Selected Research Analyses

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This publication replaces the “Recent Economic Developments” series.
This publication will also be published semi-annually, and will include analyses by the Research Department of relevant topics in Israel’s economy,
as well as a periodic fiscal survey.

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The Development of the Electricity Market in Israel: Toward a Sustainable Electricity Market[1,2]

- Electricity production through renewable energy lags significantly behind government targets, after also lagging behind in the previous decade.
- In retrospect, we see that as the costs of production through renewable energy have declined significantly, the lag saved the economy approximately 10 percent of electricity expenses, but it caused a delay in meeting the environmental targets set by the government.
- The lag is a result of unrealistic targets, onerous regulation, and delays due to the sharp decline in the costs of production.
- The lack of long-term planning, particularly of the electricity transmission grid, creates the main future barrier to producing electricity from renewable energy sources, and is already effectively blocking the expansion of the use of such energy sources.

In the past two decades, many countries have signed agreements to reduce greenhouse gas emissions, with the aim of achieving climate targets, and technology for generating electricity through renewable energy is helping the world meet those targets. Since Israel is bound by such agreements, the government has adopted greenhouse gas emission objectives, and from those objectives has derived targets for the production of electricity through renewable energy sources. The decisions to advance production targets were therefore made out of environmental motivations, with a readiness to bear the economic costs.

This paper discusses the effect of the production targets on the Israeli economy, the process the electricity market is undergoing toward implementation of those targets, the difficulties encountered in realizing those targets, the regulatory changes that have been made, and the challenges that may develop in the future.

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[2] The authors thank Haim Vider and Yossi Margoninsky of the Bank of Israel, Honi Kabalo of the Israel Public Utility Authority – Electricity (PUA), and Eitan Parness and Saar Ben-Tzvi of the Association of Green Energy Companies in Israel. Special thanks to Yuval Zohar of the PUA, for his tremendous assistance in providing access to the information and for discussions on the topic.

Renewable energy in Israel and globally

In 2009, Israel manufactured almost none of its electricity through renewable energy sources. However, a series of policy changes and technological developments have made the cost of production from solar and wind energy competitive with the cost of using fuels, and development in the field has accelerated. In 2016 Israel generated 2.65 percent of its total electricity through renewable energy sources. In this context it is worth noting that the average in the other advanced economies is approximately 24.5 percent, and that Israel mainly uses solar energy (2.5 percent of total production) while most other countries use hydro energy (about 16.6 percent of total production), followed by wind energy (4 percent) and bio-energy (2 percent). Solar energy is used to produce only about 1.5 percent of total global production (REN21, 2017).

There is significant evidence of a marked transformation in this low rate, due to the dramatic decline in the cost of production through photovoltaic cells (which convert light to electricity). Since 2009, global prices have declined from an average of $300 per mWh to an average of about $100 per mWh. This technology has thus become a means of production that is almost as inexpensive as production through fossil fuels (oil, coal and natural gas), and the least expensive technology after wind energy production (about $90 per mWh; UN, 2017). In Israel, the sea-change during this period has been even more dramatic. The price of electricity generated through photovoltaic means declined from about $470 per mWh to about $71 per mWh (see Bank of Israel, 2015). It seems that the change in Israel is greater since the authorities eased the regulatory burden on production, and because regulation in Israel before the change imposed heavier costs than in other places around the world, including betterment levies on changing land zoning to electricity production, and income tax on electricity production on private rooftops. Since it seems that for now, photovoltaic technology is more relevant for Israel than wind technology, our discussion will focus on solar energy.

Until recently, electricity produced from renewable energy sources cost more than that produced from fossil fuels, which made it necessary for the government to support such production (directly via subsidies, or indirectly by raising the prices of other forms of production) in order to encourage production and to contribute to reduced greenhouse gas emissions. The

most common tool for direct support is based on the feed-in tariff: For each kWh fed into the grid by the producer, the producer would receive a pre-determined price from the government, up to a pre-determined ceiling. The price calculation included an assessment of the fixed and marginal costs to the producer[3], plus profit. The dramatic and steady decline in production costs in recent years led producers throughout the world, once they reached agreement with the sovereign on the feed-in tariff, to delay the date of facility construction as much as possible, on the assumption that the technology would improve and the cost of production would fall.[4] Therefore, the government replaced the feed-in tariff with a feed-in premium. In this way, the profit was determined in advance, but the cost was only fixed when the producer connected to the grid. In recent years, this method too has been neglected, this time in favor of price tenders—a method in which the producer commits to a price for the entire period. In 2015, more than 60 countries adopted some kind of price tender format (REN21, 2016).

Data from recent years show that the volume of electricity production from renewable energy sources around the world has been growing at an increasing rate. In 2016, approximately 55 percent of new global electricity production capacity was generated from renewable energy sources. This was the second consecutive year in which most of the increase in supply was based on renewable energy and not on fossil fuels. About 47 percent of the addition was generated through photovoltaic technology, 34 percent through wind technology, and 15 percent through hydro technology. Global investment data indicate an even more dramatic change. Investments in renewable energy constitute 70 percent of global investment in electricity production (IEA, 2016b). While there has been no large change in terms of money since the beginning of the decade, the increase in efficiency and the decline in costs have led to a situation where each dollar invested in electricity production through renewable energy sources generates 1.3 times the volume that it did at the beginning of the decade.

[3] The fixed cost includes its capital investment.

[4] This behavior can be witnessed in China. The contract signed with most of the producers there expired in mid-2017, after it had been in effect for a number of years. At the beginning of 2017, it became clear that the government was refusing to extend the contract's validity, and within half a year, facilities were established with a capacity of about 20 gigawatts.

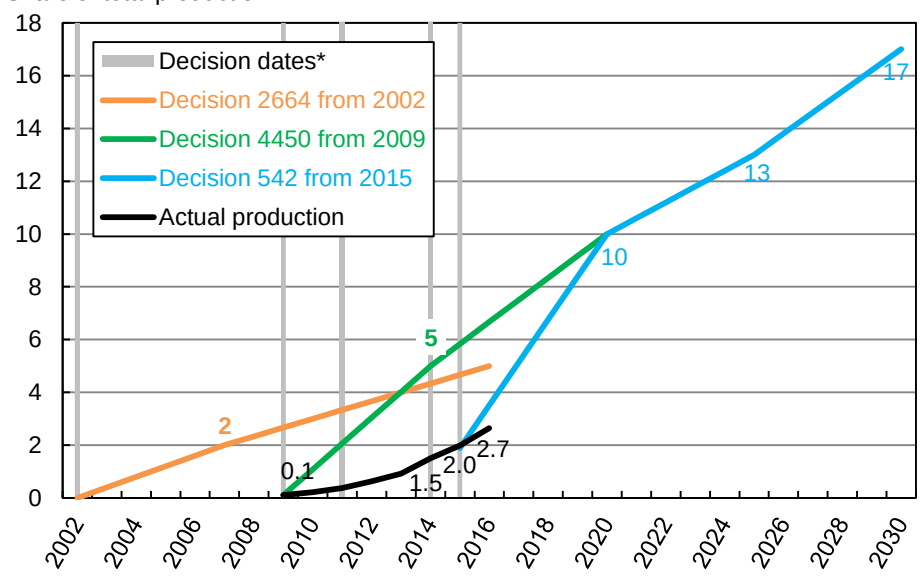
This section discussed electricity production. In order to lay the groundwork for later discussions, it is important to clarify that this term—actual production (consumption)—relates to the supply of produced (consumed) electricity multiplied by the amount of time over which it is produced (consumed), and that this is measured in kilowatt-hours (kWh). The phrase "electricity capacity" relates to the quantity of electricity that a power station is able to produce at any given moment, and is measured in watts (kilowatts, megawatts, etc.) The difference between them is of particular importance when examining renewable energy sources, since various types of facilities and/or facilities that use different types of energy are able to produce electricity for different durations. For instance, photovoltaic installations in Israel are able to produce electricity for 1,600–1,900 hours per year; wind installations are able to produce for about 2,600 hours per year, and bio-gas installations are able to produce for about 6,500 hours per year. Therefore, a bio-gas installation with a capacity of 100 megawatts is able to produce four times as much energy as a photovoltaic installation with the same capacity.

1. Between policy and its implementation: On the path to meeting targets

a. Setting targets

Over the past decade-and-a-half, the government of Israel set a number of targets for producing electricity from renewable energy sources. Figure 1 shows the dates of the decisions (gray lines), the annual targets that each decision set for production from renewable energy as a percentage of total production, and the actual rate of production. Each time a decision on targets was made we set the beginning of the target path at the actual production rate for that year, and in order to illustrate the path needed to get there we drew a line to the target that was set.

Figure 1
Government Decisions Regarding Electricity Production from Renewable Energy Sources, 2002–2030



* The decisions made in 2011 and 2014 did not change the government targets. We present them because they ratified the targets and related to the implementation of the decisions.

SOURCE: Based on decisions of the government and the Electricity Authority and Electricity Authority data.

In 2002, the first decision was made, setting concrete targets for electricity production from renewable energy source. The decision set out that from 2007, Israel would produce 2 percent of its electricity from renewable energy sources, and that this rate would gradually increase to 5 percent in 2016. These targets preceded technological abilities in the field of renewable energy, as was reflected in the fact that in 2009, two years after the date for meeting the first target and seven years after the decision was made, production from renewable energy sources was about 0.1 percent of total production—far below the target set for 2007 (Figure 1). It should be noted that the decision was made before the volume of natural gas in Israel's fields was known, so it did not take into account the shift from the use of coal to the use of natural gas or its effect on the reduction of emissions.

In 2009, the government decided that by 2020, renewable energy would be the source of 10 percent of Israel's electricity consumption. In addition, it set an intermediate target of 5 percent of consumption by 2014 (2 years before the date for this target set in the 2002 decision). The government also decided that a 250-megawatt power station would be established each

year between 2010 and 2020.[5] This time as well, the targets were ahead of their time. Even at the time of the decision, it was already clear that the path could not be adhered to in full, since it required the establishment of power stations as early as 2010, just one year after the government decision. As mentioned, when the decision was made, Israel was producing less than 0.10 percent of its electricity from renewable energy sources—a marked lag compared with the previous targets.

Even though the 2009 decision was not implemented, it advanced the government's work in the field on a number of levels. The decision led the Ministry of National Infrastructure to prepare a prospectus for electricity production and consumption from 2014 to 2020[6], and this prospectus broke down the target production quotas by type of renewable energy (solar, wind, bio-gas, and biomass), and listed the sites of electricity production from solar and wind energy that were in the planning process. (As of 2017, most of these sites had no electricity production facilities.)

Moreover, in 2011, the government adopted the recommendations of the Planning Administration of the Ministry of Interior, and added definitions of the terms and permits for producing electricity from renewable energy sources to the National Outline Plan (NOP 10/d/10). While such production was an option prior to the revision of the National Outline Plan, the approvals process was long and convoluted without a clear procedure, and required the involvement of senior officials in each decision—which led to additional costs and made such production less worthwhile.

However, the National Outline Plan of 2011 set out, among other things, that a betterment levy could be charged on land for which the zoning has been changed to electricity production from renewable energy sources. The betterment levy was added to the cost of production, and made it more difficult for the industry to develop. An exemption from this betterment levy was only finally provided in the Economic Arrangements Law of 2016. The setting of regulations and work procedures has an important role in the

[5] This decision did not define exactly what types of station would be built, so we cannot assess the annual contribution they would have been expected to make to the production (consumption) of electricity.

[6] "Policy of the Ministry of National Infrastructure to Integrate Renewable Energy in the Electricity Production Array in Israel", Ministry of National Infrastructure, February 14, 2010.

development process of a market in general, and of a market subject to strict regulatory supervision in particular, and the initial lack of consideration of this stage is among the factors that led to electricity production from renewable energy resources missing the government targets.

In 2011, the government reached another decision, which was based on the report published by the Ministry of Infrastructure in 2010. This decision set out milestones and quantitative targets for the production of electricity from renewable energy sources. While the decision does not include new targets, it did constitute a milestone in the transition to implementing the policy.[7] There is a clear difference between this decision and the government decision from 2002. Where the 2002 decision was general and was not translated into a workable program, the 2011 decision was accompanied by a path that was based on a professional report from the Ministry of Energy, and was therefore more practically workable.

Another government decision, from 2014, changed the way the production quotas are divided among the types of renewable energy. The decision did not change the targets set by the government in the 2009 decision, even though electricity production from renewable energy sources reached 1.5 percent of total production in 2014, while the target set in 2009 was for 5 percent of production in 2014. Moreover, in 2015, the government made a decision setting additional targets for electricity production from renewable energy sources: 13 percent of output in 2025, and 17 percent in 2030.

In July 2017, an amendment to the Electricity Market Law was passed. The amendment requires the Minister of Energy to formulate a multi-year plan for electricity production from renewable energy sources, and to detail the actions that must be taken each year. It establishes an interministerial committee for electricity production from renewable energy sources, and it requires the Director General of the Ministry of Energy to report to the Knesset Economics Committee on the extent to which the market is meeting production targets.

[7] Even before the decision, the authorities enabled the production of electricity from renewable energy sources. But in practice, the decision accelerated the process. The PUA published a number of regulation tracks for production in 2009, and one track in 2010, but (as of 2017), it published most of the tracks in 2011. A regulation track presents the PUA's decision regarding the relevant price arrangement and the criteria that must be met in order to produce electricity through a particular method or technology.

b. Meeting the targets

Figure 2 shows the four main stages in the process that was in place until recently.[8] In the first stage, the government set targets for electricity production from renewable energy sources, and then it or the Ministry of Energy set quotas for various types of renewable energy. In the second stage, the Public Utility Authority- Electricity (PUA) published quotas detailing the type of renewable energy, the required volume of production, and the feed-in tariff that the producer would receive.[9] Following the publication of the quotas, producers submitted plans for building facilities in accordance with the conditions set out for the quotas, and following an initial examination, they received a conditional production license with time-limited validity.[10] As the project advanced—a process that included depositing construction plans with the PUA, technical coordination with the Israeli Electric Company (IEC), an initial financing agreement and financial closing—the producer obtained approval of the fixed price that would be paid to it for each unit of electricity fed into the grid. This price was set on the basis of its costs, a figure calculated by economists at the PUA, plus a profit that was considered fair (10–14 percent), and was valid for 20 years from the beginning of production at the facility. In other words, the government undertook to purchase any amount the producer would generate up to the quota approved for that producer, at the fixed price, for the first 20 years of the facility's operation. After financial closing, the producer had to complete construction of the facility during the remaining period of the conditional license, or the State's commitment would expire.

[8] The PUA recently switched to price tenders, a method in which the producers compete over the lower price. On March 20,2017, the first price tender for photovoltaic production facilities closed. The winners will build facilities with a capacity of 235 megawatts, and will receive 19.9 agorot per kWh.

[9] In addition to the PUA, two other government entities published tenders—the Accountant General in the Ministry of Finance, and the Israel Lands Authority (ILA). The Accountant General is responsible for a tender for two thermosolar facilities and two photovoltaic facilities at Ashelim, and the ILA is responsible for land tenders for the mid-sized photovoltaic facilities that will be built on land that the State will market.

[10] The period of the conditional license was dependent on technology: photovoltaic—42 months; wind—66 months.

Figure 2
The Regulation Process Over Time

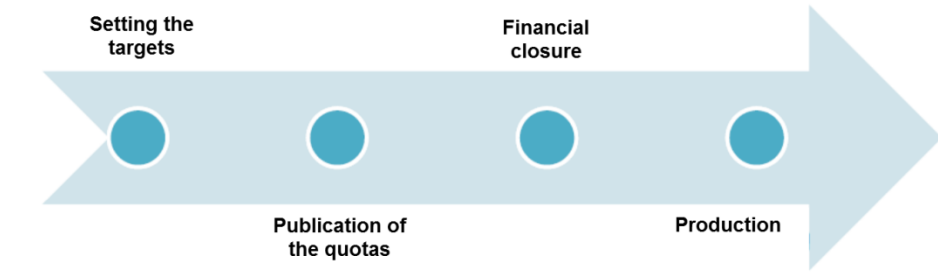
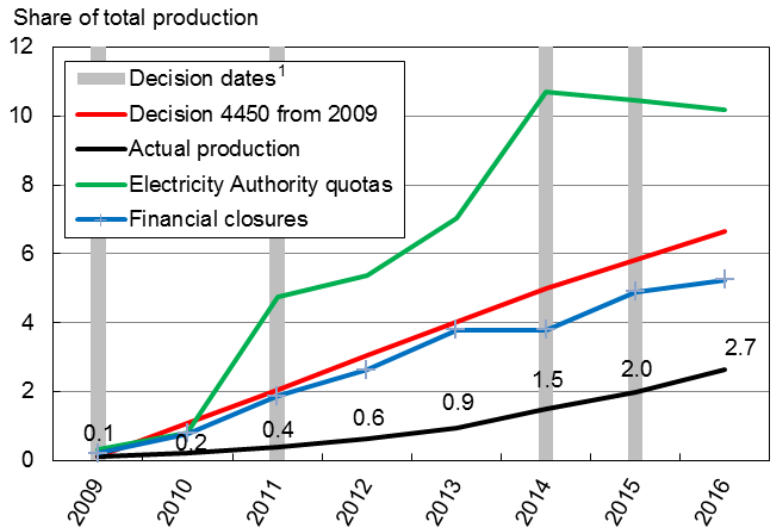


Figure 3 outlines the development of the renewable energy market during the period beginning with the government decision on targets in 2009 and ending in 2016. The Figure shows that until 2014, the PUA published quotas for about 10 percent of total electricity production, as part of an attempt to meet the long-term targets. We note that the target of 10 percent of total electricity consumption set in 2009 relates to 2020. The Figure shows that in the first years following the setting of the target (2009–2013), there is no large gap between the government's targets and financial closures, meaning that a significant part of the projects moved forward in accordance with government targets. In recent years, the gap between the target and financial closures has widened, while the gap between financial closures and actual production has narrowed.

Figure 3
Stages in the Implementation of Government Decisions on Electricity Production from Renewable Energy, 2009–2016



[1] The decisions made in 2011 and 2014 did not change the government targets, We show them because they confirmed the targets and related to the implementation of decisions.

SOURCE: Government decisions and Israel Electricity Authority. Based on IEA data.

Before discussing the reasons for each part of the gap, we must emphasize that in retrospect, it turns out that the gap saved the economy significant costs: We can now reach the production targets at a lower cost, thanks to rapid technological development and the sharp decline in the costs of producing electricity through photovoltaic technologies. At the same time, it is important to emphasize that had the targets been met in full, there would be some benefit in terms of a decline in air pollution, but we do not have the tools to assess the extent of that benefit. Table 1 shows an estimate of the costs saved. It is worth noting that in at least some of the cases, all of the profit from the delay was absorbed by the producers due to the form of regulation instituted in the market and the extent of enforcement (see below).

Table 1: Simulation of the cost of electricity had the government targets been fully met, 2009–15

	Cost of electricity production through fossil fuels and through renewable energy (NIS million per gWh)				Additional annual cost to the economy (NIS billion)			Rate of increase in total cost of electricity		
Year	Fossil fuels	Renewable low	Renewable high	Renewable median	Low	High	Median	Low	High	Median
2009	0.45	1.80	2.21	2.01	1.8	2.4	2.1	7.6	9.9	8.7
2010	0.41	1.60	2.05	1.83	2.2	2.8	2.5	9.3	12.2	10.8
2011	0.44	0.93	1.26	1.10	2.3	3.0	2.6	8.9	11.9	10.4
2012	0.51	0.46	0.71	0.59	2.2	3.1	2.7	7.0	9.6	8.3
2013	0.54	0.53	0.64	0.59	2.2	3.1	2.7	6.8	9.3	8.0
2014	0.54	0.47	0.50	0.49	2.2	3.1	2.7	6.8	9.3	8.0
2015	0.47	0.27	0.31	0.29	2.2	3.0	2.6	7.2	10.0	8.6

SOURCE: Based on Israel Electricity Authority.

In order to give a simple example, let us track the calculation of cost for 2009, when 53,267 gWh of electricity were produced. In that year, 58 gWh were produced through renewable energy sources (0.10 percent of total production). Since the target from 2002 was 2.67 percent (assuming that production advanced in linear fashion toward the 2014 target)—i.e. 1,420 gWh—actual production fell 1,363 gWh short of the target. In 2009, the median cost of production using photovoltaic technology was NIS 2.01 per kWh[11], while the cost of the alternative—production using fossil fuels—was NIS 0.45. The gap between the prices, multiplied by the required additional production to reach the target for that year (2.67%), totaled NIS 2.1 billion. As the cost of production using fossil fuels multiplied by total electricity production was NIS 24.2 billion, reaching the renewable energy target would have added 8.5 percent to the cost of electricity consumption at the median price. As stated, the government decided that it was worth paying this price in order to reduce air pollution.

