רשות החדשנות
Israel Innovation Authority

Israel Innovation Authority's

2019 Innovation Report

Foreword by the CEO and Chairman of the Board of the Israel Innovation Authority

The Israel Innovation Authority is proud to present its 2019 Innovation Report .

These are unusual times. In recent weeks, the coronavirus outbreak (COVID-19) has caused economic upheaval to the Israeli economy and to the global economy at large. We are just beginning to grapple with the virus and its ramifications, but it is already clear that there will be profound consequences for the Israeli economy in general and for Israeli high-tech in particular. Israel's high-tech sector, which has been an integral part of global innovation as a whole, will inevitably face momentous challenges and uncertainty. We are already witnessing a decline in international economic activity, stagnation in investments, and frequently imposed restrictions on the movement of people and goods. These constraints make groundbreaking innovation almost impossible to carry out.

These are trying times for the Israel Innovation Authority as well. Israel's transitional government is hindering its ability to advance legislation and policy, and is slowing down public budgeting mechanisms. In late 2019, this forced the Innovation Authority to delay payment to companies. Moreover, since there was no approved state budget at the outset of 2020, the Israel Innovation Authority was unable to provide new grants or to continue its funding of the Israeli innovation ecosystem.

Nonetheless, we believe that the data presented in this report indicates that the Israeli high-tech sector is entering this coronavirus crisis in relatively good shape. 2019 was a record-breaking year for Israeli high-tech in all surveyed parameters: private capital raising, exports, the number of skilled tech workers, state revenue from taxes, and more. These accomplishments place the Israeli high-tech sector in a solid position to tackle the challenges that are anticipated, and they demonstrate that the sector could potentially be the 'engine' that powers the recovery of Israel's economy.

The report also shows that Israeli high-tech still leads the world in innovation in its demonstration of remarkable flexibility and its ability to identify and develop future technological trends. Every crisis presents opportunity. We believe that if appropriate policy is implemented, the Israeli innovation ecosystem will be able to utilize this crisis to enhance its competitive advantage, and could even become a world leader in future medical technologies (called bio-convergence in this report). The present healthcare crisis is highlighting the relevance of these technologies to the world.

The report offers a portrait of Israel's high-tech industry in 2019, before the onset of the coronavirus crisis, detailing an analysis by the Israel Innovation Authority of trends, challenges and opportunities. The report's findings, which underscore the role of government support, point to the warning signs that the industry was facing before the emergence of the coronavirus crisis. This government support is critical in helping Israel's high-tech sector tackle challenges, identify opportunities, and fulfil its potential. The report also lays out the steps that the Israel Innovation Authority is planning to take in order to achieve these goals. We believe that the importance of support by the government and by the Israel Innovation Authority, as outlined in this report, is further validated in light of the coronavirus crisis.

We would like to thank the Strategy and Economic Division for compiling this report, as well as everyone at the Authority for their outstanding, hard work over the course of this past year. We would also like to thank members of the Authority Council for their valuable work in establishing policy, members of the Investment Committees for their dedication, as well as everyone working with the Authority, in both the public and private sectors, for their contribution to promoting Israeli innovation.

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Acknowledgements
The Israel Innovation Authority would like to thank government entities and industry experts for helping compile the data and for contributing their vast knowledge to this report: Evyatar Kirshenberg, Mark Feldman and Yair Ben Netanel, the Central Bureau of Statistics; Naftali Rozin, Department of Chief Economist, Ministry of Finance; Professor Donald Ingber, Founding Director of the Wyss Institute for Biologically Inspired Engineering at Harvard University; Alan Feld, Wyss Managing Partner; Shmulik Shelach, Marianna Shapira, Guy Holtzman, IVC; Uri Gabai, Rinat Korbet, Startup Nation Central.

רשות החדשנות
Israel Innovation Authority

Contents

2019 Innovation Report:

Growth and Prosperity Alongside Difficulties and Barriers

- **2019 was a year of growth and prosperity for the Israeli innovation ecosystem. It broke records in capital raised, exports, output, and the number of people working in the high-tech sector**. Total capital raised increased by 15% to 9 billion dollars,[1] and high-tech exports increased by 1.2% reaching a record 45.8 billion dollars. The year was marked by accelerated growth in the number of people working in the high-tech sector; for the first time in 15 years, the share of high-tech employees exceeded 9% of Israel's total workforce.[2] The fortitude of the Israeli ecosystem is also shown in the Israel Innovation Authority's High-Tech Index, which demonstrates sustained growth.[3]

- **In international comparisons, the Israeli innovation ecosystem continues to show global dominance.** Israel has significantly improved its position in a variety of global innovation indices, ranking among the top ten in indices such as the Annual Bloomberg Global Innovation Index[4] and the Global Innovation Index.[5] Israel continues to hold second place among OECD countries in the share of its R&D expenditures of its GDP sourced from private capital,[6] and is the world leader in its number of start-ups per capita.[7]

- **The data indicates that in 2019, the welcome trend of Israeli high-tech maturation continued, with an increase in its number of growth companies.** New data in this report reflects that 4,500 high-tech growth companies have sales revenue.[8] This trend is also evident in the high number of unicorns (start-ups valued at over one billion dollars) established by Israeli entrepreneurs, with 30 of these unicorns in 2019.

- **2019 saw substantial achievements in government activity in support of the high-tech sector.** In 2019, the Israel Innovation Authority funded 1,650 R&D projects at a total sum of 1.73 billion shekels. The EU also granted R&D scholarships valued at 89 million euros (340 million shekels) to Israeli companies (SMEs) funded by the Israel Innovation Authority, with Israel ranking first place both in the number of grant applications and in application success rates. Achievements by the Israeli government in 2019 include the expansion of the Pilot Program, which promotes the growth of start-ups developing innovative technologies that have not been tested in a commercial environment.[9] The Authority helped launch the national program for quantum science to help Israel maintain its future lead in the field. The Authority also funded the creation of innovation labs and entrepreneurship incubators in the periphery, which encourage the propagation of innovation in new fields and in new geographic regions. The Israel Innovation Authority's

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1 IVC data as of March 2020.

2 Central Bureau of Statistics data processed by the Israel Innovation Authority. Chart 20 – high-tech employees excluding the communications sector, according to profession and gender, 2012-2018 (2011 classification).

3 Analysis by the Israel Innovation Authority in this present report.

4 The Annual Bloomberg Innovation Index, 2019

5 GLOBAL INNOVATION INDEX 2019

6 OECD STAT 2017

7 2019 Startup Genome report

8 Central Bureau of Statistics data produced exclusively for the Israel Innovation Authority and processed by the Israel Innovation Authority.

9 The Pilot Program was launched in 2018 with the objective of helping high-tech companies conduct semi-commercial demonstrations of new technologies.

investments in projects for the advancement of human capital has led to the sustained growth of human capital skilled in high-tech professions in both academic and non-academic tracks supported by the Authority and inspired by its vision:

"...to establish Israel as a global leader in innovation and entrepreneurship that frequently grows innovation-driven companies which provide extensive, highly productive employment for all population groups and all regions of the country."

Alongside this promising data, the Israel Innovation Authority has also identified alarming trends that point to challenges and obstacles that could potentially delay the development and prosperity of the Israeli high-tech sector:

- **Analysis of high-tech output and high-tech exports shows that while there was growth in the software and R&D sectors,[10] the commodities sectors showed a decline in exports and output.** This decline in the share of commodities sectors in exports and high-tech output is concerning. Israel's high-tech commodities industry is critical for the economy due to its contribution to output and export, its nationwide distribution, and its employment of a variety of professionals including R&D specialists. A large share of companies in this field are complete companies that operate manufacturing centers throughout the country. This sector also plays a key role in creating and preserving Israel's assets and innovation infrastructure. Scaling down the high-tech commodities sectors and relying on software, including the provision of services for multinational R&D centers (this was covered extensively in last year's Innovation Report) narrows the diversity of the Israeli innovation ecosystem. This trend could hinder Israel's ability to compete in the global market and to maintain its lead in identifying and developing upcoming technological trends.

- **Today's flux of new start-ups serves as the basis for the bolstering of growth companies and for the reinforcement of future high-tech output. Yet an analysis of data on fledgling start-ups indicates that in recent years, there has been a decline in the number of new start-ups, as well as a decline in the number of funding rounds for seed-stage companies. The Israel Innovation Authority believes that these phenomena are a call for action.**
  These trends are the result of several factors: the maturation of the Israeli innovation ecosystem, global funding and technological trends that lead to more attractive funding alternatives, and the pull of creative and talented entrepreneurs by large multinational companies (in-house innovation). This has resulted in fewer funding sources at the initial funding stages. A survey conducted by the Israel Innovation Authority of 275 Israeli angel investors, and a study on the involvement of types of investors, indicate that in recent years, there has been less smart money[11] accessible in seed stages.

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10 The Central Bureau of Statistics categorizes the high-tech sector into two primary fields: knowledge-based services sectors (including communications, computing services and R&D), which for the purpose of this report will be called software and R&D sectors, and the industry high-tech sectors (including the pharma industry, electrical components, communications equipment, industrial equipment, and machinery and aircraft) which will be called commodities sectors.
Source: Central Bureau for Statistics, Subcommittee for Official Classification of High-Tech Industries (2004).

11 Investors experienced in the field or experienced entrepreneurs who help management guidance.

- **Data on growth companies points to difficulties raising debt financing sourced in Israel, which is critical for these companies' sustained growth.** Debt is an important funding instrument for growth companies that require substantial capital to finance marketing and production for their continued growth without damaging the company's ownership structure. The Israel Innovation Authority's sample data indicates that Israeli growth companies' debt-to-equity ratio is significantly lower than the ratio in similar companies across the globe. This difficulty poses a potential barrier for their sustained growth in Israel, and encourages them to transfer central aspects of their activity overseas where it is easier to raise debt capital.

- **Despite the increase in skilled human capital in the high-tech sector, high-tech companies operating in Israel are still lacking skilled personnel.** Data also shows that in 2019, the number of open high-tech positions was higher than any other R&D positions, reaching 12,500 according to the Central Bureau of Statistics,[12] and 18,500 according to the SNC and Israel Innovation Authority report published in February 2020.[13] This shortage is continuing to boost the average wage in the sector, which is eroding Israel's relative advantage in the high-tech industry.

- **Political instability in Israel makes it difficult to quickly establish and assimilate a stable, long-term government policy.** Israel's transitional government in 2019 slowed down government budget mechanisms, forcing the Israel Innovation Authority to delay its funding of companies. A transitional government also impedes the advancement of new policy and legislation processes required for the long-term growth of Israeli innovation. 2020 is expected to be under a continuous budget,[14] which could further slow down government mechanisms. The Israel Innovation Authority is using all of its resources to minimize the damage caused to work processes and to the companies it funds to the greatest possible extent.

The complex picture depicted in this report demonstrates growth and prosperity alongside challenges and barriers. It shows that the Israeli high-tech sector is facing complex challenges that could prevent it from realizing its full potential, thus posing a threat to its continued prosperity.

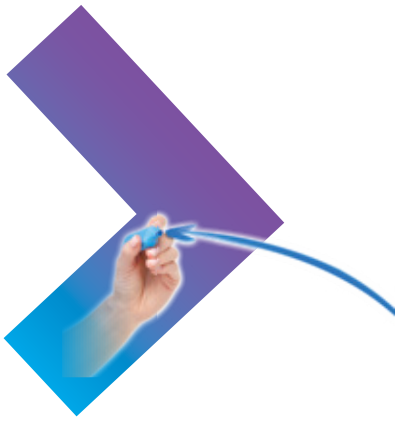
The Israel Innovation Authority is devoted to addressing market failures. Private funding sources are not always optimally invested in the Israeli economy, and sometimes government intervention is needed in order to fulfill the significant potential for growth and its contribution to Israeli society.

12 Section 25, 31 and 31 in Central Bureau of Statistics surveys. Central Bureau of Statistics, "Employees, available positions, and the ratio between supply and demand" classified by occupation (2011 classification) in select groups, 3rd quarter, 2019.

13 Human Capital Survey Report 2019, Israel Innovation Authority and Start-Up Nation Central. Based on data from the Zviran Institute.

14 With this system, the budget allocated for each issue is identical to the previous year's budget, with some slight changes.

This report provides an exhaustive description of these processes and trends:



Chapter 1: Israeli high-tech in 2019 – Prosperity and Challenges. This chapter presents key data on the 2019 innovation ecosystem. The data is presented in the Israel Innovation Authority's High-Tech Index,[15] in output data, exports data, and other data regarding the high-tech sector.

Chapter 2: Investing in Progress – Israel Innovation Authority 2019. This chapter describes the main actions taken by the Israel Innovation Authority this year, offering a review of the Authority's structure, budget and strategic plan. It includes analysis that shows that the Israel Innovation Authority focuses its grants on market failures that are overlooked in the private capital market.

Chapter 3: Growth of the Israeli Innovation Ecosystem - From Start-Up Nation to Scale-Up Nation. This chapter provides data on high-tech growth companies in Israel that reflects their position and their needs. It introduces new data derived from analysis performed by the Israel Innovation Authority of the low debt-to-equity ratio in Israeli growth companies in comparison to similar companies across the globe. It also describes the barriers to debt financing in Israel and the ramifications of these barriers.

15 Source

Chapter 4: Accelerating Israeli Entrepreneurship - The Alarming Decline in the Number of New Start-Ups Must Be Stopped. This chapter presents data that points to stagnation in the number of new start-ups in Israel and in the amount of seed-stage funding. It offers an analysis of the reasons for this stagnation. The analysis is based on data derived from a survey of Israeli angel investors performed by the Israel Innovation Authority, which points to a shortage of smart money.

Chapter 5: Bolstering Artificial Intelligence - What Can Be Done for Israel to Maintain its Leading Position in the Field of AI? This chapter was written as the continuation of a chapter that appeared in the previous Innovation Report, The Advent of the Smart Machine Era, which calls for the establishment of a strategy to advance this field in Israel. The chapter presents key achievements in AI alongside current data about Israeli AI companies, and reviews Israel's position in relation to the rest of the world. It also details barriers to further developments in this field and the various actions taken to remove these barriers.

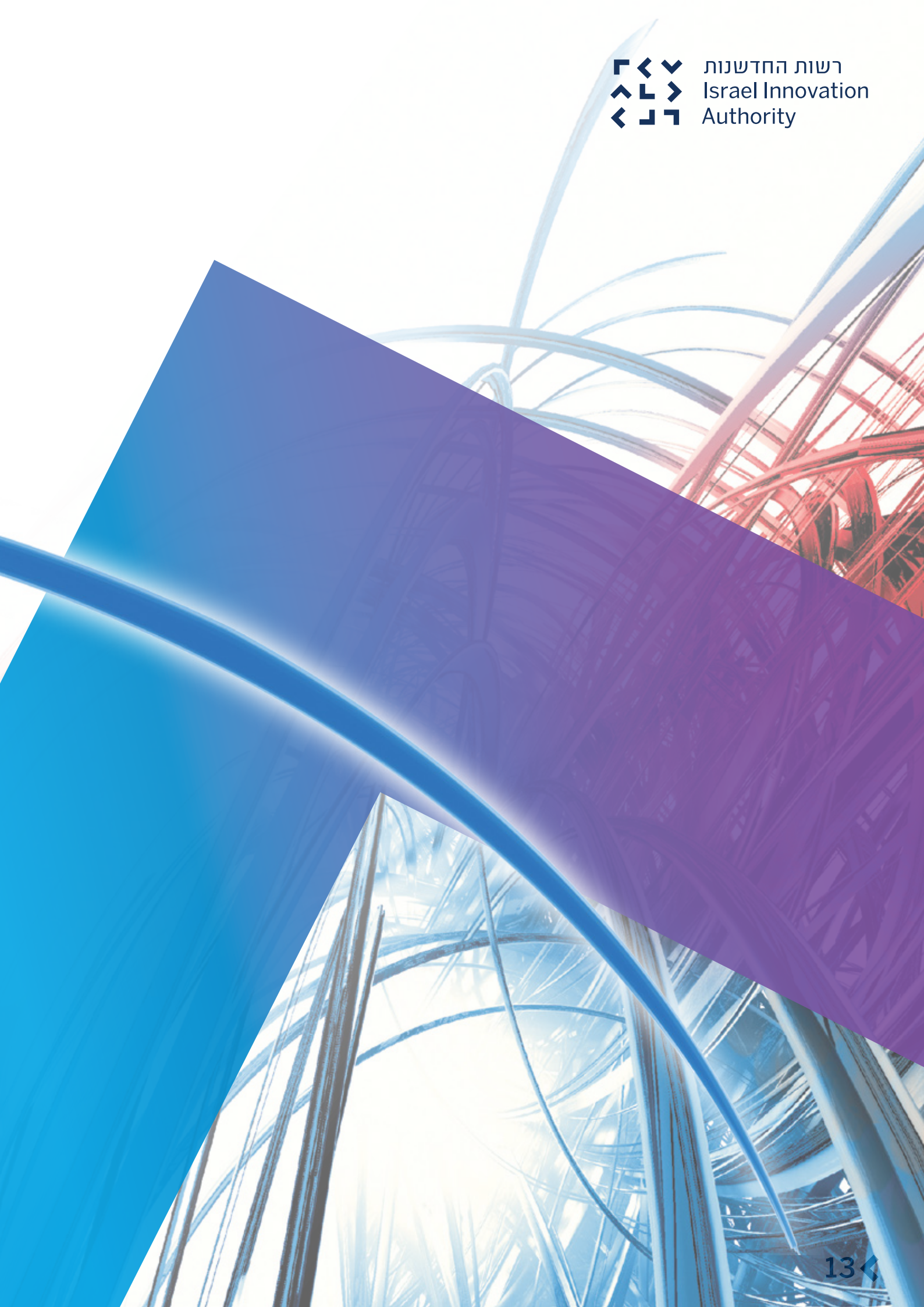
Chapter 6: Bio-Convergence – The Future of Medicine. The chapter builds on the previous Innovation Report, which called for Israeli innovation to break down barriers and to identify new ecosystems to be developed. The chapter describes the main principles of the strategic work performed by the Israel Innovation Authority in 2019, which identified substantial potential in the field of bio-convergence. It details the field's inherent potential and the steps required for its development in Israel.

Chapter 7: The Israel Innovation Authority in Action - The Parts that Comprise the Whole. The chapter reviews the main achievements of each of the domains of the Authority's operations in 2019. These domains address the challenges facing the Israeli high-tech sector.

Israeli High-Tech in 2019

Prosperity and Challenges

In 2019, the Israeli High-Tech industry continued to flourish and broke new records in several indices. Yet the Israel Innovation Authority is detecting alarming trends that call for the government's close attention, such as a decline is high-tech exports and a shortage of skilled employees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Israeli High-Tech in 2019
Prosperity and Challenges

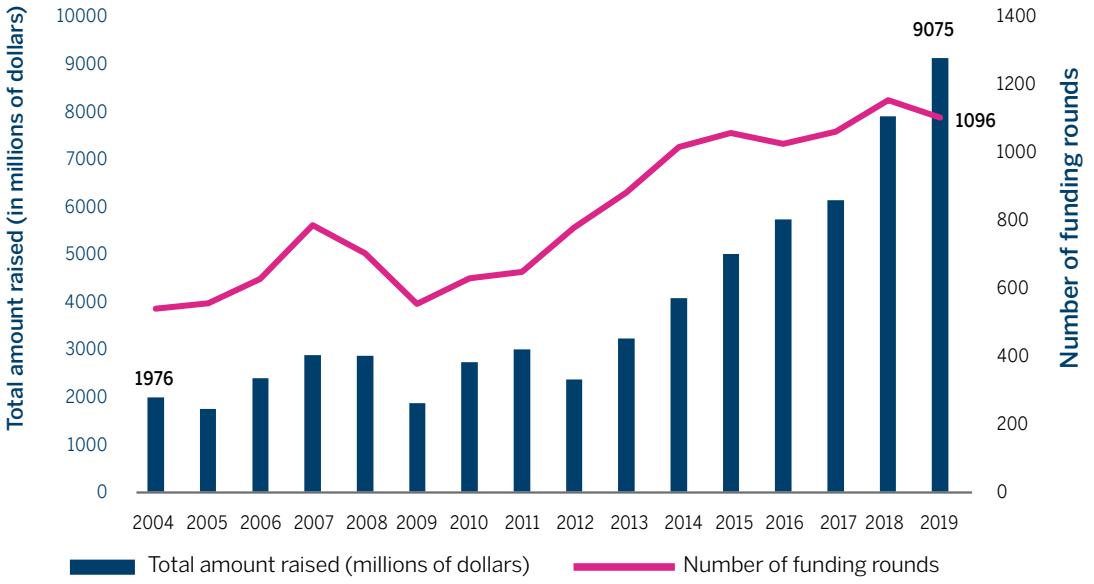
2019 was another year of growth and prosperity for the Israeli innovation ecosystem. In 2019, the high-tech industry reached new heights in capital raised, export, output and number of employees. These records are reflected in the Israel Innovation Authority High-Tech Index as well as in various international indices, which position Israel in the forefront of global innovation. The data presented in this chapter reviews some of the main markers within the high-tech industry.

Capital raised

Figure 1.1 shows that the amount of high-tech capital raised in 2019 reached a new peak of 9 billion dollars, a 15% increase compared to 2018. Since 2005, capital raised has multiplied by a factor of 4.5, growing at an average annual rate of around 13%. The number of overall funding rounds in 2019 held steady at 1,100 in 2019, similar to 2018.[1]

Data from 2019 indicates that the increase in capital raised originated mainly from higher amounts raised in each round, rather than more rounds. These higher amounts are a testimony to a wider trend that has been identified in the Israeli high-tech industry over the last decade: the scale-up of existing companies replacing the establishment of new start-up companies as the main driver of growth. This trend suggests that the Israeli high-tech industry is moving towards a new level of maturity.

