engineering and computers in the next few years. The drop in the total number of undergraduate students of math, natural sciences and engineering is already noticeable in the data for 2010 and 2011.

**Figure 8**
**Total BA Graduates* and BA Graduates in Mathematics, Natural Sciences, Engineering and Architecture as a Share of the Population Aged 25–34**




* Excluding degrees from colleges of education.
SOURCE: Central Bureau of Statistics publications on higher education.

**Figure 9**
**BA Graduates in Mathematics, Natural Sciences, Engineering and Architecture as a Share of the Population Aged 25–34**

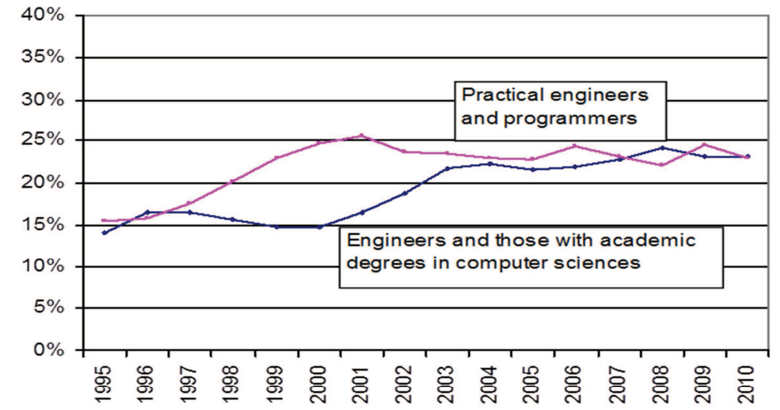



* Excluding graduates with degrees in computer engineering and electrical and electronic engineering from academic colleges.
SOURCE: Central Bureau of Statistics publications on higher education.

The developments described above can be seen in Figure 10, which shows the percentage of graduates of computer science, computer engineering and electrical and electronic engineering who are employed in the IT industries, next to the percentage of practical computer engineers, computer technicians and programmers who are employed in these industries. The diagram shows how the percentage of "practical computer engineers, computer technicians and programmers" out of the total numbers employed in the IT industries increased rapidly in the second half of the 1990s, contrasting with the stability (and even decline) in the number of workers with academic professions in computer science and engineering who were employed in the IT industries in the same period.[13] From 2001 onwards, we can see the increase in the percentage of engineers and graduates with a degree in computer science who are employed in the IT industries.

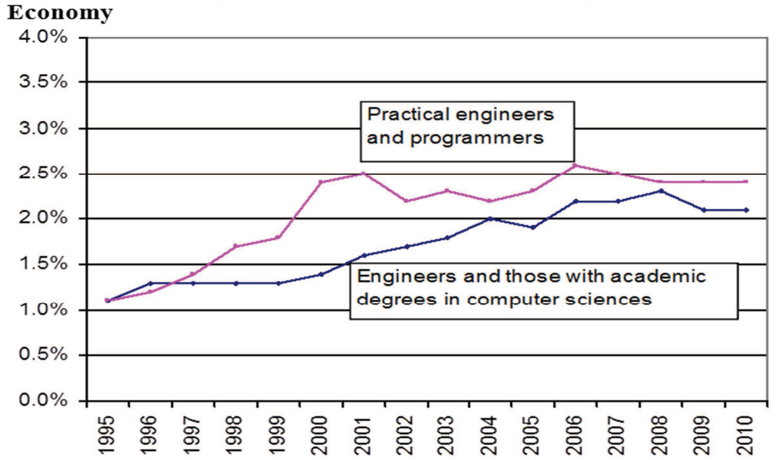
[13] The stability in the percentage of academic computer science, electrical and electronic engineering and computer engineering professionals in the second half of the 1990s reflects an absolute increase in the number of people employed in these professions in that period.

**Figure 10**
**Engineers and Computer Science Degree Holders*, and Practical Engineers and Programmers** as a Share of Those Employed in the IT Industries**




* Refers to "Systems analysts and those with academic professions in the computer sciences", "Computer engineers", and "Electrical and electronic engineers".
** "Practical computer engineers, computer technicians and programmers".
SOURCE: Based on the Central Bureau of Statistics Labor Force Survey.

**Figure 11**
**Engineers and Computer Science Degree Holders*, and Practical Engineers and Programmers** as a Share of all Employees in the Economy**




* Refers to "Systems analysts and those with academic professions in the computer sciences", "Computer engineers", and "Electrical and electronic engineers".
** "Practical computer engineers, computer technicians and programmers".
SOURCE: Based on the Central Bureau of Statistics Labor Force Survey.

To compare the effect of the change in the makeup of the IT workforce during the reviewed period on its quality (in the 1990s the stream of programmers and engineers, and in the 2000s the growing share of bachelor's degree recipients) with the changes in the rest of the economy, we will use the method employed by Aaronson and Sullivan (2001) for estimating the change in labor quality in Israel, a method that was also adopted by Zussman and Friedman (2009). In this approach, wage differences between workers provide a way of estimating the difference in worker quality, and changes in the average potential wage (in the economy or in any given industry) are an indication of changes in the quality of the workforce. The changes in workforce quality in the IT industries and other industries from 1995 through 2011 were estimated as follows: In the first stage, a separate wage equation was prepared for each of the industries for which a workforce quality index was calculated (using Income Surveys for the period 1997–2011). The dependent variable was the hourly wage per worker, and the explanatory variables in the wage equation were age (which together with age squared serves as an estimate of the worker's professional experience), family status, religion, (Jewish or other), a variable for number of years of schooling (in 5 education groupings), last place of study (elementary school, high school, vocational high school, yeshiva, post high-school institution and academic institution) and year of immigration (in four groupings by year of immigration, from 1990). Annual dummy variables and dummy variables for the year which interact with the year of immigration also served as explanatory variables.[14] In the second stage, the potential wage for each worker was calculated using the parameters that were estimated in the wage equations and the weighted average (based on work hours) of the potential wage in each industry. (The potential wage estimates were prepared based on Labor Force Surveys that included a larger number of observations.) The changes in the average differential wage were used to build an index of workforce quality in each industry.[15] An index for the development of labor quality in the business sector (excluding the IT industries) was built by weighting the quality of the workforce in the various industries, based on the labor input for each industry and the relative level of the quality of the workforce in each industry.[16]

[14] Young people below the age of 25, individuals with more than 25 years of schooling, individuals who worked less than half time and individuals who worked more than 50 hours a week were eliminated from the sample.