2. Bottlenecks in past regulatory procedures

a. The gap between the quotas and financial closure—barriers to specific regulatory tracks

[11] This calculation begins in 2009 and assumes that the facilities that completed meeting the 2009 target were built at 2009 construction costs. The addition required to meet the target each year was calculated at the construction costs of that year.

Table 2 lists the quotas published until 2014 by the source of energy and regulation track. Generally, the energy sources can be divided into four groups: (1) Solar (based on heat [thermosolar] or light [photovoltaic][12]); (2) wind[13]; (3) bio-gas[14]; and (4) burning biomass and waste.[15] (As mentioned, these sources and tracks differ, among other things, in the number of hours they can produce electricity per year, and therefore in the quantity of energy they actually produce at a given capacity.) There is also a fifth source of energy—water—which is used globally to produce significant amounts of electricity, but this source is not available to the Israeli market. The Israeli market has plentiful sunlight, and a large portion of the quotas are assigned to solar energy, with wind energy in second place.

[12] Photovoltaic energy is divided into a number of regulatory tracks: Small facilities—with a capacity of up to 50 kW; medium facilities—with a capacity of between 50 kW and 12 mW and connected to the distribution grid; large facilities—with a capacity of more than 12 mW that is connected to the transmission grid; net metering facilities—with a capacity of up to 5 mW and used first of all for self-consumption; experimental facilities—various testing facilities; and land tenders—medium facilities to be built on land marketed by the State through ILA tenders.

[13] Wind energy is divided into two regulatory tracks: (1) small facilities—with a capacity of up to 50kW; and (2) large facilities—with a capacity of more than 50 kW.

[14] Producing electricity from bio-gas, which is derived from organic waste through anaerobic digestion.

[15] Production of electricity from agricultural crops, agricultural trimmings or biologically breaking down organic waste, without using anaerobic digestion technology.

Table 2: Quotas and financial closures (capacity in mW) by technology, 2014

Technology	Regulation	Quota	Financial closure	Closure rate
Solar - Photovoltaic	Net metering	400	60	15
Solar - Photovoltaic	Small Photovoltaic	310	274	88
Solar - Photovoltaic	Medium Photovoltaic	470	300	64
Solar - Photovoltaic	Large Photovoltaic	370	200	54
Solar - Photovoltaic	Experimental facilities	50	0	0
Solar - Photovoltaic	Land tenders including Ashelim PV	150	106	71
Solar - Photovoltaic	Thermosolar converted to PV	180	0	0
Solar - Thermal	Thermosolar	252	252	100
Bio-gas: Anaerobic digestion	Bio-gas: Anaerobic digestion	100	11	11
Bio-mass and waste	Bio-mass and waste	50	0	0
Wind	Large wind	730	21	3
Wind	Small wind	10	0	0
Total		3072	1224	40

SOURCE: Based on government decisions, and PUA decisions and data.

The Table also includes the quantity of financial closures, i.e. the total capacity for which the developers have progressed in the construction process to the point of obtaining a secured price. It shows that most of the gap between the quotas and the closures is in three specific regulatory tracks: wind turbines, net metering, and producing electricity through bio-gas and bio-mass.

The regulatory track for producing electricity through wind turbines was published back at the beginning of the decade, but the rate of financial closures in the wind category is very low. There are two parts to the explanation for this: (a) Construction of facilities in the Golan Heights encountered opposition from the defense establishment. A proposal was recently put forward to grant the Defense Ministry budgets for technological means to overcome the problem that it had and which it could not detail.[16] (b) Construction of facilities in the Galilee encountered opposition from environmental organizations that claimed that the turbines have a negative impact on bird migration. Production quotas from wind energy were 730 mW, but by 2014, just 21 mW were realized. Had capacity from wind energy been 709 mW higher, in accordance with the published quotas, it

[16] http://m.knesset.gov.il/News/PressReleases/pages/press180117-k.aspx

would have contributed 3.0 percent of Israel's electricity consumption in 2014.

The phrase "net metering"[17] relates to electricity production from solar energy through installations on the rooftops of private and commercial properties. The home or business owner produces electricity for self-consumption and feeds surplus production into the grid, where he accumulates electricity credits to use as necessary. The realization rate of this track is low, mainly due to the multiplicity of regulatory barriers. While many such barriers have recently been removed[18], there remain financing problems that restrict the expansion of the use of net metering. The production capacity on this track was 400 mW, but by 2014, only 60 mW had been realized. Had the difference been realized, it would have contributed 1 percent of Israel's electricity consumption in 2014.

Production quotas from bio-gas and bio-mass are also beset by low realization. While the volume of quotas for these sources totals just 150 mW, production from these sources can be very high since the facilities can be used almost non-stop, in contrast to facilities based on solar and wind energy. However, it seems that despite their low volume, these quotas will also not be met, as an examination by the Ministry of Environmental Protection showed that the potential production from such sources totaled just a few mW (Ministry of Environmental Protection, 2014), and even when they were issued, the odds of these quotas being met were low. Had the quotas been fully realized, it would have added about 1.4 percent of electricity production to the market in 2014.

Had all the quotas on these tracks reached financial closure and production, they could have added another 4.1 percent of electricity consumption to the market in 2014.

b. The gap between financial closure and production—the issue of price

[17] Decision 1 from meeting 302 of the PUA, July 27, 2010.

[18] The measures to remove such barriers include: exemption from maintaining a VAT file, income tax exemption, municipal tax exemption, and exemption from obtaining approval from the planning committee.

Between the financial closure stage and the production stage, there is a significant quantitative gap. Some of the developers at this stage chose to delay construction of the facilities even though their financial state made it possible not to delay it, and they had obtained approval for the feed-in tariff. The reason for this apparently has to do with the fact that the firms noticed the sharp decline in the cost of production, particularly the prolonged decline in the cost of solar panels.

At the time of financial closure and approval of the price, the developer gets a fixed price for 20 years from the date of the start of production. The price includes a profit considered reasonable under the market conditions in the year it was set (10–14 percent). Once the price is approved, any improvement in costs before the actual investment—such as a decline in the cost of solar panels— increases the producer's profit, assuming that the new and less expensive technology is used. As the prices of facilities declined, an economic incentive was created for the producers to delay construction as much as possible in order to increase the return on the projects. While the conditional production license limits the extent of the delay, since in order to obtain the approved price the developer must complete construction during the license period, it seems that in response to this, the developers pressured the government to extend the conditional license period and/or make it more flexible. In at least 10 cases, a photovoltaic facility began production more than 42 months after obtaining the conditional license.[19]

The explanation offered above is supported somewhat by the microeconomic data in Table 3. The Table shows the average number of years that elapse from obtaining the conditional license until the beginning of production. It shows that when the facilities began producing 2011, a year and a half had passed since the conditional license was obtained. As the downward trend in the cost of photovoltaic production became entrenched, the average period grew longer, so that in 2016, it reached 3.5 years. Figure 3 also shows that the period between financial closure and

[19] During the price approval process, the firms must provide guarantees for meeting the terms of the contract. But exercise of the guarantees is not a simple matter from a legal and bureaucratic standpoint, so it is generally not done. Producers therefore take a relatively low risk in not meeting the timetable set out in the contract, but they cause a delay in increasing electricity production from renewable energy sources, as well as an energy shortage, since they receive a quota, thereby preventing other potential producers from using that quota and producing electricity.

production is about 3.5 years. This is reflected in the horizontal gap between the financial closure curve and the actual production curve.

Table 3: Averageconstruction time for photovoltaic facilities and their electricity production costs, by year completed, 2011–16

Construction year of the facility	Average number of years from obtaining the conditional permit to start of production	Cost of production (agorot per kWh)
2011	1.4	160–205
2012	2.0	93–126
2013	2.3	46–71
2014	2.8	53–64
2015	3.4	47–50
2016	3.6	27–31

SOURCE: Based on PUA data (to May 2017).

3. Future challenges

An electrical grid that supports the production of electricity from renewable energy sources needs far greater capacity and durability than a grid that produces electricity from fossil fuels only. First, a significant portion of production in Israel is possible primarily in the south of the country (photovoltaic) or in the north (wind energy), relatively far from the main areas of consumption, making transmission essential. Second, since electricity production from renewable energy sources requires decentralization (rooftops and many sites spread over broad areas), it requires increased electricity transmission volumes and numerous connections to the grid. Finally, the volume of production at the facilities is very volatile, changing depending on the hour of the day, the season and the weather. As a result, and because it is currently impossible to store significant amounts of electricity, expanding the use of renewable energy requires an electrical grid that is able to withstand frequent changes in the volume and in the transmission direction of the electricity.

The infrastructure for the electrical grid is divided into a transmission grid and a distribution grid, which are connected through transformers to change voltage. The transmission grid transmits electricity from the production facility (in the case of renewable energy sources, most production takes place in the south) to the consumers (mainly in the center of the country). The distribution grid distributes electricity to buildings, and the transformers convert the electricity voltage from ultra-high voltage (in the transmission

grid) to high voltage (in the distribution grid). Each of the grids contains potential bottlenecks, since some of the facilities for production from renewable energy sources (mainly large facilities) are connected to the transmission grid, and some to the distribution grid (for instance, the electricity produced in rooftop installations). The transformer system may also contain a bottleneck, because if it reaches its maximum capacity, electricity from a facility connected to the transmission grid will not be able to move to the distribution grid. During 2017, the PUA and the IEC announced that while the transformers were allowed to reach 100 percent of capacity in the past, they would now be used only to 60 percent of capacity, as common in most advanced economies.[20] As a result, the system's ability to support electricity from renewable energy source declined significantly, and projects for such electricity production were delayed.

The government decisions relate only to production targets from renewable energy sources. Actually meeting those targets, however, depends on infrastructure in all segments of the grid, particularly the transmission and distribution grids. Even at this stage, the capacity that can be connected to the grid is already limited.[21] Upgrading the infrastructure will take a number of years, so resources must already be dedicated to it now in order to meet the targets for the coming decade. Moreover, the existing plans for infrastructure development do not take into account the need to support electricity production from renewable energy sources. The financial report published by the Electric Company for 2016 clearly states that "the Company cannot connect all of the initiatives to establish renewable energy power stations with significant volume to the electricity grid without completing the project to connect Eilat and the southern Arava to the transmission grid…".

There are also infrastructure problems elsewhere in the world, and in recent years, there have been many cases where the infrastructure failed to cope with developments in production from renewable energy sources, particularly through photovoltaic means. The leaders in production of electricity through photovoltaic means are China, the US, Japan, India, the

[20] https://www.themarker.com/dynamo/energy/1.3904668

[21] See the report of the Team Examining the Electric Company's Preparedness and Conduct during the Power Outages of October 2015 (Ministry of Energy, 2016). Moreover, in 2017, the PUA published quotas that were lower than the target, inter alia due to the Readiness Survey conducted by the IEC concerning connection and transmission ability.

UK, and Germany, and they are joined by other countries which have been developing this field significantly, including South Korea, Australia, the Philippines, and Chile. The rapid increase in distributed production capacity and the need to connect facilities to the electrical grid, have more than once created transmission congestion in the electrical grids of these countries, which has been reflected in blackouts and in irregular operation of the grids. Production output through photovoltaic means in China has increased eleven-fold since the end of 2012. In 2015, the Chinese grid was overburdened by the load and there were many blackouts.[22] The situation worsened in 2016, and the Chinese regulator is now trying to correct the problem. In 2016, initial signs of transmission congestion were discovered in Germany, and the German regulator decided to slow the increase of electricity production from renewable energy sources until the transmission and distribution systems could close the gap.[23] In that year, for the first time, there were blackouts in Japan due to transmission congestion, and the country stopped connecting new facilities to the electricity grid.[24] In India as well, grid limitations pose the main challenge to implementation of the renewable energy targets.[25]

The planning failures that many countries are dealing with, and the problems with the electricity infrastructure in Israel, emphasize the need for long-term planning that takes into account all parts of the electricity system, i.e. the need to advance a master plan for the energy market in Israel.

In order to cope with these challenges and solve some of the past problems in this field, an interdepartmental team was established in 2016[26] to examine the barriers to constructing facilities for the production of electricity from renewable energy sources. The team is led by Shaul Meridor, Director General of the Ministry of National Infrastructure, Energy and Water. "The aim of the team is to remove the jams and barriers, to realize the government's targets, and to build additional renewable energy facilities,

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[22] http://www.renewableenergyworld.com/articles/2016/04/china-s-grid-operator-blames-bad-planning-for-idled-renewable-energy.html

[23] https://www.theguardian.com/environment/2016/oct/11/germany-takes-steps-to-roll-back-renewable-energy-revolution

[24] https://www.pv-tech.org/news/japans-fit-degression-back-to-previous-levels-as-utility-curtails-solar-out

[25] http://www.bridgetoindia.com/tamil-nadu-takes-top-slot-for-solar-capacity-in-india/

[26] Following Government Decision 1403.

with an emphasis on rooftops."[27] The committee is expected to publish its recommendations soon.

4. Summation and conclusions

We find that a gap has developed between the targets for electricity production from renewable energy sources and the realization of the targets. In retrospect, it turns out that the gap led to considerable savings because of technological developments in the field of renewable energy and sharp price declines. However, as a result, polluting emissions have not been reduced at the rate set out by the government. We also found that even when it is worthwhile for developers in Israel to adopt technology to produce electricity from renewable energy sources, it still requires many regulatory changes, proper planning, and appropriate infrastructure in order to put such electricity to use.

Even so, electricity production using renewable energy sources has been developing in Israel in recent years. Photovoltaic technology, a field in which Israel enjoys a relative advantage due to the climate, has recently become more competitive against the alternatives, and many of the barriers that were preventing its development have been removed. The low prices of solar cells and the guaranteed profit to developers are also apparently removing a barrier to the realization of the quotas allocated by the government. There are additional regulatory barriers in the field of wind energy, and removing them will enable the development of production from this type of energy. The main challenge now is posed by the infrastructure for the electricity grid. Without long-term investment, it may halt the continued development of electricity production from renewable energy sources and the ability to meet the targets set by the government in this field.

[27] http://energy.gov.il/AboutTheOffice/SpeakerMessages/Pages/GxmsMniSpokesmanREJune16.aspx

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Is there a gender difference in the basic skills of workers and in the return on those skills in Israel?

- **An analysis of PIAAC survey data shows that the basic numeracy skills (grasp of basic mathematics) of male workers are higher than those of female workers. There is no significant gap in literacy skills.**
- **Men's hourly wages are 26.3 percent higher, on average, than women's. The gap in the skills level explains only about 15 percent (about 4 percentage points) of the wage gap.**
- **The increase in wages as a result of an increase in skills (return on skills) for men is higher than for women, and explains some of the mechanism by which the gender wage gap is created.**
- **The gender gap in the return on skills is reflected mainly in the business sector and among full-time workers.**
- **The rate of men employed as senior managers or as IT workers is significantly higher than that of women. The gap in favor of men in the return on skills in these occupations is double the gap among non-managers and workers in the professions and other industries.**

In all advanced economies, there is a significant gap between men and women, in favor of the men, in monthly wages and in hourly wages. This finding holds even after taking into account the observed characteristics of the workers, such as education, age, experience and demographic characteristics. An analysis carried out by the Bank of Israel Research Department examines whether the gender gaps in skills can explain the part of the wage gap that is not explained by the observed characteristics, and whether there is a gender difference in the return on skills. Therefore, this analysis adds to a skills variable, as estimated in the PIAAC survey, to the wage calculation that is common in the literature. This variable has not so far been included in studies on this issue in Israel.

It is important to note that the gender wage gaps do not necessarily show wage discrimination in favor of men, just as explaining wage gaps through various variables does not show a lack of discrimination. There are other factors, that are not measured in various studies, that may lead to gender wage gaps.

In the past, most of the wage gap in favor of men was attributed to gender differences in education and in employment experience, but the differences in these characteristics have narrowed. Currently, the main hypotheses

being examined in the literature deal with differences in attributes that are not directly observed, including risk aversion (men are, on average, less risk-averse), competitive tendencies (men, on average, like to compete more), social preference (women tend more toward equality), and negotiating ability—also an area where the genders differ. Other attributes, such as assertiveness, neuroticism, being opinionated, agreeability, and self-confidence ("The Big Five Model") are also mentioned in this context. The source of the differences in these attributes was also examined, whether it is mainly social/normative or natural/genetic ("nature vs. nurture").[1] In practice, taking some or all of these attributes, inasmuch as they can be measured, into consideration does not noticeably reduce the unexplained wage gap in favor of men.

In Israel as well, there has been much research on the issue of gender wage gaps.[2] A recent study[3] found that in 2015, taking gender differences in the scope of employment (full-time vs. part-time) into account narrowed the gap from 32 percentage points when measuring the monthly wage to 15 percentage points when measuring the hourly wage. When also taking into account the gap in the level of formal education[4] (without differentiating between fields of study) and the difference in the various professions, there are still 13 percentage points that are not explained by observed variables.

Below in this paper, the authors attempt to explain the gaps using psychometric test scores and the difference in the mix of subjects in the matriculation exams. These variables, which narrowed the unexplained wage gap in favor of men, did not completely eliminate it.[5] Geva (2016) used Expenditure Surveys and Income Surveys to show that in most industries, there is a gap in hourly wages in favor of men, which is not explained by other characteristics. In other words, the gap is not a result of different industry distributions of men and women. On average, the gap is about 10 percent, but it varies widely between industries.

[1] For a broad review of the literature on these topics, see "New Perspectives on Gender" in "*Handbook of Labor Economics*", 2010, Volume 4B, Chapter 17.
[2] For instance, Mazar (2008), Mazar and Peled (2010), and Michelson and Mazar (2012).
[3] Taub Center for Social Policy Studies in Israel, State of the Nation Report, 2016.
[4] In Israel, working women have a higher level of education than working men.
[5] The study does not report on what percentage of the gap is explained by these variables.

Adults in Israel (aged 16-64) were recently surveyed as part of an international project: the PIAAC skills survey.[6] In addition to the observed characteristics examined in the past (wages, work hours, education, age, and others), the PIAAC survey also examined the informal skills of workers—their basic skills. These skills were divided into three categories: literacy, numeracy, and problem solving in a technological environment. The subjects were tested in a language they were familiar with, and their skill level was derived from these tests.

Studies both globally[7] and in Israel[8] have shown a positive correlation between workers' basic skill level and wages. This study examined whether, and to what extent, the unexplained gap in hourly wages between men and women can be attributed to (a) a gender gap in basic skills; (b) a gap in the return on skills, meaning whether wages increased more rapidly for men than for women as a result of an identical increase in their skills; (c) factors that are not dependent on skills; and (d) various combinations of these three factors. These hypotheses are outlined in Figure 1.

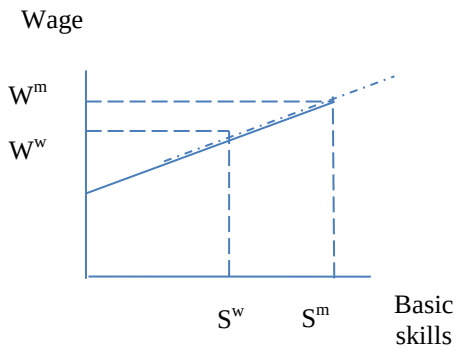
[6] A new international survey by the OECD. For more information on the survey, see the Central Bureau of Statistics announcement from June 2016: http://www.cbs.gov.il/reader/cw_usr_view_SHTML?ID=998

[7] For instance, Hanushek et al. (2013).

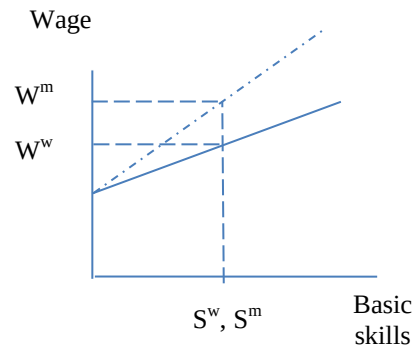
[8] Bank of Israel (2016a) or Mazar (2017).

Figure 1:
Schematic Outline of the Link Between Basic Skills and Wages

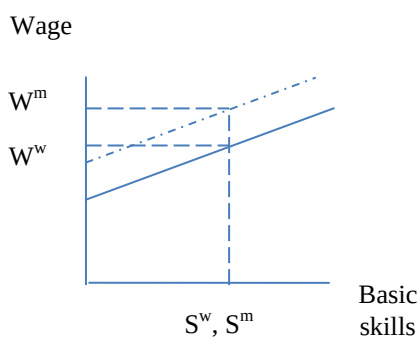
a. The gap in basic skills in favor of men



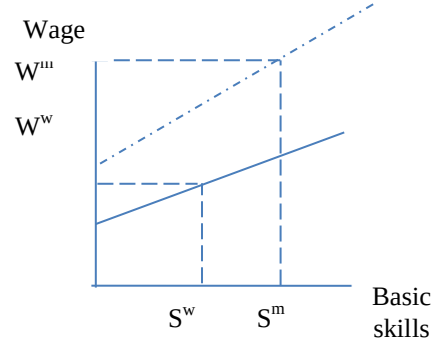
b. The gap in the return on basic skills in favor of men



c. The wage gap unconnected to basic skills



d. Higher return on wages for men, higher skill level of men, and the wage gap unexplained by skills



The dotted line shows men's wages, and the sold line shows women's wages. ^{m} shows men, and ^{w} shows women.