Figure 1.1: Capital Raised in Israel – Amounts and Number of Rounds



Source: IVC data processed by the Israel Innovation Authority

1 IVC Data

Barriers in Local Fundraising

The road to maturation includes an increasing number of growth companies in the Israeli high-tech industry, a development which holds many advantages.[2] As reported in last year's report by the Israel Innovation Authority,[3] Israeli innovation must break through its current ceiling and expand its influence on the Israeli economy. An increase in the number of growth companies can help realize this goal.

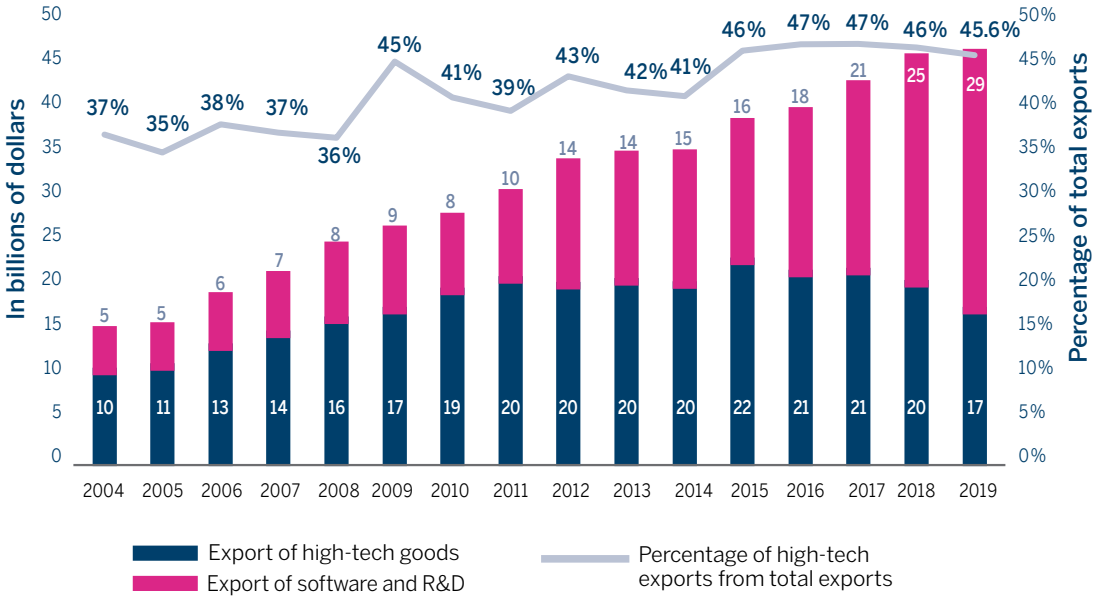
Fast-developing growth companies have potential to become "complete" companies that employ a large number of employees in a variety of positions other than R&D. Complete companies can significantly increase the number of high productivity employees that characterize the Israeli high-tech sector.

Ensuring that growth companies continue to multiply and flourish is crucial for the Israeli high-tech sector and the Israeli economy. Accordingly, barriers to scale-up must be examined and appropriate solutions offered. One obstacle, notable in the Israeli industry, is the difficulty for growth companies to obtain debt based finance. In chapter 3, "Growth of the Israeli Innovation Ecosystem", additional data about the increasing number of growth companies in the Israeli high-tech sector is presented, and the challenges of debt financing and the impact of these challenges on Israeli growth companies is analyzed.

High-Tech Export

Data on high-tech export in 2019 reflects the growth of the industry. In 2019, Israeli high-tech export continued to grow, and reached an all-time record of 45.8 billion dollars, about 46% of all Israeli exports, an increase of 1.2% compared to 2018.[4]

Figure 1.2: Export of High-Tech Goods, Software and R&D



Source: Ministry of Finance. 2019 data refer to January through October, calculated for the whole year

2 Growth companies are high-tech companies with a mature, saleable product. These companies grow at a rapid pace and allocate significant resources into marketing, sales, support, and possibly production

3 Israel Innovation Authority Report, 2018-2019

4 Based on data provided by the Ministry of Finance and the CBS, processed by the Israel Innovation Authority. Total export data for 2019 represent an annual evaluation based on data from the first half of 2019

The Central Bureau of Statistics (CBS) divides the high-tech industry into two sub-sectors: software and R&D, and commodities.[5] Figure 1.2 presents Israel's high-tech export split by sub-sector. As shown, most of the growth in high-tech export stems from software and R&D export, which together make up 63% of high-tech export, and which grew by around 14% since 2018, up to 28.8 billion dollars.

Changes in High-Tech Export

Figure 1.2 demonstrates that despite accelerated growth in software and R&D export, the export of high-tech goods (medicine, electronic and optical equipment, etc.) decreased by around 15%, continuing 2018's trend. Figure 1.2 also shows that in 2019, the share of high-tech export from total export decreased slightly to 45.6%, following six years of over 46%.

It can be concluded from these figures, that due to the drop in the export of high-tech goods, high-tech is no longer the driving force of Israeli export. Today, Israeli high-tech export is growing at a rate similar to the rest of the economy's export, which is reflected in its unchanging share of overall export.

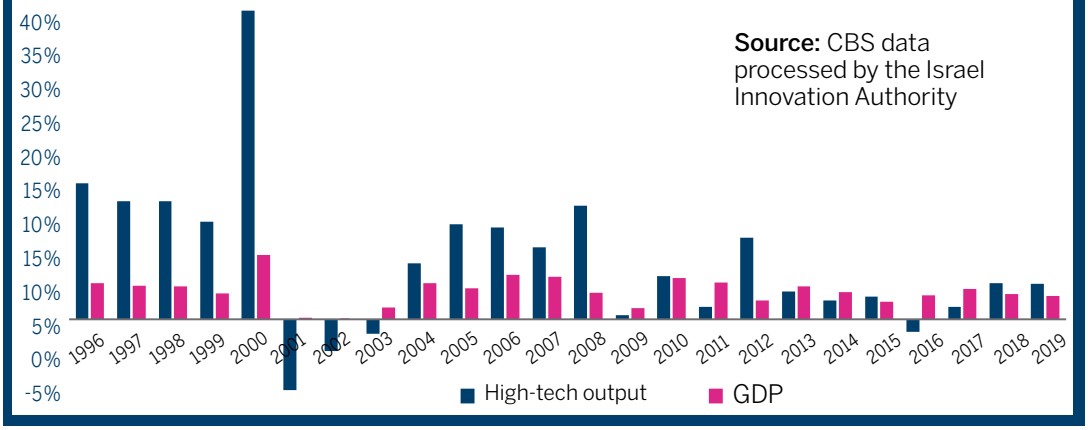
The relative slowdown is also evident in data pertaining to high-tech output, as shown below. These figures suggest that the high-tech "engine" has become a "railcar", growing at a similar pace to that of the entire economy instead of pushing it forward, and consisting mainly of software and R&D, and less on products and goods.

High-Tech Output – From Engine to Railcar

For decades, the Israeli high-tech industry was considered the growth engine of the Israeli economy. Indeed, in the past, high-tech output grew at a significantly higher pace compared to other sectors, leading the overall GDP growth of the Israeli economy.

Commissioned by the Authority, the Central Bureau of Statistics computed updated data about high-tech output (2019 data is still not complete), presented in Figure 1.3. The data suggests that in recent years, high-tech output growth was in line with overall GDP growth. The Israeli high-tech industry is no longer a "growth engine". It is now one of many railcars, growing at a similar pace to other sectors.

Figure 1.3: Annual Growth Rate, GDP and High-Tech (1996-2019)

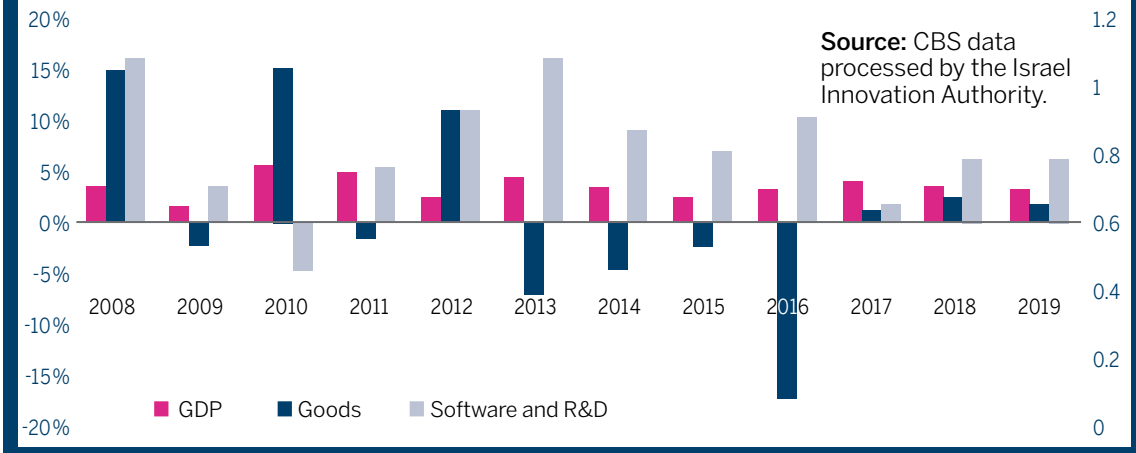


Source: CBS data processed by the Israel Innovation Authority

5 Software and R&D include knowledge-intensive service branches, such as computation and R&D, while goods refer to high-tech industrial branches such as medicine, electronic components, communication equipment, industrial and machine equipment and aircrafts.
Source: CBS, Subcommittee for Official Classification of High-Tech Industries

Figure 1.4 presents the growth of high-tech output by sub-sector, and indicates that the high-tech commodities sub-sector is the main source of the slowdown in high-tech output. Figure 1.4 also shows that since 2013, while software and R&D output continues to grow at a higher pace than to the GDP, the output of high-tech goods has been declining and growing at a slower pace than the GDP.

Figure 1.4: Growth Rate, GDP and High-Tech Subsectors (2008-2019)

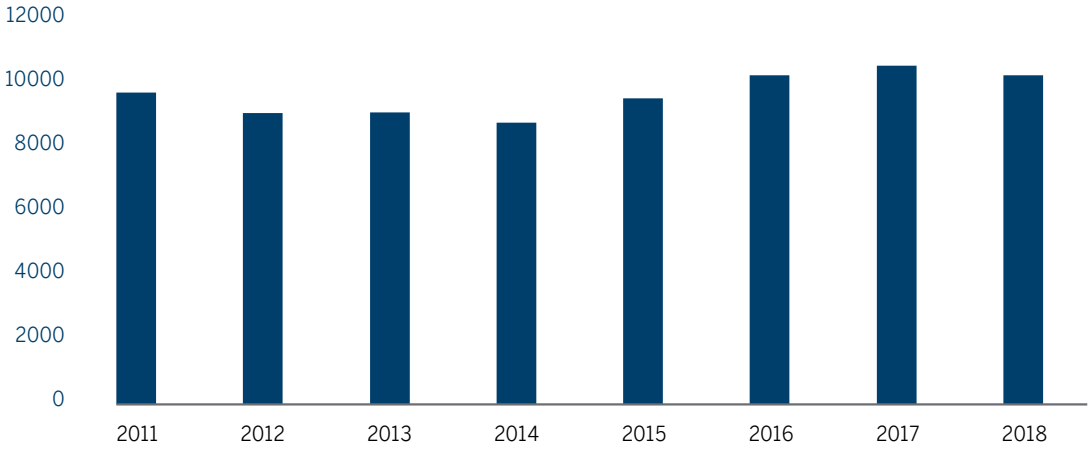


Source: CBS data processed by the Israel Innovation Authority.

Some argue that the decline in export of Israeli high-tech goods has been caused primarily by downward business cycles in Teva and Intel, which are collectively responsible for about 50% of high-tech's goods output. Yet, even when the impact of these two companies on high-tech export of goods is controlled for, the evidence shows that the export of goods is slowing moderately.

Figure 1.5 presents the export of high-tech goods without Intel and Teva. In 2017, the export of high-tech goods grew by about 2.9%, and in 2018 it shrank by almost 2.7%, indicating the decline is not a result of changes to these two specific companies.

Figure 1.5: High-Tech Export of Goods Without Intel and Teva, 2011-2018 (millions of dollars)



Source: CBS data processed by the Israel Innovation Authority[6]

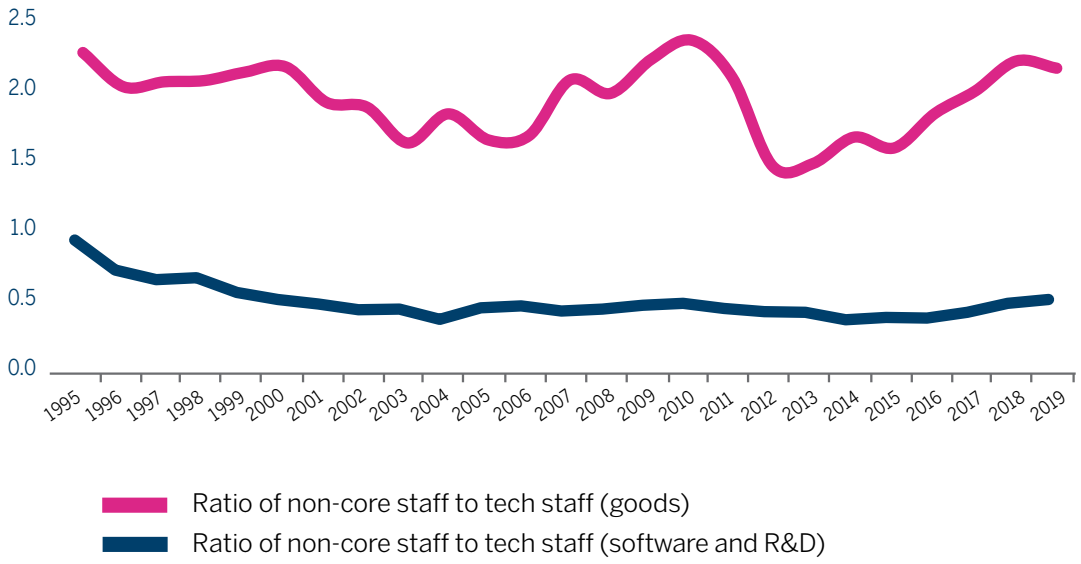
6 Data on 2019 was not yet published in full at the time of the publication of this report

The Israel Innovation Authority believes that the decline in the output and export of high-tech goods is cause for concern. The contribution of high-tech commodities to the Israeli economy is crucial. Beyond their significant contribution to the GDP and export, many high-tech manufacturing companies are complete companies and offer a wide range of jobs beyond R&D. Manufacturing firms are also spread across the country, with production plants in various locations in Israel, and are not clustered in the center of the country. These companies play a significant role in creating and preserving innovation assets and infrastructure in Israel.

The reduction in the export of high-tech commodities and the growing reliance on software, including the provision of services for international R&D centers (an issue that was extensively reviewed in the previous Innovation Report), negatively affect the versatility of the Israeli innovation ecosystem. This trend can hinder Israel's ability to compete globally and maintain its lead in identifying and developing the next wave of technology.

The contribution of the high-tech goods sector to broad employment – employment of more than just R&D employees – is evident in Figure 1.6, which depicts a 2:1 ratio of non-technological employees (finance, marketing, manufacturing, etc.) to technological employees in high-tech manufacturing companies, compared to a 1:2 ratio in software and R&D companies.

Figure 1.6: Ratio of Non-Technological Employees to Technological Employees in High-Tech Sectors (1995-2019)



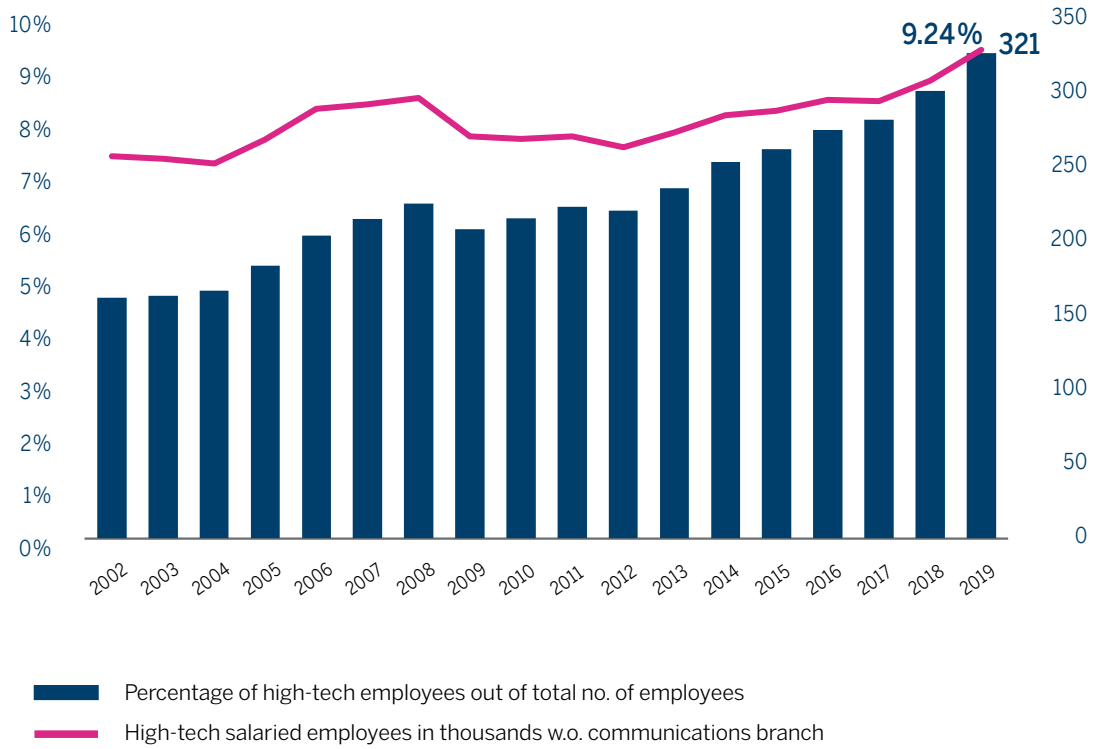
Source: CBS data processed by the Israel Innovation Authority

Chapters 2 and 7 of this report present various tools offered by the Israel Innovation Authority, aimed, among other things, at encouraging the growth of innovative complete companies, including goods and commodities companies. The creation of new technological ecosystems, as described in Chapter 6 "Bio-Convergence: The Future of Medicine", could also potentially facilitate the regrowth of these segments.

Employment in High-Tech

Figure 1.7 indicates that in 2019, the number of high-tech employees grew at a growth rate of 8.4%, to 321,000, up from 295,000 in 2018, and for the first time crossed the 300,000 threshold.[7] Also for the first time, the ratio of high-tech employees in the workforce exceeded 9%, and today stands at 9.2%.

Figure 1.7: Salaried Employees in High-Tech



Source: CBS data processed by the Israel Innovation Authority

The increase in high-tech employment reflects the growth of high-tech companies and the success of government action in expanding the pool of skilled high-tech professionals (which was extensively covered in the Authority's previous report). Collaborations between all the stakeholders in the Israeli high-tech ecosystem are beginning to bear fruit, and the rate of employees joining the high-tech professions is growing.

7 Data on 2019 was not yet published in full at the time of the publication of this report

A Shortage of Skilled Employees

Despite the increase in the number of skilled high-tech professionals, there is still a significant shortage of skilled employees required by high-tech companies in Israel.

According to a survey conducted by the Central Bureau of Statistics, Israeli high-tech is in need of an additional 12,500 thousand tech professionals.[8] A survey conducted by the Startup Nation Central (SNC) and the Israel Innovation Authority estimates this number to be even higher, reaching approximately 18,500. The shortage of human capital is driving a rapid increase in high-tech salaries compared to the general average salary (annual growth rates of 4.3% and 3.1%, respectively),[9] with Israel having the fifth highest wages for software developers in the world.[10]

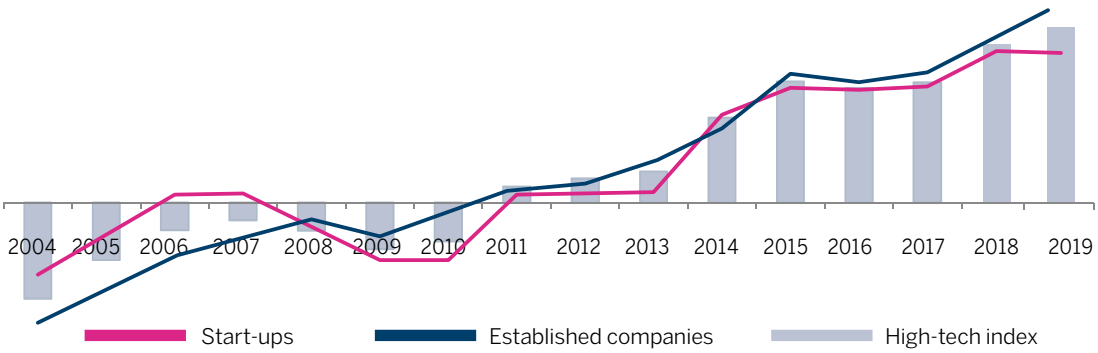
The Authority sees this shortage as one of the main barriers for the future growth of the high-tech sector. As will be explained later in the report, the Authority continues to operate in different ways to overcome this obstacle and increase the number of skilled professionals in the high-tech workforce.

The High-Tech Index

The growth of the Israeli high-tech sector is also reflected in the Israel Innovation Authority's High-Tech Index, presented in Figure 1.8. This index is based on a number of indicators defined by the Authority, which together show an overall picture of the Israeli high-tech industry.[11] The index is divided into two groups: start-ups and established companies.[12]

An analysis of the high-tech index suggests that the overall performance of Israeli high-tech is excellent, and that the index of established companies continued its upward trend during 2019. In the start-up group, the index remained steady following a decline in the scale of capital raised by the funds (for further details on the index indicators and measures, see Appendix A on page 105).