[15] In contrast with Zussman and Friedman's paper (2009), we ran a single wage regression for the entire period, adding annual dummy variables. The advantage of this method is the significant increase in the number of observations in each regression, which is important when running separate wage regressions for the different sectors of the economy. The drawback of this method is that it does not facilitate change over time in the return on education (or in any of the other parameters that appear in the regression). To test the robustness of the results of grouping the observations for all the years in one regression, we calculated another index of workforce quality based on the wage regressions for 2008–2010 and we found that the results are not sensitive to this change.

[16] The addition of the Russian immigrants to the workforce in the early 1990s, and the low wages paid to them when they first entered the labor market, lowered the quality of the labor force in Israel in the early 1990s (according to this method of measurement), but had little impact on the changes in the quality of the labor force beginning in the second half of the 1990s. In addition to the immigrants who continued to enter the labor market after 1995 (thus downgrading the quality of the labor force according to this

Figures 12 and 13 present the results of the estimation of changes in the index of workforce quality in the IT industries and in other selected industries. The figures show an increase over time in the quality of the workforce, mainly reflecting the rising education levels of those participating in the labor force. Labor quality in the IT industries remained stable from 1995 through 1998, dropping slightly in the next two years, then increasing rapidly from 2001 through 2005, and continuing to improve with some fluctuations in the subsequent years. This development in the IT industries is a reflection of the development of demand for labor and of employment in these industries over the period.[17] In the second half of the 1990s, in view of the massive recruitment of workers who were not engineers or computer science graduates for work in the IT industries, no increase was recorded in labor quality in these industries, and in some years it even declined. Subsequently, when the stream of bachelor's degree recipients in the professions relevant for working in the IT industries began and the pace of recruitment slowed, labor quality jumped according to the above calculation. The improvement in the quality of the workforce in the IT industries between 2000 and 2011 is also pronounced when compared with other important industries such as manufacturing (excluding the IT industries), trade, food services and banking. Considering that the proportion of college graduates employed in the IT industries in 1995 was higher than in each of the other industries listed above, there has been an impressive increase in the quality of the workforce in the IT industries since 1995.[18]

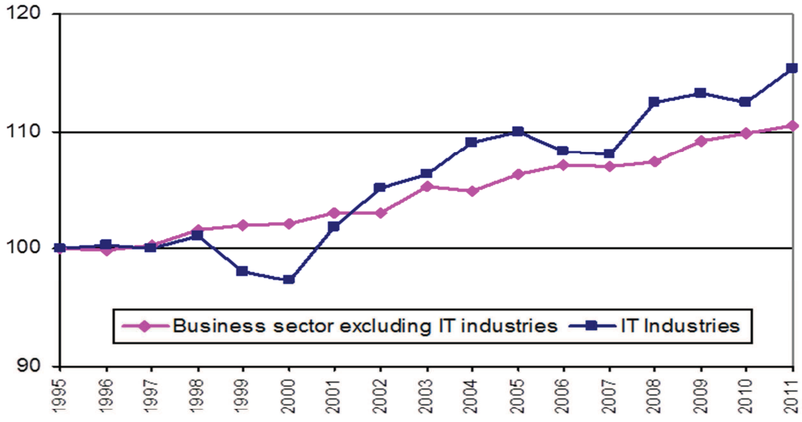
One of the key assumptions of the method presented here for calculating labor quality is that the same workforce characteristics that we know about any given worker also form the basis for determining his wage, and that there is no change in the distribution among the workers of unobserved characteristics that are relevant to the quality of the workforce in the period addressed in the study. The robustness tests that we conducted indicate that the addition of the "academic" profession or "free or technical professions" variable, which to a certain extent is affected by the way the employer evaluates the employee's abilities, had no significant effect on the results.

method of measurement), the work experience of the immigrants who had already entered the labor market increased, improving their contribution to the labor market.

[17] In the period of the sample, 1995–2010, multinational companies gained a firm foothold as employers in the IT industries, apparently pushing up wages in the industry. Changes in wages are not expected to affect the workforce quality index calculated here. The activity of the multinationals might affect the index of the quality of the workforce if the premium for characteristics of the individual that they pay their workers differs from that of the Israeli employers.

[18] Since labor quality in any particular industry is affected mainly by the proportion of academics employed in that industry, and since there is a limit to this proportion, the greater the proportion of academics the greater the difficulty in continuing to improve the quality of the labor employed in that industry.

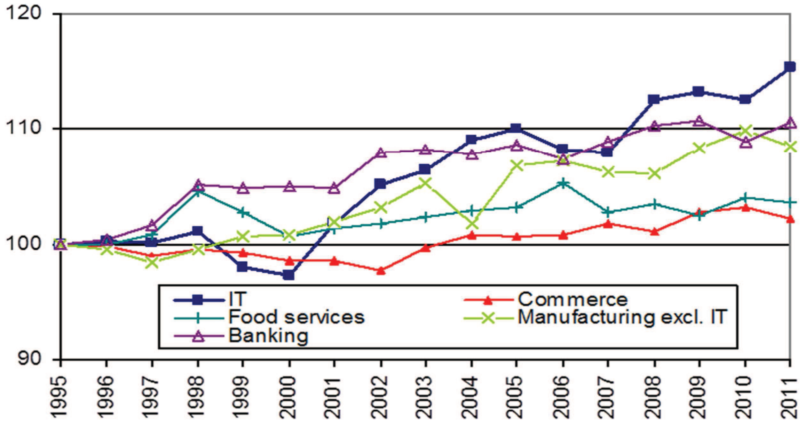
**Figure 12**
**Index of Workforce Quality, IT Industries Compared to the Rest of the Business Sector*, 1995–2011**




* Changes in the relative weights of the industries, and the workforce quality gaps between them, show that the increase in workforce quality in the general business sector is greater than the increase in each of the industries separately.