Statistical estimation

In order to examine the hypotheses shown in Figure 1, we will use three basic estimation equations:

1) $w_i = C_2 + \beta_1 X_i + \theta_1 \cdot Men + \varepsilon_i$

2) $w_i = C_3 + \beta_2 X_i + \theta_2 \cdot Men + \delta_1 S_i + \varepsilon_i$

3) $w_i = C_4 + \beta_3 X_i + \theta_3 \cdot Men + \delta_2 S_i + \lambda_1 \cdot S_i \cdot Men + \varepsilon_i$

where w_i is the log of hourly wages, *Men* is a dummy variable for men, and X_i is a standard set of observed variables: experience, experience squared, formal education (the worker's highest certificate, without differentiating between areas of study), number of work hours, number of children, a dummy variable for Arabs, and a dummy variable for ultra-Orthodox. S_i is an index of the worker's basic skills. In this study, we used only two types of skills—numeracy and literacy[9]—because a significant portion of the subjects were not tested in problem solving in a technological environment, and this portion was not chosen coincidentally.

In Equation 1, which is a Mincerian equation that is common in the literature[10], θ_1 represents the unexplained wage gap between men and women after controlling for other observed variables, but not controlling for the workers' basic skills. In Equation 2, θ_2 is the parameter when the workers' basic skills are controlled for. Therefore, $1-\frac{\theta_2}{\theta_1}$ is the percentage of the gap that is explained by the wage remainder through differences in skill level between genders. δ_1 is the estimated return on basic skills in terms of wages.

In Equation 3, λ examines whether the return on skills differs between men and women (cases b and d in Figure 1).

Table 1 shows the results of the basic estimation.

[9] We divided the skill by its standard deviation in order to standardize it and so that the coefficients in the regression would be in terms of the standard deviation.
[10] For instance, Mulligan and Rubinstein (2009) or Oaxaca (1973).

Table 1: Regression results: Log of hourly wage[a]

	1	2	3	4	5	6
Dependent Variable	Log of hourly wage					
Men	**0.273*** **	**0.263*** **	**0.224*** **	**0.251*** **	**0.235*** **	**0.224*** **
	(0.0300)	**(0.0292)**	**(0.0290)**	**(0.0289)**	**(0.0289)**	**(0.0291)**
Experience	0.0268***	0.0268***	0.0258***	0.0256***	0.0255***	0.0258***
	(0.00491)	(0.00491)	(0.00482)	(0.00487)	(0.00484)	(0.00483)
Experience squared	-0.000405***	-0.000406***	-0.000357***	-0.000351***	-0.000346***	-0.000358***
	(9.97e-05)	(9.97e-05)	(9.81e-05)	(9.91e-05)	(9.85e-05)	(9.84e-05)
Formal education	V	V	V	V	V	V
Work hours	-0.00463***	-0.00463***	-0.00474***	-0.00475***	-0.00476***	-0.00474***
	(0.00105)	(0.00105)	(0.00103)	(0.00104)	(0.00104)	(0.00103)
Number of children	0.0182**	0.0185**	0.0194**	0.0205***	0.0202***	0.0194**
	(0.00773)	(0.00773)	(0.00759)	(0.00766)	(0.00761)	(0.00760)
Ultra-Orthodox	0.00648	-0.0573	-0.0610	-0.0562	-0.0585	-0.0610
	(0.0754)	(0.0596)	(0.0585)	(0.0590)	(0.0586)	(0.0585)
Arab	-0.0800	-0.0843	-0.0151	-0.0343	-0.0160	-0.0152
	(0.0668)	(0.0667)	(0.0660)	(0.0665)	(0.0662)	(0.0661)
Arab*Men	-0.152*	-0.141*	-0.177**	-0.164**	-0.175**	-0.177**
	(0.0817)	(0.0814)	(0.0801)	(0.0807)	(0.0802)	(0.0801)
Ultra-Orthodox*Men	-0.156					
	(0.113)					
Numeracy Skills			**0.124*** **			**0.125*** **
			(0.0144)			**(0.0219)**
Literacy Skills				**0.0938*** **		**-0.000762**
				(0.0146)		**(0.0220)**
Average Skills					**0.124*** **	
					(0.0154)	
Fixed	1.712***	1.706***	1.337***	1.366***	1.296***	1.338***
	(0.137)	(0.137)	(0.141)	(0.145)	(0.144)	(0.144)
Number of observations	2,028	2,028	2,028	2,028	2,028	2,028
R-squared ADJ	0.2046	0.2042	0.2323	0.22	0.2291	0.2319

The standard deviation is in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

[a] Experience in the regression is the employment experience reported in the survey. The equations show that the increase in wages declines with experience, and that after 35 years of experience, they actually decline. Work hours are the average work hours per week. Education is the highest certificate obtained by the worker: 12 years of study, matriculation, practical engineer, Bachelor's degree, and so forth. In the equation, education is represented as a dummy variable for each category. The worker's skill is in terms of the standard deviation. The experience, education and number of children variables appear in absolute, not logarithmic, values.

Controlling for the observed variables (Column 1) shows that the hourly wage gap unexplained by the observed variables between men and women is about 27 percent. The result is higher than in other studies done in Israel partly because the control for work hours, which was not done in previous studies, increasing the value of the "men" parameter by about 4.5

percentage points.[11] Among Arabs (Column 1), the wage gap between men and women, where the other characteristics are constant, is smaller than among non-ultra-Orthodox Jews (the coefficient is men x Arab), and there is no statistically significant wage gap between non-ultra-Orthodox Jewish women, Aram women and ultra-Orthodox women, where the other attributes are constant (Column 1).

Controlling for numeracy skills (Column 3), the skill where the gap between men and women is the greatest, further reduces the unexplained gap to 22.4 percent (reduced by about 14.8 percent).[12] In contrast, controlling for workers' literacy skills (Column 4), where the gap between men and women is smaller, reduces the gap to 25.1 percent (by about 4.6 percent). The explanatory ability of the variance in wages increased by about 2–3 percentage points as a result of adding basic skills.

In the fifth column, we examined the average effect of numeracy skills and of literacy skills, and in the sixth column, we included both types of skills in the same estimation. Since the results show that literacy skills do not contribute to an explanation beyond numeracy skills, we will now continue to estimate the wage equations with only the numeracy skills.

In order to examine the source of the results, we made an itemized examination of a number of sub-populations (Table 2). In general, we did not find that the effect of adding workers' numeracy skills on the gender wage gap differed greatly between the sub-populations. This was true when we estimated the equation regarding the non-ultra-Orthodox Jewish population (a slightly larger effect than for the general population), and when separating into the public and private sectors[13] (a slightly larger effect in the public sector, because the gap in skill level in favor of men is smaller in the business sector). However, since the selection of what sector to work in is not exogenous, the basic equations that we estimate (Table 1) are common to both sectors. Separating into younger and older workers, we found a larger effect among younger workers. We did not find statistically significant wage gaps between men and women when we examined only part-time workers.

[11] This is because given the other variables, the number of work hours is negatively correlated with hourly wage, and on average men work more hours than women.
[12] According to the Wald test, the gap between the coefficients is not statistically significant.
[13] See Bank of Israel (2016a).

Professions

Many studies in Israel[14] and abroad have shown a clear gender polarization in the selection of workplaces, some of which is already reflected in the different mix of high school matriculation tests, and in the selection of professions and employment industries. For instance, male teens have a greater tendency to matriculate in the sciences and then to work in workplaces that are characterized by high wages and a high number of work hours, such as hi-tech. In contrast, women have a greater tendency to choose the public sector, which is characterized by fewer work hours and more convenient and flexible working conditions. This study does not discuss the question of whether controlling for profession or the industry in which the workers are employed is correct in estimating the gender wage gap[15], but in order to understand whether and to what extent the skills gap between men and women is reflected in the selection of industry or profession, we estimated an equation controlling for these two variables as well.

Taking profession into account[16] narrows the unexplained hourly wage gap (Column 2 in Table 1) from 26.3 percent to 18.8 percent (a decline of about 29 percent), and taking both profession and industry into account lowers the gap to 15.2 percent (a decline of about 42 percent). If we add the workers' numeracy skills to these regressions, the unexplained hourly wage gap narrows to 17.3 percent taking into account profession and to 14.0 percent taking into account both profession and industry.

We chose to focus on a number of industries and professions characterized by high wages[17], where women are under-represented relative to their

[14] For instance, Geva (2016); Taub Institute (2016).

[15] The choice of what profession to work in depends on the wage that the worker believes he will get in that profession, which in turn depends on the return on skills. According to one argument, in contrast to the level of skills, which are mostly obtained before entering the work force, the choice of profession and the yield on skills are not exogenous to the labor market; they depend on each other. According to another argument, the choice of profession and industry may reflect unobserved attributes and characteristics of the worker.

[16] The PIAAC survey lists the profession and the industry in which the workers are employed at the 2-digit level.

[17] About 24 percent of all workers in the economy are employed in these industries. According to the PIAAC survey, the percentage of men in these industries is 18 percentage points higher than in the rest of the economy. IT workers work an average of 48 hours per week—about 7 hours more than in the rest of the economy. The numeracy skills of

proportion of all workers—IT workers (high tech, engineering and sciences workers) and senior managers.[18] Table 2 shows that both among IT workers and senior managers and among other workers, adding the skills variable narrows the unexplained hourly wage gap between men and women. But it narrows the gap more among IT workers and senior managers (by about 22 percent, compared to about 9 percent among other workers). This is due both to the fact that the gender gap in numeracy skills is higher among IT workers and senior managers, and to the fact that the wage return on this skill is double in those industries.

Table 2: Additional Estimations, Divided into Sub-Groups

	Secular and non-ultra-Orthodox only		Public sector		Business sector		Full-time workers		Part-time workers	
Dependent variable	Log of hourly wage									
Men	0.262***	0.216***	0.208***	0.174***	0.281***	0.244***	0.258***	0.219***	0.117	0.0794
	(0.0314)	(0.0310)	(0.0468)	(0.0465)	(0.0374)	(0.0372)	(0.0286)	(0.0281)	(0.0935)	(0.0939)
Numeracy skills		0.141***		0.122***		0.122***		0.132***		0.103***
		(0.0160)		(0.0233)		(0.0184)		(0.0143)		(0.0391)
Control for additional attributes[a]										
Number of observations	1,412	1,412	736	736	1,292	1,292	1,561	1,561	471	471
R-squared	0.215	0.256	0.276	0.303	0.192	0.219	0.284	0.321	0.155	0.168

	Aged 25-44		Aged 44-64		Managers and IT industries		Rest of the economy	
Dependent variable	Log of hourly wage							
Men	0.258***	0.217***	0.259***	0.236***	0.205***	0.165***	0.222***	0.203***
	(0.0338)	(0.0337)	(0.0557)	(0.0550)	(0.0507)	(0.0501)	(0.0340)	(0.0341)
Numeracy skills		0.120***		0.132***		0.152***		0.0743***
		(0.0170)		(0.0272)		(0.0308)		(0.0160)
Control for additional attributes[a]								
Number of observations	1,330	1,330	698	698	480	480	1,548	1,548
R-squared	0.232	0.261	0.200	0.227	0.243	0.281	0.183	0.194

The standard deviation is in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

[a] In the regression, we controlled for the attributes listed in Table 1.

employees in these industries is about 0.8 standard deviations higher, and the hourly wage is about 30 percent higher.

[18] CEOs (Profession classification 1 according to the 1-digit classification), scientists and engineers (profession classification 31 in the 2-digit classification in all industries, and all workers in the high-tech industry (21, 26 and 27 according to the 2-digit industry classification), communications (59 and 60), finance (64) and R&D (72).

Is there a gap in the wage return on skills between men and women?

In this section, we will examine whether gender wage gaps in the return on skills contribute to the creation of gender wage gaps. Table 3 lists the results of the estimation.

Table 3: Regression results: Interaction between skills and gender

	1	2	3	4	5
Dependent variable	Log of hourly wage				
Men	**0.158**				
	(0.113)				
Numeracy skills	**0.0934*** **	**0.0992*** **	**0.106*** **	**0.103*** **	**0.118*** **
	(0.0156)	**(0.0152)**	**(0.0159)**	**(0.0202)**	**(0.0171)**
Numeracy skills*Men	**0.0126**	**0.0500*** **	**0.0360*** **	**0.0436**	**0.0122**
	(0.0206)	**(0.00655)**	**(0.0111)**	**(0.0275)**	**(0.0168)**
Experience*Men			0.00365*		
			(0.00202)		
Education*Men				V	
Work hours	-0.00471***	-0.00452***	-0.00463***	-0.00460***	-0.00664***
	(0.00104)	(0.00103)	(0.00103)	(0.00104)	(0.00134)
Work hours*Men					0.00398**
					(0.00163)
Control for additional attributes[a]					
Number of observations	2,028	2,028	2,028	2,028	2,028
R-squared ADJ	0.2321	0.2317	0.2323	0.2307	0.2336

The standard deviation is in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

[a] In the regression, we controlled for the attributes listed in Table 1.

Column 1 of Table 3 shows that the additional interaction between gender and skills (which represents the gender gap in the return on skills) causes the gender wage gap to lose its statistical significance. This means that the unexplained wage gaps between genders are, to a large extent, correlated with a higher yield for men due to skills. Removing the "men" dummy variable—which is not statistically significant—causes the yield gap to become statistically significant (Column 2 in Table 3), and shows that men

have a higher yield for numeracy skills (by about 50 percent).[19] In other words: the wage gap between men and women reflects a larger increase in salary for men due to an increase in skills than for women.

In Columns 3–5 of Table 3, we also examine two additional interaction variables, and examine how they affect the coefficient of the interaction between men and skills. Adding an interaction variable between men and experience shows that the return on experience for men is greater than for women, but even given the control on this return, the gap in the return on skills remains statistically significant.

The addition of an interaction between men and education is not statistically significant[20], and its effect on the interaction between gender and skills loses its statistical significance (Column 4 in Table 3). It is worth noting that without the interaction variable between gender and skill, the interaction between men and formal education is positive and statistically significant, meaning that the higher return on formal education among men reflects, to a large extent, a gender gap in the return on numeracy skills.

In contrast with experience and education, the interaction between work hours and gender shows that as the number of work hours increases, the hourly wage of men declines less than for women (Column 5 in Table 3). Therefore, adding this variable greatly reduces the estimate surplus yield on skills for men in terms of wage, and even cancelled out its statistical significance. This means that the transmission from skills to surplus return in terms of wages for men is consistent with the higher yield they receive for the scope of the position (full-time vs. part-time).

And indeed we found that given the other characteristics, the higher the men's skills are the *more* hours they work, while the higher women's skills are, the *fewer* hours they work. (The possible reasons for this choice are not the subject of this study.) Both coefficients are statistically significant and robust (Table 4). When we controlled in this estimation for the group of professions and industries as we defined them in the previous section (IT workers and senior managers), we found that about half of the gender gap in the effect of skills on work hours is explained by men's preferences for

[19] The ratio between the interaction coefficient of gender with skills and the coefficient of the level of skills.

[20] According to an examination of the interaction between gender and the dummy variables of the formal education categories.

these industries and professions.[21] These findings are also consistent with the results of the study by the Chief Economist (Geva et al. 2017), according to which women with similar basic skills to those of men (in that study according to the results of psychometric tests) obtain higher education in professions where their yield in the labor market is lower, and there is no significant difference between men and women in the wage premium in respect of their areas of study.

Table 4: Regression results: Weekly work hours

	1
Dependent variable	Average work hours per week
Numeracy skills	-0.786**
	(0.330)
Numeracy skills*Men	2.016***
	(0.135)
Control for additional attributes[a]	V
Fixed	39.81***
	(2.956)
Number of observations	2,028
R-squared Adj	0.1772

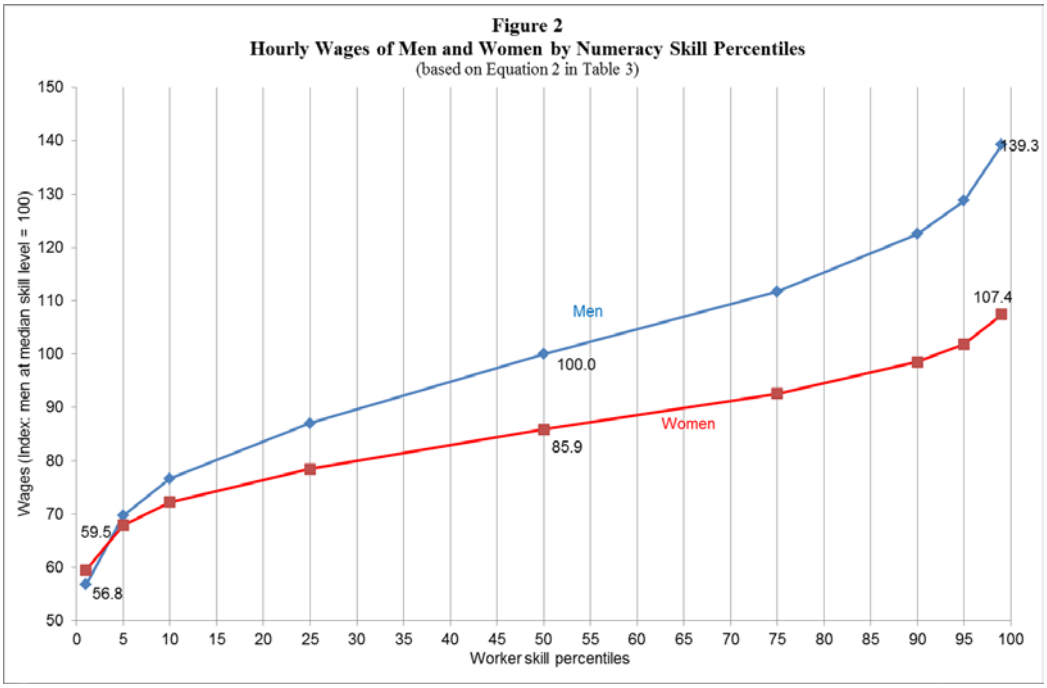
The standard deviation is in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

[a] In the regression, we controlled for the attributes listed in Table 1.

Based on the results of the estimation (Column 2 in Table 3), Figure 2 presents an index[22] of the hourly wage of men and women as a function of their percentile in basic skills. The Figure shows that through almost the entire skills range, given the other characteristics of the employees, men's wages are higher than women's. Since the return on skills in terms of wages is higher for men, the wage gap increases as the level of the workers' skills increases, up to a gap of more than 20 percent at a high level of skill. The use of Column 2 and not Column 5 in the Table is due to the basic assumption in the study, that basic skills are, for the most part, acquired before entering the labor market, and are therefore an exogenous variable to the labor market. This is in contrast with the selection of profession or the

[21] Controlling for the public sector does not affect the results of Table 4.
[22] The index was calibrated to 100 for the wages of men at the median skill level, and according to the wage gap at the point of the averages we derived the calibrated wage of women at the median skill level.

number of work hours, which are determined as part of the decisions in the labor market itself.



Additional examinations we conducted in order to test the source of the gender gaps in the return on skills showed the following results:

1. **Arabs and ultra-Orthodox Jews:** When we estimated the equation only regarding the non-ultra-Orthodox Jewish population, both the gender gap in the return on skills and the statistical significance were found to be similar to the general population.
2. **In the public sector and in the business sector:** In both sectors, wages increase as the worker's skills increase, but in the public sector, the gender gap in the return on numeracy skills is not statistically significant, while in the business sector it is.
3. **Work hours:** The source of the gap in the return on skills is among those who work more than 34 hours per week. Among those with a lower scope of employment, no gender gaps in the return on skills were found.
4. **Professions:** Table 5 shows the parameter of return on skills calculated through a separate estimation. The Table shows that the

return on skills among IT workers is almost double that of other works, as is the gap in the gender yield on skills in favor of men. However, a gender gap in the return on numeracy skills was also found in the rest of the economy. This means that some of the gender gap in the return on skills is a result of the fact that men have a greater tendency to work at places where the return on skills is higher, and is also a result of the gender gaps among IT workers.[23,24] As in the result presented in Column 5 of Table 3, the higher return on skills for men in this case also passes through the work hours mechanism.