Figure 1.8: High-Tech Index 2004-2019



8 CBS, Employed persons, job vacancies and supply – demand ratio, by selected occupations, 9.33

9 CBS, statistical yearbook

10 Global Developers Salaries, Daxx.com

11 As detailed in Appendix A of this report period

12 The complete methodology of the high-tech index is described on the Israel Innovation Authority website

International Comparison

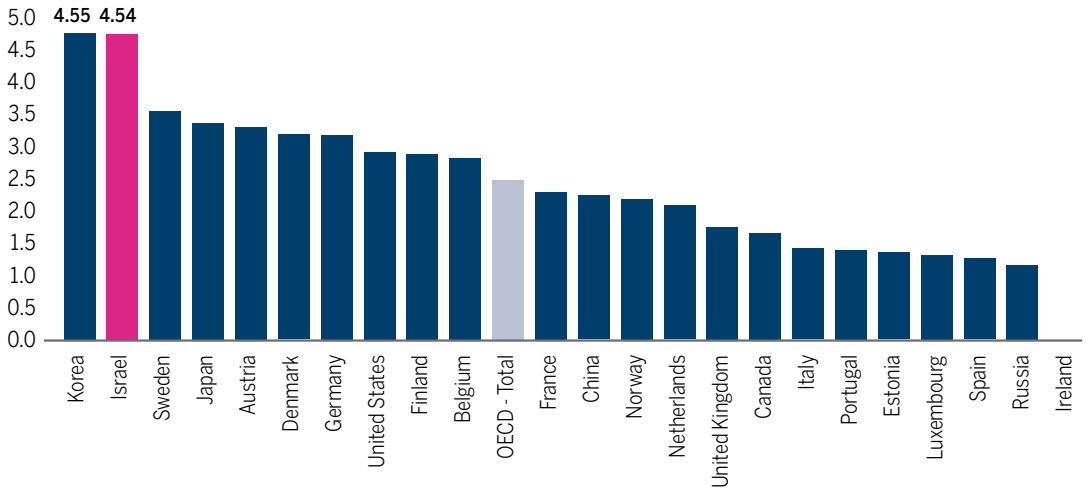
The Israeli innovation ecosystem maintained its leading position in 2019, and is highly ranked in different international indices.

As seen in Figure 1.9, Israel is ranked 6th in Bloomberg's Innovation Index,[13] went up from 10th to 11th place in the Global Innovation Index[14], and maintained its 6th place position in the Global Start-Up Ecosystem Ranking.[15]

Figure 1.9: Israel – A Leader in International Innovation Indices

In the OECD R&D Intensity Index (R&D investment as a ratio of GDP), presented in Figure 1.10, Israel continues to hold a leading position, sharing first place with Korea, with its national spending on R&D being 4.5% of the GDP.

Figure 1.10: National Spending on R&D as a Percentage of GDP (2017)



Source: OECD STAT 2017

13 The Annual Bloomberg Innovation Index, 2019 out of 95 countries

14 Global Innovation Index 2019, out of 129 countries

15 Start-up Genome report 2019, out of 150 ecosystems

Changes to the Israeli High-Tech Map

Israel has been dubbed the Start-Up Nation for a reason. Over the last decade, the fertile ground of Israeli entrepreneurship has yielded over 750 startup companies every year. Israeli entrepreneurs continuously manage to position themselves as global leaders in a variety of fields, repeatedly being able to identify the emergence of new trends and segments early on, maintaining its position at the forefront of global innovation.

Figure 1.11 presents recent years' changes to the Israeli high-tech map (2019 compared to 2016).

Figure 1.11: Changes in the Israeli High-Tech Map (2019 Compared to 2016)

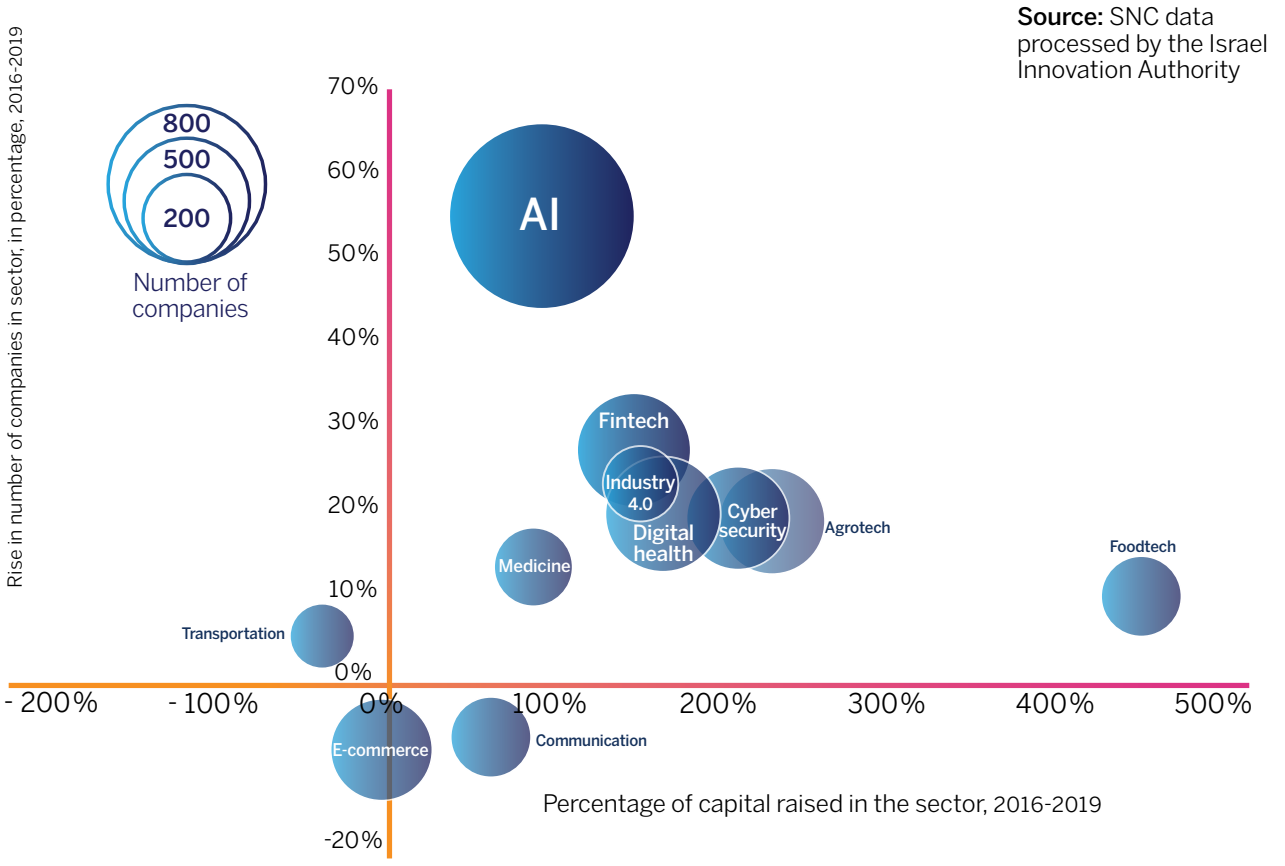


Figure 1.11 shows that AI has the most companies of any high-tech sector, and will be extensively covered in Chapter 5: "Bolstering Artificial Intelligence - What Can Be Done for Israel to Maintain its Leading Position in the Field of AI?". Israeli entrepreneurs' ability to identify the potential in this field at an early stage and enter it quickly has made Israel a world leader in AI.

Beyond AI, there is a significant increase in the number of fintech, cyber and digital health companies, and in capital raised by foodtech companies. These sectors are at the cutting edge of global innovation, and have been promoted by the Israeli government through various government initiatives.[16,17,18] The increase in the number of companies and capital raised in these segments highlight both the importance of government support, and the government's ability to be a driving, motivating engine of new technological sectors in the Israeli innovation ecosystem.

Alongside the development of new technological sectors, the dynamic nature of the Israeli innovation ecosystem is also reflected in its ability to quickly reduce activity in fields that are more mature. Figure 1.11 indicates a significant decrease in the amount of capital raised and the number of active companies in communication technologies, as well as a decrease in the volume of capital raised for e-commerce. These declines may suggest that the aforementioned sectors have matured and face more vigorous competition in the global innovation arena and are less attractive for private capital investments.

In conclusion, this chapter reveals a complex picture of growth and prosperity alongside challenges and barriers. The Israeli innovation ecosystem faces some difficult, complex challenges, which can hinder it from realizing its full potential and might even hamper its future prosperity. The Israel Innovation Authority believes that government support is required in order to overcome these challenges, and is employing every measure available to address these challenges in the best possible way.

16 Government decision – Cyber

17 Government decision – Digital Health as a Growth Engine

18 Government decision – Sandbox Fintech

Investing in Progress

Israel Innovation Authority 2019

The Israel Innovation Authority's vision is to establish Israel as a world leader in innovation and entrepreneurship that frequently grows innovation-driven companies, in order to provide extensive, highly productive employment for all population groups and all regions of the country

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Israel Innovation
Authority

Israel Innovation Authority 2019
Investing in Progress

Figure 2.1: Israel Innovation Authority - 2019 in Numbers

2019 was a productive, colorful, momentous year marked by the continued growth and development of programs and measures designed to advance the Innovation Authority's vision, and to enact the strategic plan outlined by the Authority's Council.

Key measures taken by the Innovation Authority in 2019 include:

- **Developing an array of new tools and measures to advance the ecosystem of innovation in Israel's periphery.** These measures include launching a program to aid in the establishment of large companies' R&D centers in the periphery, establishing three entrepreneurship incubators in Karmiel, Yeruham and Bnei Shimon, a foodtech incubator in Kiryat Shemona, two innovation labs in Haifa and Beer Sheva, an innovation center in Haifa, and a collaboration with the Ministry of Economy to advance the establishment of a foodtech center in Kiryat Shemona and a center for advanced manufacturing in Karmiel.
- **Developing an array of new tools and measures to increase the volume and diversity of skilled human capital.** These measures include promoting the Coding Bootcamp program, launching a program to encourage women's entrepreneurship, and establishing two new training programs:
  - **High-tech specialization program** – helping companies hire and train inexperienced graduates (juniors) in high-tech professions.
  - **The Workshop program** – an association for advanced technology studies to help high-tech companies train workers in advanced development professions, particularly in AI.
- **Developing an array of new tools and measures to advance growth companies**. These include a significant expansion of the pilot program, which helps growth companies perform semi-commercial demonstrations in beta sites. A series of actions was taken to expand the capital market and the availability of debt financing for growth companies: a program to encourage institutional investments, to advance collaborations with the European Bank, and to help growth companies apply for EU funding. Efforts were also made to remove regulatory obstacles and to create regulation that is supportive for innovations, such as the establishment of a dedicated center – an Israeli branch of the World Economic Forum's Center for the 4th Industrial Revolution (C4IR) for the regulation of innovative technologies.
- **Advancing Israeli leadership in future technologies.** As a member of the TELEM Forum (the forum for national R&D infrastructures),[1] the Innovation Authority participates in the national program for the promotion of quantum science and technological applications. The Authority advances a national program for AI as well as a national program for bio-convergence (for further details see Chapter 6).
- **Advancing efforts to improve customer service,** such as simplifying and eliminating procedures and bureaucracy, upgrading the website and computer systems, establishing a service center, and cutting response time (providing a response within 11 weeks of submission).
- **Relocating the Innovation Authority to Jerusalem:** in 2019, in adherence with R&D Law, the Authority moved from central Israel to Jerusalem. This complicated relocation had no impact on its ongoing operations.

Israel Innovation Authority's workplan for 2020 includes several measures aimed at advancing Israel's innovation ecosystem in adherence with the Council's five-year strategic plan. However, political unrest in Israel hinders the Authority's ability to quickly formalize and implement a stable, long-term government policy.

Israel's provisional government in 2019 decelerated governmental budgetary mechanisms and forced the Authority to defer its payments to companies. This provisional government also limits the ability to advance the new policy and legislation processes required for the long-term elevation of Israel's innovation ecosystem. The 2020 budget will primarily be a continuous budget,[2] which could further decelerate governmental mechanisms and could jeopardize the Authority's budgets and its capacity to advance its programs.

The Innovation Authority believes that substantially slashing its budget and hindering its ability to advance its programs could deal a heavy blow to Israel's high-tech industry. The first to be hit will be start-ups, but the damage is expected to eventually affect the entire high-tech industry.

1 The TELEM Forum also includes the Ministry of Science, the Ministry of Finance, the Planning and Budgeting Committee of the Higher Education System, and the Administration for the Development of Weapons and Technological Infrastructure in the Ministry of Defense

2 By this method, the budget allocated to each issue is identical to last year's budget with mild changes

Israel Innovation Authority – 2018-2022 Strategic Plan

In 2018, the Authority's Council devised a strategic plan for 2018-2022. The plan is comprised of four strategic goals and highlights ten strategic objectives.

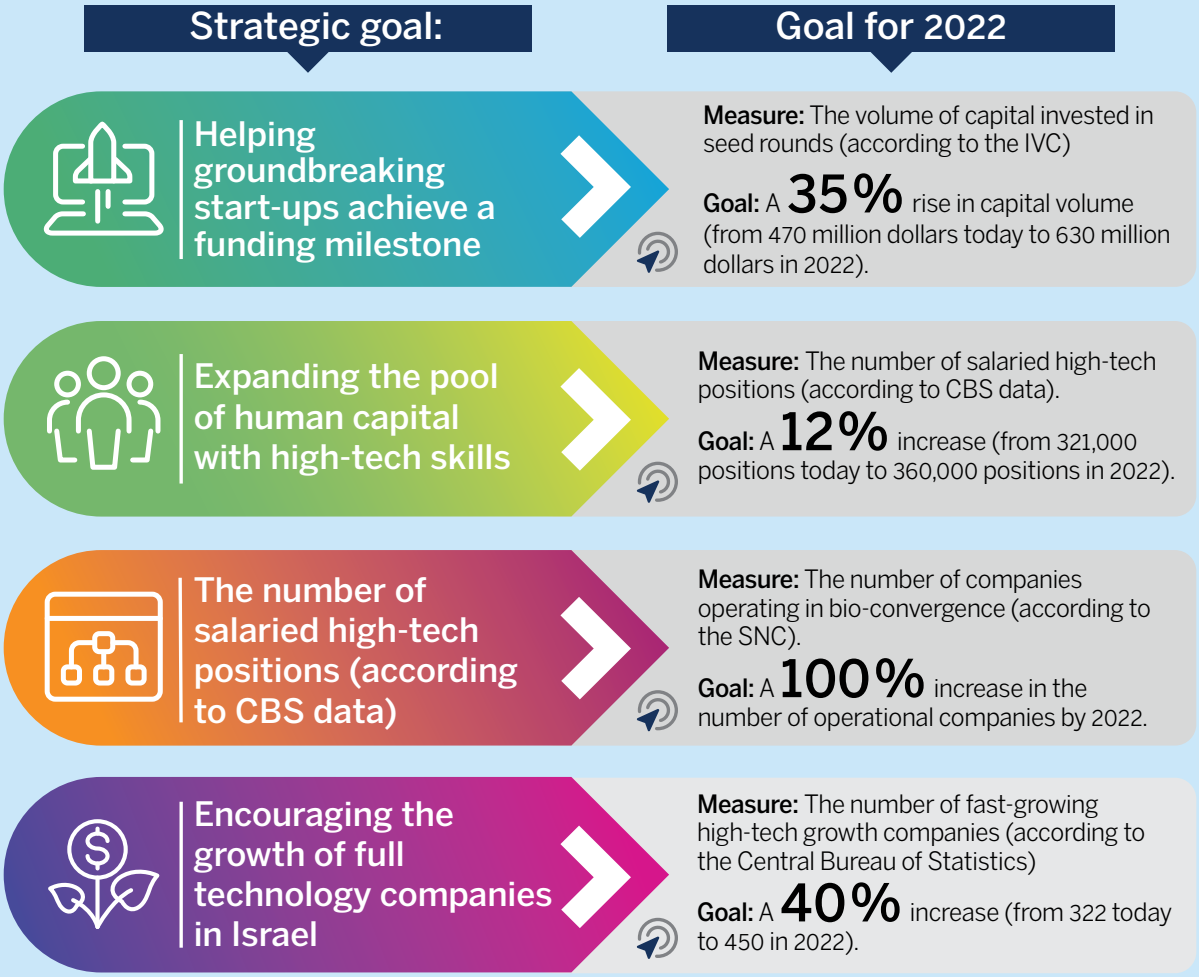
Figure 2.2: Israel Innovation Authority's Strategic Objectives

To ensure sustainable **technological leadership** in the high-tech industry	To increase the **economic impact** of high-tech companies	To support technological innovation aimed at fostering **competitiveness and productivity** in the business sector	To promote technological innovation with **social and economic** return
Advancement of Israeli leadership in **future technologies**	Supporting the **growth of complete technology companies** in Israel	Supporting competitiveness via R&D in the **manufacturing industry**	Promoting and positioning Israel as an Impact Innovation Nation that produces innovative technological solutions for **societal challenges.**
Assistance to groundbreaking start-up companies to reach a **fundable milestone**	Increasing the economic impact of **multinational corporations'** R&D centers	Increasing productivity via technological innovation in the **entire business sector**	Promoting **technological innovation in the periphery** in order to fully utilize innovation potential throughout Israel and to increase regional productivity
Accelerating development of **new ecosystems and communities**			
Integration of efforts to increase the **supply of skilled human capital** to high-tech			

The Israel Innovation Authority employs various programs and measures to realize these ten strategic goals. Further details on the Authority's operations can be found in Chapter 7: The Israel Innovation Authority in Action.

In preparing the workplan for 2020, the Authority defined four strategic goals as its main focus this year (assuming it will be feasible with the continuous budget of 2020). Macro measures and quantitative goals were defined for each of these goals, and a quantitative objective to facilitate progress to reach the goal by the end of the five-year period (2022).

Figure 2.3: Goals and Objectives at the Core of the Workplan



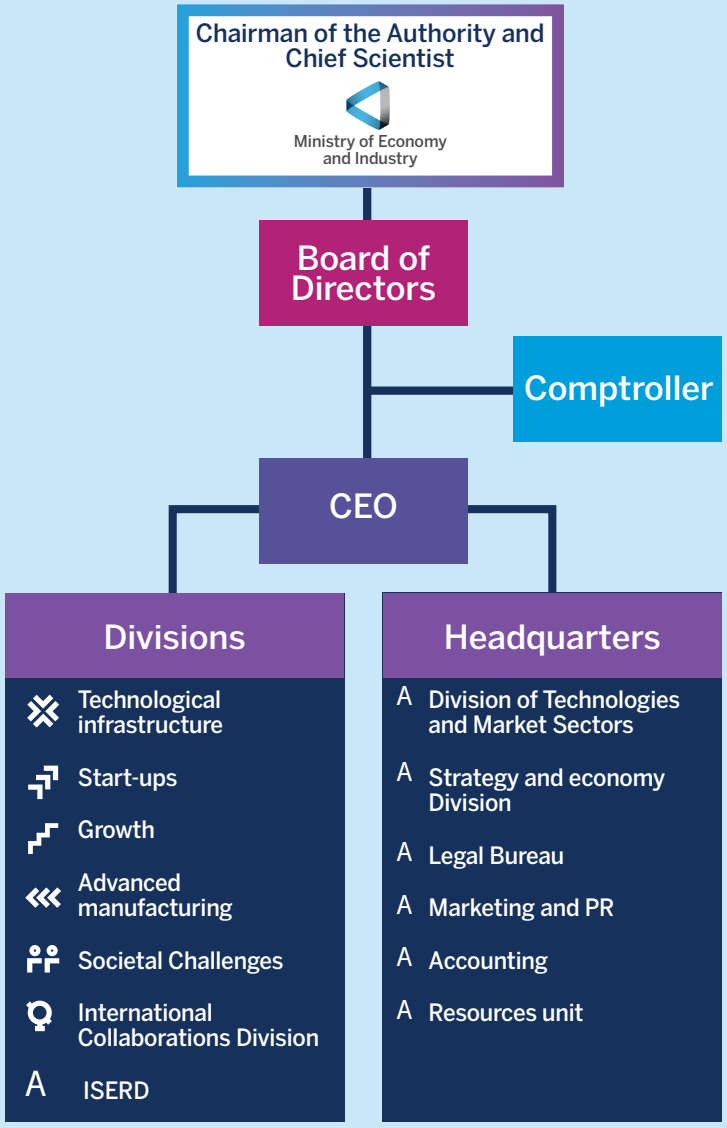
The Israel Innovation Authority's Structure and 2019 Budget

The Structure of the Israel Innovation Authority

According to the R&D Law,[3] the Innovation Authority is led by a council headed by the Chief Scientist at the Ministry of Economy and Industry. The council appoints the CEO who is supervised by the Council.

The Authority is divided into different divisions that specialize in professional challenges, target audiences, and tools to achieve their goals. Figure 2.4 describes the structure of the Innovation Authority.

Figure 2.4: The Structure of the Israel Innovation Authority



3 The Law for the Encouragement of Research, Development and Technological Innovation in Industry Law of 1984

The Israel Innovation Authority's Budget

The Israel Innovation Authority's budget is divided into three sections:

- In 2019, **the Innovation Authority's budget for grants** (allowance budget) was 1.73 billion shekels. Out of this amount, **175 million shekels were provided by other government entities** for shared projects.
- **The European R&D Horizon 2020 program** – in 2019, the Innovation Authority's share of participation in the program amounted to about 334 million shekels.
- **The operational budget of the Innovation Authority** in 2019 amounted to about 172 million shekels.

Figure 2.5: Specifications of the Israel Innovation Authority grants' budget in 2019:

Division	Grants' Budget in 2019 (in millions of shekels)
Growth	580
Start-up	484
Technological infrastructure	324
Advanced manufacturing	150
International	108
Societal / public	86
Total (excluding ISRAD)	1731

Figure 2.6: Specifications of the Israel Innovation Authority's 2019 Operational Budget, Divided by Sections:

Section	Grants' Budget in 2019 (in millions of shekels)
Operation	60
Technological evaluators and accountants	56
Wages	56
Total	172

Revenue from royalties and knowledge transfer

The Israel Innovation Authority charges royalties for sponsored projects that were able to generate sales (3%-5% of sales until the grant is covered).[4] The Authority also charges for knowledge transfer, when knowledge acquired from a particular project is sold to another company (1 to 6 times the grant amount calculated according to a fixed formula).