SOURCE: Based on Central Bureau of Statistics Income Surveys and Labor Force Surveys.

**Figure 13**
**Index of Workforce Quality, IT Industries and Other Selected Industries, 1995–2011**




* Changes in the relative weights of the industries, and the workforce quality gaps between them, show that the increase in workforce quality in the general business sector is greater than the increase in each of the industries separately.

SOURCE: Based on Central Bureau of Statistics Income Surveys and Labor Force Surveys.

Another key assumption is that wages are the optimal expression of the quality of labor input. This assumption seems to be reasonable in the IT industries, where unionization is virtually non-existent, and is also true for most of the business sector if we examine wage developments over the past ten years for the business sector as a whole. This view is reinforced when we note that similar results were obtained for the development of the labor force in Israel when the calculations were based on wage data for 2008–2010.

## 4. UNIQUENESS OF THE HUMAN CAPITAL IN THE IT INDUSTRIES

70 percent of those employed in the IT industries in academic professions fall under one of the following three professional categories: "systems analysts and those with academic professions in computer science", "computer engineers" and "electrical and electronic engineers" (2011 data). In itself, this figure is indicative of the specific type of human capital employed in the IT industries, that constitutes the key engine for activity in the IT industries. Furthermore, graduates of computer science and computer, electrical and electronic engineering are employed almost exclusively in the IT industries: More than 65 percent of the systems analysts and academic professionals in computer science in Israel, more than 55 percent of the electrical and electronic engineers, and almost 80 percent of computer engineers, are employed in these industries (Table 4).[19] Given that working in these professions requires specific academic qualifications, the concentration of these professionals in the IT industries leads us to conclusions regarding the unique nature of the human capital employed in the IT industries.

[19] This figure does not include those with academic degrees in one of these three professions who work in other occupations.

**Table 3**
**Distribution by economic sector of selected professions in the IT industries, 1995-2011 (percent, data for 1995 are shown in square parentheses)**

| | Total IT industries (Codes 32–34, 72–73) | Manufacture of Electronic components (Code 32) | Manufacture of Telecommunications equipment (Code 33) | Manufacture of Industrial Control & Supervision equipment (Code 34) | Computer services (Code 72) | R&D services (Code 73) |
|---|---|---|---|---|---|---|
| Total number of employees in the industry (absolute numbers in parentheses) | 100 (192,700) | 100 (24,800) | 100 (8,400) | 100 (34,800) | 100 (91,900) | 100 (32,000) |
| Total professionals: 015, 023, 027, 130 | 48 [29] | 22 [12] | 28 [20] | 19 [20] | 72 [63] | 34 [4] |
| Systems analysts and computer science academic professional (015) | 8 [3] | 2 [0] | 1 [0] | 0 [1] | 14 [7] | 16 [0] |
| Electrical and electronic engineers (023) | 6 [6] | 11 [6] | 13 [11] | 12 [11] | 1 [1] | 12 [2] |
| Computer engineers (027) | 8 [5] | 4 [2] | 6 [3] | 3 [3] | 11 [11] | 8 [0] |
| Practical computer engineers, computer technicians and programmers (130) | 25 [15] | 5 [4] | 8 [5] | 4 [4] | 46 [43] | 9 [1] |
| Total other professionals | 52 [71] | 78 [88] | 72 [80] | 81 [80] | 28 [37] | 66 [96] |

**SOURCE**: Author's calculations based on Labor Force Surveys.

**Table 4**
**Distribution of employment of computer and electronic engineers and practical computer engineers and programmers in the principal industries, 1995–2011 (percent, 1995 data in square parentheses)**

| | Key professions in the IT industries * | Systems analysts and academic professionals in computer science (015) | Electrical and electronic engineers (023) | Computer engineers (027) | Practical computer engineers and programmers (130) |
|---|---|---|---|---|---|
| Entire economy | 100 (143,700) | 100 (24,500) | 100 (21,700) | 100 (19,000) | 100 (78,400) |
| Employed in IT industries and computer services, R&D | 64 [54] | 66 [46] | 57 [47] | 79 [63] | 61 [57] |
| IT industries | 13 [19] | 3 [8] | 36 [41] | 15 [20] | 4 [9] |
| Computer services, R&D | 52 [36] | 63 [38] | 21 [5] | 64 [43] | 57 [48] |
| Employed in other industries | 36 [46] | 34 [54] | 43 [53] | 21 [37] | 39 [43] |

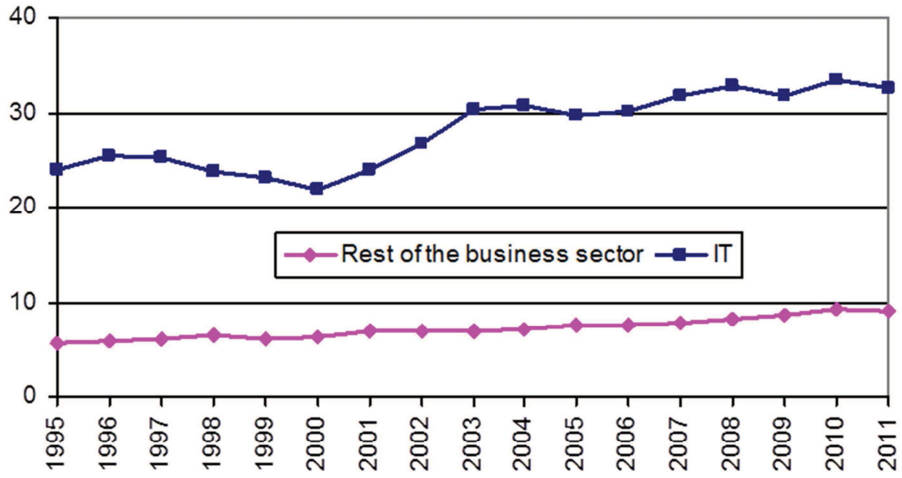
* Including: Systems analysts and academic professionals in computer science (015), electrical and electronic engineers (023), Computer engineers (027), and practical computer engineers, computer technicians and programmers (130).
**SOURCE**: Author's calculations based on Central Bureau of Statistics Labor Force Surveys.