Table 5: Control for professions and industries

	1	2
Dependent variable	Log of hourly wage	
	Rest of economy	IT workers
Numeracy skills	0.0639***	0.121***
	(0.0175)	(0.0348)
Numeracy skills*Men	0.0231*	0.0496**
	(0.0127)	(0.0212)
Control for additional attributes[a]	V	V
Number of observations	1,548	480
R-squared ADJ	0.1842	0.2515

The standard deviation is in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

[a] In the regression, we controlled for the attributes listed in Table 1.

5. **Examination by skills percentile:** When we estimated three difference equations regarding the ranges of skills—below the 25th percentile, between the 25th and 75th percentiles, and above the 75th percentile—we found that the return on skills for men is higher in all ranges (by a statistically significant difference). As in the finding regarding IT workers and senior managers, the relative gender gap in the returns is the smallest among workers in the 75th percentile and higher, because the return on skills is the highest among them.

[23] Adding a dummy variable for IT workers to the basic equations (Column 3 in Table 1) narrows the hourly wage gender gap by about 3 percentage points.
[24] Similar to the result presented in Column 5 of Table 3, the surplus return on skills is cancelled out in this case as well when the interaction between work hours and gender is added.

Conclusion

This study estimated the effect of differences in skills on the gender wage gap in Israel. It found that among Israeli workers, the numeracy skill level of men is higher than that of women, but this gap narrows the unexplained wage gap by just 3 percentage points (15 percent) beyond the effects of education and experience. It also found that in Israel, the return on basic skills for men is higher than it is for women: Wage increases for men as a result of an increase in skill level are higher than for women. The study also found that the higher payment for skills among men is consistent with the higher scope of employment (part-time vs. full-time) and that men with higher skills work at higher scopes of employment while women do not. Finally, the study found that the return on skills in terms of wages among senior managers and works in the IT industries—a group of workers with a high proportion of men—is double what it is in the rest of the economy, that the gender gap in the return on skills is particularly prominent in these industries, and that some of the gender gap in the return reflects the fact that men have a greater preference to work in these professions and industries than women.

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Analyzing the quality of 12-month forward inflation forecasts[1]

- **Forecasts of inflation 12 months forward carry tremendous importance, and this study attempts to examine the quality of the forecasts obtained from the various sources and to create from them a more precise forecast that is absent any deviation.**
- **We examined the quality of the forecasts both in-sample and out-of-sample, and found that the best forecast is generated by the weighting that includes the professional forecasters' projections and the expectations derived from the capital market, the banks' internal interest rates, and futures contracts. The weighting that includes only the capital market and futures contracts also has good predictive ability.**
- **We also found that when the examination is based on quarterly data, the Companies Survey improves the precision of the forecasts.**
- **There is a high level of correlation between 12-month inflation forecasts and actual inflation, but there is a fixed upward deviation.**
- **The Business Tendency Survey provides a good in-sample explanation of inflation, but its out-of-sample forecasting is imprecise.**

1. The inflation forecast compared with the actual figure

The forecasts of inflation 12 months forward carries great importance, since they present the public's expectations regarding inflation, which reflect, inter alia, the public's confidence in monetary policy. Policy makers take these forecasts into account even though it is more difficult to be precise with them than with forecasts for one month forward, since they relate to a longer horizon and are therefore more exposed to shocks.

Forecasts of inflation in the coming 12 months are obtained from a number of sources[2]: the capital market, professional forecasters, the banks' internal interest rates, Last Price quotes from futures contracts, the Business Tendency Survey, and the Bank of Israel Companies Survey. Many studies

[1] This study makes a technical analysis of inflation forecasts and the ways of weighting them, and does not present the economic considerations behind them.
[2] Appendix A presents explanations of the sources for the forecast.

deal with the question of how to combine and weight the forecasts from various sources with the aim of improving them. For instance, Hubrich and Skudenly (2017) conducted a study for the ECB, which examined whether weighting the forecasts would help predict inflation in the eurozone better than a single forecast, following the volatile inflation in the eurozone since 2007. Genre, Kenny, Meyler and Timmermann (2010) show that combining the professional forecasters' projections of inflation, GDP and unemployment has advantages over a single forecast.

This paper examines the forecasts in two ways. First, an in-sample examination reflects the extent to which the forecasts "predicted" the data that were obtained. This is used to examine the quality of the forecasts derived from each source separately and the quality of the forecasts derived from their various weights. The second is an out-of-sample examination that looks at the extent to which the forecasts can predict the data that have still not been obtained. This is used to examine the quality of the forecasts derived from the weight of the sources[3] in two ways—when the size of the sample is variable, and when the size is fixed (in a moving window).

All of the sources provide monthly assessments, except for the Companies Survey, which is conducted on only a quarterly basis.[4] The comparison between them is based on monthly data from 2008 onwards, which provides many observations (101) from a period in which annual inflation was not particularly volatile, since from that year, there was far less tendency to link rents to the dollar.

In order to prepare the background for the discussion, the following graphs present the forecasts compared with actual inflation (deviated 12 months backward in order to compare between the forecasts and the data to which it relates; Figure 1) and the errors in the forecasts from the various sources, meaning the gap between the forecast and actual inflation (Figures 2a and 2b).

[3] In this case as well, we examined the forecasts obtained from each of the sources separately, but we do not present the results.
[4] Appendix B details the range of data of each source for the forecasts.

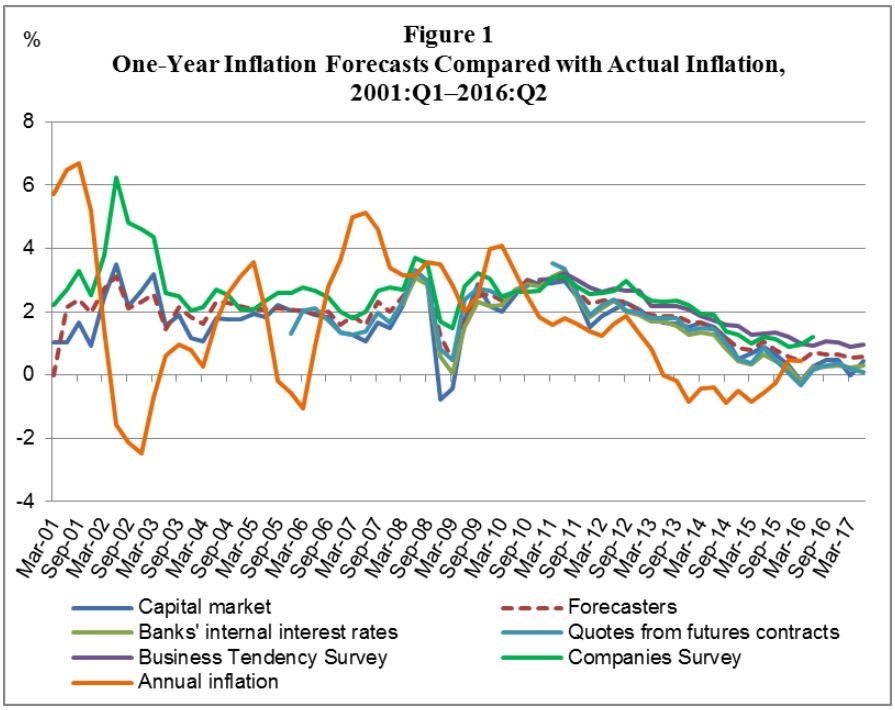
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Figure 1
One-Year Inflation Forecasts Compared with Actual Inflation,
2001:Q1–2016:Q2
8
6
4
2
0
-2
-4
Mar-01
Sep-01
Mar-02
Sep-02
Mar-03
Sep-03
Mar-04
Sep-04
Mar-05
Sep-05
Mar-06
Sep-06
Mar-07
Sep-07
Mar-08
Sep-08
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Sep-09
Mar-10
Sep-10
Mar-11
Sep-11
Mar-12
Sep-12
Mar-13
Sep-13
Mar-14
Sep-14
Mar-15
Sep-15
Mar-16
Sep-16
Mar-17
Capital market
Forecasters
Banks' internal interest rates
Quotes from futures contracts
Business Tendency Survey
Companies Survey
Annual inflation

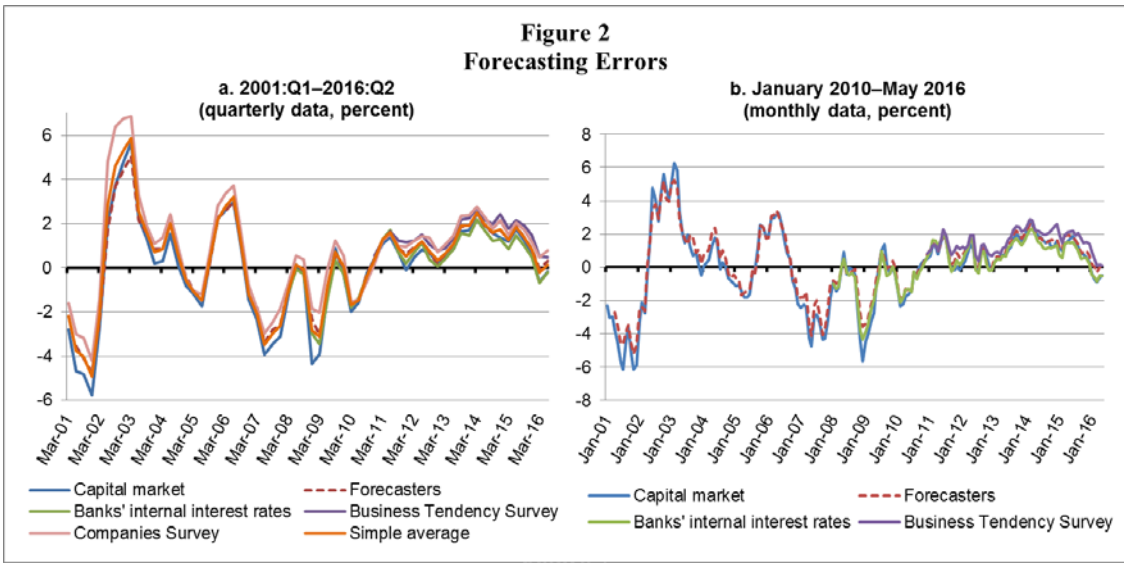


Figure 2
Forecasting Errors
a. 2001:Q1–2016:Q2
(quarterly data, percent)
6
4
2
0
-2
-4
-6
Mar-01
Mar-02
Mar-03
Mar-04
Mar-05
Mar-06
Mar-07
Mar-08
Mar-09
Mar-10
Mar-11
Mar-12
Mar-13
Mar-14
Mar-15
Mar-16
Capital market
Forecasters
Banks' internal interest rates
Business Tendency Survey
Companies Survey
Simple average
b. January 2010–May 2016
(monthly data, percent)
8
6
4
2
0
-2
-4
-6
-8
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Capital market
Forecasters
Banks' internal interest rates
Business Tendency Survey

The graphs show that until 2010, annual inflation was very volatile, leading to large errors in forecasting. Starting in 2010, other than the final quarter in the sample, there is a fixed upward deviation in the forecasts.

The quality of the forecasts from each of the sources separately: In-sample examination

We first examined the quality of each of the sources separately through OLS regressions where each of the forecasts is the explanatory variable and annual inflation is the dependent variable. We used data from 2008 onward, except for the regression that includes the Business Tendency Survey, since in that case, there are data only since 2010. All of the regressions showed that the coefficient estimates are statistically significant at a level of 1 percent, and the intercepts are not significant, other than the intercepts in the regression that includes the capital market and the regression that includes the Business Tendency Survey.[5]

We compared the forecasts through the root mean square error (RMSE), a statistic that reflects the deviations of the estimated value from the actual figure. As common in the literature, we compared the forecasts to a certain measurement point (benchmark), and selected for this purposes the simple average of the various sources, because studies show that it generates good forecasts—particularly the simple average—is preferable over a single forecast. Aiolfi and Timmermann (2006) showed that in many cases, the best forecast is obtained from a combination that provides each of the models with the same weight. Table 1 presents the ratio between the RMSE of each of the sources and the RMSE of the simple average. As the ratio declines, the quality of the forecast increases over the simple average.[6]

[5] Appendix C presents the results of the regressions based on monthly data.
[6] Appendix D presents the ratios obtained in the samples from various periods.

Table 1: RMSE Ratios

(January 2008–May 2016)

	Forecast source	With interceptor	Without interceptor
RMSE value	Simple average	**1.4**	**1.4**
Ratio between the RMSE of the forecast from the various sources and the RMSE of the simple average	Simple average	1.00	1.00
	Business tendency survey[a]	**0.91**	1.06
	Forecasters	0.94	**0.95**
	Banks' internal interest rates	0.96	0.97
	Futures contracts	1.00	1.01
	Capital market	1.06	1.08

[a] The Business Tendency Survey begins in 2010, so we compare it with the simple average of 2010.

Despite the results of the aforementioned studies, in our case, most of the forecasting sources are preferable to the simple average. The Table shows that in-sample, the Business Tendency Survey provides the most precise forecast, and it can be deduced from this that there is a very high correlation between the Business Tendency Survey and actual annual inflation. However, this forecast contains a fixed upward deviation, since the intercept in the regression is negative and statistically significant. The professional forecasters are also quite precise, and when the examination is carried out without an intercept, they provide the most precise forecast.

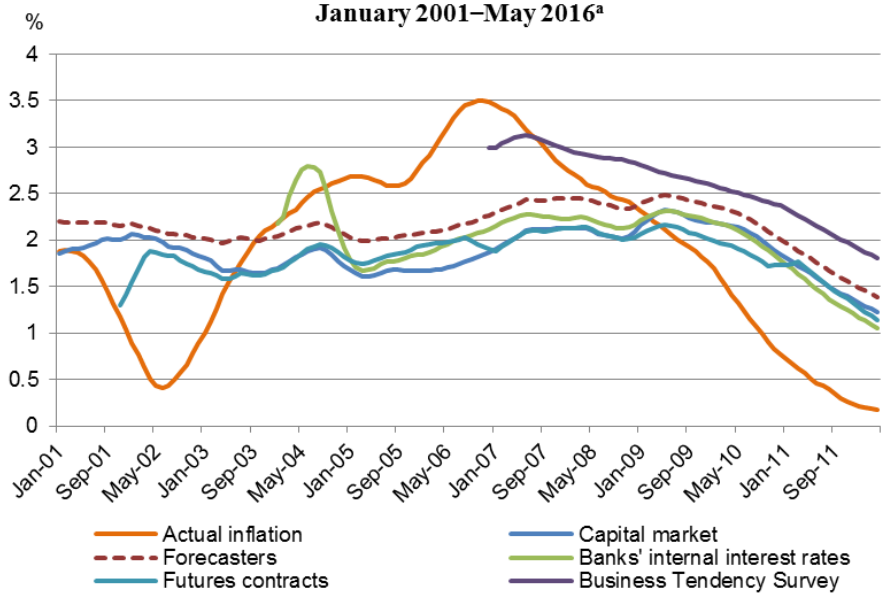
We conducted a similar test using two alternatives to the measurement point—(1) a forecast that assumes that annual inflation will always be at the midpoint of the target range (2 percent), and (2) a forecast that assumes that inflation in the next 12 months will mimic inflation in the past 12 months (backward looking). In both cases, we found that the tested forecasts are preferable to the alternatives, and it is particularly important to note that this is also true regarding the simple average.[7]

From 2010, there is a fixed upward deviation in the observations, and in order to examine whether there is an adjustment to actual inflation, we broke them and actual inflation down into two factors—a fixed factor (J_t) and a variable factor (ε_t)—and we estimated equations of the form $\pi_t = J_t + \varepsilon_t$, which includes only an intercept with a fixed sample size in a moving window. We focus on the fixed factor and examine how it varies

[7] The RMSE ratios range between 0.85 and 0.96. There is one outlier ratio—1.00—between the futures contracts and the backward looking forecast.

over time, based on a fixed sample in a moving window covering 50 months. Figure 3 shows the intercepts that were obtained.

Figure 3
Estimate of the Intercept in the Regression Where Only the Intercept Serves as an Expalantory Variable for Actual Annual Inflation, January 2001–May 2016[a]



[a] The horizontal axis notes the date of the beginning of the sample.

It seems that the forecasts adjusted themselves to the continued decline observed in inflation beginning in 2007, but the adjustment is not complete.

2. Improving the quality of the forecasts by weighting them

a. In-sample test

In an attempt to arrive at more precise forecasts in RMSE terms, we ran regressions where the dependent variable is the actual index, and the explanatory variables are various combinations of the sources for the forecast with Newey regressions—a process that corrects the standard deviations obtained from the OLS regression in respect of the serial coefficient in the explanatory variables. This process made it possible to test hypotheses while using the corrected standard deviations. In order to

test whether the forecasts are unbiased, we examined the hypothesis in the regression that includes all sources, a total coefficient equal to one, and an intercept equal to zero. We found that the zero hypothesis can be rejected at all levels of significance. In other words, there is a bias in the forecasts.

In order to obtain a weighted average that generates a good forecast, we examined an estimation that weights the various forecast sources, we forced the total of the coefficients to be one, and we added an intercept since in the various weights, most of the intercepts are statistically significant. We found that unlimited weighting is preferable to limited weighting, so we removed the limitation in the following estimations.

We examined a variety of possible weights, and found that they improve the forecast obtained from each of the sources separately, and that most of the intercepts are statistically significant. Both the monthly data and the quarterly data showed that the best forecast is generated by the weight that includes the capital market, the professional forecasters, the banks' internal interest rates, and futures contracts. The monthly data showed that the same quality is obtained from the weight that includes only the capital market and the professional forecasters. It should be noted that there are weights where some of the coefficients are negative. This can be attributed to the fact that there is a positive correlation between the various forecast sources. The negative coefficient enables lower variance.[8]

We examined the best weighting plus the "errors in previous forecasts" variable in order to try to improve the forecast, but the addition provided a small improvement in RMSE terms (0.06), and coefficients that were not statistically significant were obtained (other than the coefficient of annual inflation with a lag).

Table 2 shows the results of the in-sample regressions.

[8] More information appears in Dana Orfaig (Flikier), "The Weighting of the Bank of Israel CPI Forecast—A Unified Model", page 2.

Table 2: Regression Results

	(1)	(2)	(3)	(4)
Capital market	-2.094***	-2.031***	-2.048***	0.346
	(0.315)	(0.293)	(0.320)	(0.348)
Forecasters	3.105***	3.398***	1.798***	0.857
	(0.815)	(0.369)	(0.521)	(0.824)
Banks' internal interest rates	0.125		1.041*	-1.272*
	(0.717)		(0.572)	(0.715)
Futures contracts	0.225		0.210	0.0268
	(0.163)		(0.166)	(0.128)
Annaul inflation with a lag*				0.700***
				(0.0647)
Fixed	-1.563***	-1.658***	-0.615***	0.0318
	(0.493)	(0.317)	(0.180)	(0.247)
Number of observations	101	101	101	89
R^2	0.54	0.53		0.56
Adjusted R^2	0.52	0.52		0.53
RMSE	1.09	1.09	1.11	1.02

Standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1

Regression (1): The selected weighting, meaning the weighting that received the lowest RMSE value in the in-sample examination.

Regression (2): The selected weighting, meaning the weighting that received the lowest RMSE value in the in-sample examination.

Regression (3): The weighting that includes the limitation that the sum of the coefficients equals 1.

Regression (4): The weighting where the errors of the previous forecasts serve as an explanatory variable.

* The coefficient of π_t from Appendix E.

b. Out-of-sample test

While the in-sample test examines the quality of the weighting's consistency with the observations included in the estimation, the out-of-sample test generates forecasts of observations that are not in the sample. The out-of-sample test is more important than the in-sample test since in the end, we are interested in forecasting ability and not in post-facto explanatory ability. White (2000) showed that the results of the out-of-sample forecasts are more credible than the results of in-sample forecasting since the latter are more sensitive to outlier observations and to data mining. Moreover, Diebold and Rudebusch (1991) emphasize the importance of the use of

partial data in the forecasting process, since it enables the out-of-sample forecast to better reflect the data available in real time, i.e. when the forecasts were actually made. We tested a selection of weightings in two ways—varying sample size and with a fixed ample size (in a moving window). The varying size makes it possible to use more observations, but the fixed size in a moving window makes it possible to cancel the effects of observations from the distant past, meaning observations that we can safely assume are less relevant. We chose to test the weightings that the in-sample test found to be characterized by a low RMSE, meaning weightings that generate a good forecast.[9]

1) **Varying sample size:** We estimated a regression where we used only a partial sample of explanatory variables, and we tried to use them to forecast annual inflation in the first month where the data were not used in estimating the regression. We examined the error in the forecast (the difference between the actual figure and the out-of-sample forecast generated by the weighting), and then added data for the month related to by the forecast to the data used in the estimation. We repeated the forecasting process and the error measurement regarding the following month, and so forth. We obtained a series of the error values in each forecast, which enabled us to test and compare the forecasting quality of the various weights using an index of the errors in their forecasts—the forecasting root mean square error. The lower the index value, the more precise the weighting is. Table 3 shows the results of the weightings that generated the most precise out-of-sample forecasts.