According to the R&D Law, revenue from royalties and knowledge transfer are paid to the State Treasury and are used as a funding source for Innovation Authority's grants.

Roughly 459 million shekels were charged in 2019, including 299 million shekels in royalties and 160 million shekels from knowledge transfers.

The Israel Innovation Authority's grants focus on addressing "market failures" in the Israeli innovation ecosystem

The overall 2019 grant budget amounted to 1.7 billion shekels. This budget comes to around 5.5% of the total capital raised by the Israeli high-tech industry (in 2019 it amounted to 9 billion dollars–30.8 billion shekels),[5] and 2.5% of the total expenditures on civilian R&D in Israel (which amounted to roughly 65 billion shekels in 2018).[6]

In accordance with the R&D Law[7] and the Innovation Authority's vision, the Authority grants are designed to encourage technological and industrial R&D and innovation. However, some question the validity of governmental R&D support in a sector where numerous venture capitals operate and there is ample private funding. Others question the impact of a budget that is 2.5% of the total R&D civil expenditure on the ecosystem of Israeli innovation.

The justification for governmental investments in R&D is in cases of market failures – i.e.: where capital investment is expected to yield significant gains, but the private market does not invest the required capital or that its investments are very minimal. This occurs when the private sector disregards market gains (that do not translate to revenues), and when the private sector tends to stick with familiar sectors that are relatively low risk and offer short-term gains.

New data suggest that unlike the private capital market, Israel Innovation Authority's grants focus on sectors that experience market failures – innovative, less familiar sectors that are high-risk and that offer long-term gains. In these sectors, the Innovation Authority's grants make up a significant share of the total investment and can significantly impact developments.

Figure 2.6 presents the distribution of Israel Innovation Authority's grants by technological sectors in comparison to the distribution of private capital raising in the same sectors.

4 Plus LIBOR interest

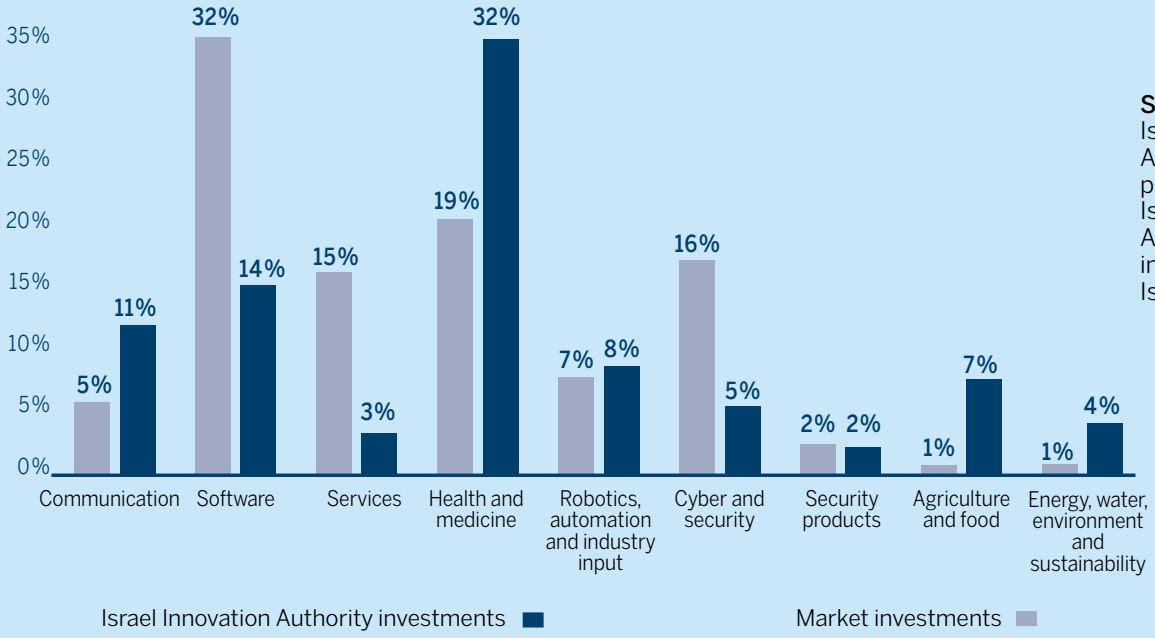
5 IVC data. For further details, see Chapter 1 of this report

6 CBS data, August 2019, national spending on civilian R&D, 2018

7 The Law for the Encouragement of Research, Development and Technological Innovation in Industry, 1984

Figure 2.7 suggests that while software leads in private capital raising with 32% of the total amount of funds raised, Israel Innovation Authority's grants focus on healthcare and medicine. Grants for healthcare and medicine, which are high-risk and offer long-term gains, comprise 32% of the total Innovation Authority grants. Figure 2.7 also suggests that Innovation Authority grants tend to focus on less familiar sectors such as agriculture and food, energy, and environment. These segments are less popular in the private sector, despite their potential to significantly contribute to the market and for becoming the next technology trend.

Figure 2.7: Israel Innovation Authority vs. Private Investments - By Sector (2018)

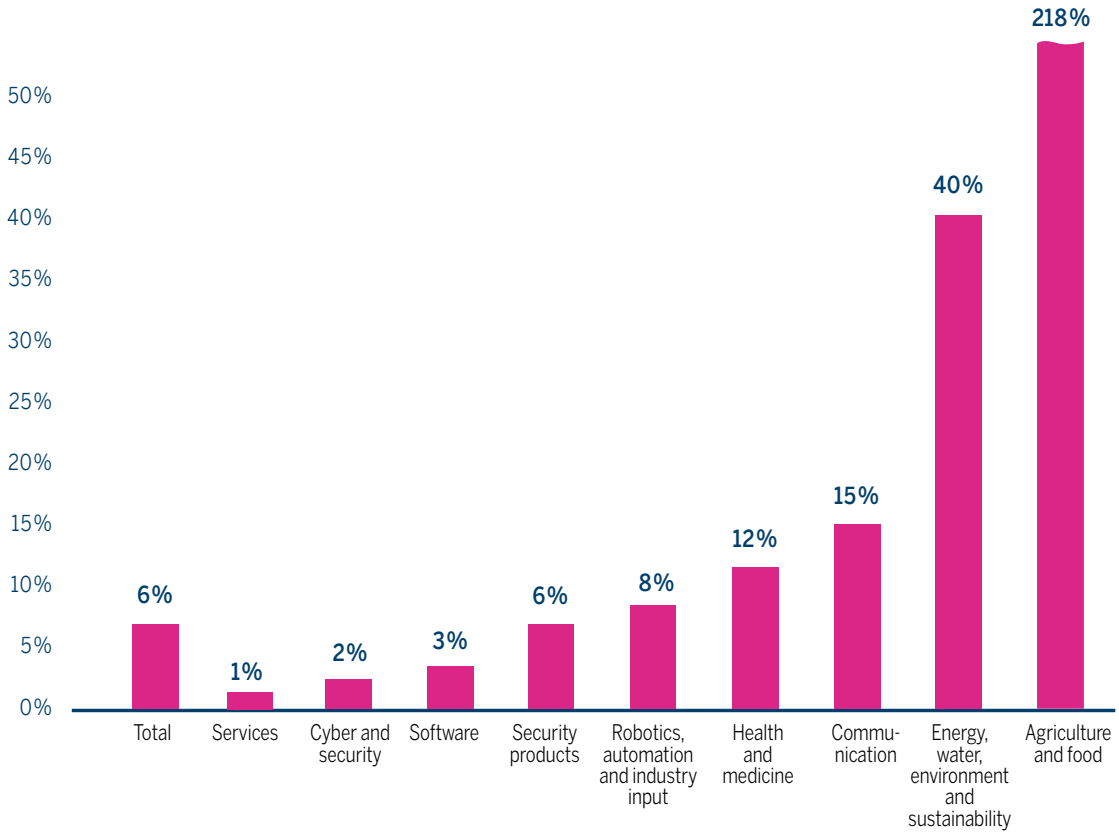


Source: IVC and Israel Innovation Authority data processed by the Israel Innovation Authority for total investments in the Israeli market

Figure 2.8[8] completes the picture. It shows that by focusing Israel Innovation Authority grants on industries experiencing market failures and a shortage of human capital, the Authority becomes a key player, thus having a substantial impact on the total capital raised for R&D in this field.

Figure 2.8 shows that while the total amount of the Innovation Authority grants in 2018 was only 5.5% of the total capital raised, the Authority's preference for providing grants to high-risk, less popular segments significantly increased its share of grants in these specific sector – 12% in healthcare and medicine, 15% in communication, 40% in energy, water and environment, and over 200% of private capital raised for agriculture and food (in many fields, the Israel Innovation Authority invests in collaboration with relevant ministries.

Figure 2.8: The Share of Israel Innovation Authority Grants out of Overall Capital Raising (2018)



Source: IVC and Israel Innovation Authority data processed by the Israel Innovation authority for total investments in the Israeli market

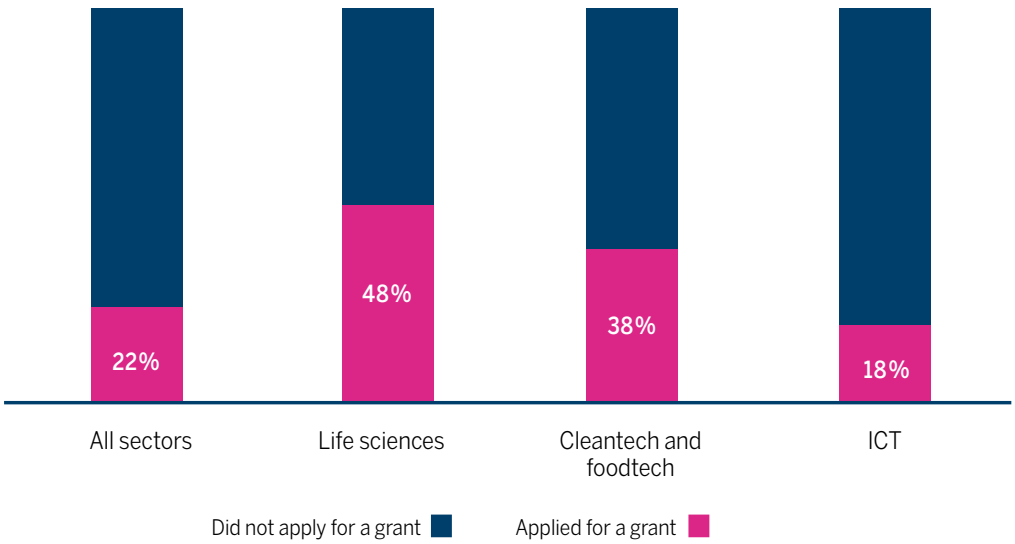
Another approach to understanding the importance of the Authority's grants' focus on market failures is to analyze the scope of the support the Authority offers for the establishment of new start-ups. As will be further detailed in Chapter 4, in recent years, private capital investments in early stage start-ups (seed stage) have been in decline. The Authority believes that this decline reflects insufficient private investments in seed-stage companies, investments that are crucial for Israel's high-tech industry. This indicates yet another market failure, which calls for governmental support.

8 Distribution of market investments is based on IVC data processed by the Israel Innovation Authority

Figure 2.9 examines the number of start-ups that were established in 2014-15 and that applied for Innovation Authority grants (by 2018). The diagram indicates that a relatively high share (22%) of new start-ups that requested support and applied for grants. It also shows that in industries with an inherent market failure, such as life sciences, cleantech and foodtech, this share is even higher, reaching 48% and 38%, respectively.

The data show that the Innovation Authority plays a key role in funding new start-ups, particularly in segments that have inherent high risk with long-term gains like medicine and life sciences. The Authority is an important, meaningful player. Support by the Authority has a significant impact on the establishment of new start-ups, which ultimately offer long-term contribution to Israel's market and economy

Figure 2.9: Share of Israel Innovation Authority Grant Applications for New Start-Ups By Sector (2018)



Source: SNC and Israel Innovation Authority data processed by the Israel Innovation Authority (among companies established in 2014-2015, data for 2018)

Growth of the Israeli Innovation Ecosystem

From Start-Up Nation to Scale-Up Nation

Recent years have shown an increase in the number of Israeli high-tech companies that are in sales and growth stages. The Israel Innovation Authority recognizes that these companies struggle to raise debt financing in Israel. This obstacle could damage their competitive advantage and encourage them to divert their operations overseas

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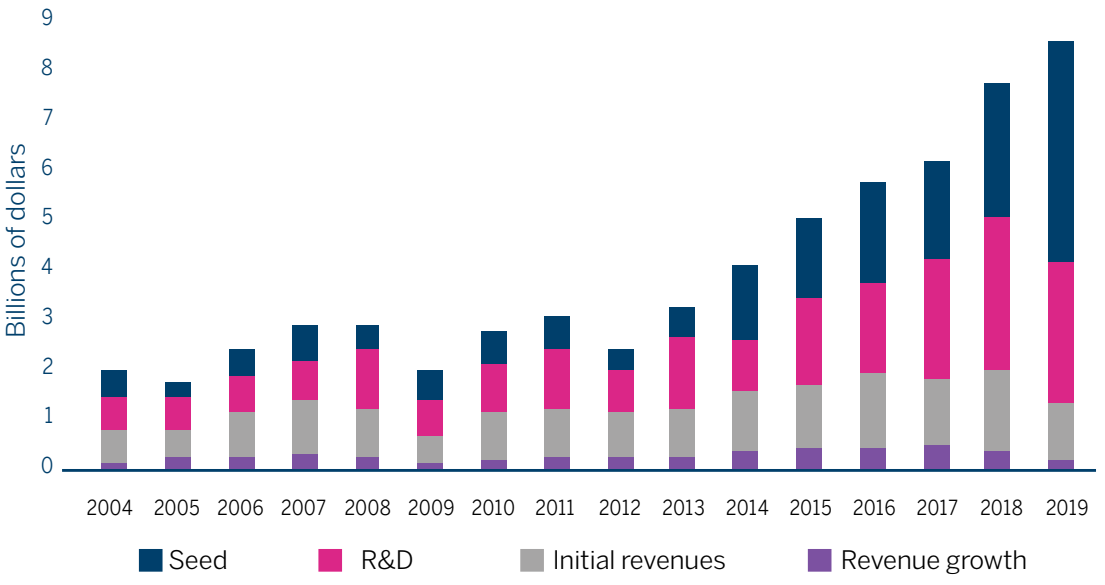
Growth of the Israeli Innovation Ecosystem

High-tech companies undergo significant changes throughout their life-cycle, especially between preliminary start-up stages and more mature start-up stages, such as scaling. In preliminary stages, most of the company's resources are allocated to R&D and the product has generally not yet reached the market. In later stages, such as scale-up, companies have successfully developed an in-demand product and have fast-growing sales, and accordingly allocate much of their resources to marketing, sales, support, and sometimes manufacturing.

There has been a recent trend of maturation in Israeli high-tech. This is evident in the significant uptick in the number of companies in more mature stages, which have grown both in sales and in the number of workers they employ. This growth has led to a relatively higher proportion of mature companies in the high-tech industry, which is reflected in various indices that analyze the state of Israeli high-tech.

Figure 3.1 illustrates the size of investments in Israeli companies by stages in their life-cycle.[1] Particularly noticeable is the continuous growth in total investment in start-up companies that have matured to initial revenue and growth stages. The past decade has seen a dramatic surge in investments in companies offering a mature product, with investments climbing from 1.6 billion dollars in 2010 to 7.2 billion dollars in 2019.[2]

Figure 3.1: Investment Distribution in the Various Stages of Company Development



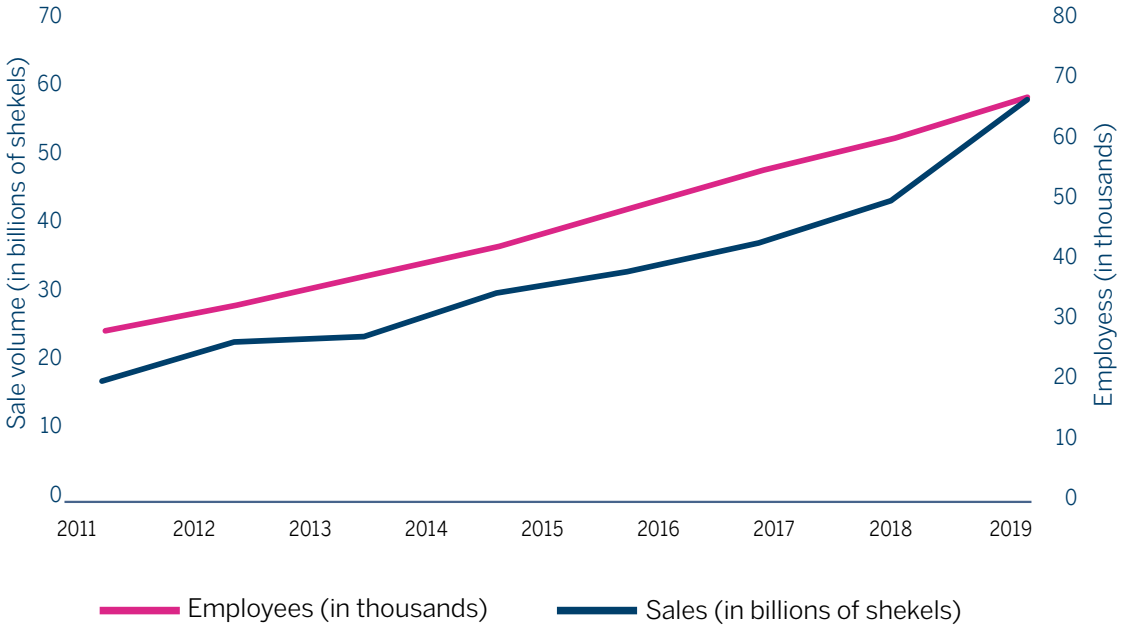
Source: IVC data processed by the Israel Innovation Authority

1 The stages of high-tech companies as defined by the IVC:
Seed stages – a start-up company in its infancy, in the stage of product development and capital raising
R&D stages – a start-up company discovering new knowledge about products, processes and services, and implementing this new knowledge to meet market demands
Initial revenue stages - a company whose revenue does not exceed 10 million dollars a year
Growth stages – a company whose revenue exceeds 10 million dollars a year

2 For additional information on developments in start-up companies at seed stages, see chapter four of this report

Figure 3.2 provides further evidence for the growth of mature companies, and shows the change in sales and in the number of people in Israel employed by companies in revenue and growth stages. The diagram demonstrates that from 2011 to 2019, the number of workers employed by these companies increased from 23,000 to 70,000, and sales rose from 12 billion shekels to 61 billion shekels.

Figure 3.2: Companies in Revenue and Growth Stages – Sales and Number of Employees



Source: Central Bureau of Statistics data processed by the Israel Innovation Authority

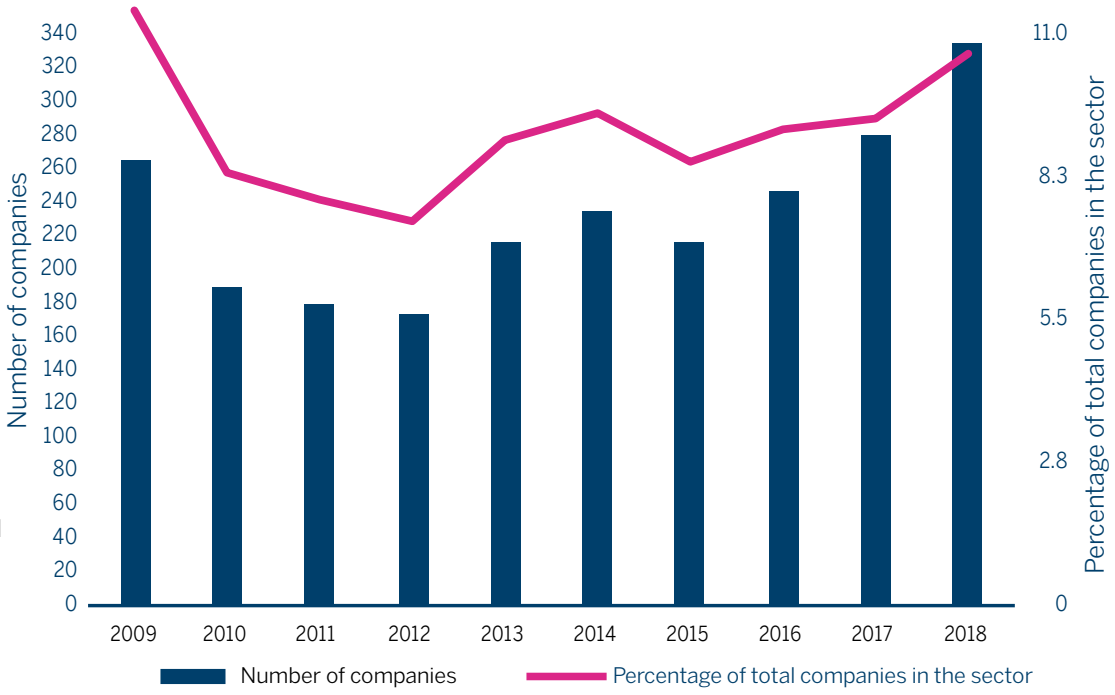
The number of companies that successfully reached the revenue and growth stage has risen accordingly. In 2011, there were 2,400 companies in Israel in these stages. By 2019, the number had increased twofold to around 4,500 operational companies.

There are also over 30 Israeli unicorns – private companies valued at over one billion dollars – in the revenue and growth stage. Twelve of them became unicorns in the past year.[3]

3 Based on data from TechCrunch.com and NoCamels.com

Another interesting group of companies in revenue and growth stages is high-growth companies - companies whose number of employees has increased for three consecutive years and whose annual growth rate exceeds 20%.[4,5] **Figure 3.3 shows that the number of high-growth companies has almost doubled in size over the past decade**. In 2010, 172 of these companies operated in Israel; in the past decade, this number increased by roughly 78%, reaching 322 companies in 2018.