Practical computer engineers, computer technicians and programmers are another important profession in the IT industries. More than 60 percent of workers in this profession are employed in the IT industries and more than half of them have at least a bachelor's degree. Although the training period for working as a practical computer engineer, computer technician or programmer is shorter than a full academic degree, it is also significant and generally lasts between one and two years. Consequently, it can be said that the concentration of practical engineers and programmers in the IT industries also supports the view that the human capital in the IT industries is unique. Overall, in 2011, 48 percent of the workers in the IT industries were qualified in one of the four professions listed above.

Human capital in the IT industries was already unique in the 1990s, but at the aggregate level it intensified considerably during the reviewed period. In 1995, about 54 percent of workers in these professions—"systems analysts and qualified computer scientists", "electrical and electronic engineers", "computer engineers" and "practical computer engineers, computer technicians and programmers"—were employed in the IT industries. In 2011, this figure was 64 percent—about 10 percentage points higher than in 1995. It is worth noting that this increase was accompanied by a doubling of the employees in these professions as a percentage of all employees in the economy. This pattern of professionalization is part of a structural change that has taken place in the IT industries as well as in other industries. In view of the high proportion of those with specific professions and with a high level of human capital who are employed in the IT industries, we can say that at the macro level, those qualified in these professions have few employment options outside the IT industries.

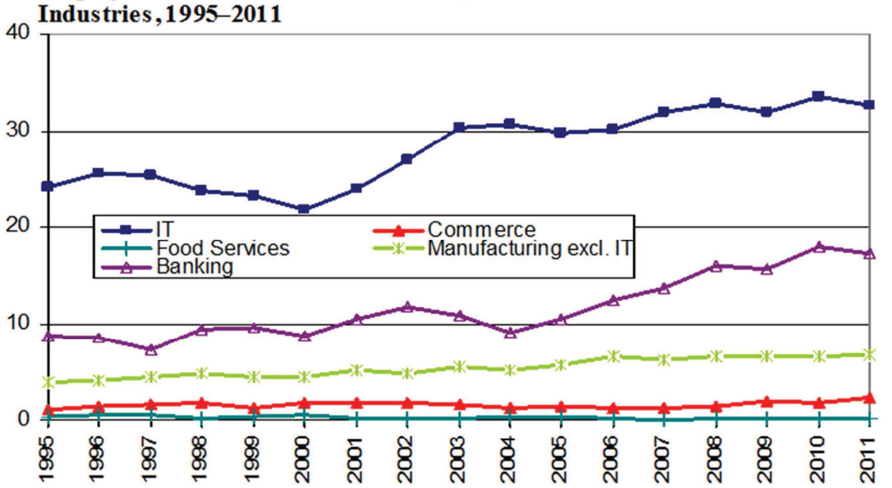
Figures 14 and 15 show the development of the academic professions in the IT industries compared with other industries. The diagrams provide another dimension of the extent of professionalization in the IT industries compared with other industries. They show that between 2001 and 2011, the proportion of workers in the IT industries with academic professions rose from 24 percent to 33 percent. In contrast, in the rest of the business sector, the proportion of workers with academic professions increased from 5.5 percent to 9 percent. Banking is another notable sector in which the proportion of workers with academic professions increased sharply—by 8 percentage points from 2004 to 2011.

**Figure 14**
**Employees with Academic Professions, IT Industries Compared with the Rest of the Business Sector, 1995–2011**




SOURCE: Based on Central Bureau of Statistics Labor Force Survey.

**Figure 15**
**Employees with Academic Professions, IT Industries and Other Selected Industries, 1995–2011**




SOURCE: Based on Central Bureau of Statistics Labor Force Survey.

## 5. WAGES AND WAGE ELASTICITY

As described in Section 2 above, real wages for employees in the IT industries rose by more than 50 percent in the second half of the 1990s, while wages for salaried positions in the rest of the business sector increased by 20 percent. Although this increase in real wages in the IT industries came to a halt in 2001, wages have remained high and relatively stable until today. A sharp change of this kind in the relative wage in the IT industries cannot easily be explained using a competitive wage model. For this purpose we must assume that there was some improvement in the characteristics for which wages are the reward among those working in the IT industries (compared with other workers in the economy) and/or that the return on the characteristics of workers in the IT industries increased in the relevant period. Regarding the characteristics of the workers, in the previous section we showed that in the IT industries they did in fact improve by about 5 percent (in terms of wage value) compared with the rest of the business sector. No data is available about the return on the characteristics, although intuitively, it seems likely that the return on the characteristics of college graduates with a degree in engineering or computers increased at the end of the 1990s.

The competitive wage model also provides a basis for discussing changes in work conditions or the risks facing workers in the IT industries, which in turn have led to higher wages (and how the number of workers in the industry adjusted itself so that the wage did not deviate from the worker's marginal output). Thus for example, workers in the IT industries might consider themselves exposed to risks arising from the nature of the industry, such as a shorter career or frequent changes in wages, that have intensified in the last decade. With respect to work conditions, the increased pressure under which employees in the IT industries work should also be considered.