Table 3: Results of the Regressions made out-of-sample with a variable sample size

Start of data	Frequency	Explanatory variables								Number of observations	Number of observations out-of-sample	RMSE
		Capital market	Forecasters	Banks' internal interest rates	Futures contracts	Business Tendency Survey	Companies Survey	Simple average	Intercept			
2008	Monthly	+			+					101	40	**0.724**
		+	+	+	+					101	40	0.783
					+					101	40	0.809
		+	+	+						101	40	0.842
2008	Quarterly	+	+	+			+			34	10	**0.500**
		+	+	+	+		+			34	10	0.512
		+	+	+						34	10	0.564
		+	+	+	+					34	10	0.565

[9] This may cause a problem, but we used it anyway in order to focus the study.

The most precise forecast was generated by the weighting of the capital market and futures contracts. It is interesting to see that the best in-sample weighting (capital market, forecasters, banks' internal interest rates and futures contracts) is the second-best here, but rises to the best if we use quarterly data. If we use quarterly data, adding futures contracts lowers the forecasting ability. The Business Tendency Survey, the source with the lowest in-sample RMSE value, does not contribute to the out-of-sample forecast. If we compare the forecasts made based on monthly data with those made based on quarterly data, we find that adding the Companies Survey increases the precision of the forecasts. This may be because there is a low correlation between the Companies Survey and the other sources.[10]

2) **Fixed sample in a moving window:** For the purpose of the out-of-sample forecast, we estimated rolling regressions, meaning regressions with a fixed number of observations that advance with time. We ran regressions of the weightings that, in the previous instance, we tested using a varying sample size. Table 4 shows the results that we obtained.

Table 4: Results of the Regressions made out-of-sample with a fixed sample size

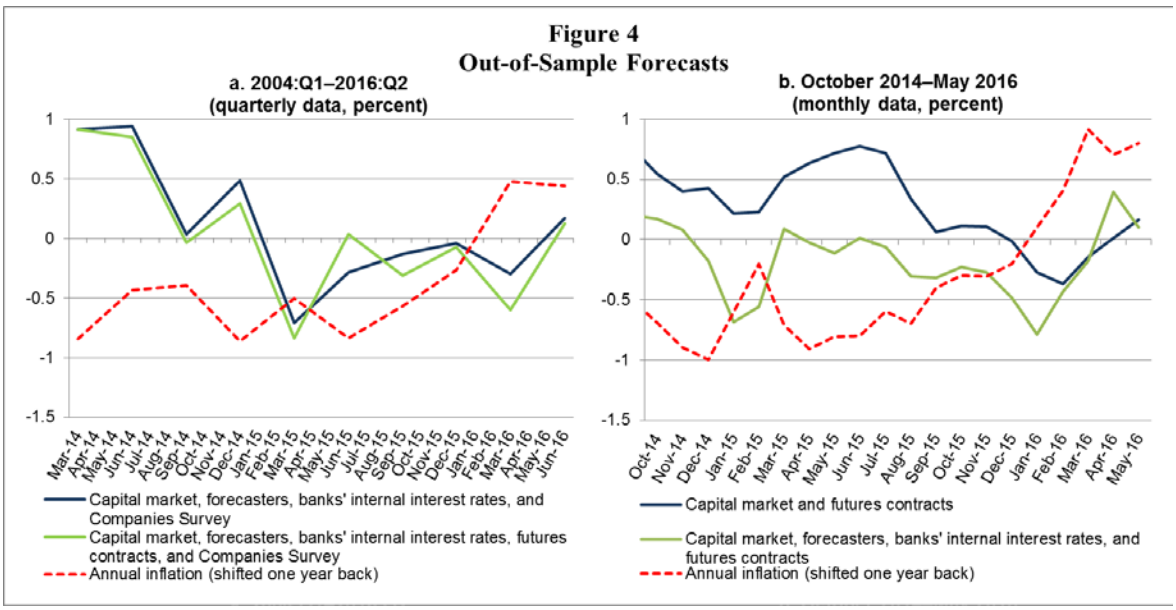
Start of data	Frequency	Explanatory variables								Number of observations	Number of observations out-of-sample	RMSE
		Capital market	Forecasters	Banks' internal interest rates	Futures contracts	Business Tendency Survey	Companies Survey	Simple average	Intercept			
2008	Monthly	+	+	+	+					61	40	**0.695**
		+			+					61	40	0.700
		+	+	+						61	40	0.741
					+					61	40	0.758
2008	Quarterly	+	+	+	+		+			24	10	**0.506**
		+	+	+	+					24	10	0.512
		+			+					24	10	0.548
		+	+	+			+			24	10	0.573

The results show that there are two weightings that generate the most precise forecasts. When the data are monthly, it is the weighting that includes the capital market, the professional forecasters, the banks' internal interest rates, and futures contracts. When the data are quarterly, it is the weighting that includes the capital market, the professional forecasters, the banks' internal interest rates, futures contracts, and the Companies Survey. The weighting including the

[10] Appendix F shows the correlations between the indicators.

capital market and futures contracts generates the most precise forecasts when using a varying sample size, and in this case as well its performance remained good. We can deduce from this that the weighting of the capital market and futures contracts generates a good forecast, and when we add the professional forecasters and the banks' internal interest rates to it, we obtain a forecast that is at least as good. Of particular interest is the finding that when we use quarterly data, the Companies Survey improves the forecasting ability of the weightings. Also of interest is the finding that the quality of the weighting that includes the capital market, the forecasters, the banks' internal interest rate, and futures contracts is reflected in all three tests—in-sample, out-of-sample with a varying sample and out-of-sample with a fixed sample. The following Figures relate to the ten forecasts based on two selected weightings that were examined out-of-sample, and present them compared with actual annual inflation (after we moved it 12 months backward) at quarterly (Figure 4a) and monthly (Figure 4b) frequency.

Figure 4
Out-of-Sample Forecasts



It is evident that until the end of 2015, the forecasts were higher than inflation, and that starting in 2016, the trend reverses and the forecasts are lower than inflation. This is in line with the upward trend in annual inflation since the end of the reviewed period (see Figure 1).

Table 5 shows the coefficients of the regressions that generated the best forecasts in the out-of-sample test based on monthly data, with a varying sample size and with a fixed sample size.

Table 5: Selected Weighting Coefficients

January 2008–May 2016

	(1)	(2)
Variable	Annual inflation	
Capital market	0.0998	-0.563
	(0.192)	(0.441)
Forecaters		-0.482
		(0.332)
Banks' internal interest rates		3.786***
		(0.727)
Futures contracts	0.726***	-2.076***
	(0.195)	(0.732)
Number of observations	100	61
R^2	0.569	0.632

Standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1

Regression (1): The weighting of the capital market and futures contracts with a variable sample size.

Regression (2): The weighting of the capital market, forecasters, the banks' internal interest rates, and futures contracts with a fixed sample size.

In addition, we examined the extent to which the estimated coefficients in the weightings we chose to test show stability over time. It seems that they are stable in all tests, other than the one with monthly data and a fixed sample size with a moving window.[11]

[11] See Appendix 7.

3. Summation of the findings

We found that there are two good weightings for out-of-sample forecasting: (1) the capital market and futures contracts, and (2) the capital market, professional forecasters, the banks' internal interest rates, and professional forecasters. We also found that in recent years, there is a high correlation between the forecasts of inflation in another 12 months and actual inflation, but there is a fixed upward bias. It is interesting to note that the Business Tendency Survey is prominent in its ability to explain the CPI in-sample, but that its out-of-sample forecasting ability is not high, and since there is a high correlation between it and the other sources, it does not contribute much to out-of-sample forecasts.

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5. Appendices

Appendix A: The sources for the forecast

The capital market: Calculating the forecasts from the capital market is based on the rationale upon which the Fisher Equation is based: the real interest rate plus the inflation forecasts equals the nominal interest rate. The forecasts are based on the difference between the yield on bonds that are not indexed to the CPI and the yields on indexed bonds. The data from the capital market are available at monthly frequency, and begin in 2001.

The professional forecasters: In Israel, there are 15 professional forecasters providing assessments regarding inflation in each of the next three months and to the end of 12 months. We do not have information regarding how they calculated their assessments. The forecasters' projections begin in 2001, and are available at monthly frequency.

The banks' internal interest rates: The forecasts from the internal interest rates of the five largest banks are derived from the gap between the unindexed and indexed interest rates. The internal interest rate at each bank is based on the marginal price it pays in exchange for raising sources (deposits) and on the marginal price that it charges in exchange for allocating uses (credit). The forecasts derived from the banks' internal interest rates are available at monthly frequency and begin in 2008.

Futures contracts: Futures contracts reflect undertakings to purchase or to sell some asset at a future time, at a price set in advance and paid on the date of delivery. Inflation forecasts are obtained from quotes of these contracts.

The Business Tendency Survey: The Survey examines the state of a business in the present based on responses to questions on variables relevant to the surveyed industry (output, volume of sales, inventory of finished goods, volume of credit obtained by the business, number of workers it employs, and so forth). In addition, the Survey examines future expectations for those variables. The questions regarding inflation include an assessment of the cumulative rate of change in the Consumer Price Index in the coming 3 months and the coming 12 months. The text of the questions was changed in January 2015, and they now relate to a

comparison between the past month and the previous month instead of a comparison between the three past months and the three previous months, as well as relating to the past 12 months instead of the coming 12 months. The data from the Business Tendency Survey are collected on a monthly basis, and begin in December 2010.

The Bank of Israel Companies Survey: The Companies Survey is based on the responses of about 370 businesses and corporations from the various industries. The respondents are asked about their expectations regarding inflation in 12 months and the shekel/dollar exchange rate, as well as the state of the business: output, sales, inventory, number of workers, orders, and so on. The companies are asked to report on the directions of change of the various variables (increase, decline or stability) and on their intensity (high or low). In general, the data from the Companies Survey are found to be correlated with the macroeconomic data on the economy, and are obtained more rapidly than data from the other sources. The forecasts from the Companies Survey are gathered on a quarterly basis and begin in 2001.

Appendix B: The data used by the various sources for the forecasts: ranges, frequency and number of observations

Source of the forecast	Start of data	Frequency	Number of observations
Capital market	2001	Monthly	185
Forecasters	2001	Monthly	182
Banks' internal interest rates	2008	Monthly	101
Quotes from futures contracts	2005	Monthly	122
Business Tendency Survey	2010	Monthly	66
Companies Survey	2001	Quarterly	62

Appendix C: The results obtained from estimating the regressions

Results of the regression estimations of the sources for the forecast of annual inflation

(January 2008 to May 2016)

Variable		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(11)	(12)
						Annual inflation					
Capital market		0.510***	0.764***								
		(0.137)	(0.0751)								
Forecasters				1.002***	0.799***						
				(0.153)	(0.0628)						
Banks' internal interest rates						0.791***	0.858***				
						(0.132)	(0.0691)				
Futures contracts								0.664***	0.820***		
								(0.130)	(0.0716)		
Simple average										0.766***	0.790***
										(0.148)	(0.0673)
Fixed		0.600**		-0.467		0.153		0.366		0.0550	
		(0.273)		(0.323)		(0.255)		(0.255)		(0.305)	
Number of observations		101	101	101	101	101	101	101	101	101	101
	R-squared	0.123	0.508	0.301	0.618	0.267	0.607	0.208	0.568	0.213	0.579
	Adjusted R^2	0.114	0.503	0.294	0.615	0.260	0.603	0.200	0.563	0.205	0.575
	RMSE	1.477	1.505	1.319	1.326	1.350	1.346	1.403	1.411	1.399	1.392

Standard errors in parentheses

*** p<0.01; ** p<0.05; * p<0.1

Appendix D: RMS ratios

		Monthly data		Quarterly data	
Source of forecast	Start of data	With intercept	Without intercept	With intercept	Without intercept
Capital market	2010	1.09	1.02	1.10	1.00
	2008	1.06	1.08	1.09	1.10
	2005	1.03	1.07	1.04	1.08
	2001	1.00	1.06	1.01	1.05
Forecasters	2010	0.97	1.01	0.97	1.00
	2008	0.94	0.95	0.97	0.98
	2005	0.95	0.95	0.96	0.97
	2001	0.96	0.94	0.96	0.94
Banks' internal interest rates	2010	1.07	0.94	1.00	0.92
	2008	0.96	0.97	0.98	0.97
Futures contracts	2010	1.13	0.99	1.06	0.93
	2008	1.00	1.01	0.97	0.96
	2005	1.00	1.01	0.99	0.99
Business Tendency Survey	2010	1.20	1.06	0.93	1.07
Companies Survey	2010	-	-	0.97	1.06
	2008	-	-	0.93	0.98
	2005	-	-	0.97	0.98
	2001	-	-	1.01	1.01

Appendix E: Estimates of the regression in which the explanatory variables include the forecasting error

The estimated equation is:

$$\pi_{t+12} = c_0 + c_i * \pi^e_{i,t} + \gamma[\pi_t - \{c_0 + c_i * \pi^e_{i,t-12}\}]$$

where t is the current time, and I is the indicator of the various sources for the forecast. The expression $\pi_t - \{c_0 + c_i * \pi^e_{i,t-12}\}$ represents the error of the forecast made 12 months previously. In order to estimate the equation, we took algebraic actions and obtained:

$$\pi_{t+12} = (1-\gamma)c_0 + c_i * \pi^e_{i,t} + \gamma\pi_t - \gamma c_i * \pi^e_{i,t-12}$$

We estimated this equation through a nonlinear regression.

Appendix F: The various correlations

- **The correlations between the various sources for the forecasts, starting in 2008**

	Capital market	Forecasters	Banks' interest rates	Futures contracts	Business Tendency Survey	Companies Survey	Simple average
Capital market	1.00						
Forecasters	0.94	1.00					
Banks' interest rates	0.95	0.99	1.00				
Futures contracts	0.92	0.97	0.98	1.00			
Business Tendency Survey	0.95	0.98	0.97	0.96	1.00		
Companies Survey	0.88	0.94	0.93	0.95	0.96	1.00	
Simple average	0.97	0.99	0.99	0.98	0.98	0.95	1.00

- **Correlations with the CPI**

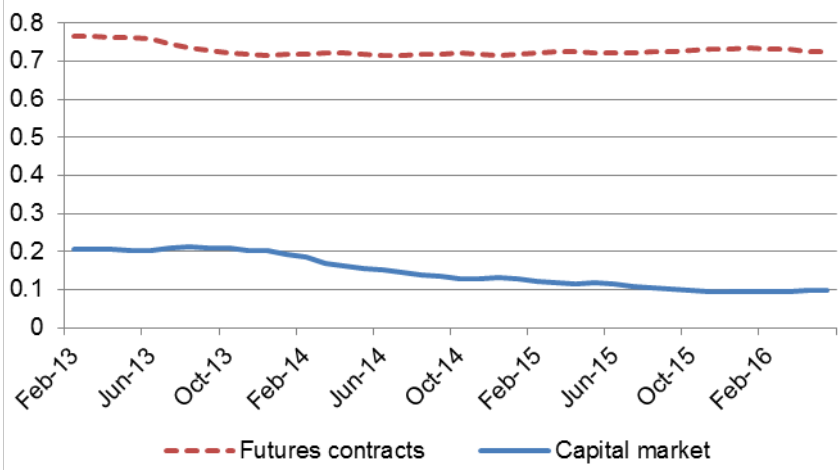
Data period	Capital market	Forecasters	Banks' interest rates	Futures contracts	Business Tendency Survey	Simple average
2001-2016	-0.1	0.3				0.1
2005-2016	0.2	0.4		0.3		0.3
2008-2016	0.3	0.5	0.5	0.5		0.5
2010-2016	0.7	0.8	0.8	0.7	0.9	0.8

- **Quarterly data**

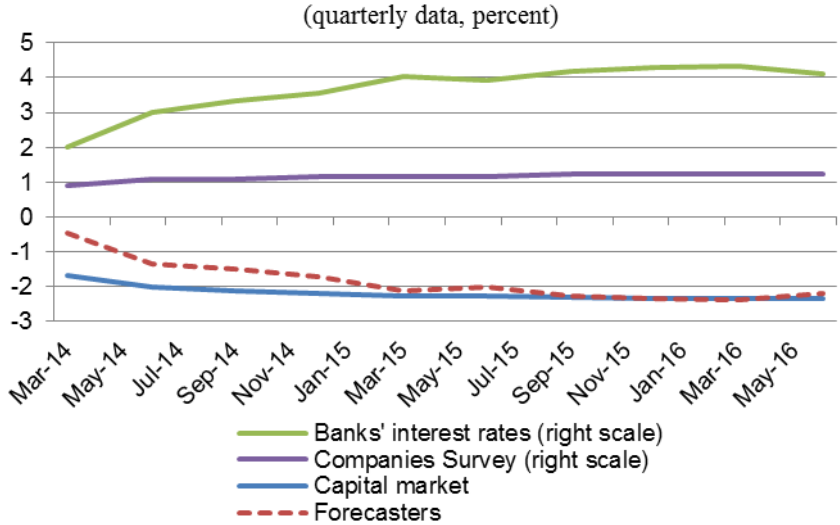
Data period	Capital market	Forecasters	Banks' interest rates	Futures contracts	Business Tendency Survey	Companies Survey	Simple average
2001-2015	-0.0	0.3				0.1	0.1
2005-2015	0.2	0.4		0.4		0.4	0.4
2008-2015	0.4	0.6	0.6	0.6			0.5
2010-2015	0.7	0.8	0.8	0.7	0.8	0.8	0.8

Appendix G: Coefficients of the weightings we tested in the out-of-sample examination – development over time

Development of the coefficients of the selected weightings over time, variable sample window, February 2013 to May 2016
(monthly data, percent)

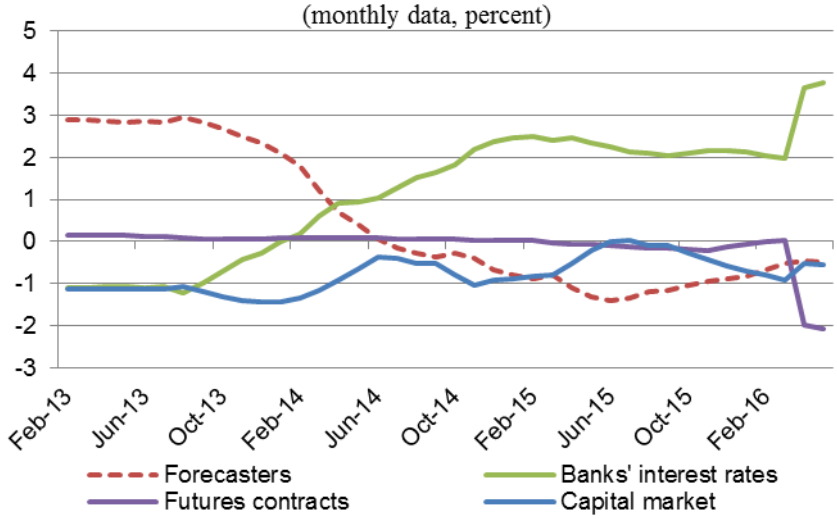


Development of the coefficients of the selected weightings over time, variable sample window, 2014:Q1 - 2016:Q2
(quarterly data, percent)



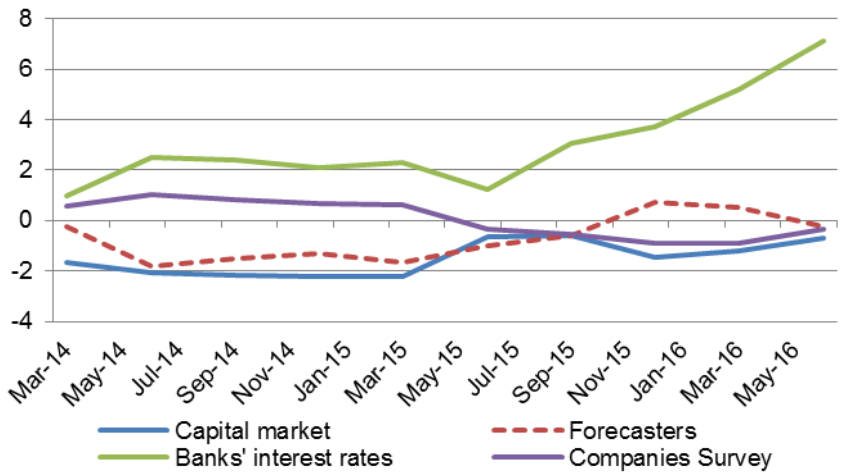
Development of the coefficients of the selected weightings over time, fixed sample window, February 2013 to May 2016

(monthly data, percent)



Development of the coefficients of the selected weightings over time, fixed sample window, 2014:Q1 - 2016:Q2

(quarterly data, percent)



The GDP Deflator, CPI and Terms of Trade

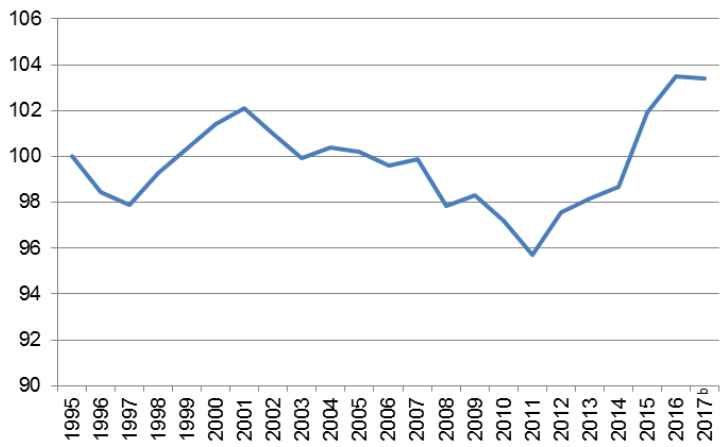
Yoav Friedman and Arnon Barak

- **Over the past three years, the GDP deflator has increased by a cumulative 4.4 percent, while the Consumer Price Index has declined by 0.8 percent. This means that the increase in GDP in terms of the basket of consumer goods and services exceeded its (quantitative) growth.**
- **The relative increase in the GDP deflator reflects improved terms of trade for the economy—an increase in export prices relative to import prices. This improvement is, to a great extent, a result of external factors—the decline in energy prices and the strengthening of the dollar relative to the euro—and to a lesser extent a result of domestic factors, chiefly the strengthening of the shekel.**
- **The improvement in the terms of trade (and the increase in the GDP deflator) made it possible to increase private consumption beyond the quantitative growth of GDP, in parallel with an increase in savings.**
- **Looking ahead, it is not likely that the trend of improved terms of trade will continue over time, or that the GDP deflator will continue to increase at a higher rate than the CPI.**

The GDP deflator—a weighted index of the prices of uses in the economy that reflects the nominal change in the value added in the economy—increased in recent years even though the Consumer Price Index declined. In other words, the increase in the economy's power to purchase the basket of consumer goods exceeded the increase that resulted from real growth.[1] In the past three years (mid-2014 to mid-2017), the increase in the relative price of GDP totaled about 5 percent, and contributed about one-third of the increase in the economy's purchasing power. The other two-thirds are a result of real growth.