Figure 3.3: High-Growth Companies



Source: Central Bureau of Statistics data

The increased focus on mature companies is not exclusive to the Israeli high-tech industry. Investments in start-up companies at more mature stages have grown worldwide, alongside a decrease in investments in companies at earlier stages. Another expression of higher investments in start-up companies at more mature stages is evident in the increase in funding raised via external financing rounds by high-tech companies in Israel and worldwide.[6]

As outlined in the first chapter of this report, the increasing number of companies in revenue and growth stages is part of the welcome trend of the maturation of Israeli high-tech. The significant number of later stage companies in Israeli high-tech calls for closer study of the obstacles potentially impeding their growth in Israel. The remainder of this chapter explores one of the primary obstacles – Israeli companies' difficulty in raising debt.

4 High-growth companies, as defined by the OECD and EuroStat. High-growth businesses have at least ten employees in the start-year and an average annual employment growth exceeding 20% for 3 consecutive years. High-growth companies had an average of 83 employees in 2018

5 Data from Central Bureau of Statistics, Business Demography 2016-2018, processed by the Israel Innovation Authority

6 KPMG, Venture Pulse, Q3 2019

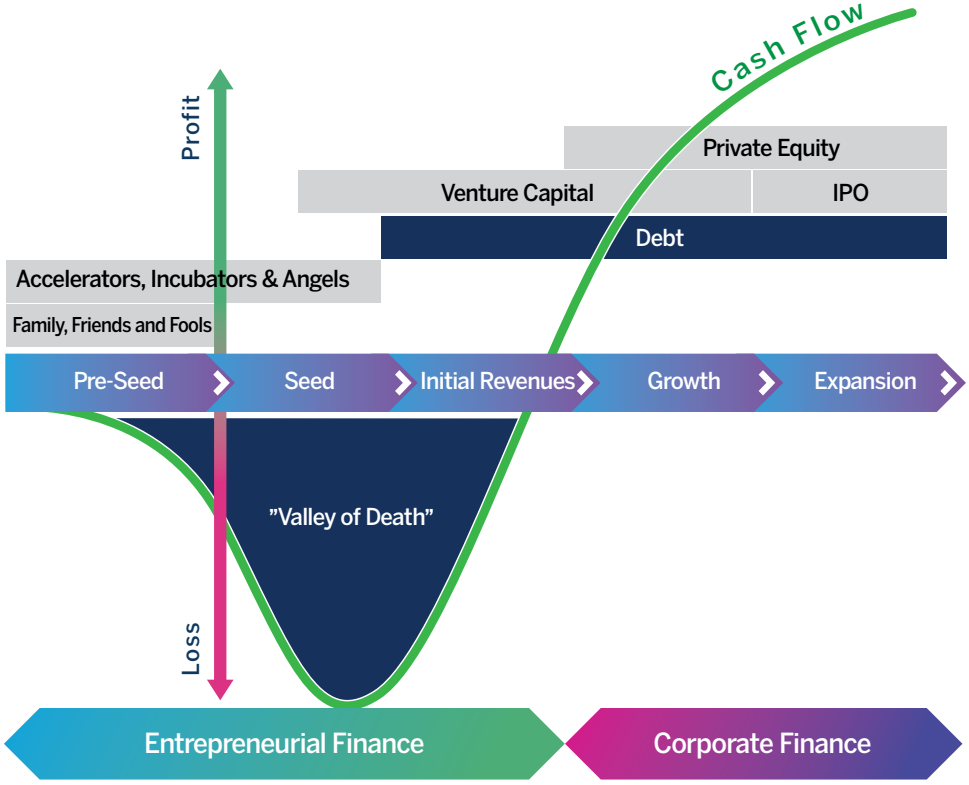
Appropriate Financing for High-Tech Companies in Growth Stages

High-tech companies in growth stages require substantial capital to finance their engines of growth, such as marketing existing products, business development, increasing sales, geographic expansion, technical support, manufacturing, and the acquisition of synergetic companies that facilitate their expansion to additional geographic markets and sectors.

When these companies begin to raise capital, they need to decide which financial instrument to employ. Financial instruments used by companies are generally equity based, debt based, or a combination of the two. Equity financing includes stock, options, and convertible loans (loans that can be converted to stock). Debt financing generally comes in the form of loans, bonds and more. There are also hybrid financial instruments that combine equity and debt (quasi-equity), such as mezzanine credit (from the Italian word mezzano, meaning 'go-between').[7]

Figure 3.4 displays the appropriate type of financing in the various life-stages of a high-tech company. The change in financial instruments throughout the life of the company reflects the diminishing level of investment risk in accordance with the maturity of the company and the cost of capital, respectively.

Figure 3.4: Types of Financing in a High-Tech Company's Life-Cycle



Source: StartExplore and TechCrunch diagrams processed by the Israel Innovation Authority[8]

Figure 3.4 shows that debt financing is essential for the growth stage and is often employed at the beginning of the revenue stage.

7 Investopedia.com's definition for mezzanine debt.

8 Israel Innovation Authority, based on startupxplore.com and crunchbase.com

Debt financing has two main advantages over equity:

- The price of debt in high-growth stages is usually lower than the price of equity.
- Debt does not dilute the current ownership share. Equity financing changes the company's ownership structure and diminishes the relative holdings of existing owners, especially those of the company's founders.

It is important to note that changes to a company's ownership structure could grant foreign investors significant influence over the company's development. Foreign investors may appreciate Israel only for its R&D capabilities, and can look to divert the company's business operations overseas.

Yet despite the benefits of debt financing, Israeli companies in growth stages face a variety of obstacles in raising debt in comparison to corresponding companies in the US. This leads them to rely primarily on equity financing, which could damage their competitive advantage and encourage them to move significant operations overseas.

Capital structures differ between Israeli and foreign high-tech companies in growth stages

Currently, there is no single source of comprehensive information in Israel on the capital structure of high-tech companies in growth stages. In order to tackle this challenge, the Israel Innovation Authority performed a comparative analysis of public Israeli high-tech companies in growth stages and US companies comparable both in size and in the sector in which they operate.[9]

The results of the comparison are demonstrated in Figure 3.5, which depicts the difference in credit markets available to Israeli and US firms.

Figure 3.5: Credit Markets Available to Israeli and US Companies

Parameter	Israeli companies	Foreign companies	Significance
Leverage ratio (debt-equity ratio)	0.36	1.5	Foreign companies are 3 times more leveraged than Israeli companies
Average interest rate	5.78%	4.73%	The interest rate offered to Israeli companies is higher than the rate in other countries
Duration (years)	5.16	6.4	Foreign companies are granted credit for longer periods of time
Percentage of equity financing	88%	78%	Israeli companies rely more heavily on equity – the initial owners and entrepreneurs are diluted

Figure 3.5 shows that credit terms made available to Israeli high-tech companies are inferior to those available to US companies, and that Israeli companies use less debt to

9 Based on a sample of 26 Israeli companies and 26 US companies.

finance their operations. The Israel Innovation Authority believes that it is more difficult for Israeli companies to raise debt capital, which hurts their competitive advantage and their ability to grow in Israel.

It is important to note that the data in Figure 3.5 reflects a sample of public companies. Although information on conditions in private companies is not available, expert estimations and several roundtable sessions that the Israel Innovation Authority held with growth companies and high-tech capital industry leaders indicate that for private companies, the discrepancies between loan size, interest rates on debt, and the duration are even greater.

Barriers to debt financing in Israel: a small local market and taxation of foreign loans

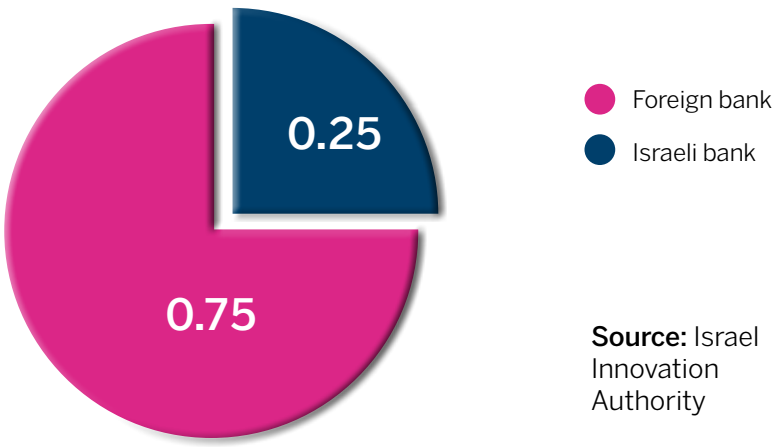
Market research and the roundtables conducted by the Israel Innovation Authority revealed two primary difficulties of obtaining debt financing for Israeli growth-stage high-tech companies:

- **There is a narrow supply of available local debt and a lack of financial expertise.** Growth-stage high-tech companies can require loans with unique structures, valued at hundreds of millions of shekels, which are tailored to meet the specific needs of their operations. Local credit providers have more difficultly offering loans on this scale, and they have less relevant experience in providing appropriately designed loans and assessing the intrinsic risk of loans for growth-stage high-tech companies (companies that are inherently new and operate in innovative fields).

- **Foreign credit is significantly taxed**. The Income Tax Ordinance and tax treaties state that an Israeli company borrowing foreign debt is subject to taxation deducted at source, unlike interest on a loan granted by an Israeli entity. Deduction at the source is an additional tax payment submitted on the date of the interest payment, which in turn raises interest on the debt owed by the company. The Israel Innovation Authority estimates that this tax increases interest on the debt by an average of 1-3%.

The difficulty in raising debt in Israel is also seen in data provided by the sample of Israeli companies. Data from the sample presented in Figure 3.6 indicates that 75% of the debt raised by Israeli companies was obtained from foreign sources, while only 25% of it was obtained from the Israeli banking system.

Figure 3.6: Sources of Debt Financing for Israeli Growth-Stage High-Tech Companies



Source: Israel Innovation Authority

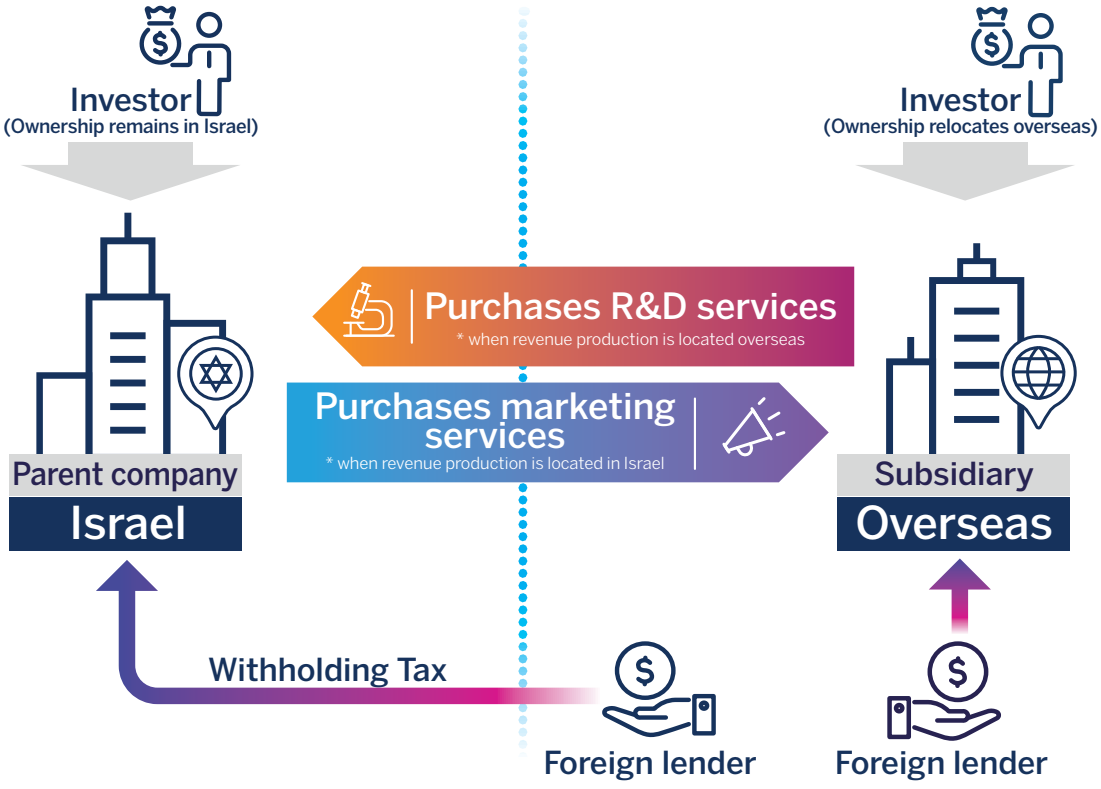
The significance of raising debt outside of Israel: company expansion overseas and ultimate departure from Israel

As shown, there are significant difficulties in obtaining debt financing for Israeli companies. Another option for raising debt is through a foreign subsidiary. Most Israeli growth-stage high-tech companies already have subsidiaries abroad as part of their business network (marketing, sales and technical support), making financing through a subsidiary accessible.

Figure 3.7 depicts the standard structure of a high-tech company in growth stages, including an overseas subsidiary. The right side of the diagram shows the tax obstacle it faces when obtaining a loan from a foreign lender, the left side shows the company's opportunity for debt financing with no tax deduction through the subsidiary located overseas.

A scenario where most of the company's available capital is in the account of the subsidiary located overseas could result in the transfer of increasing segments of the Israeli company's operations to the foreign subsidiary, due to convenience or through pressure from the creditor. Foreign credit suppliers, who work opposite the overseas subsidiary, may grant credit on the condition that management and business operations are moved to the funding location. This process could gradually deplete the Israeli company's operations in Israel, transforming the Israeli firm into a de-facto R&D site of a foreign company, with the majority of its non R&D operations (marketing, sales, production, technical support, etc.) located outside of Israel.

Figure 3.7: Common Organizational Structure of an Israeli Growth-Stage High-Tech Company



Source: Israel Innovation Authority

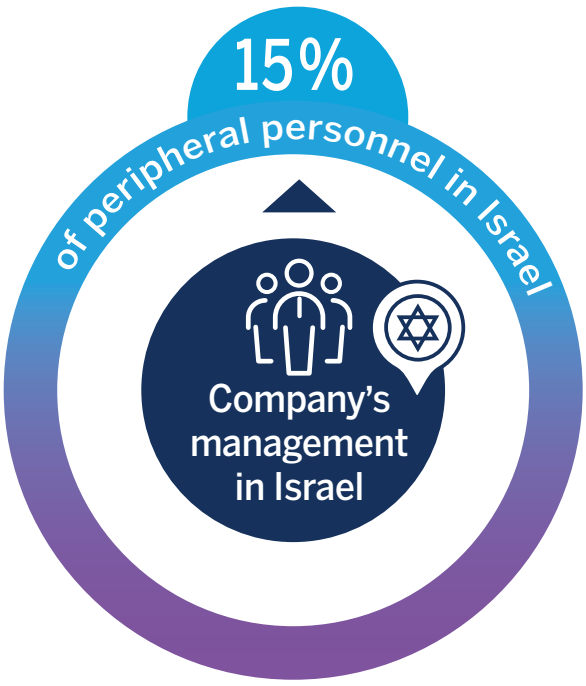
Costs to the Israeli market

The current situation, in which Israeli high-tech companies struggle to raise debt in Israel, damages the Israeli innovation ecosystem in several ways. First, Israeli companies face difficulties in employing the financial instruments that are best suited for their growth. In turn, this could impede their development and their global competitive advantage.

Second, the inability to raise finances locally forces companies to transfer operations overseas, which reduces the companies' contribution to the Israeli economy, both in terms of tax revenue and in their potential of becoming "complete companies" in Israel. Complete companies employ a wide range of high-productivity personnel beyond R&D, including marketing, business development, technical support, and management.

Figure 3.8 shows the result of a survey conducted by the Israel Growth Forum in 2019, which found that the location of companies' management has a significant impact on their contribution to the Israeli economy.[10] According to the survey, an average of 85% of these companies' R&D staff are employed in Israel, while less than 30% of peripheral staff (working in administration, marketing, manufacturing and sales) work in Israel. Conversely, the survey determined that if management is situated in Israel, the average number of peripheral employees jumps to roughly 45%.

Figure 3.8: The Impact of Management's Location on the Employment of Peripheral Personnel



Source: The Israel Growth Forum survey processed by the Israel Innovation Authority

10 A sample of 15 companies with sales exceeding 50 million dollars.

Accelerating Israeli Entrepreneurship

The Alarming Decline in the Number of New Start-Ups Must Be Stopped

In recent years, there has been an alarming decline in the number of new start-ups and in the amount of funding rounds by seed-stage start-ups. The Israel Innovation Authority analyzes the causes of this decline and is taking action to reverse the trend and to relaunch Israeli entrepreneurship

רשות החדשנות
Israel Innovation
Authority

Accelerating Israeli Entrepreneurship

Israeli high-tech entrepreneurship continues to stand out globally, with the highest number of start-ups per capita[1] and a third place global ranking in venture capital investments.[2] In 2019, Israeli high-tech companies raised an all-time high in capital, reaching a total of roughly 9 billion dollars, a 15% increase since 2018.[3] In the past decade, exit value grew eightfold, from 2.6 billion dollars in 2010 to 21.7 billion dollars in 2019.[4]

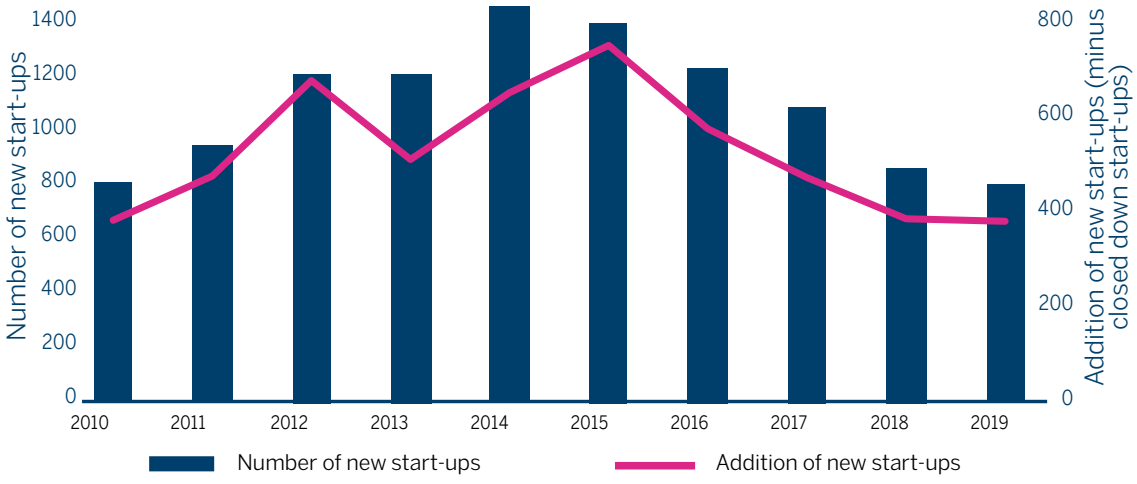
Israel excels in entrepreneurship and in launching new ventures. Israeli entrepreneurs have shown remarkable ability in identifying technology trends at the forefront of global innovation before the new fields become overly competitive and crowded, and that ability is an essential asset for Israeli industry.

Yet despite the sustained success of Israeli entrepreneurs, an analysis performed by the Israel Innovation Authority found some troubling trends. In recent years, the number of seed-stage funding rounds for start-ups dropped and the amount of new start-ups established declined, so much so that in 2019, the number of new start-ups launched was the lowest seen in a decade. The Israel Innovation Authority believes that these worrying trends are a call for action.

Decline in the Number of Start-Up Companies

Analysis conducted by the Israel Innovation Authority indicates that recent years have shown a decline in the number of start-ups added to the Israeli innovation ecosystem. Figure 4.1 demonstrates that from 2012 to 2017, 1,000 new start-ups were established per year, with a net of 500 companies added to the high-tech industry per year (the sum of new start-ups after deducting those that closed). However, since 2015, there has been a decline in the number of new start-ups, with 800 new start-ups registered in Israel in 2019, a net addition of just 360 companies – the lowest number seen in a decade.

Figure 4.1: The Number of New Start-Ups in Israel



Source: IVC data processed by the Israel Innovation Authority

1 2019 Startup Genome Report

2 Global Innovation Index 2019

3 IVC data processed by the Israel Innovation Authority

4 IVC Exits Report

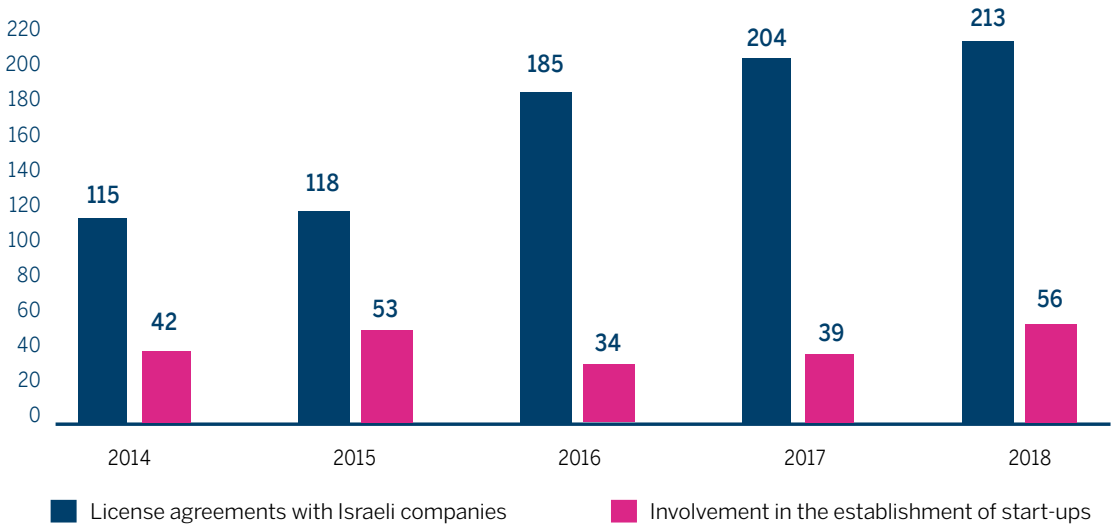
The reduction in today's new companies is not merely a problem of quantity. The decline in the number of new companies also means a decline in the diverse technologies and new fields of innovation developed by Israeli high-tech. This drop could hinder Israeli high-tech's dynamism and flexibility, as well as its ability to continue to maintain its position as a world leader in up and coming technology trends.