Another explanation for the increase in wage differences between those working in the IT industries and other workers in the economy, beyond the explanations provided above, lies in rent sharing. According to this approach, there could be wage differences between industries, which change in line with changes in the profitability of the different industries.[20] The uniqueness of the human capital in the IT industries, and the fact that those working in this industry generally do not have any satisfactory alternatives for employment outside the industry, supports the view that the rent-sharing approach is suited to the development of wages in the IT industries.[21]

Empirical findings from the literature support the theory of a relationship between wages in a particular industry and the profitability of that industry. Holmlund and Zetterberg (1991) found such a relationship for the USA, and to a lesser extent for Germany, although they concluded that there is no such relationship regarding the Nordic countries. In a paper on the Italian economy, Guiso et al. (2005) showed that 15 percent of the variance in workers' wages is attributable to permanent shocks absorbed by the firm. Papers by Cardoso and Portela (2009) with data from Portugal, and Guertzgen (2009) with data from Germany, reinforced those findings, and also found that the probability of bankruptcy by these firms and the lack of collective labor agreements increase the relationship between wages and the shocks absorbed by the firm.[22,23]

These results are consistent with other findings about the downward rigidity of wages that show that such rigidity is weaker when the unions have less power, and that wage agreements settle at lower levels (for example, at company level rather than at industry level) as is the case in the IT industries (Messina et al. (2010); Knoppik and Beissinger

[20] This model takes us away from competitive wage models, at least in the short term. In the longer term, wage parity will be achieved when younger workers enter the labor market.

[21] For empirical findings on the loss of human capital entailed in the transition between sectors, see Sullivan (2010), Parent (2000) and Neal (1995). Rogerson (2005), assumes that there is a cost to workers moving between sectors and shows that at equilibrium, existing workers are not displaced and that the structural change takes place through new workers entering the labor market.

[22] In a theoretical model, Gamber (1988) does in fact show that when the probability of bankruptcy is taken into account, the workers in the firm will be willing to participate in absorbing the negative shock absorbed by the firm. In this respect, the fact that wages as a share of output in the IT industries is high places additional pressure on the workers to participate in absorbing negative shocks to the industry, given that if wages fail to adjust there is a strong chance that a negative shock could lead to bankruptcy.

[23] Lagakos and Ordonez (2011) found that workers who have obtained higher education enjoy greater wage security (in other words, their wages are less affected by shocks to productivity) thanks to the loss of the higher wage if they are laid off and change industries. If this finding is also true of the Israeli economy, the implications are that rent sharing by workers will also have a strong presence in other industries. The fact that workers in broad sectors of the economy agreed to wage reductions during the crises of 2002 and 2009 shows that rent sharing in Israel exists in different industries and not only in the IT industries.

(2009); Dickens et al (2007)). Notably, the empirical findings with respect to wage rigidity relate to remaining workers, so that in industries where worker mobility is high, this rigidity becomes less important and wage adjustments at company level may occur through the recruitment of new workers at lower salaries. Another interesting empirical finding emerged from the work of Messina et al. (2010), showing that where competition in the market for products is stronger, the downward wage rigidity of workers in that industry is lower.[24] This finding supports low rigidity of wages in the IT industries (where there is strong competition in international markets) and the ability of firms in the industry to adjust wages to correspond with profitability.

The question of wage adjustment in the IT industries in response to shocks in labor productivity in the industry is mainly empirical, where in case of a negative shock the adjustment will be affected in part by the degree of downward rigidity. I am not aware of any empirical work that examined the degree of downward wage rigidity in Israel, and specifically in the IT industries, although Zussman and Lavi (2005) hint at the notion that where employees are better educated and the human capital is more unique, downward wage rigidity is lower. In their paper, Zussman and Lavi found that the relationship between unemployment among skilled and non-skilled workers negatively affects wages in the economy.[25] In other words, at the macro level, a negative shock that affects skilled workers will support wage reductions more than a similar shock absorbed by non-skilled workers.

The possibility that wages in the IT industries are influenced by the development of productivity in the industry has been mentioned in the past based on the assumption that problems of worker mobility (wage loss) are a contributory factor. For example, the Bank of Israel Annual Report (2011) uses the term "dual economy" to describe the gap between wages in the hi-tech industries that employ a small proportion of all workers in the economy and the rest of the business sector, and it raised the hypothesis that wage reductions are a way of coping with potential damage to profitability in the export industries (of which the IT industries are a key component). A similar notion was proposed by Lavi and Friedman (2006) in addressing the weak relationship that they found between the real exchange rate and exports. However, it is doubtful whether the authors actually

[24] In practice, there may also be reverse causality whereby industries that suffer from relatively severe shocks are able to grow only to the extent that there is employment flexibility.

[25] Zussman and Lavi's interpretation of this finding is somewhat different given that it addresses the response of a wage increase in the case of an increase in the demand for labor. Here we are addressing the opposite case of a drop in the demand for skilled labor, and since the supply of labor is relatively rigid among workers with unique human capital, we would expect to see wage reductions. It is interesting to note that Zussman and Lavi found that the effect of this variable was stronger before the Stabilization Plan than after it. One possible interpretation of the decline in the relative effect of unemployment among skilled and unskilled workers on the average wage in the economy is that the difference in wage elasticity between skilled and unskilled workers has diminished over time, thanks to the weakening of the power of the workers and to cooperation between workers and employers in times of crisis. According to this approach, it is fair to assume that at present, the difference in wage elasticity between skilled and unskilled workers is even lower than Zussman and Lavi found at the time.

believed that the wages of workers in the export industries could develop differently than wages in the domestic industries.[26] The view that the wages of workers in the export industries eroded relative to the wages of workers in the domestic-oriented industries as a result of the currency appreciation of 2008 was also found in a 2008 Bank of Israel analysis of the profitability of manufactured exports.[27]