[1] It is accepted practice to measure GDP growth in real terms, meaning net of the change in the GDP deflator. Therefore, when there is a change in the ratio of the GDP deflator to the CPI, there will be a change in purchasing power that is not measured in real (quantitative) growth.

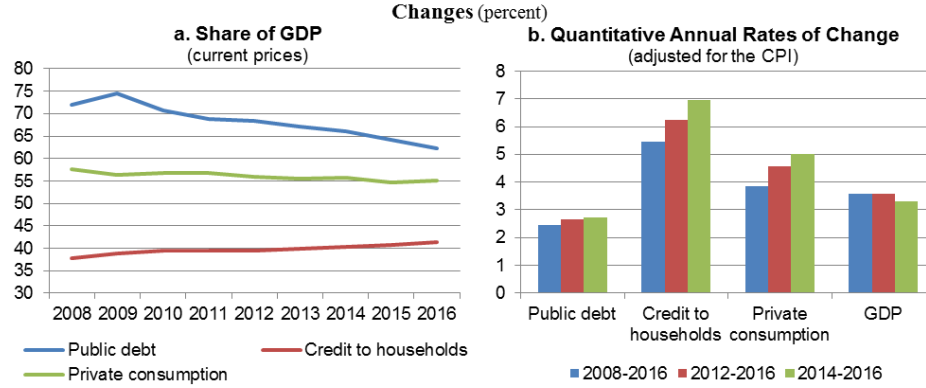
Figure 1
The Ratio between the GDP Deflator and the CPI, 1995–2017[a]



[a] A change of 1 percent in the ratio is the equivalent of about NIS 5 billion in terms of the basket of consumer products in 2015 prices.
[b] The data for 2017 relate to the first half of the year, and are based on seasonally adjusted data.
SOURCE: Based on Central Bureau of Statistics.

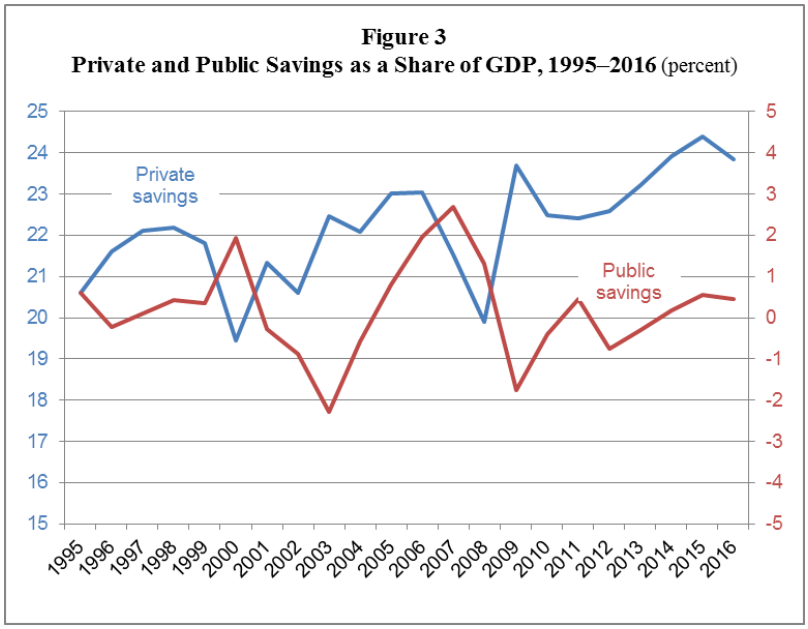
Figure 2 shows how the relative increase in the GDP deflator affected the development of several macroeconomic variables that receive considerable attention when analyzing the economy's development. Private consumption as a share of GDP declined slightly, even though it increased more rapidly than the quantitative growth of GDP. Credit to households as a share of GDP increased moderately even though such credit grew rapidly. The annual rate in the past two years was close to 7 percent; there was a decline in the ratio of public debt to GDP, without which debt would currently be 3 percentage points higher than it actually is (62.3 percent); and tax revenue increased rapidly.[2] These all indicate an increase in the economy's income that is not reflected in real growth data—the data that are commonly examined and analyzed.

Figure 2
Private Consumption, Credit to Households, and Public Debt, as a Share of GDP and Quantitative Changes (percent)



The increase in the economy's income is also reflected in the ability to rapidly increase consumption while maintaining a high level of savings and even increasing it. Figure 3 shows private savings and public savings in GDP terms between 1995 and 2016. It shows that the economy has been characterized by a high level of savings in recent years, during which time private consumption has increased rapidly and became a driving force for growth.

Figure 3
Private and Public Savings as a Share of GDP, 1995–2016 (percent)



The GDP deflator increased relative to private CPI prices[3], mainly due to Israel's improved terms of trade, meaning the ratio between export prices and import prices.[4] The prices of goods and services that Israel exports increased relative to the prices of goods and services Israel imports. The price differences leave the economy with a profit, and even though this is not reflected in real growth, it does make it possible for the economy to increase consumption and/or savings. The improvement in the terms of trade over the past three years increased the

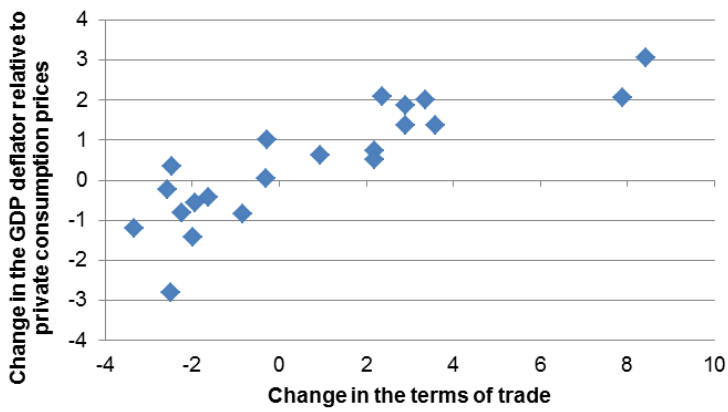
[3] Thus far, we have discussed the Consumer Price Index since it is the most well-known figure. From here on, we will use the private consumer price, since like the GDP deflator, it is derived from National Accounts data and is therefore exposed to revisions to which the Consumer Price Index is not exposed. The private consumer price is not the same as the Consumer Price Index due to differences in the weighting of consumption items and in measuring the consumption of housing services. In the 1990s, there were significant differences between the two, and notable differences developed in 2009 as well. However in recent years, the differences between them are negligible.

[4] In order to calculate the terms of trade, we use import prices excluding taxes.

economy's income by about NIS 40 billion, some of which reached households directly, for instance due to the fact that fuel prices declined and wages increased beyond the increase in productivity, and some reached them indirectly, for instance through the increase in profitability of firms and the increase in government revenue from taxes.

Figure 4 shows a scatter graph of the change in the terms of trade index (the horizontal axis), and in the ratio of the GDP deflator to CPI prices (the vertical axis), between 1995 and 2016. It shows that there is a positive correlation between them. An estimation based on a linear regression shows that an increase of 1 percent in the terms of trade contributes to an increase of about 0.36 percent in the ratio of the GDP deflator to CPI prices.

Figure 4
Changes in the Terms of Trade and in the Ratio Between the GDP Deflator and Private Consumer Prices, 1996–2016 (percent)



SOURCE: Based on Central Bureau of Statistics.

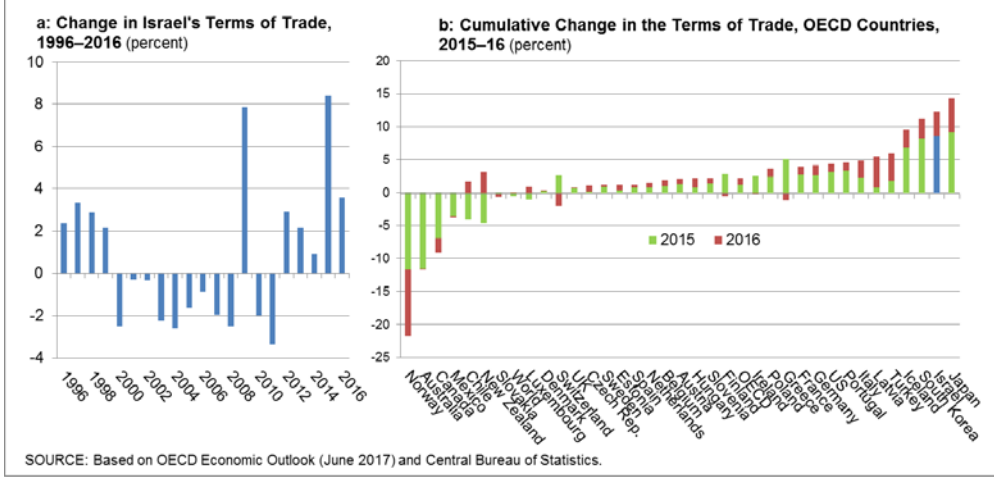
Israel's terms of trade improved in 2015–2016 by about 12 percent in cumulative terms. Figure 5a shows that this is an exceptional improvement (particularly in relation to 2015). In 2009, there was also an exceptional improvement, since energy prices declined sharply that year. But that increase took place following a number of years of worsening terms of trade. A somewhat similar improvement took place before then, back in 1996–1999. In those four years, the improvement also reached about 12 percent cumulatively.

If we compare Israel to the other OECD countries, and focus on 2015–2016, we find that the terms of trade increased to a greater extent only in Japan (Figure 5b). Even taking into account the fact that the economy is a less open economy[5] than

[5] Imports and exports as a share of GDP.

the OECD average, the positive contribution that the terms of trade make to the economy's income, in terms of GDP or in terms of the basket of consumer goods, is exceptional by international comparison.[6]

Figure 5
Change in Israel's Terms of Trade Over Time and Compared with the Other OECD Countries



SOURCE: Based on OECD Economic Outlook (June 2017) and Central Bureau of Statistics.

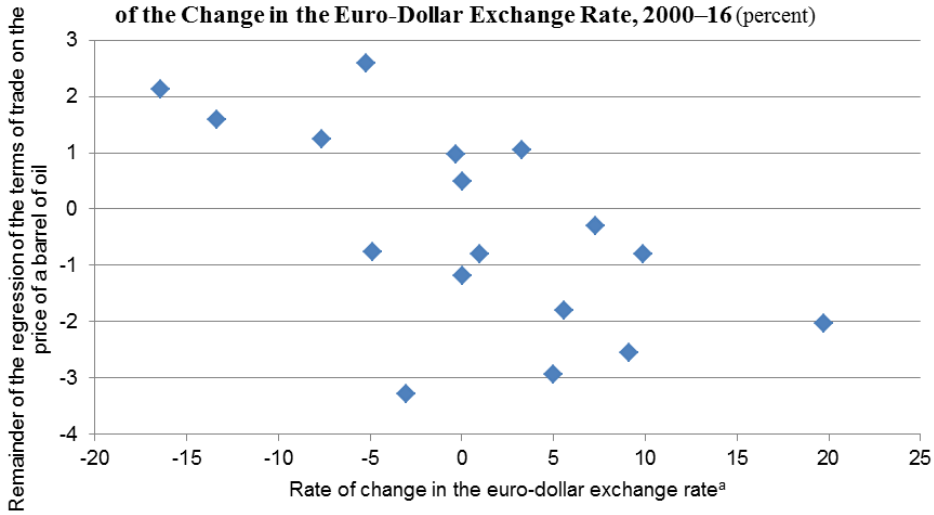
The profit accumulated by the economy as a result of the improved terms of trade may be a result of a relative increase (decline) in the global price of goods and services that Israel exports (imports), or it may be a result of initiated changes in the price of a product that Israel exports or imports. Israel is an energy importer (mainly oil and coal), and one of the main positive developments took place in this area—global energy prices declined from mid-2014, after remaining stable between 2011 and 2014. This decline explains part of the increase in the ratio of the GDP deflator to the CPI and part of the increase in the economy's purchasing power.[7] Direct estimations conducted by the Bank of Israel showed that the decline reduced the economy's expenditure on energy by about $5 billion per year.

[6] The profit derived in GDP terms from a change in the terms of trade depends positively on exports and imports as a share of GDP. The Bank of Israel Annual Report for 2015 presents an international comparison of the effect of an improvement in the terms of trade on the current account in GDP terms.

[7] The decline in energy prices not only contributed to a decline in CPI prices and an increase in the ratio of the GDP deflator to CPI prices, it also directly contributed to an increase in the GDP deflator. In a certain way, this is a technical increase—when the rest of the variables are fixed, a decline in import prices raises the value added of production—but it also has an economic value: an increase in the manufacturer's profits.

Another positive development resulting from changes in relative prices in the world has to do with the fact that the dollar strengthened relative to the euro from mid-2014. Figure 6 shows a scatter graph of the change in the terms of trade (net of the effect of oil prices) and in the euro-dollar exchange rate between 2000 and 2016[8], and shows that the strengthening of the dollar relative to the euro contributes to Israel's terms of trade. The link between the euro-dollar exchange rate and the terms of trade reflects the fact that Israel's exports are biased toward countries that trade in dollars, while the euro has a heavier weight in imports.[9]

Figure 6
Change in the Terms of Trade that is Unexplained by the Price of Oil as a Function of the Change in the Euro-Dollar Exchange Rate, 2000–16 (percent)



[a] When the euro strengthens relative to the dollar, the change is positive.
SOURCE: Based on Central Bureau of Statistics.

In terms of initiated price changes, some of the improvement in the terms of trade may reflect developments connected to the domestic economy, such as price increases initiated by exporters in view of the appreciation of the shekel, and the market power available to them. Such increases raise the export price relative to the import price, and are reflected in an increase in the GDP deflator (and an

[8] The Figure begins in 2000 because the euro entered use only in 1999. We adjusted the for effects of oil prices (in dollars) on the terms of trade through a linear regression. We also adjusted for the effect of the decline in the dollar price of oil that reflected a strengthening of the dollar.

[9] This refers not only to the currency in which the export price is denominated, but also to the currency in which the product is finally sold. Both together have an effect on the change in the real price of the product when there are changes in the exchange rates.

increase in the ratio of the GDP deflator to CPI prices). It can be postulated that when the price increase takes place against the background of appreciation that does not result from the success of exports, but due to other factors, it will be accompanied by some reduction in the quantity sold. If the price increase takes place due to the success of exports, such as due to increased demand abroad or successful marketing campaigns, we can expect to see an increase in both the ratio of the GDP deflator to CPI prices and in the quantity sold.

Initiated price increases are consistent with a common assumption in the literature, which is that the prices of tradable goods are "sticky" in the manufacturer's currency. If this assumption is valid, we can expect to see that there is a full transmission from the nominal exchange rate to the import price in the domestic currency, while the export price in the domestic currency does not change (at least in the short term). As a result, changes in the exchange rate affect the terms of trade, since they are measured by the ratio between export prices and import prices. The empirical findings around the world support this assumption to some extent. The elasticity of import prices in terms of the domestic currency relative to the exchange rate is higher than the elasticity of export prices, but the elasticity is not equal to one and zero, respectively, rather it is in between.[10]

The pricing of research and development services exports provides a clear example of a case in which changes in the exchange rate affect export prices (in foreign currency terms) and the ratio between the export price and the import price.[11] Such exports are frequently priced in shekels, particularly in regard to multinational companies' development centers in Israel, since expenses in the field mainly include wages. Such pricing means that an appreciation of the shekel increases the export price in foreign currency terms, thereby contributing to the increase in the economy's purchasing power, on condition of course that the export price increases without having too negative an impact on the quantity sold.[12]

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[10] See: Choudhri, E.U. and D.S. Hakura (2015), "The Exchange Rate Pass-Through to Import and Export Prices: The Role of Nominal Rigidities and Currency Choice", *Journal of International Money and Finance*, 51, 1–25.

[11] In the services industries, the concept of price is elusive. It is difficult to separate between quantity, quality and price in these industries, particularly the research and development services industry, and it is therefore unclear how precise the current separation is in the data. It is likely that in some cases, an improvement in quality may be recorded as an increase in price.

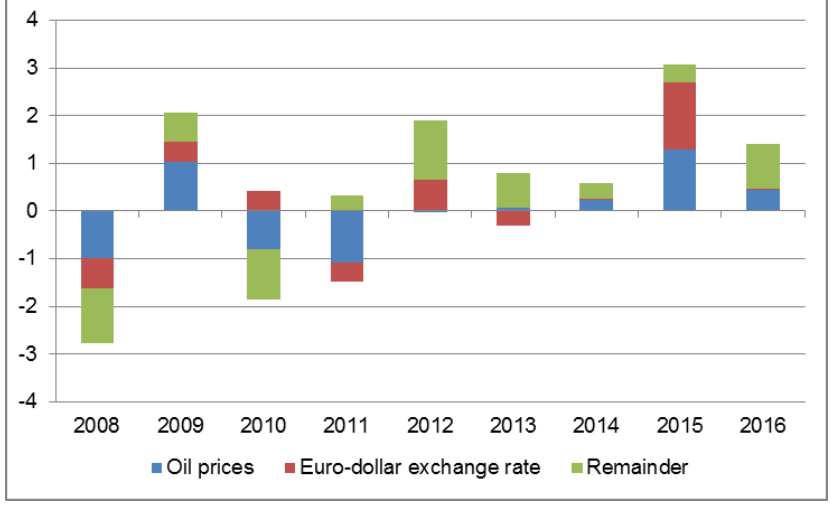
[12] It is difficult to identify the effect of appreciation on the terms of trade index, since the direction of causality is not clear. Improved terms of trade create pressure for appreciation, and appreciation may create upward pressure on export prices and the improvement of terms of trade.

Another example of a domestic development that has an impact on the ratio of the GDP deflator to CPI prices—this time through a channel that does not pass through changes in the terms of trade—involves public sector wage increases. Such an increase may be reflected in an increase in the ratio of the GDP deflator to CPI prices, and mainly reflects a change in the relative prices in the economy rather than a monetary profit for the economy. Since there is a mutual relationship between public sector wages and private sector wages, an increase in export prices as a result of increased demand for exports and of the wage increases that follow may roll over to public sector wages and to a further increase in the GDP deflator. In such a case, some of the increase in the ratio of the GDP deflator to CPI prices may reflect monetary profit and some may reflect a change in the relative prices in the economy.