Knowledge Transfer from Academia to Start-Ups Increases - Slightly

Academia plays a key role in the creation of innovative knowledge and groundbreaking ideas, and in developing concepts to the point they can be used to establish start-up companies. Consequently, mechanisms that support the transfer of knowledge and collaborations between academia and industry play a crucial role in the creation of new start-ups. In recent years, there has been a moderate uptick in the number of license agreements signed by research institutions with Israeli companies, and in the number of start-ups established by the institutions' knowledge commercialization companies.

The Authority believes that despite the moderate increase, academia's contribution to innovation has huge untapped potential, and that the number of companies and license agreements that originate from research institutes can and should be substantially higher. The Council of Higher Education's Planning and Budgeting Committee (Vatat) and the Israel Innovation Authority, in collaboration with the Ministry of Finance, are working together on a proposal aimed at increasing the transfer of knowledge from research to marketable products.

Figure 4.2: The Commercialization of Knowledge in Israel – License Agreements with Israeli Companies and the Establishment of Start-Up Companies



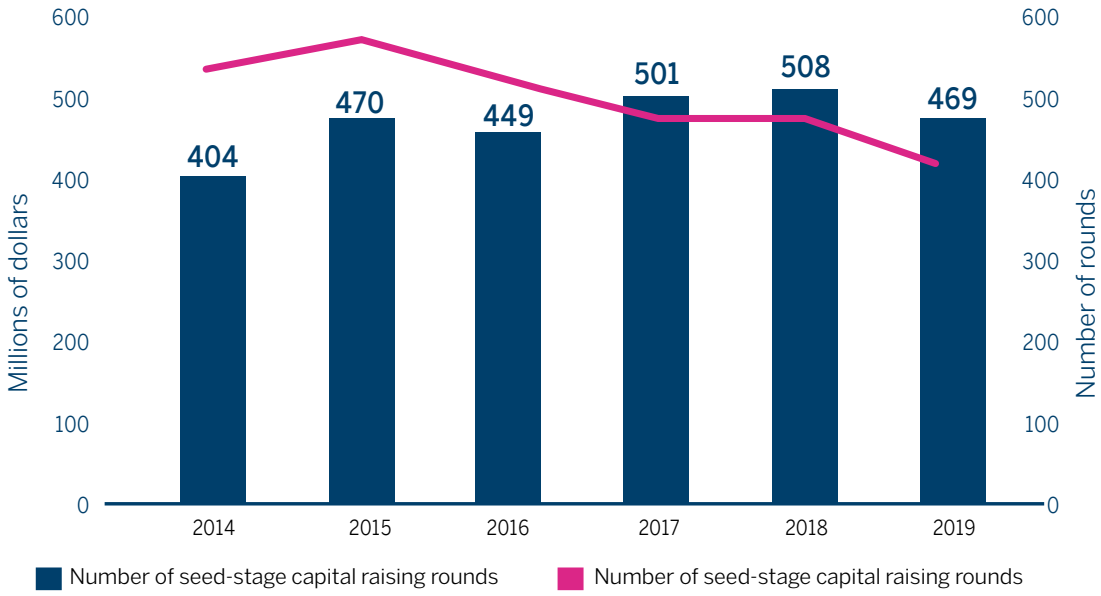
Source: Data from the Central Bureau of Statistics' Survey of Knowledge Commercialization, 2018, processed by the Israel Innovation Authority. The data includes the activity of all knowledge commercialization companies in Israel – universities, colleges, research institutes, and hospitals

Declining Investments in the Early Stages of Start-Up Companies

The Israel Innovation Authority's analysis of the Israeli high-tech industry shows an alarming a decline in funding rounds and in the total amount of capital raised by seed-stage start-ups.

As indicated in Figure 4.3, the total investment in seed-stage companies has remained constant in recent years, with a decline in 2019. At the same time, there was a gradual decline in the number of funding stages of seed-stage start-ups, dropping from roughly 570 funding rounds in 2015 to 410 in 2019.

Figure 4.3: The Amount and Number of Investments in the Seed-Stage



Source: IVC data processed by the Israel Innovation Authority

Reasons for Deceleration in the Early Stages of Start-Up Companies

In order to discern the reason for the slowdown in the creation and investment in new start-ups, the Israel Innovation Authority analyzed a variety of sources, including roundtable sessions with investors and a survey of 270 Israeli angel investors, and discovered several potential causes for the decline:

- **Maturation of the Israeli ecosystem**
- **Global technology and funding trends**

} **More attractive investment alternatives**

- **Fewer active early investors**
- **An overall shortage of groundbreaking research, along with large companies performing more innovation in-house (instead of acquiring start-ups).**

Maturation of the Israeli Ecosystem

One of the primary reasons for the decline in the number of seed-stage companies with access to capital is that Israel's innovation ecosystem has matured significantly in the past few years. **The growth of the ecosystem has two effects of the opening of new ventures:**

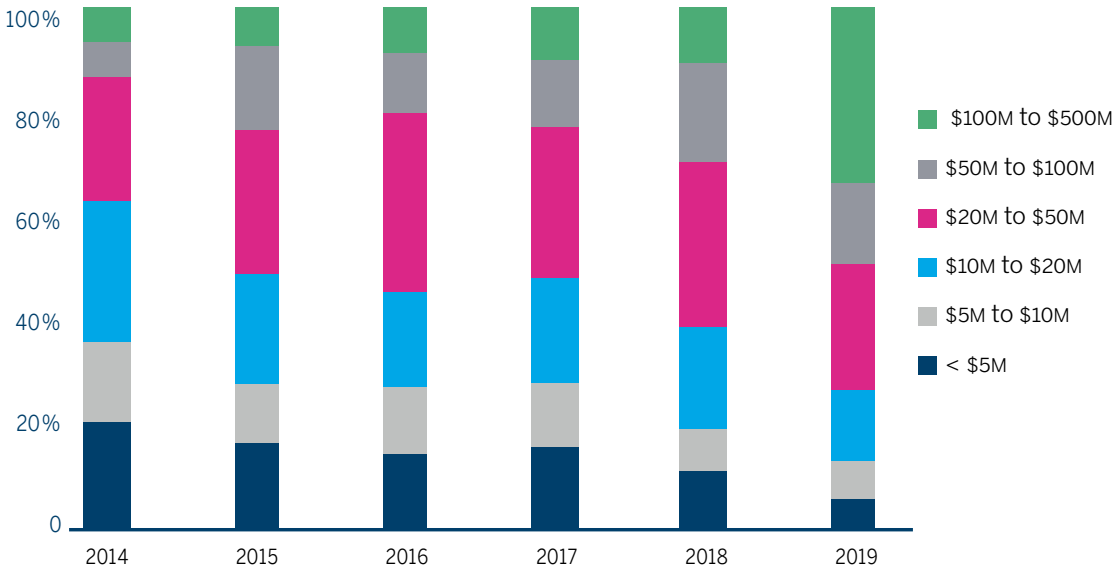
- **Quality, not quantity:** One widely held belief is that Israeli seed-stage investors and entrepreneurs, 20% of whom are serial entrepreneurs,[5] are currently capable of better identifying the more successful, high-quality companies, essentially separating the wheat from the chaff. Their accumulated experience enables higher precision in selecting quality investments and in avoiding the opening of a large number of low-quality start-ups and investing in them.

- **Sufficient deal flow of growth-stage companies:** The increasing number of growth-stage companies in Israel offers investors a broad selection of investment opportunities. Investors usually prefer to invest in more mature companies. While the amount needed to invest in these companies is higher, the risk level is generally lower and the payback period is shorter.

While the first claim, of quality replacing quantity, points to a positive trend and a more efficient allocation of resources, the second claim, diverting investments to growth-stage companies, is not as beneficial for the Israeli innovation ecosystem, as it shows that are less resources available for seed-stage start-ups.

Figure 4.4 also shows that more and more investments are being diverted from seed companies to growth-stage companies. The amount of investments in Israeli start-ups valued at up to five million dollars has decreased both absolutely (from 853 million dollars in 2018 to 509 million dollars in 2019) and as a percentage of total investments in Israeli start-ups (from 11% to 6%, respectively).

Figure 4.4: Investments in Israeli Start-Ups



Source: IVC data processed by the Israel Innovation Authority

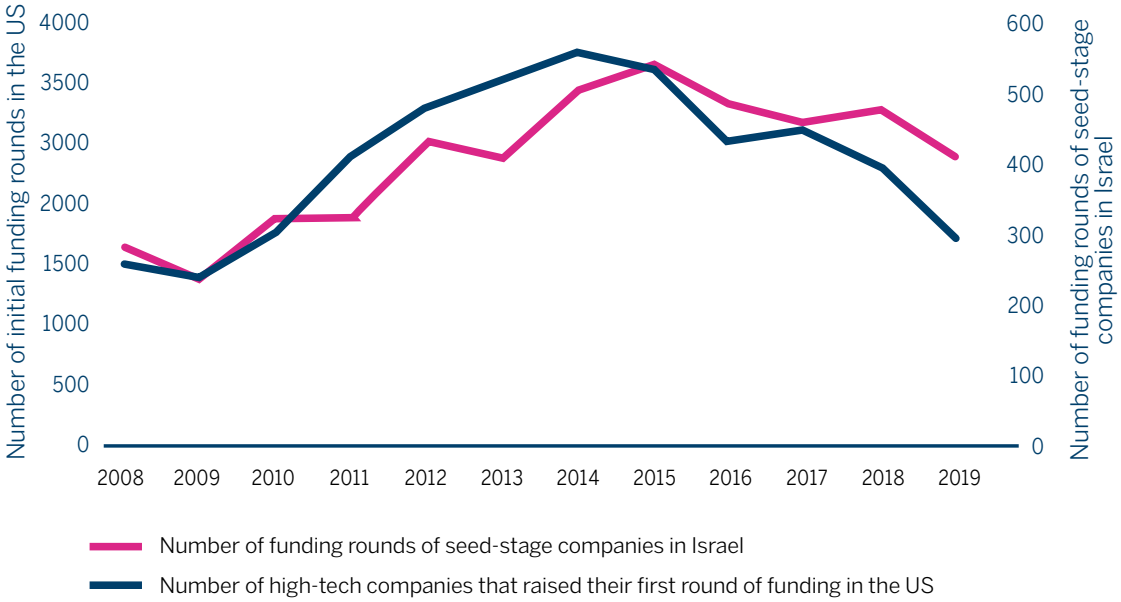
5 IVC data

Global Technology and Funding Trends

Notable trends in Israeli seed-stage companies are also evident in the US ecosystem and in other places around the world. The lower number of fundraising rounds, the higher median amount of the funding round, and the longer it takes, on average, for a company to reach initial funding,[6] can all be seen in global markets, along with Israel.

Figure 4.5 demonstrates that in 2009-2015, the number of funding rounds conducted by Israeli seed-stage companies grew at an average rate of 15% per year, which is similar to the growth rate of several start-ups that raised initial funding in the US. In 2015-2018, there was a decline in the number of funding rounds in Israel at an average rate of 4% per year, while in the US there was an even more rapid decline averaging 9% per year.

Figure 4.5: Initial Funding Rounds in the US Compared to Israel, 2008-2019



Source: PitchBook and IVC data processed by the Israel Innovation Authority

Other trends observed both in Israel and the US are growth in the median sum raised in seed rounds and an increase in the age of the company at the time of the round. In 2014, the median sum of a seed-stage funding round in Israel was 750,000 dollars and 700,000 dollars in the US, while in 2019, the median sum raised in seed rounds was 2 million dollars in Israel[7] and 2.2 million dollars in the US.[8] Furthermore, as demonstrated in Figure 4.6, companies took longer to begin to raise seed funding, with the average time between a company's founding and its seed round growing from 10 months in 2014 to 29 months in 2019.[9] This trend was evident in the US, where the average age of companies raising seed capital increased from 29 months in 2017 to 36 months in 2018.[10]

6 Venture Pulse, Q3 2019 KPMG

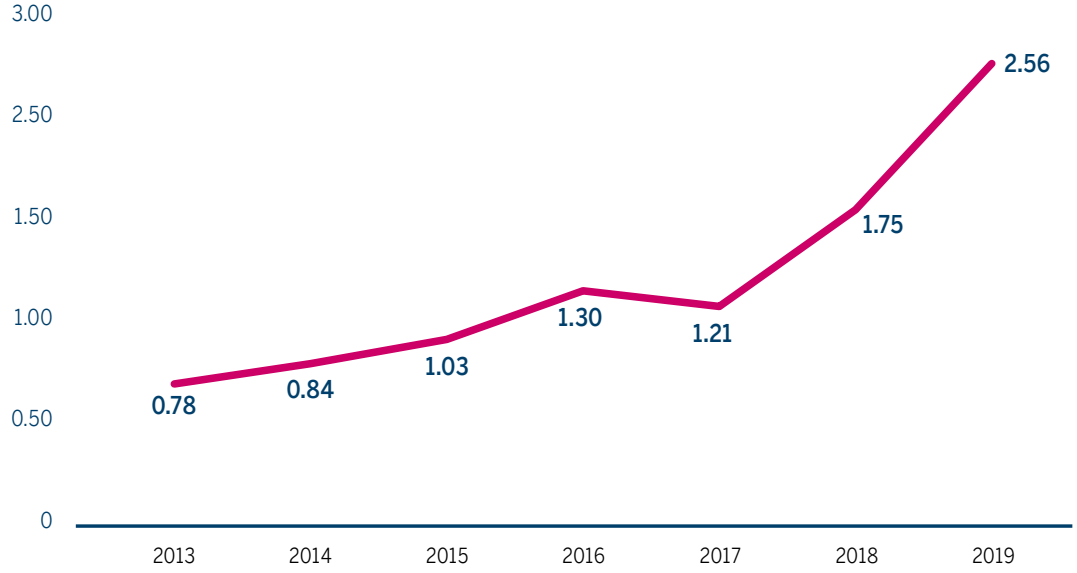
7 SNC data

8 Venture Pulse, Q3 2019 KPMG

9 SNC and IVC data processed by the Israel Innovation Authority

10 PitchBook data processed by the Israel Innovation Authority

Figure 4.6: Average Age of Israeli Companies when Raising Seed Funding



Source: SNC data processed by the Israel Innovation Authority

There are several possible explanations for these global phenomena. One explanation for the decline in the number of funding rounds is that today, investors have a range of attractive investment alternatives at more advanced stages in the private market, or even in the capital market. For example, in 2019, Nasdaq 100 saw gains of roughly 38%.[11]

The decline is also the result of a global trend of giant tech companies (such as Google, Facebook, Apple, Amazon and Microsoft) shifting to intensive in-house innovation, and creating new ventures within organizations instead of acquiring or establishing new start-ups.

The higher amounts raised in the seed rounds[12] stems from the fact that the global low-interest rate environment increased the supply of capital available for private investors, allowing entrepreneurs in initial stages to find private, "under the radar" funding solutions. As such, their need for a public seed-raising round was postponed to a later stage in the maturation of the company, when the sums required are greater and the risk level is lower.

An additional explanation is the revolution of cloud computing, which makes the world even more global, and the ever-growing geographic distribution of accelerators and hubs for fledgling entrepreneurs. The combination of cloud computing and easy access to early guidance led to a substantial decline in the ongoing costs of start-ups in their early stages (especially in software). Cutting early stage costs allows some fledgling entrepreneurs to reach more advanced stage in the maturation of the company using only personal capital.

The Israel Innovation Authority believes that despite the low-interest rate environment and the lower costs stemming from cloud computing and accelerators, the decline in seed-stage funding sources and the increase in the amount of time it takes, on average, to raise seed funding, indicate that for a growing number of quality seed-stage ventures, it is harder than it was in the past to raise investments and to reach funding milestones.

11 Nasdaq 2019 Review

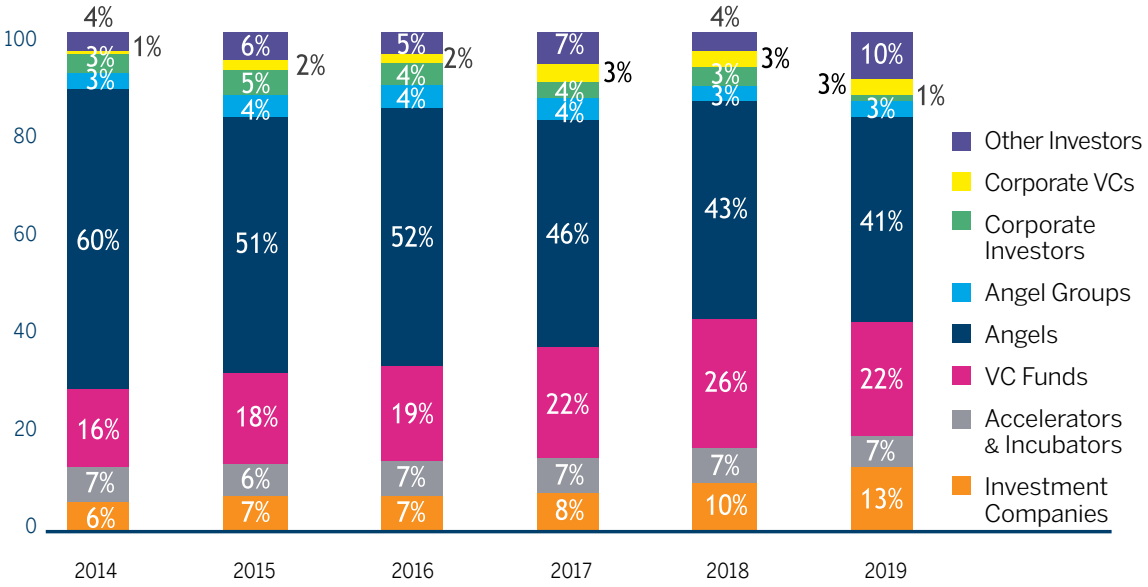
12 In 2014, the global median amount of a seed funding round was 500 thousand dollars while in 2019, the global median amount of a seed funding round was 1.9 million dollars

Decline in Available Funding and in the Number of Seed-Stage Investors

There is a discernible decline in the number of seed-stage investors in Israeli high-tech. This translates into fewer smart money opportunities for seed-stage companies - investors who provide experience, connections, and management guidance along with capital.

The Authority's analysis indicates than while in 2014-2017, the number of seed-stage investors remained steady at approximately 675, in 2018 and 2019, this number dropped by 17% to roughly 560. Among the various types of investors, the largest apparent decline is in angel investors. Figure 4.7 describes the involvement of various types of investors in seed-rounds and shows that the percent of angel investors dropped 19%, from roughly 400 angel investors in 2014 to 230 in 2019.

Figure 4.7: Types of Investors Involved in Seed Rounds



Source: IVC data processed by the Israel Innovation Authority

Angel investors play a key role in the growth of new companies during their seed stages. These investors, many of whom were once entrepreneurs themselves, bring important business and management experience to the fledgling start-ups. Moreover, these investors usually focus on investing in start-ups at the earliest stages of their life-cycle, when the risk is high but investment amounts are lower. The investments and experience that these investors bring can help companies reach a significant milestone in their R&D, enabling them to raise larger sums of capital from additional investors.[13]

Figure 4.8 presents the results of a survey performed by the Israel Innovation Authority of 275 Israeli angel investors. It indicates that the large majority of angel-investors invest up to one million dollars, and that 65% of them invest up to 500,000 dollars. Although these are lower sums in comparison to advanced rounds, however, in early stages, even small investments are the oxygen that allows young companies to grow.

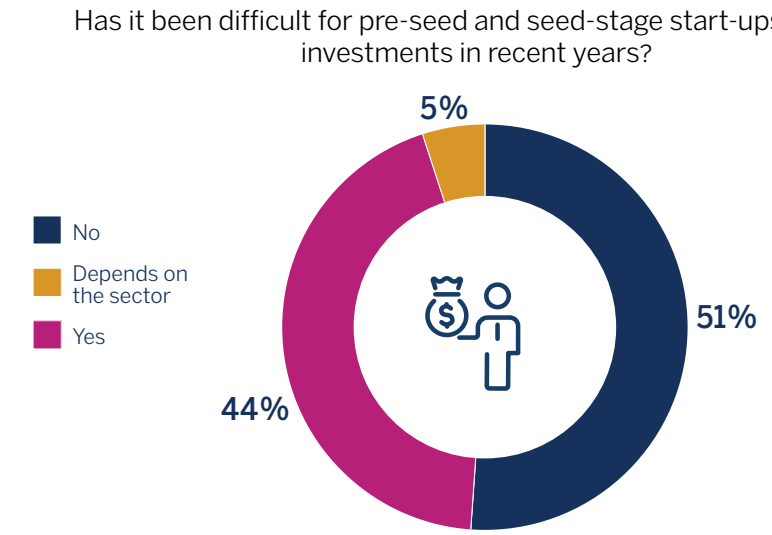
Because of the decline in investments by Israeli angel investors (Figure 4.7), new start-ups, which require relatively low sums of money (up to one million dollars) in order to reach a milestone to facilitate the raising of larger sums of money, currently have fewer smart money funding sources at their disposal in a critical stage.