We will now turn our attention to wage volatility by industry. Figure 16 shows the annual rate of change in real wages for salaried employees in the last ten years in the IT industries and in other industries. Due to the steep wage increases in the IT industries in 1996–2000, and to emphasize wage developments in the industry in more difficult periods, the diagram shows wage changes from 2001.[28] Table 5 presents data that include the real wage volatility for a salaried employee in 1996–2000. The decline in wages in all key industries during the severe crisis of 2002 is marked. In aggregate, real wages in the IT industries in 2002–2003 declined by almost 10 percent. This decline is particularly significant if we consider the sharp increase in the quality of the workforce in the IT industries during the same period. The diagram also shows that wages declined significantly in the rest of the business sector as well. This was the result of the deep recession in that period, and the willingness of the labor unions to accept wage cuts as a way of curtailing further unemployment. Although the crisis of 2008–2009 was less severe, the wage reductions in that period were also significant.[29] The aggregate decline in real wages in the IT industries in those years was almost 7 percent. In that crisis, wage reductions in the IT industries were more marked than in the rest of the business sector, where wages declined by an aggregate 2.5 percent. It is likely that were it not for the weakening of the power of the workers in the business sector as a whole, the wage reductions in the IT industries relative to the rest of the business sector in both crises of the 2000s would have been even more significant.[30]

[26] The theory put forward by Lavi and Friedman was that the characteristics of workers (such as education and human capital) in the tradable sector are very different from the characteristics of workers in the nontradable sector, so that the relationship between wages in the two sectors is weak.

[27] Recent Economic Developments, 122, pp. 30–32, Bank of Israel, 2008.

[28] Two industries that are not represented in the diagram are banking, insurance and financial institutions and the business services industry. Wage volatility in the banking industry are noticeably higher than in other industries and they originate in the variable bonuses that form a significant component of wages in the industry. The business services industry is not shown here due to the heterogeneous nature of the work and the fact that a large proportion of those working in this industry are self-employed.

[29] Data on wages per employee post do not take into account changes in the number of work hours per position, which in some cases are forced on the employee. For a description of the reduction in work hours per employee in the crises of 2002 and 2008–2009, and a comparison with the development of labor inputs in other countries, see the Bank of Israel Annual Report for 2009, pp. 214–216.

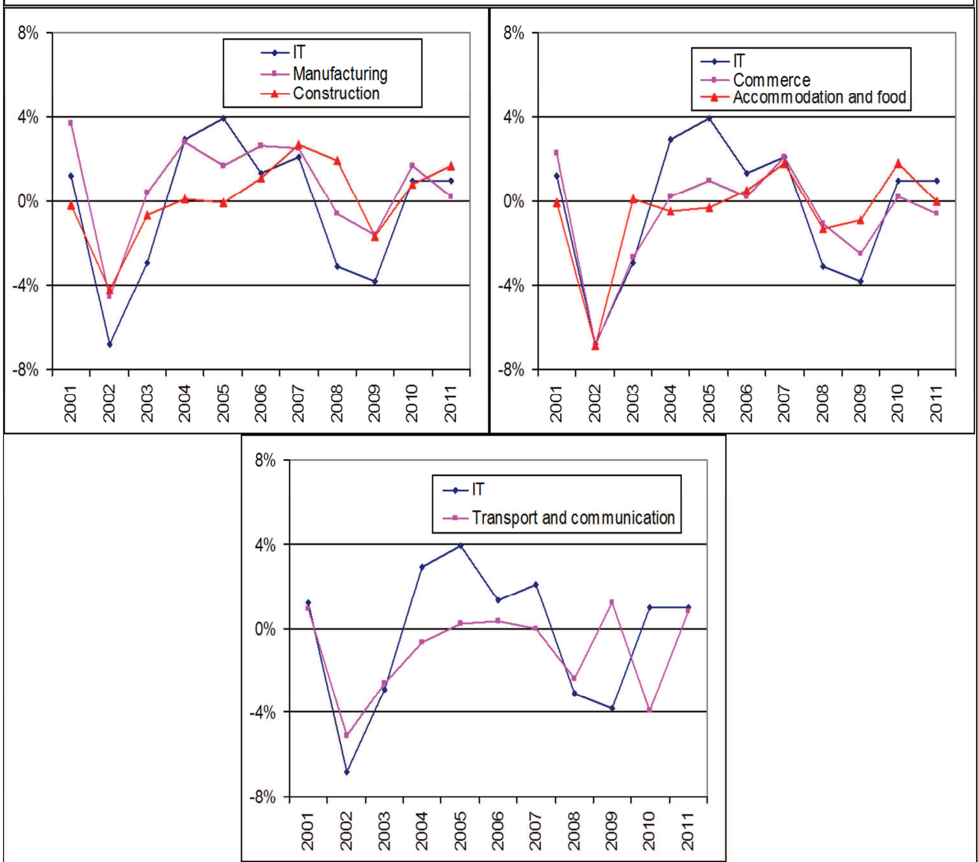
[30] The prevalence of personal employment contracts in the IT industries makes discussion of a decline in the power of workers employed in these industries in the last decade irrelevant, and in any event the weakening of the power of the other workers in the economy did not negatively impact their wages. For a discussion of the factors that led to an erosion of wages in the economy in the last ten years, see “Workers, Employers and the Distribution of Israel’s National Income, Report for 2008”, Adva Center (2009).

A look at the upward changes in wages in the IT industries shows that they are also generally more significant than in other industries. In the 2004–2007 period of rapid growth, the real wage per employee post in the IT industries rose by more than 10 percent, compared with just 5 percent in the rest of the business sector. Table 5 shows the standard deviation of the change in real wages per employee post in different industries in the period between 1996 and 2011. The Table shows that wage volatility in the IT industries is higher than in the other industries (except for banking and finance), and that it remains higher during different sub-periods in the sample.