Empirically, energy prices and the euro-dollar exchange rate—two factors that reflect developments outside the Israeli economy—provide good explanations of the increase in the ratio of the GDP deflator to CPI prices (explaining close to 70 percent of the variance). In particular, the decline in oil prices and the strengthening of the dollar between 2014 and 2016 explain slightly more than 3 percent out of the 4.5 percent increase (Figure 7). We can posit that the (unexplained) gap is largely a result of changes in export prices as a result of the development of the exchange rate. If the terms of trade are used as an explanatory factor, we find that almost all of the increase is explained.

It is difficult to assess the extent to which the improvement in the terms of trade will persist. Oil prices remained relatively stable this year, and remain low compared to prices in 2011–2014. Industry assessments are generally that the price decline reflects structural and technological changes in response to the high price levels reached at the end of the previous decade, but the decline may lead to a smaller rate of increase in supply, which will push oil prices back up in the future. While the dollar has weakened relative to the euro in 2017, the change is minor, and there is no reason to assume that the dollar-euro exchange rate will develop in a trend either way. Accordingly, it is not reasonable to rely on the possibility that the GDP deflator will continue to increase more rapidly than private CPI prices, or on this trend's contribution to the positive development of the macroeconomic aggregates reviewed above.

Figure 7
Change in the Ratio between GDP Deflator and Consumer Price, and Contribution of Exogenous Factors to this Change, 2008–16 (percent)



Changes in the risk distribution mechanism in the new pension funds in Israel and their effect on the intergenerational subsidy[1]

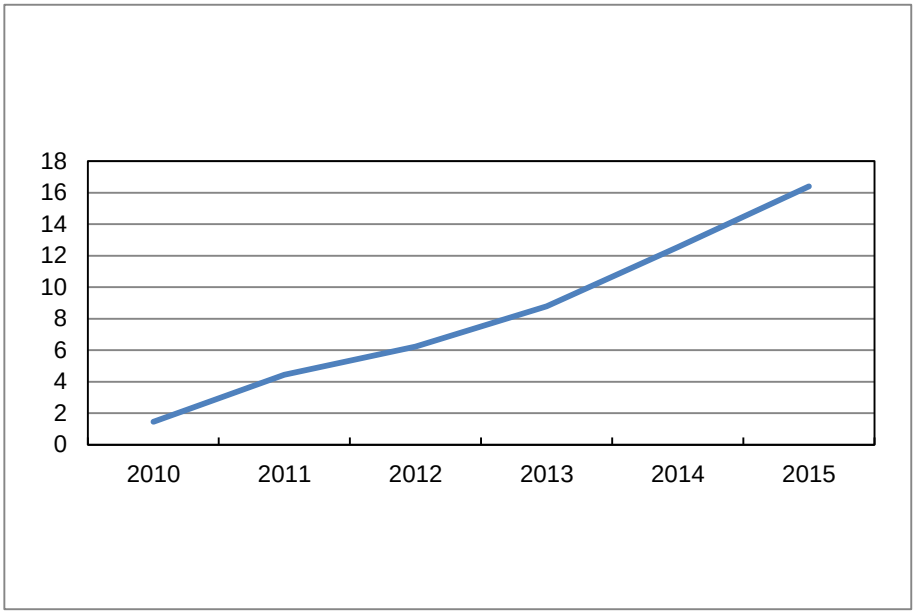
- The changes made in the pension funds reduce the intergenerational distribution of risk, which, in recent years, has created actuarial deficits (effectively, an intergenerational subsidy) as a result of the manner in which the yield and discount rate are set.
- The new mechanism imposes on retirees a greater share of the market risk (the risk deriving from yield volatility), yet, at the same time, the exposure of their assets to market risks has been mitigated by a re-allocation of earmarked bonds, since retirees are now entitled to invest 60 percent of their assets in such bonds, in contrast to only 30 percent previously.
- Without these changes, the actuarial deficit and intergenerational subsidy would have continued to increase as retirees' assets account for an increasing share of pension funds' assets, but the Capital Market, Insurance and Savings Authority took preventive action to eliminate this distortion.
- Although the new mechanism reduces risks, additional measures, such as alternative mechanisms to distribute market risks across generations, should be considered to increase social welfare and reduce potential shocks to retirees' benefits in exchange for an increase in the potential yield on young savers' assets.
- Examples of actions designed to increase social welfare include modifications that increase the intergenerational distribution of risk while eliminating the use of arbitrary assumptions, and transitioning to automatically set, market-based assumptions. Changes that potentially increase the intragenerational distribution of risk among retirees may also be introduced, in order to prevent imposing the entire risk on young savers.

1. Introduction and background

Pension funds must ensure that they have the assets necessary to pay all their future benefit payouts. They ensure their ability to meet these commitments through distributions of intragenerational and intergenerational risks (mutual insurance). These distributions are determined in the actuarial balancing process, a process that checks and eliminates any differences between the value of retirees' savings and retirees' benefits, and is performed once every quarter or once a year. In the actuarial balancing process, an intragenerational risk distribution entails a reduction or increase of retirees' rights, and the use of or addition to a "safety-net" fund that is equal to 1 percent of the funds' total commitments (the safety net is designed to

[1] Thanks to Liran Amihai for his assistance in data collection and processing.

absorb mild shocks).[2] An intergenerational risk distribution entails an increase or decrease in young savers' assets. As the share of young savers' assets of the total fund assets increases (or decreases), the rate at which these savers fund the difference between the value of retirees' savings and benefits increases (declines), though this deficit or surplus of fund assets decreases (increases). In other words, young savers assume the risk that the retirees' benefits will exceed the value of retirees' savings in the fund, which may be caused by, for example, an unanticipated rise in life expectancy. In return, young savers benefit from excess yields when retirees' savings exceed the value of their benefits. They also benefit from a guarantee that in the future, when they retire, their retirement benefits will also enjoy the same stability and lower risks that today's retirees enjoy.



The mutual insurance arrangement in the old pension funds contained an intergenerational risk distribution mechanism that made it possible for very large differences to evolve between the value of a fund's accrued liabilities and the value of its accrued assets. This mechanism created actuarial deficits, which is why the old pensions funds were closed to new members in 1995, and new pensions funds were opened. The new pension funds are Defined Contribution (DC) funds, and are based on a different type of mutual insurance and intergenerational risk distribution mechanism. In the new pension funds, the commitments to young savers equal the young savers' actual savings and therefore, by definition, no difference can develop between the value of their assets and the value of the funds' commitments to them. Commitments to retirees equal the value of the benefits that were calculated for

[2] An intergenerational risk distribution among a single cohort of retirees by pooling risks. To illustrate, the demographic risk is pooled when some individuals live longer on average than others. There is no deficit or surplus on average if the life-expectancy assumption is correct on average.

them at retirement, and therefore a discrepancy between the value of their accrued assets and the value of a fund's commitments to them might arise,[3] but this difference is much smaller than the difference that could potentially develop under the old pension plans. The mechanism in the new pension funds was designed to ensure that these pension funds remain viable and resilient.

At the end of 2016, **the four largest new pension funds had 1.75 million savers**, of whom only 18,500 were retirees, but the share of retirees and their total assets are expected to grow in forthcoming years—as savers transition from the old savings products (those that were completely closed to new members in 2004, when Defined Benefit (DB) pension plans were discontinued), and as compliance with mandatory pension savings rules becomes more widespread—and are expected to stabilize only in several decades.[4] See Figure 1 for the growth in retirees' assets in recent years.

Today the intergenerational distribution of risk stemming from [commitments in respect of] retirees' benefits is small, but it will increase (wherever it develops) as the (new) pension funds mature and the share of retirees' assets of total fund assets increases. **To illustrate, if life expectancy figures are systematically underestimated or if the assumed yield used to calculate benefits is systematically overestimated—two assumptions that the Supervisor of Capital Markets determines uniformly for all pension funds, and both entail uncertainty—young savers might consequently find themselves in a situation in which they are expected to subsidize older fund members while they themselves are uncertain of receiving a comparable subsidy.[5] In such a case, young savers might take steps to opt out of paying the subsidy by migrating their savings to alternative savings products.[6]** The new long-term savings market offers other savings products, such as provident funds and life insurance plans, and savers in Israel have a right to move their assets from one fund to another or from a pension fund to a savings product that has no mutual insurance, at any time before retirement. (**Note that although young savers can leave a pension fund, retirees may not, because when they retired they entered into a quasi-contract based on the benefits calculated for them at that date**.) The difference between these products is based, first and foremost, on their insurance component. Pension funds have mutual insurance among fund members, which means that any deficit or surplus of assets that arises is corrected using the funds' internal sources of

[3] This is because the fund committed to pay retirees benefits based on the savings they accrued, their life-expectancy, and the expected yield on their savings. This calculation, however, is based on assumptions concerning retirees' life expectancy and future market conditions, and there is no certainty that these assumptions will prove to be correct.

[4] The document "Appropriate pension savings – Report of the team to increase certainty in pension savings" presents forecasts concerning allocations of earmarked government bonds, and indicates that the share of retirees' assets of total pension fund assets will increase until 2050.

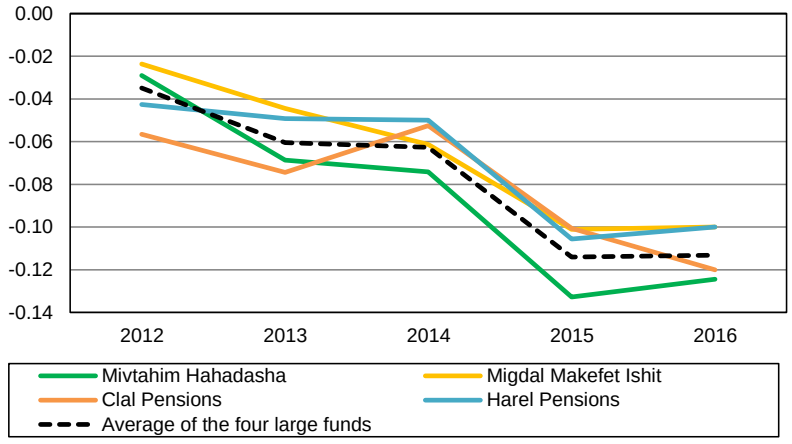
[5] Because their benefits are defined upon their retirement, based on the information available at that time.

[6] Significant intergenerational subsidy may not trigger migration if the expected utility from savings in the pension funds remains positive due to other pension fund features.

capital—the members' own funds; pension funds have no external source of capital. In the case of life insurance, savers purchase such insurance directly from the insurance company; and provident funds contain no structural insurance component at all. It is worth noting that, as a result of the mutual insurance and pooling of risks in the new pension funds, the cost of insurance in these funds is significantly lower than the cost of purchasing it from insurance companies. The management fees in the new pension funds are also lower, on average, than the management fees on other savings products. Finally, only the new pension funds may invest a portion of the accrued savings in earmarked government bonds. These bonds guarantee a relatively high real yield of 4.86 percent per annum.

In recent years, the assumed yield used to calculate retirees' benefits was higher than the actual yield on their savings in the funds (see below for more details). Since savers constitute a large majority of new pension fund members, in 2016 this difference reduced the value of their savings by only 0.11 percent in 2016 (Figure 2), and caused only a slight reduction in pension allowances as well. If, however, young savers believe that the difference between the assumed yield and actual yield will persist, they will be motivated to leave the pension funds — an action that could have a potentially destabilizing effect on these pension funds in the future. To address this concern, a new actuarial balancing mechanism will be introduced in January 2018 and will eliminate the intergenerational distribution of risks stemming from changing market conditions. Furthermore, a target annual yield of 4.26 percent is set for pension funds' entire asset portfolios, and any deviation from this yield will cause a corresponding change in retirees' allowances. In addition, the government also decided to reduce retirees' exposure to capital market risks: It increased the share of retirees' savings that may be invested in earmarked government bonds from 30 percent of retirees' savings to 60 percent of their savings, while reducing the allocation of earmarked government bonds to young savers.

Figure 2
The Actuarial Surplus Derived from Pensioners' Retirement as a Share of the Funds' Assets, the Four Largest New Pension Funds, 2012–16



SOURCE: Based on the financial statements for 2016 published by the four pension funds.

At this point we should note that our study focuses on the distribution of risks from older savers to young savers, because it potentially affects the stability of the financial system since young savers may migrate from pension funds in response to this shifting of risk. Mutual insurance, however, has additional risk distributions: (1) intragenerational risk distribution (mentioned earlier), and (2) reverse intergenerational risk distribution, which arises when the population of retirees shares the risk stemming from young savers' disability and death.

This document is organized as follows: Section 2 presents a review of literature. Section 3 describes the current (pre-reform) mechanism of intergenerational risk distribution and the solution proposed by the new mechanism, and discusses risks that remain and additional potential improvements. Section 4 concludes.

2. Review of literature

The economic literature demonstrates that intergenerational risk distribution can improve social welfare as it allows risks to be smoothed over time, and therefore stabilizes retirees' incomes without causing a long-term adverse impact on young savers (Gordon & Varian, 1988; Shiller, 1999). Young savers partially finance shocks that affect retirees, and in exchange receive higher yields on their savings in favorable periods. As a result, young savers' portfolio volatility increases while that of retirees' portfolios decreases. Several models show that intergenerational risk distribution has benefits (Allan & Gale, 1997, Bonenkamp & Westerhout, 2014; Cui et al., 2009; Gollier, 2007). The literature also addresses the case in which an intergenerational risk distribution leads to a subsidy and asset transfers between generations, and indicates that such a situation is disadvantageous if it leads to instability resulting from young savers' incentive to leave the pension fund (Westerhout, 2011). Instability is exacerbated if (a) savers anticipate that when they retire, they will receive less from young savers in the future than the subsidy they are giving to retirees in the present and (b) it is economically feasible for them to migrate their savings to other savings products. In other words, instability is exacerbated if the benefits of saving in the current pension fund do not compensate for the loss caused to them by their subsidy to retirees.

Instability may be caused by an **ex ante subsidy**—a situation in which the mechanism not only includes a distribution of risk but also fixes the rate of intergenerational subsidy, independent of market conditions. In some cases, a fund knows in advance that its commitments to retirees are calculated on the basis of an incorrect assumption, either because the fund or the regulator— he authority that defines the assumptions for the pension funds—defined an incorrect assumption or failed to correct an assumption when it proved to be incorrect, either due to short-sightedness or political pressure. In these situations, a fixed subsidy arises, and may also drive young savers to abandon the pension funds. Kocken (2012) analyzes the

public pension plans that US states provide for their employees, and highlights the structural subsidy they contain. In the US, valuation of retirees' rights is based on the anticipated yield of their assets and does not take into account the risk component. As a result, pension plans are motivated to make risky investments, creating concerns that they will be unable to pay the future benefits. In other words, when young savers join the system, they are already aware that the pensions they will receive will be smaller than what is promised to them, and also smaller than the pensions that current retirees receive—unless the government intervenes and injects funds into the pension funds from an external source of capital. Analyses indicate that large deficits have developed because, despite the changes in market conditions, these public pension funds failed to modify their assumption that the annual yields will range from 7 percent to 9 percent per annum (Brown et al., 2011). Accordingly, research shows that savers are migrating to pension plans with no intergenerational subsidy, and that investors are foregoing investments in states with high, incorrectly priced pension commitments.

Instability can also arise from an **ex post intergenerational subsidy** – This situation arises after risks have already materialized, and is dependent on market conditions. Cremer et al. (2000) argue that products that include intergenerational risk distribution mechanisms are sensitive to large unexpected shocks, and after such risks materialize, they may generate a significant intergenerational subsidy, leading to a rapid collapse of the risk distribution mechanism. These researchers examined a pension savings model that is administered through Social Security and which savers may leave, and they show that when the yield on private savings exceeds the yield on funds saved through social security, young savers withdraw from the Social Security system and migrate to private savings, and the risk distribution mechanism ceases to exist. The literature notes several factors that might mitigate such ex-post instability. Allen and Gale (1997) show that constructing a shock-absorbing financial margin reduces intergenerational subsidy because it allows the current generation of retirees to finance part of the shock themselves. They emphasize the significance of mandatory pension savings, which is a system in which savers are "locked" into their savings and therefore have no choice but to finance intergenerational transfers. Cremer et al. (2000), however, showed than even a mandatory savings mechanism does not necessarily provide stability since the population can take action to change it through political pressure.

A prominent example of correcting an intergenerational subsidy mechanism and addressing the potential instability of pension funds is the worldwide transition from defined benefit (DB) plans to defined contribution (DC) plans. DB pension plans set a series of assumptions (concerning life expectancy, interest rates, and yields) at the beginning of the savings period, and these are used to calculate retirees' benefits—decades prior to retirement. When this mechanism was created, it contained no ex-ante subsidy because the assumptions that were set reflected the market conditions at the time. However, after conditions changed (especially

conditions related to life expectancy), an intergenerational subsidy developed, which triggered the establishment of the new pension funds that contain no structural element of loss[7] to young savers, and calculate benefit rights only at retirement, for each individual according to her accrued savings.

3. Intergenerational subsidy in the new pension funds in Israel

The new pension funds in Israel are regulated by the Capital Market, Insurance, and Savings Authority. The Authority determines the assumptions that are used to calculate retirement benefits and determines the method of actuarial balancing, and all the pension funds must use the same set of assumptions. In May 2017, the Authority introduced a reform in the intergenerational distribution of risk in the pension funds, which is scheduled to come into effect in early 2018. The reform, which changes the method of calculating the actuarial deficit, is designed to address the distortion in the intergenerational distribution of risk created by the current mechanism.

In this study we examine two of the risks that affect intergenerational subsidy: market risks and life expectancy risks. The reform modified the exposure to market risks and is therefore analyzed separately. The reform made no change to the exposure to life expectancy risks: In that respect, there is no difference between the current mechanism and the new mechanism. Therefore, life expectancy assumptions are analyzed for both mechanisms together.

3a. Market risks: Interest rate risks and yield risks in the current system

In the current system—the system that is in effect until end 2017—the pension allowance is calculated at retirement on the basis of an assumed annual yield, but the value of the corresponding commitment is calculated on the basis of an entirely different assumption. Benefits are calculated according to an **expected real long-term yield**, which is 4.26 percent (4 percent is the assumed yield on unrestricted assets—total assets less funds invested in earmarked bonds—which constitute 70 percent of the portfolios, and 4.86 percent is the yield on earmarked government bonds, which constitute 30 percent of the portfolios). The fact that the yield is defined as a fixed rate should grant stability to retirees' benefits. In contrast, the value of the corresponding commitment is calculated on the basis of an entirely different assumption: In actuarial balancing, the present value of the stream of

[7] To illustrate, observe the cohort of savers who join a defined benefit (DB) plan at age 30, and assume that their life expectancy increased when they reached age 50 yet their benefits at retirement (at age 65) did not change accordingly. This cohort generates a constant structural actuarial deficit. In this case, new savers assume a share in financing the deficit, which creates intergenerational subsidy that is known in advance. Due to the demographic structure of society and the rising share of older individuals in the population, the young savers who are subsidizing retirees may assume that if they themselves create similar deficits, future (young) generations of savers will finance a smaller share of those deficits because their savings will comprise a smaller share of the funds' total assets. Therefore, the intergenerational subsidy creates negative profit for current young savers. In response, they put pressure to modify the arrangement or avoid joining pension funds whose members include older savers.

retirement allowances (the value of the funds' commitments to retirees) is discounted using an **interest rate that should reflect the risk free interest rate under current market conditions**, based on the yield curve of tradable CPI-indexed government bonds.[8] The **difference** between the assumed fixed yield and the discount rate creates an actuarial risk.[9]

If the assumed fixed yield used as the coefficient in the benefit calculation formula reflects the actual long-term yield, and the discount rate accurately reflects future interest rates, the system maintains a balanced intergenerational distribution of risk, and a temporary intergenerational subsidy will develop only when the market deviates from the long-term yield. In contrast, a constant difference between the assumed yield and the discount rate will give rise to a fixed intergenerational subsidy. Such a difference might arise when the assumed real yield is over-estimated and/or when the discount rate is too low.

The concern that the assumed fixed yield is biased to the upside stems from the fact that using a lower assumed yield directly reduces retirement benefits and has significant public implications. Setting the fixed yield is not a simple decision: Although the current assumed yield is based on many years of experience regarding past yields, there are solid grounds for believing that current market returns are lower than historical returns, and therefore an assumed real yield of 4 percent may be too high. According to the secular stagnation approach, for example, global yields have dropped significantly and will not rise in the future. Some regulators around the world have taken action accordingly, by setting the assumed long-term riskless yield at a rate significantly below 4 percent. To illustrate, we turn to Solvency II, the regulation that applies to insurance companies in Israel (insurance companies' life insurance products whose composition of assets is similar to the composition of assets in pension funds). Under Solvency II, the Capital Market Authority defined the ultimate forward rate (UFR) (the real long-term rate) at 2.6 percent, and debates are ongoing whether this rate should be reduced even further.