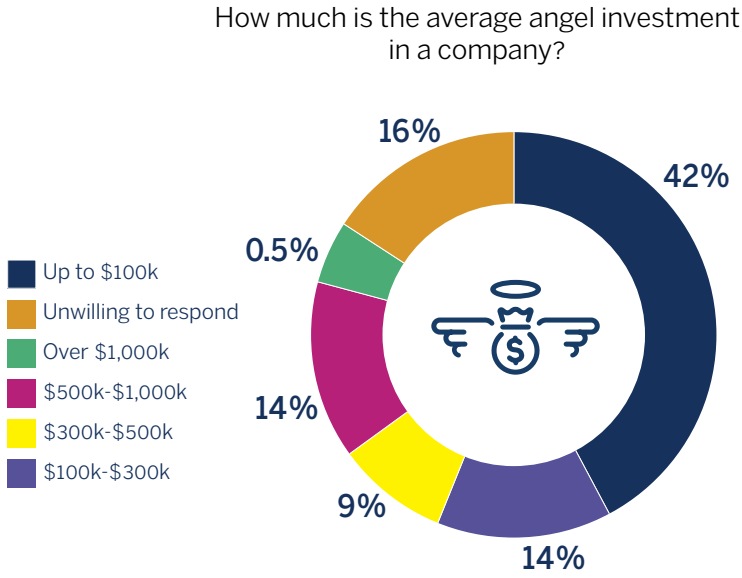
13 Diamanto Politis, "Business Angels as Smart Investors: A Systematic Review of Evidence". Handbook of Research on Business Angels, page 147

Figure 4.8 also demonstrates the distribution of angel investors' responses to the question: "Do you think that in recent years, it has been difficult for pre-seed and seed-stage start-ups to raise funds?" Responses show that the angels' views on this are divided. Half of the respondents described recent circumstances as difficult, whereas the other half expressed that there is no such difficulty.

This discrepancy of views on a general lack of seed-stage funding was also articulated in interviews and roundtable sessions that the Authority held with various investors and entrepreneurs in seed stages, yet there was consensus that there is currently less smart money and fewer angel investors available in Israel.[14]

Figure 4.8: Results of the Israel Innovation Authority's Survey of Angel Investors





Source: Israel Innovation Authority survey data

14 Roundtable sessions were conducted in October 2019

Human Capital

As covered extensively in earlier Israel Innovation Authority reports, there is fierce competition for skilled professionals in the Israeli high-tech industry. According to a survey conducted by the Central Bureau of Statistics,[15] Israeli high-tech is in need of an additional 12,500 tech professionals. A survey conducted by the Startup Nation Central (SNC) and the Israel Innovation Authority estimates this number to be even higher, reaching approximately 18,500.[16]

The growing number of multinational high-tech companies operating in Israel has also increased the demand for highly skilled and talented workers, which in turn has increased their pay. For example, in 2017, multinational companies offered an average annual salary of 500,000 shekels, in comparison to an average annual salary in start-ups of up to 336,000 shekels.[17]

The fierce competition for skilled professionals and the abundant supply of attractive, high-paying positions in growth companies and in multinational companies operating in Israel make it difficult for fledgling entrepreneurs to recruit the core team they need to establish a new start-up.

Israel Innovation Authority's Support of Seed-Stage Companies

The Israel Innovation Authority believes that the decrease in the establishment of new start-ups in Israel (dropping to the lowest rate seen in a decade), alongside a concurrent decline in the volume of seed-stage investments, are worrying phenomena that require a response. Israeli entrepreneurship, and especially the establishment and growth of new start-ups, is essential to the preservation of a dynamic, advanced ecosystem of innovation and for its lasting prosperity.

In an effort to support Israeli entrepreneurship and the establishment and growth of innovative, groundbreaking companies, the Authority operates in a myriad of ways to remove the obstacles standing in the way of these companies and to help them raise the capital that they need. The Authority believes that these efforts should be expanded and accelerated in order to "relaunch" Israeli entrepreneurship.

The primary method employed by the Authority to help new start-ups raise the capital they need in seed stages is by providing grants for R&D projects. As delineated in the second chapter of this report, the Authority focuses on fields with a market failure in regards to available capital – innovative, less prominent fields that usually carry high risk and offer long-term returns, and thus are less likely to attract private capital. Notable examples of these include:

- Seed-stage companies led by first-time entrepreneurs, especially founders from sectors underrepresented in high-tech (such as women, ultra-orthodox Jews and minorities).
- Seed-stage companies with high-risk tech solutions and long development times before reaching market, such as companies in silicone, clean-tech, pharma or agriculture sectors.

15 Central Bureau of Statistics, "Employees, available positions, and the ratio between supply and demand" classified by occupation (2011 classification) in select groups, 9.33

16 Human Capital Survey Report 2019, Israel Innovation Authority and Start-Up Nation Central, work version

17 CBS, "R&D Activity in Startups and Multinational R&D Centers", 2017

In addition to providing grants for R&D funding, the Authority aids in the formation of new start-ups by establishing innovation labs and incubators, which provide tech infrastructure and auxiliary knowledge. For more information on these and other tools, see chapter 7 on the Start-Up Sub-Market.

Furthermore, the Israel Innovation Authority is also working with the Ministry of Finance and the Tax Authority to look into ways to diversify sources of smart money, such as exploring ways to amend and improve the Angels' Law.[18]

Alan Feld / Managing Partner, Vintage Investment Partners[19]

"I am not troubled by the number of startups created; this number increases and decreases continually. What makes me optimistic is that the quality of the entrepreneurs keeps improving, which to me is the most important point. Having said that, most of the companies being created lately seem to be focused on three areas: Cyber Security, Cloud Infrastructure and FinTech. Going forward, I think it will be very important to see far more startups created in other important areas in which Israel has an advantage, such as AgTech, Foodtech, Digital Health, Semiconductors and even selected areas in Energy and Water. As a country, we cannot have our eggs in too few baskets.

"Israeli companies tend do a great job when there is a complex, multi-disciplinary technology challenge. Examples of this are computational biology, where advanced hardware, data science and biology meet. Remote patient care is another example, taking advantage of Israel's skills in sensor and communications technologies."

"I see the Innovation Authority as a bridge between innovative academic research and the creation of new companies and industries emerging from this research. The Authority helps to reduce the financial risk of investments in the emerging sectors I noted previously, serving as a catalyst for the success and growth of new technology sectors."

18 The Angels' Law refers to Section 20 of the 2011-2012 Economic Policy Law (legislation provisions), which legislates tax incentives in order to encourage private investment in seed-stage start-ups

19 Vintage Investment Partners is an Israeli venture capital fund that invests in venture capital funds (a fund of funds), in secondary funds, and in advanced-stage growth companies. The fund manages roughly 1.8 billion dollars, and follows over 500 venture capital funds and roughly 6,000 private high-tech companies

Bolstering Artificial Intelligence

What Can Be Done for Israel to Maintain its Leading Position in the Field of AI?

For Israel to realize its full potential in AI and to maintain its leading position in the field, it must make a concerted effort to meet the challenges posed by regulation, human capital, accessibility to databases, and sub-par supercomputer infrastructure

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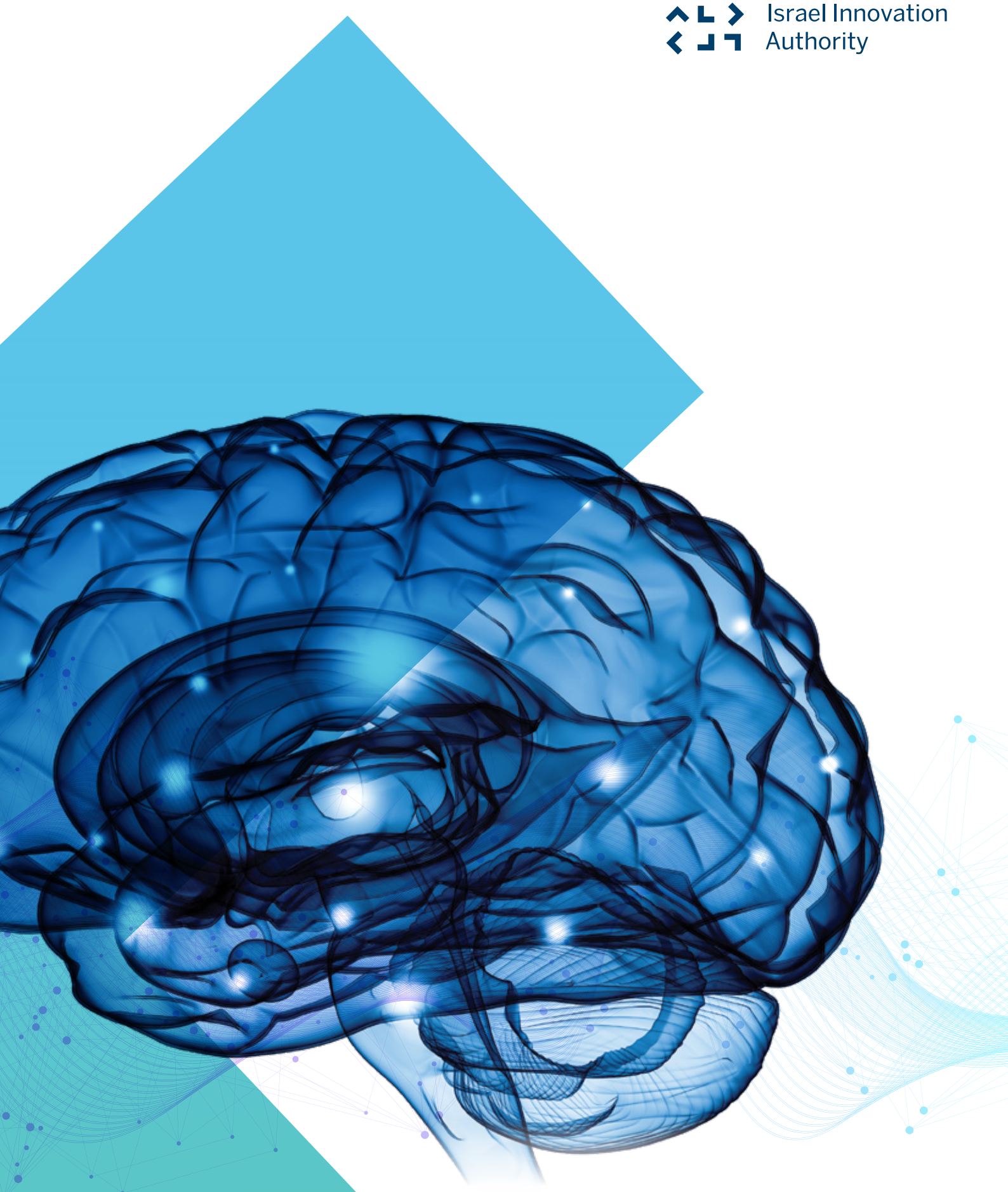
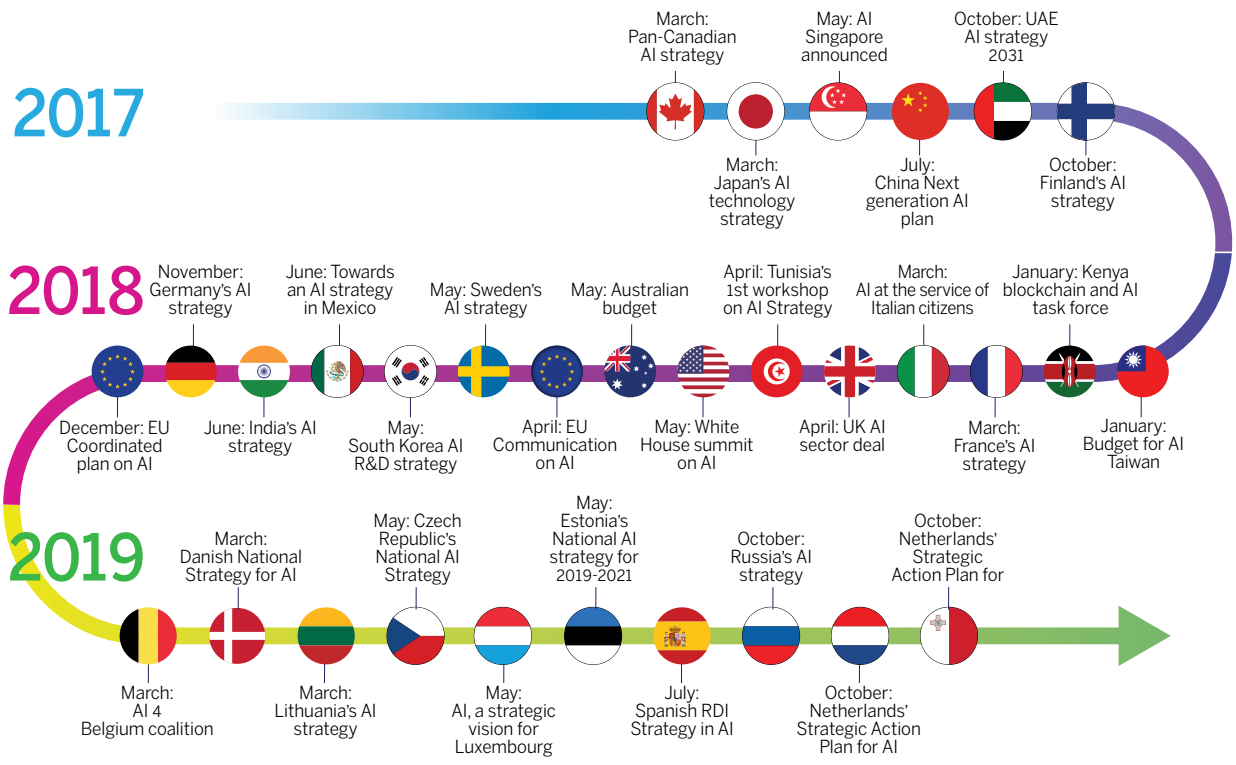


Bolstering Artificial Intelligence

AI is at the center of the current industrial revolution, and its significance is likely to increase in the coming decade. Many people believe that AI will lead society to a new technological era, propelling a revolution even more momentous than previous industrial revolutions. In recent years, the ability of computer systems to use statistical algorithms to simulate human cognitive processes, such as learning and self-correction, has grown leaps and bounds. These systems are also capable of harnessing enormous amounts of information accumulated in various databases around the world in order to gain valuable insights.

In recent years, thanks to a surge in AI technologies and their enormous economic potential, many countries have devoted a great deal of effort and resources to the race for technological leadership in AI.

Figure 5.1: The World Acknowledges the Importance of Artificial Intelligence as an Economic Growth Engine



Source: Politics = AI, Tim Dutton, 2018 + European Commission data 2019

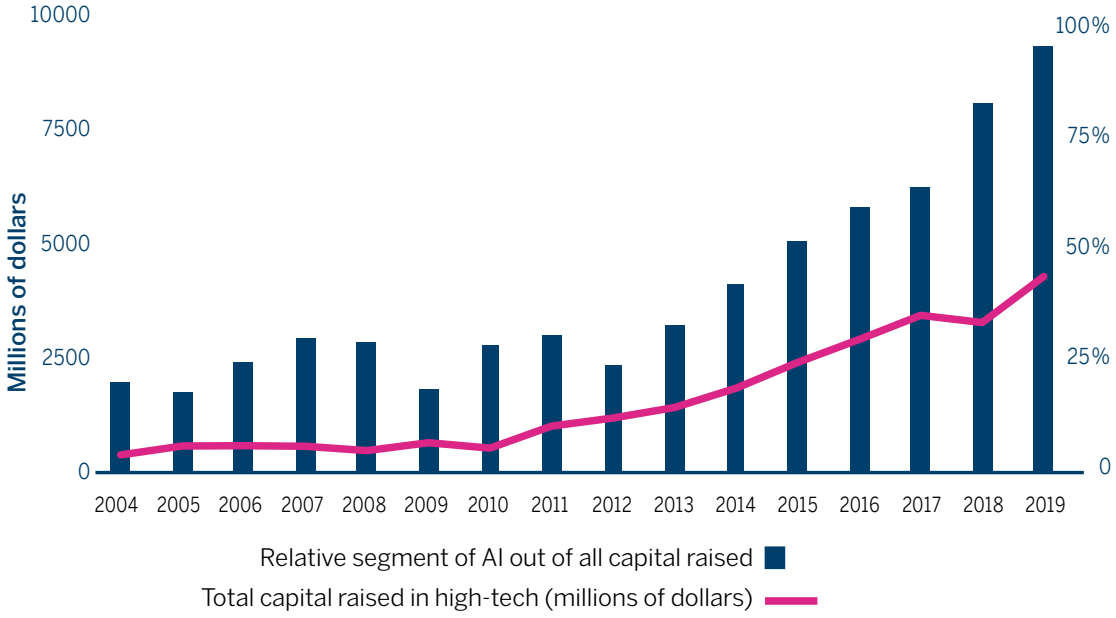
The 2018-2019 Innovation Report[1] included a survey conducted by the Israel Innovation Authority that delineated the heavy investment in AI made by nations such as China and other East Asian countries. Since then, the US, Europe, and other countries have revealed strategic plans aimed at advancing AI. Figure 5.1 shows a timeline of countries that have thrown their hat in the AI ring and announced national plans dedicated to AI.

A small country like Israel cannot realistically compete with the enormous investments made by countries like China or leading global high-tech companies like Amazon or Google. The Israeli innovation ecosystem has, nonetheless, many relative advantages that allow Israeli companies to assume technological leadership, such as entrepreneurial spirit, audacity, and flexibility. Another advantage that Israel possesses, exclusive to AI, is the large amount of raw digital information in national databases, particularly in healthcare. Access to large databases is critical for young companies developing machine learning processes or fine-tuning algorithms, and is essential to the technological development of AI. Such access could contribute to Israel's capability to lead this field.

Israeli Leadership in AI

The growth of AI technologies is reflected in investments made in the field. In 2011-2019, investments in Israeli high-tech AI projects increased by a factor of 12.5, from 305 million dollars to 4 billion dollars. Figure 5.2 shows that in 2019, 42% of the total sum invested in Israeli high-tech went towards AI technologies.[2]

Figure 5.2: Investments in AI Start-Ups in Relation to Total Investments



Source: IVC data processed by the Israel Innovation Authority

1 Israel Innovation Authority, "The Race for Technological Leadership: The Advent of the Smart Machine Era." Israel Innovation Authority Report, 2018-2019

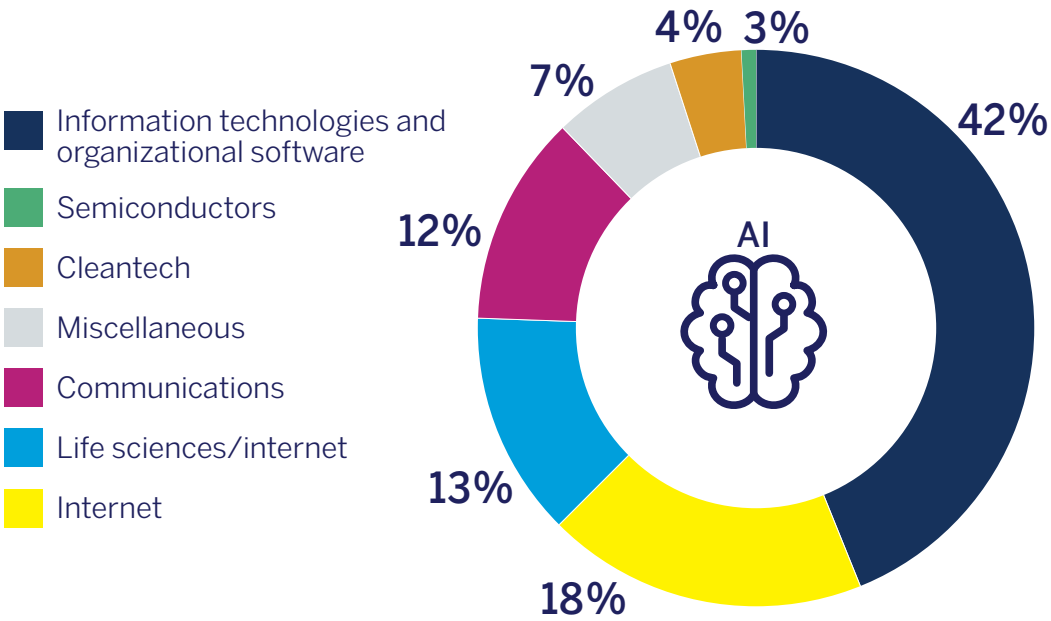
2 IVC data processed by the Israel Innovation Authority

Bolstering Artificial Intelligence

In recent years, Israeli high-tech has held a leading global position in the field of AI. Israel is now among the world's top three countries operating in the field of AI, following China and the US.[3] Moreover, according to research company CB Insights, Israel ranks second, after the US, in its number of leading AI start-ups.[4] It also ranks high in the number of companies that develop infrastructure technologies for AI such as special-purpose chips, infrastructure algorithms, and complex systems for the acceleration of computing.[5]

There are currently 1,400 companies in Israel working on AI technologies, and roughly 70% of them were established in the past five years, which is significant industry growth. Around half of these companies are in R&D stages and half have matured to sales. Figure 5.3 shows that Israeli start-ups develop and apply AI to a variety of uses, such as business analysis, apps, cyber security, and health. Over 40% of AI companies in Israel are in the information technology and software sector, 30% provide online services and communications, and 13% are in life sciences.

Figure 5.3: Distribution of AI Companies by Sector



Source: IVC data processed by the Israel Innovation Authority

3 The Global Artificial Intelligence Landscape, Asgard

4 CB-Insights top startups ranking

5 MMC Ventures & Barclays UK Venture, "The State of AI 2019: Divergence", 2019

Giant tech corporations, such as Google, Amazon, Apple, Netflix, Facebook and Microsoft, hold a dominant global position in AI research and in the development of core technologies that employ AI.[6] This has ramifications on Israeli companies operating in the field. On the one hand, large multinational corporations leave little room for small competitors trying to develop core technologies for AI, as this requires tremendous expertise, abundant resources, and proximity to academic research.[7] On the other hand, the dominance of large corporations also offers the Israeli innovation ecosystem a significant advantage and contributes to its reinforcement and enrichment in several ways. The massive presence of roughly 90 R&D centers of multinational corporations working on AI in Israel (out of around 400 foreign R&D centers operating in Israel)[8] positions Israel at the forefront of global technology. The large international presence produces a flow of information between the multinational corporations and local start-ups, and exposes Israeli companies to the cutting edge of the field. Multinational corporations also contribute to the development of local human capital, by giving local engineers and leaders technological and managerial experience, which enriches Israeli high-tech.[9]

Maintaining Israel's Lead in AI

Despite the rapid growth of Israeli high-tech, and of AI in particular, strategic analysis performed by the Israel Innovation Authority has identified four obstacles that can slow future growth in the field:

- **A shortage of human capital skilled in the field of AI**
- **Limited access to public and government databases for use by new companies**
- **Inadequate supercomputing infrastructure for the development of advanced technologies**
- **Slow-changing regulation and a lack of ethical guidelines**

Insufficient government support on these issues may result in the deterioration of Israel's high standing in the development of AI technologies. The Innovation Authority, in collaboration with its partners in the government and the industry, is working to create solutions to these challenges.