Wage volatility in the IT industries, and specifically significant wage decreases in times of crisis, support, but do not prove, the theory that wages in these industries respond more sharply to economic developments than in other industries. While our assessment is that the IT industries were more deeply affected by shocks during the reviewed period than other industries, which could explain the sharp changes in wages, in the long term an industry that is exposed to severe shocks must also have the flexibility (in wages or employees) to allow employers to adapt. In this context, Cunat and Melitz (2012) found that the exports of countries with more flexible labor markets clearly tend towards high-volatility industries (which in their paper are measured by the variance in the increase in sales). Saint-Paul's theoretical work (1997), which shows that countries with a more flexible labor market will specialize in the production of more innovative products, also corresponds with the view that wage changes are the principal instrument through which IT industries adjust themselves to shocks.[31]

[31] Both these papers address wage elasticity in the economy in general terms, and their conclusions dovetail with the fact that the exogenic shocks in the first decade of the century have led to a decline in wages in many industries.

**Figure 16**
**Change in the Real Wage Per Employee Post in the IT Industries and in Other Selected Industries, 2001–11**




SOURCE: Central Bureau of Statistics.

**Table 5**
**Standard deviation of change in the real wage per employee post in the principal industries**

| Industry | Employee posts in 2010 (thousands) | Standard deviation of change in real wage per employee post [2] | | |
|---|---|---|---|---|
| | | 1996-2011 | 2001-2011 | 2003-2011 |
| Information technology[1] | 189 | 5.1 | 3.3 | 2.8 |
| Manufacturing excluding technology | 291 | 2.5*** | 2.4 | 1.6* |
| Construction (D) | 138 | 2.9** | 1.9** | 1.4** |
| Trade (E) | 412 | 2.9** | 2.6 | 1.6* |
| Accommodation & food services (F) | 158 | 2.3*** | 2.3 | 1.1*** |
| Transport and communications (G) | 169 | 2.2*** | 2.1* | 1.8 |
| Banking & finance (H) | 98 | 6.8 | 6.9 | 6.7 |
| Education (K) | 397 | 2.6*** | 2.8 | 2.5 |
| Health and welfare (L) | 319 | 4.8 | 2.6 | 1.7* |

[1] Industries 32–34 and 72–73.
[2] Due to limited data in some industries, calculation of the wage change includes wages for foreign workers.
* Less than the standard deviation in the IT industries at significance level of 10 percent; ** Less than the standard deviation in the IT industries at a significance level of 5 percent; *** Less than the standard deviation in IT industries at significance level of 1 percent. All the significances are in accordance with an F test for comparing variances between observations sampled in different populations. The test assumes that the distribution of the wage changes in each population is normal.
**SOURCE**: Author's calculations based on data from the Central Bureau of Statistics on employee posts and wages per employee post.

## 6. SUMMARY

The increase in relative labor productivity in the IT industries in the second half of the 1990s led to these industries doubling their share of GDP, to an increase in the relative wages of the professional employees in these industries, and to an increase in the proportion of electrical and electronic engineers and those with degrees in computer science among employees in the IT industries and in the economy as a whole. High productivity in the IT industries boosted the concentration of engineers and computer specialists in those industries, a fact that may have repercussions at the macro level when there are shocks in this industry.

The unique nature of the human capital in the IT industries means that there is a prolonged adjustment process between changes in productivity and the size of the industry. For example, it took 5–8 years for the IT industries' share in the economy to adjust to the changes in relative productivity that occurred in the second half of the 1990s, and that adjustment was to a large extent based on young people entering the labor market.

When the industry is affected by a negative shock, the adjustment of the supply of labor to the demand for workers in the IT industries and vice-versa may be difficult and is likely to take the form of a combination of wage reductions and fewer young people entering the workforce in this industry. The departure of workers from the IT industries will cause a significant loss in their earning power, and it can therefore be assumed that a substantial share of the employees will agree to a cutback in their relative wages before seeking employment opportunities in other industries. This process occurred both in the crisis of 2001–2003 and in the 2008–2009 period, when a decline in global demand (in both crises) and a real currency appreciation (in the second crisis) combined to lower wages. Although in the crisis of 2001–2003 wages and the proportion of workers in the IT industries decreased concurrently, the latter was driven by the drop in the number of employees with relatively low human capital. In this context, it can be said that the falling number of electrical engineering and computer science graduates from 2006 onwards is the outcome of the dot-com crisis, and it is certainly possible that the real currency appreciation of 2008–2010, the slowdown of global trade in the last few years and the fear that Europe's debt crisis will lead to a further drop in global demand will affect the number of college graduates with these degrees in coming years.

The fact that the IT industries are the principal source of employment for those with degrees in electrical and electronic engineering, computers, math and statistics and the natural sciences, and that output per worker in these industries is influenced by the exchange rate, creates a close relationship between the exchange rate and the wages of workers employed in the IT industries. For example, an exogenic appreciation of the exchange rate lowers the nominal output per worker in the IT industries, which in turn works to reduce wages. Given that the wages of employees in the IT industries are among the highest in the economy and that employees in these industries have no real alternative in the domestic-oriented industries, this relationship will probably be stronger than in other export industries where the employees have alternative employment opportunities.

## BIBLIOGRAPHY

Hebrew sources:

Abuganim, M. and M. Feldman (2002), "The Development of Israel's Hi-Tech Industry 1995–1999: Manpower and Wages", Working Papers Series, no.1 Central Bureau of Statistics.

Dar, F. (2001), "The Effect of Startup Companies on the Israeli Economy", *Israel Tax Quarterly*, 113, pp. 7–15.

Central Bureau of Statistics (2008), The Information Technology Industries (ICT) 1995–2006.

Central Bureau of Statistics (2010), Development of Israel's Hi-Tech Sector 1995–2007, publication no. 1389, November.

Central Bureau of Statistics (various years), Income Surveys and Labor Force Surveys.

Zussman, N. and J. Lavi (2005), "Setting the Real Wage in the Long Term and Wage Changes in the Short Term—Israel, 1968–1998", *Bank of Israel Review*, 77.