A second concern is related to the fact that the discount rate is too low, because government bond yields are lower than the riskless market interest rate, due to, for example, intervention in the bond market by central banks.[10] These conditions create what appears to be a fixed intergenerational subsidy: the value of the

[8] In effect, the discount rate is a vector of interest rates determined according to the following formula: 70 percent - based on the riskless interest curve in the market, representing the real yield on tradable government bonds; and 30 percent (according to the allocation of earmarked bonds to pension funds) - based on the real yield on earmarked bonds (4.86 percent). To illustrate, at end 2016, the yield on 10-year CPI-indexed government bonds was 0.56 percent.

[9] A positive (negative) gap between the assumed real yield and the market interest rate creates an actuarial deficit (surplus). In this case, retirees' benefits, which are a function of the value of their assets, are calculated on their retirement date using one method (assumed real yield) but the value of the pension funds' liability, which is created immediately after the retirement date, is calculated otherwise (using the discount rate). The result is a discrepancy between assets and liabilities.

[10] It should be noted that although the majority of the literature uses government bond yields as the riskless interest rate, several theories point to the problems in this method (Greenwood et al., 2010).

commitments is over-estimated because the valuation uses a discount rate that is too low. As a result, the actuarial deficit is too large, and the adjustments are exaggerated.[11] The UFR can also be used here as an example, but this time, to illustrate that the discount rates used by the pension funds are too low. The UFR sets the long-term interest rate for insurance companies in Israel at 2.6 percent—which is much higher than the long-term interest rate reflected in government bond yields. This means that, today, insurance companies in Israel discount their liabilities using a higher interest rate vector than the interest rate vector used by pension funds, even though both types of entities have similar liabilities and are regulated by the same agency. Still, it should be recalled that an excessively high discount rate also creates a problem by over-estimating surpluses that are then distributed to all the pension fund members. If it emerges that the actual yields on savings is lower than the interest rate used in the calculation, accrued savings will be insufficient to meet benefit commitments, because the excessive withdrawals by retirees in the past can't be corrected in retrospect.

In 2013, the Capital Market Authority published a draft regulation to equalize the yield used to calculate pension benefits at retirement and the discount rate used to calculate pension funds' commitments (which would vary according to market conditions), but this draft did not enter into force.

In effect, actuarial deficits developed in recent years, and young savers have subsidized new retirees as a result of the method used to set the assumed yield and the discount rate (Figure 2). In the absence of the new reform, such subsidy could be expected to grow as the share of the retirees' assets in the pension funds increases, as long as the assumed yield and the discount rate differ. The Capital Market Authority, however, addressed the current distortion before it caused significant harm to young savers and to the stability of the pension funds. The actuarial reports of the four largest pension funds indicate that in 2016, the difference between the formula used to calculate retirees' benefits upon retirement and the formula used to calculate the value of the pension funds' commitments to pay benefits on the actuarial balancing date created an annual deficit of NIS 712.5 million, or NIS 410 per pension fund member[12], based on a savings balance per saver of NIS 56,000, averaged over these four pension funds.

Moreover, the current actuarial balancing mechanism (which will be in force until end 2017) determines that after the benefits are calculated, any surplus yields or deficits resulting from market risks are shared by retirees only (where such surplus or deficit is created by a difference between the assumptions used to calculate yields and the actual market discount rates). In other words, the regulator intended to prevent young savers from assuming any of the retirees' post-retirement market

[11] A discount rate that is too low creates surpluses over the years due to excess returns. However, since savers do not share retirees' yield risk (elaborated further below), they cover only the initial deficit, and consequently, a constant intergenerational subsidy develops.

[12] At end 2016, the deficit in the four largest pension funds was NIS 712.5 million, with 1.74 million savers (including retirees).

risks. However, as explained earlier, under the current conditions, young savers already subsidize new retirees upon retirement, and since the current method does not allow the redistribution of surplus funds to them over the lifetimes of retirees, the subsidy cannot be reversed when market conditions improve, which exacerbates the harm to savers. To achieve an actuarial balance, retirees' post-retirement assets must achieve a target yield that is equal to the discount rate for the upcoming year. This is a low target yield, and consequently, an actuarial surplus develops even when the assets are invested in conservative vehicles. As Table 1 indicates, the average annual yield on retirees' assets alone created a large surplus — an average of 0.31 percent per annum[13] in the last five years. Young savers did not benefit from this surplus even though they had financed a considerable share of the actuarial deficit that was caused by the valuation of the benefits defined upon retirement, because the assumed yield was higher than the discount rate.

Table 1

Yield in various pension tracks and share of actuarial surplus in pensioners' assets in respect of the actual yield (percent)

	New Mivtachim	Migdal Makefet Ishit	Clal Pension	Harel Pension	Surplus in respect of annual yield	Real yield from the 10-year zero curve (illustration of the target yield)
2012	11.64	7.59	11.85	12.44	0.19	1.53
2013	4.49	6.85	7.89	5.79	0.08	1.57
2014	9.56	4.43	6.97	9.98	0.26	0.77
2015	2.5	2.2	2.54	2.79	0.28	0.68
2016	1.72	3.11	2.66	3.44	0.76	0.55
Five-year average[a]	5.98	4.84	6.38	6.89	0.31	1.05

[a] Geometric mean.

SOURCE: Based on Pension.net data.

Any change in the discount rate curve (a vector) affects the value of the pension funds' stream of commitments. Table 2 illustrates the volatility of the effect of changes in the discount rate vector between 2012 and 2016. We see that over time, changes to the discount rate curve generated considerable surplus funds in those years in which sections of the interest curve rose slightly, such as 2015. Between

[13] Excess returns refer to the current year, while the pension funds' liabilities are discounted over several decades, which explains why the excess returns in 2012 (10 percent) led to an actuarial surplus of "only" 0.19 percent.

2014 and 2015, the real 6-year yield rose by 0.8 percent and the 7-year yield rose by 0.1 percent, which generated an actuarial surplus even though interest rates on the remainder of the discount rate curve declined. A rise in the discount rate curve will produce a large actuarial surplus, but under the current mechanism this surplus will not be distributed among the young savers. Furthermore, we observe a high negative correlation between the surplus/deficit that stems from yields on the assets and the deficit/surplus that stems from changes in interest rates. This negative correlation results from the fact that the pension funds' investment portfolio is considerably exposed to interest vector risks. This is not an inevitable situation, because no restrictions are imposed on the pension funds' investments. Nonetheless, many funds choose to employ the asset liability management method (ALM) when managing retirees' funds. Optimally under the ALM method, on a retiree's retirement date, the pension fund buys government bonds whose stream of income is identical to the stream of the retiree's benefits. In this case, the yield and interest risks cancel each other (the surplus/deficit from the yield is identical to the deficit/surplus from the interest rate) and retirees are not subject to any post-retirement market risks. Under the current calculation method, the benefits of the ALM method are obvious: stability to retirees and to pension funds.

Despite young savers' subsidy to retirees, and despite efforts to eliminate retirees' post-retirement market risks, the deficit produced by the actuarial mechanism of balancing retirees' market risks has also generated slight fluctuations in retirees' benefits in recent years (Table 3).

Table 2

Proportion of the surplus/deficit created in pensioners' assets deriving from the changes in discount rate, over the course of a year, the four largest pension funds

2012	-0.19
2013	-0.03
2014	-0.39
2015	0.22
2016	-0.57
Average	-0.19

SOURCE: Based on data for 2016 published by the four largest pension funds.

Table 3

Value of 1 shekel of someone who retired in 2012, at the end of succeeding years

2012	1.003
2013	1
2014	0.994
2015	1.001
2016	0.997

We multiplied 1 shekel of pension savings by the actuarial surplus/deficit deriving from retirement, by the surplus/deficit in respect of actual yield, and by the surplus/deficit deriving from changes in the discount vector of each year.

SOURCE: Based on data for 2016 published by the four largest pension funds.

3b. Yield risks under the new mechanism

The Capital Market Authority changed intergenerational risk distribution by modifying the actuarial balancing process that adjusts for market risks, because in recent years the current mechanism created a fixed intergenerational subsidy due to such adjustments. Under the new mechanism, a real annual "target" yield of 4.26 percent was set for retirees' entire portfolio (this yield is equivalent to the current assumption for the benefits calculation at retirement). Every time the yield on these assets deviates from this target yield, a deficit/surplus is created that year; **one third of this deficit/surplus is imposed on/distributed to the retirees in each of the three years following the year in which the calculation is performed**. The new mechanism is not forward looking: It refers exclusively to the deficits and surpluses that are generated in a specific year and the accrued deficit/surplus in the previous three years.

The new mechanism reduces retirees' exposure to fluctuations in the capital market through a reform in the allocation of earmarked bonds: Until July 1, 2017, 30 percent of the assets of all pension fund members were invested in earmarked bonds. From this date onward, 60 percent of the assets of all retirees in the funds will be invested in earmarked bonds. This change is designed to increase the certainty of retirees and older savers regarding the value of their future benefits without affecting government spending. Under this reform, retirees' exposure to capital market volatility is limited to 40 percent of their portfolio, which makes it possible to reduce the annual "target" yield on this share of their portfolio to 3.36 percent. Since increasing the allocation of earmarked bonds to retirees is made at the expense of an allocation of these bonds to young savers, this move effectively constitutes an intergenerational distribution of risks that increases young savers' exposure to capital market fluctuations in exchange for increasing the retirees' certainty. This is an external allocation to pension funds that is funded by the government.

If it transpires that the real target yield on retirees' unrestricted assets, which is 3.36 percent, is systematically too high, retirement benefits may experience a general decline over time. Since individuals prefer to smooth their income, the utility of a downward trend in benefits is smaller than the alternative—smaller benefits from the outset and less volatility.[14] According to estimates, under the new mechanism, retirees' funds will be invested in riskier investment vehicles[15] and achieve higher returns than the yields shown in Table 1, and therefore **pension funds' yields are not expected to underperform**. For the sake of comparison, in recent years, the average real yield on investments by life insurance policies (that are not permitted

[14] Bender and Jivan (2005), Burchardt (2005), Diener and Fujita (2005), Kahneman and Tversky (1979), Pantis (2004), Sundali et al. (2008).

[15] If an effort is made to match liabilities to assets using the ALM method, pension funds will try to purchase investment products that generate a constant yield of 3.36 percent and will — under current market conditions — refrain from investing in government bonds, which offer a lower yield.

to invest in earmarked bonds) is 4.5 percent.[16] Under the current conditions, even a downward yield trend will not compromise the system's resilience because 60 percent of pension fund assets are invested in earmarked bonds and are therefore less exposed to capital market fluctuations, compared to alternative investment products, in which 100 percent of the assets are exposed. However, if significant changes are made in the allocation of earmarked bonds to pension funds or among other long-term savings products, the appeal of these savings products will increase and induce savers to migrate from pension funds.

We conducted a series of simulations under the assumption that the annual real yield is 4.5 percent and the standard deviation is 4.4 percent.[17] The simulations are presented in Table 4. These are conservative simulations: They assume a normal distribution even though we know that actual yields have a long left tail (are negatively skewed). There is a non-insignificant probability to obtain low yields on the investment portfolio, which will generate a deficit, and in that case, the expected difference may be significant, especially in the short term. To illustrate: When yields are 10 percent lower than the target yield on average (that is, the rate of return is 3.02 percent), this generates an underperformance of 0.13 percentage points on retirees' total assets, which accordingly slows the growth rate of their assets. When the yield is 40 percent lower than the target yield on average (2.02 percent), this generates an underperformance of 0.55 percentage points on retirees' total assets. The Chief Economist of the Ministry of Finance also conducted simulations on pension fund yields and found that in 25 percent of the cases, the yield of a theoretical 37-year investment portfolio is below 3.3 percent.[18]

Table 4

Simulations of the unrestricted assets portfolio in the new pension funds: Probability of a deficit in the fund at the end of the period, and average final yield when there is a deficit in the fund

Years of savings	Probabiility of a deficit in the fund at the end of the period (percent)	Average yield on unrestricted assets when there is a deficit in the fund (percent)
5	29	2.4
10	25	2.9
20	16	3.2
30	13	3.4[a]

The simulation assumes a normal distribution on the assumption that the real annual yield is 4.5 percent and the standard deviation is 4.4 percent. It is based on data from "BituachNet" regarding new policies, policies issued from 2004 onward. The simulations relate to data from 2012 to 2016, a period in which average annual inflation was 1.2 percent.

[a] The average yield over a period of 30 years is slightly higher than the target yield of 3.36 percent, but still creates a deficit since the distribution of the deficit over three years can create cases in whch an average yield that is actually higher than the target yield leads to a deficit.

SOURCE: Bank of Israel calculations.

[16] Data from "Insurance.Net" on the new policies, issued after 2004. The simulations use data from 2012 to 2016, when the average annual inflation was 1.2 percent.

[17] Data from "Insurance.Net" on the new policies, issued after 2004. The analysis refers to data from 2012 to 2016, controlling for annual inflation. Due to the limitations of the data, the analysis is based on the non-conservative assumption that the relevant variance is an annual rate rather than the variance over a longer period.

[18] Krill (2016). In this document, the nominal expected yield is 5.08 percent and the standard deviation is 10.7 percent.

3c. Life-expectancy risk

The pension allowance is calculated at retirement, based on an individual's life expectancy on that date. If life expectancy subsequently increases beyond the assumed life-expectancy rate, an actuarial deficit is generated, and young savers are required to participate in covering the deficit. A small or temporary deficit will not lead to instability because young savers can expect to receive a corresponding subsidy from young generations of savers in the future. An intergenerational subsidy may, however, cause instability when life expectancy assumptions are not corrected in a timely manner, and young savers anticipate an actuarial imbalance in the future that will further adversely affect the value of their assets and such imbalance will be corrected before their own retirement. Furthermore, they may also assess that though life expectancy will be consistently biased, they will receive a smaller intergenerational subsidy from future generations of young savers because the assets of young savers will constitute a smaller share of the fund assets, due to future demographic developments.[19]

The Capital Market Authority conducts a study approximately every three years and, based on it, adjusts the assumptions that pension funds use. The most recent study, dated September 2017[20], stated that "efforts to forecast future mortality rates, even in the short term, are not always successful, mainly because they were overly "pessimistic" (in other words—the actual rate of improvement was higher)." This study found that the decline in mortality rates in the past five years effectively reduces the previous assumed mortality rate of the over-65 population by 15 percent, and diminishes linearly thereafter up to age 75, which will reduce the benefits of new male retirees by up to 0.6 percent and by up to 0.1 percent for new female retirees. Therefore, early this year, the Chief Actuary of the Capital Market Authority established a professional committee to study mortality in Israel with the aim of defining the best method to set life expectancy assumptions.

The analysis conducted by the Capital Market Authority in 2012[21] indicated that male retirees' life expectancy was 5.5 percent higher than the life-expectancy rate used to calculate their benefits. If we assume that retirees will account for 33 percent of pension fund assets in the future,[22] an increase of 5.5 percent in liabilities

[19] As noted above, a reverse intergenerational risk distribution also exists when retirees share the demographic risk of young savers' disability benefits and survivor benefits. Such a distribution increases the utility that young savers derive from membership in the pension funds, and therefore such subsidy encourages them to remain in the pension funds, and supports the pension funds' viability.

[20] A position paper entitled "Update on the set of demographic assumptions in pension funds—draft".

[21] A position paper entitled "Update on the set of demographic assumptions in pension funds and life insurance." It is impossible to examine how this adjustment affects the pension funds because its effect on the actuarial deficit is presented together with the effects of other changes that were introduced to various elements of the pension funds' actuarial balancing mechanism, following the same study.

[22] This rate is based on forecasts presented in a document entitled "Appropriate pension savings – Report of the team to increase certainty of pension savings." Under the assumption that retirees' assets are equal to the assets of savers over age 50, the value of the retirees' assets will exceed one third of the pension funds' assets by 2043.

to retirees will require 1.8 percent of the funds' assets and cause a deficit and underperformance of 1.8 percent to young savers. If the public sees that a large number of actuarial deficits arise during their savings period, they may develop misgivings about the pension funds' actuarial balancing process and transfer their savings to a pension product that they believe is safer. Therefore it is important for the regulator to introduce the necessary changes in a timely manner.

4. Conclusion

Israel is one of the first countries to transition to defined contribution retirement plans with mutual insurance. The transition to DC plans improves the viability of pension savings compared to savings in the old pension funds.[23] Mutual insurance allows young generations to assume the volatility risk stemming from retirees' assets (in order to reduce the shocks to retirees' benefit, in exchange for a higher yield on their own assets); in other words, mutual insurance supports intergenerational distribution of risk and thereby contributes to social welfare. However, when the intergenerational distribution of risk involves a transfer of assets between generations, an intergenerational subsidy develops, and if this situation continues over years without an appropriate regulatory response, it might undermine the system's stability. It is therefore important to find a way to increase risk distribution while preventing a persistent subsidy.

In the beginning of 2018, a new actuarial balancing and intergenerational risk distribution mechanism will enter into force. This mechanism terminates the intergenerational distribution of market risks, and sets a real "target" yield for retirees at 3.36 percent per annum for assets that are not invested in earmarked bonds. The mechanism calculates the actuarial surplus (deficit)—generated when the actual yield is higher/lower than the "target" yield—every year, and distributes (imposes) it to the retirees over a three-year period. This move is supported by a re-allocation of earmarked government bonds: the share of retirees' assets permitted to be invested in earmarked bonds was increased from 30 percent to 60 percent, with the aim of reducing their exposure to market risks. This allocation effectively constitutes external government-funded intergenerational risk distribution in the pension funds; under the current market conditions, this distribution creates an intergenerational subsidy. Under the new mechanism, intergenerational risk sharing is limited to demographic risks and shocks related to retirees' life expectancy (in addition to the intergenerational subsidy on elements related to employment duration, a topic that is not discussed here).

The new actuarial balancing mechanism, including all its elements, is characterized by stability, and it addressed the defects of the current mechanism, yet it should be noted that some, albeit reduced, risks remain. Specific situations may create an intergenerational subsidy as a result of a delay in the regulatory response to an

[23] However, this transition also creates problems because Israel is a pioneer in this transition and therefore a design of an optimal mechanism cannot be based on global comparisons or past data.

unanticipated rise in retirees' life expectancy, which may induce young savers to move their savings to products that contain no intergenerational subsidy (such as life insurance policies or provident funds). Moreover, the simulations we presented indicate that although the probability of underperformance is not high, it cannot be ignored in the intermediate term (25 percent over a ten-year period), and pension benefits may suffer from a downward trend — which might reduce savers' trust in the system. On the other hand, as long as the allocation of earmarked bonds remains at its current rate and their yield exceeds the market yield, it is not reasonable to assume that migration life insurance will generate positive expected profit.

Reducing market intergenerational risk distribution has important advantages, yet it also reduces the potential benefits. Alternative mechanisms can maintain stability while supporting the benefits of intergenerational risk distribution. Potential alternatives include changes that increase intergenerational risk distribution and eliminate the use of arbitrary assumptions, and instead use automatically set, market-based data. Proposals for consideration include: automatically defining a "target" yield that reflects the weighted average of recent years, and introducing modifications to the retirement benefit calculation mechanism so that the yield is based on the average conditions during a period of time rather than on a single retirement date.[24] Furthermore, other modifications may increase the intragenerational distribution of risk among retirees to avoid imposing the entire risk on young savers. For example, retirees' assets can be used to increase the fund that is already meant to partially absorb yield and demographic shocks. Such measures would increase the stability of the retirees' benefits and enable intergenerational risk distribution in stress situations, when a large deficit is created by market risks or life expectancy risks.

As has been shown in this analysis, changes in the foundation of the mechanism and adjustments (even automatically) to its assumptions in line with changing market conditions have a significant impact on the size of retirees' benefits and on the assets of young savers, and this impact increases as the share of retirees' assets in pension fund total assets increases. An important step was taken to optimize the management of these effects in early 2016: The Capital Market, Insurance, and Savings Division was separated from the Ministry of Finance and became an independent authority. This move will allow the Authority to modify the actuarial balancing mechanism and its underlying assumptions on the basis of professional considerations.

[24] To illustrate, a tiered retirement mechanism might be added, constructing an allowance for new retirees that is not solely a function of the economic conditions existing on the retirement date, but rather takes into account the conditions over a longer period. To illustrate, a tiered retirement mechanism might be added, constructing an allowance for new retirees that is not solely a function of the economic conditions existing on the retirement date, but rather takes into account the conditions over a longer period.

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