Zussman, N. and A. Friedman (2009), "Workforce Quality in Israel", *Bank of Israel Review*, 82.

Lavi, Y. (1997), "Effect of the Real Exchange Rate on the Development of the Import Surplus as a Share of Output, 1961–1996", Bank of Israel Research Department (not published).

Lavi, Y. and A. Friedman (2006), "The Real Exchange Rate and Israel's Foreign Trade", *Bank of Israel Review*, 79.

Adva Center (2009), "Workers, Employers and the Distribution of Israel's National Income", Report for 2008.

Prime Minister's Office (2012), "The Shortage of Skilled Manpower in High Technology" – Recommendations of an Interministerial Task Force, July. (http://www.pmo.gov.il/Lists/FAQkalkala/Attachments/21/tech.pdf - Hebrew)

Sofer, Y. (2005), "Measuring the Real Exchange Rate in Israel and its Impact on Imports and Exports", Issues in Foreign Exchange 1/05, Bank of Israel.

Kirsch, U. (2010), "Higher Education Policy in Israel: Accessibility, Quality and Excellence with Limited Resources", Samuel Neaman Institute for National Policy Research.

Kirschberg, E. (2012), "Business Demographics and the Movement of Workers in the Research and Development Industry", Working Paper Series 72, Central Bureau of Statistics.

English sources:

Aaronson, D. and D. Sullivan (2001), "Growth in Worker Quality", *Economic Perspectives,* 25(4), Federal Reserve Bank of Chicago, pp. 53–74.

Bank of Israel Annual Reports (various years).

Bank of Israel (2008), "Recent Economic Developments 122", August.

Baxter, M. and A. C. Stockman (1989), "Business Cycles and the Exchange Rate Regime, Some International Evidence", *Journal of Monetary Economics,* 23, 377–400.

Berman, N., P. Martin and T. Mayer (2012), "How do Different Exporters React to Exchange Rate Changes?", *Quarterly Journal of Economics,* 127(1), 437–492.

Cardoso, A.R. and M. Portela (2009), "Micro Foundation for Wage Flexibility: Wage Insurance at the Firm Level", *Scandinavian Journal of Economics,* 111(1), 29–50.

Cunat, A. and M. Melitz (2012), "Volatility, Labor Market Flexibility, and the Pattern of Comparative Advantage", *Journal of the European Economic Association,* 10(2), 225–254.

Deckle, R., H. Jeong and H. Ryoo (2010), "A Re-Examination of the Exchange Rate Disconnect Puzzle: Evidence from Firm Level Data", mimeo, University of Southern California.

Dickens, W. T., L. Goette, E. L. Groshen, S. Holden, J. Messina, M. E. Schweitzer, J. Turunen and M. Ward (2007), "How Wages Change: Micro Evidence from the International Wage Flexibility Project", *Journal of Economic Perspectives*, 21(2), 195–214.

Gamber, E.N. (1988), "Long-Term Risk-Sharing Wage Contracts in an Economy Subject to Permanent and Temporary Shocks", *Journal of Labor Economics,* 6(1), 83–99.

Goldberg, P.K. and M. M. Knetter (1997), "Goods Prices and Exchange Rates: What Have We Learned?", *Journal of Economic Literature,* 35, 1243–1272.

Guertzgen, N. (2009), "Wage Insurance Within German Firms: Do Institutions Matter?", ZEW Discussion Papers, No. 09–043.

Guiso, L., L. Pistaferri and F. Schivardi (2005), "Insurance Within the Firm", *Journal of Political Economy*, 113(5), 1054–1087.

Holmlund, B. and J. Zetterberg (1991), "Insider Effects in Wage Determination – Evidence from Five Countries", *European Economic Review,* 35, 1009–1034.

Justman, M. (2001), "Structural Change and the Emergence of Israel's Hi-Tech Sector", in: A. Ben-Bassat ed., "The Israeli Economy 1985-1998: From Government Intervention to Market Economics, Collection of Studies in Memory of Prof. Michael Bruno," Tel Aviv, Am Oved, in Hebrew, 2001, pp. 558-610; and, in English, Cambridge, MA: MIT Press, 2002, pp. 445-483.

Knoppik, C. and T. Beissinger (2009), "Downward Nominal Wage Rigidity in Europe: an Analysis of European Micro Data from the ECHP 1994–2001", *Empirical Economics*, 36, 321–338.

Lagakos, D. and G. L. Ordonez (2011), "Which Workers Get Insurance Within the Firm", *Journal of Monetary Economics,* 58, 632–645.

Messina, J., C. F. Duarte, M. Izquierdo, P. D. Caju and N. L. Hansen (2010), "The Incidence of Nominal and Real Wage Rigidity: An Individual-Based Sectoral Approach", *Journal of the European Economic Association,* 8(2-3), 487–496.

Neal, D. (1995), "Industry-Specific Human Capital: Evidence from Displaced Workers", *Journal of Labor Economics,* 13(4), 653–677.

OECD (2012), Internet Economy Outlook 2012, OECD Publishing, Paris.

OECD (2013), OECD Factbook 2013: Economic, Environmental and Social Statistics, OECD Publishing, Paris.

Parent, D. (2000), "Wage Profile: Evidence from the National Longitudinal Survey of Youth and the Panel Study of Income Dynamics", *Journal of Labor Economics,* 18(2), pp. 306–323.

Rogerson, R. (2005), "Sectoral Shocks, Human Capital, and Displaced Workers", *Review of Economic Dynamics,* 8, 89–105.

Saint-Paul, G. (1997), "Is Labor Rigidity Harming Europe's Competitiveness? The Effect of Job Protection on the Pattern of Trade and Welfare", *European Economic Review,* 41, 499–506.

Sullivan, P. (2010), "Empirical Evidence on Occupation and Industry Specific Human Capital", *Labor Economics,* 17, 567–580.