6 OECD and EU-JRC, World Corporate Top R&D Investors: Shaping the Future of Technology and of AI, 2019

7 OECD and EU-JRC, World Corporate Top R&D Investors: Shaping the Future of Technology and of AI 2019

8 Startuphub.ai 2019

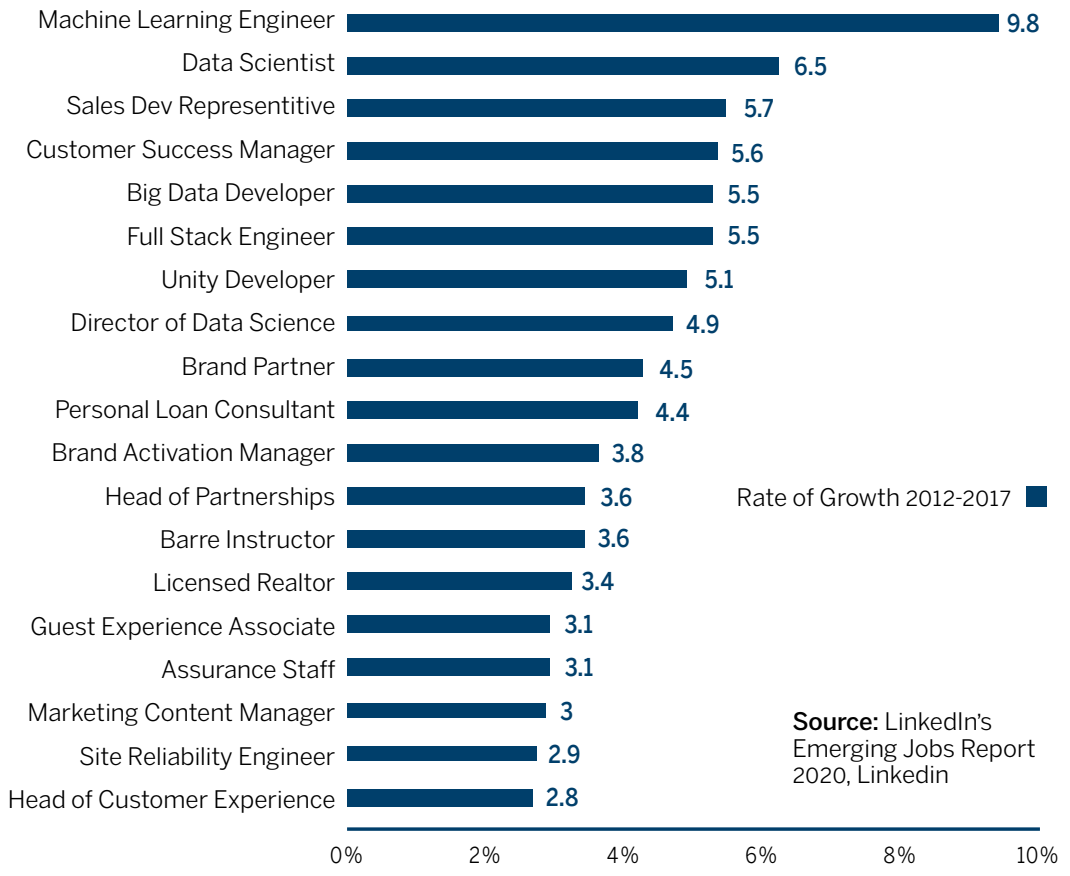
9 For more information, see: Multinational Corporations' R&D Centers in the 2017 Innovation Report, the IIA

A Shortage of Skilled Human Capital in AI

Advances in AI have led to a sharp global surge in demand for skilled professionals at every level of the professional pyramid: analysts and data scientists, machine learning specialists, and algorithm developers. Figure 5.4 mimics a LinkedIn graph showing the demand for data scientists and AI professionals, which increased more than any other profession in the past decade. Demand for AI specialists had the highest growth rate, with an annual increase of 74% in the recruitment of AI professionals in the US.[10]

According to Israel's 2019 High-Tech Human Capital Report by the SNC and the Israel Innovation Authority, 7% of available tech positions in the industry, some 1,300 positions, are for AI or data sciences professionals.[11]

Figure 5.4: Highest Demand Professions



Israel ranks 18th out of the 42 listed countries in its number of AI scientific publications per capita.[12] While the number of Israeli publications on the topic has grown annually, the growth rate is slower than other countries, and the proportion of Israeli AI research

10 LinkedIn, "2020 Emerging Jobs Report"

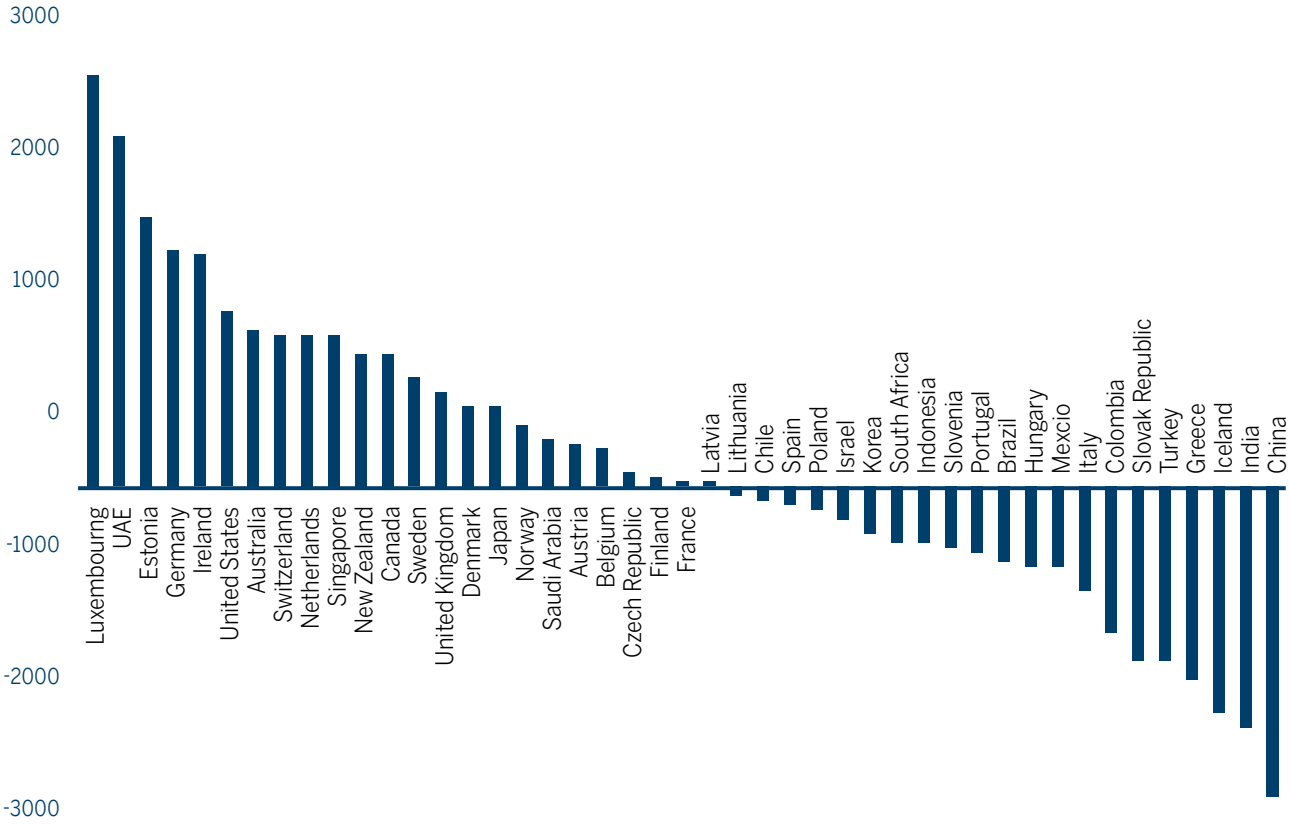
11 Israel Innovation Authority and Start-Up Nation Central, "Human Capital Survey Report 2019", working version

12 Ranking of countries that published articles on AI in the academic database Scopus in 2013-2017. Source: The Samuel Neaman Institute for National Policy Research, Artificial Intelligence, Data Science and Smart Robotics. First Report, 2018, p. 13

is shrinking.[13] Should this trend continue, Israel's ability to lead global AI research will be limited. The amount of research is affected, in part, by the high demand for data scientists in the private sector, which makes it difficult to recruit and retain academic faculty in AI related research fields. This, in turn, hinders academic research and instruction, and impedes the ability to create future generations of leading researchers in academia, who are required to develop and transfer knowledge from academia to industry.

Furthermore, Israel is also losing skilled human capital in AI due to migration, illustrated in Figure 5.5.

Figure 5.5: Negative Migration of Skilled Human Capital in AI



In recent years, Israeli academia has responded to the increasing demand for skilled AI professionals, and launched the National Program for the Advancement of Data Science in Higher Education accordingly, among other endeavors.[14] However, more must be done, and the long term policies must be complemented by short-term, targeted training programs.

As will be detailed later in this chapter, the Innovation Authority is working on non-academic training programs to provide alternative career paths in AI, such as coding boot-camps and the Workshop for Advanced Technology Training.[15]

13 Ibid, p. 15.

14 In 2018, 17 new data science education programs were submitted for approval by the PBC (the Planning and Budgeting Committee). In 2019, the PBC approved the National Program for the Advancement of Data Science with a budget of approximately 150 million shekels, which includes the funding of scholarships for doctoral and postdoctoral students

15 For more information, see chapter 7 of this report, The Public Social Arena

Limited Access to Data

The development and training of AI algorithms require access to large databases that facilitate insight mining and machine learning. These large databases are usually owned by the government or by multinational corporations like Google and Facebook. The Israeli government has thousands of national databases, but only around 700 of them are accessible to the public. Most are not normalized, with non-validated and unlabeled data, and therefore do not qualify as high-quality data.

Enabling access to high quality databases requires work on several fronts simultaneously: organizing data in existing databases, synchronization between databases, data anonymization,[16] creating synthetic research databases based on existing databases, collecting data and building new databases, establishing regulation, and building centralized computing infrastructure to manage information between all entities who will make use of the data.

Regulation in Israel is not currently suited to keep up with technological developments. Start-ups' access to databases is often blocked unnecessarily, slowing product development. The Israel Innovation Authority is working in collaboration with a variety of government entities, including Digital Israel and the Ministry of Justice, to improve regulation standards for data. The Authority is also working to advance data unification processes and the standardization of national databases that have applicable value.

Supercomputer Infrastructure

Other forms of infrastructure that are critical for the development and training of AI algorithms are computational capacity and High-Performance Computing (HPC), which is necessary for meeting the demands of data processing. Currently, there is no such advanced infrastructure in Israel, despite its importance to both industry and academia.

Figure 5.6 shows a list of the countries with supercomputing centers - Israel does not appear on the list.[17]

Figure 5.6: 500 Globally Strongest Computing Infrastructures Rating

China	228	Singapore	4	Sweden	2
United States	117	South Korea	3	India	2
Japan	29	Brazil	3	Spain	2
France	18	Australia	3	Czech Republic	1
Germany	16	Saudi Arabia	3	Hong Kong	1
Netherlands	15	Russia	3	Poland	1
Ireland	14	UAE	2	Finland	1
United Kingdom	11	Taiwan	2	Australia	1
Canada	9	Switzerland	2		
Italy	5	Norway	2		

Source:
TOP500 List
Supercomputer

16 Data anonymization is when a database that contains personally identifiable information undergoes a process that includes the extraction of identifying information, ultimately creating a new database that does not allow the exposure of personal information, and whose use does not violate the privacy and confidentiality of the people included in the original database

17 TOP500, Supercomputer List - November 2019

The lack of supercomputing infrastructure can also be seen in the Global AI Index. The index ranks Israel third (out of 54 countries) in AI investments, fifth in R&D, but only 36th in infrastructure.[18]

Local supercomputing infrastructure would lower expenditures for Israeli companies and would increase their capacity to advance independent R&D. While giant companies maintain their own infrastructure, small companies must use cloud computing services and overseas storage at a high cost, and are limited to generic, inflexible tools, available in the private sector. In addition to high costs and inflexibility, relying on foreign cloud infrastructure also causes slow response time – the time it takes between running the data and receiving results. Another problem arises when information is sensitive and classified (such as personal medical information or information that is classified for security purposes), or when information cannot or should not be transferred to foreign infrastructure.

The Israel Innovation Authority believes that the lack of local AI supercomputing infrastructure is limiting Israeli high-tech's competitive advantage and that establishing this type of infrastructure in Israel is vital. This is further corroborated by the fact that many governments worldwide are currently working to provide infrastructure to academia and local industry.

Changes Needed to Privacy and Ethics Policy in AI

Implementation of smart systems raises ethical concerns that call for clear regulatory definitions. Using large databases poses privacy challenges that mandate information classification by sensitivity levels. Moreover, at times, it is not clear how AI systems make decisions. The responsibility of the manufacturer or the user for the machine's 'independent' activity, in the case of critical error, remains unclear (for example, in an autonomous car accident).

Israel Innovation Authority Advances Israeli AI Leadership

The Authority, in collaboration with relevant government entities, employs a variety of tools to promote growth in AI and to remove obstacles facing the field:

Israel Innovation Authority Backs Groundbreaking AI Projects

In order to continue encouraging the successes Israel has already experienced in the field of AI, the Authority provides financial aid and support to companies with groundbreaking AI technologies. In 2019, the Authority provided grants to 219 companies working on AI technologies for a total sum of roughly 415 million shekels. These grants were mostly provided for AI infrastructure projects and in sectors underfunded by private investment.

18 "The Global AI Index", Tortoise Media

Developing Skilled Human Capital for AI

In an effort to address the increasing shortage of human resources in AI, the Authority believes that both academic and non-academic training is required, and that foreign specialists should be encouraged to come to Israel. To this end, the Authority is operating various tools to train employees for in-demand AI professions.

The Authority recently launched a new program to support professional training in high-tech: The Workshop for Advanced Technology Training, which focuses especially on AI. The innovative model will allow companies to achieve relatively quick results by propelling **existing developers and engineers** in the industry to become AI specialists, and will encourage information sharing and the creation of an AI community. Four of these workshops are slated to be held in 2020-2022. Each workshop will train at least 200 employees, with a total government investment of 16 million shekels. The Authority will also continue to fund professional training via coding boot-camps, and will add professional training workshops to R&D consortiums focused on AI, which are funded by the authority through its MAGNET (Generic Technologies R&D Consortiums) programs. Two coding boot-camps in data science, which receive financial backing from the Authority, are already operational.[19]

Technology Infrastructure for AI – Databases, Software and Computing Power

The Israel Innovation Authority believes that there is a pressing need for a national supercomputing infrastructure for the industry, academia, and security sectors. In order to gauge the scale of infrastructure that would meet the needs of its users, the Authority, together with its partners in the TELEM forum (the National Infrastructure Forum for Research and Development)[20] referred to potential partners who specialize in this field. These partners include large companies, researchers and professors from all over the country, security and government entities, and specialists from similar companies overseas.

Infrastructure characterization will focus on the use of technologies developed in Israel in order to ensure availability and high-quality engineering support, while reinforcing commitment to the project and bolstering the financial contribution to Israeli high-tech.

In addition, the Authority is backing a range of MAGNETs (collaborations between companies and academic researchers for the development of generic technology) and user organizations in order to facilitate the development of dedicated databases and technological tools that support AI, such as software infrastructure and code libraries. These consortiums currently operate in a variety of fields, such as digital health, transportation, and natural language processing. The total investment in this infrastructure is slated to reach a total of 320 million shekels throughout the duration of the program.

19 For further details, see chapter 7 of this report, The Public Social Arena

20 The TELEM forum includes, in addition to the Israel Innovation Authority, the Ministry of Science, the Ministry of Finance, the PBC, and the Administration for the Development of Weapons and Technological Infrastructure for the Ministry of Defense

Advancing Supportive Regulation in Collaboration with the World Economic Forum

The Israel Innovation Authority works in several ways to advance regulation that supports innovation in the Israeli high-tech industry. To this end, one of its primary tools is the operation of the center for the regulation of innovative technologies in collaboration with the World Economic Forum (WEF).

In 2019, Israel joined a network of WEF centers that advocate regulatory advances to promote innovation. The Israeli center, which recently began operating under the auspices of the Israel Innovation Authority, will work with local regulators to adjust local regulation to better accommodate future technologies. In concert with the network administrator in the US, the Israeli center has begun exploring regulation that would encourage a competitive, supervised and sophisticated market. Being a part of this network allows Israel to advance regulatory changes while gaining insights from regulatory innovation across the globe. Projects undertaken by this global network include civilian use of drone systems, IoT regulation, improved transportation management capabilities, and auxiliary applications in medical informatics. In 2019, the Israeli center concentrated on assisting regulators in smart transportation and digital health.

At the same time, in September 2019, Israel adopted ethics guidelines for responsible R&D in AI as a member of the OECD. These guidelines ensure the protection of users' privacy and ready access to public databases.

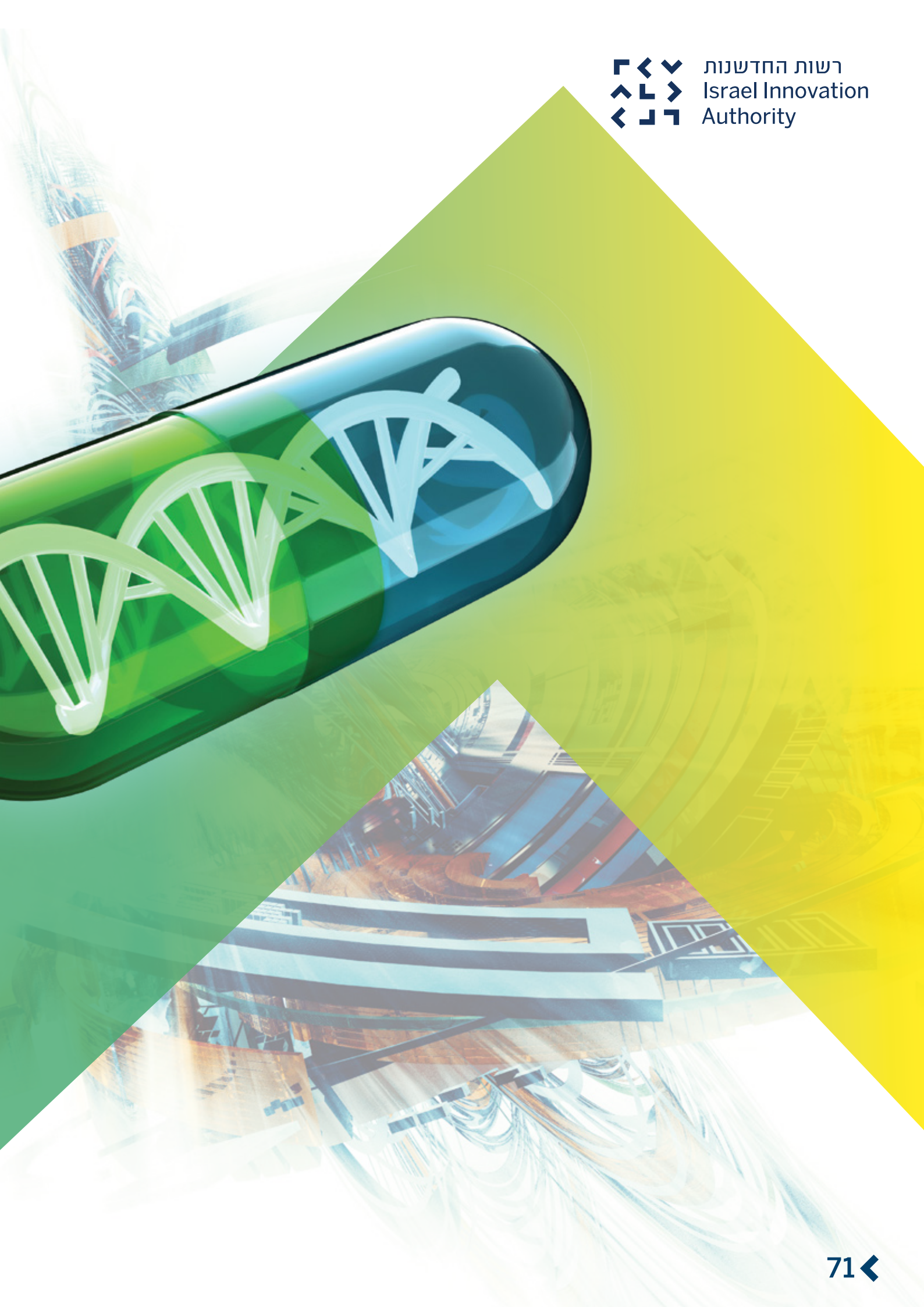
In conclusion, AI technologies are projected to have an unprecedented impact on the global economy. The Israeli innovation ecosystem, at the forefront of technology and knowledge, is in prime position to lead this field. For Israel to realize its full potential, it must make a concerted effort to meet the challenge of a lack of human capital, improve access to databases, enhance sub-par computing infrastructure, and amend the regulatory environment. The Israel Innovation Authority is working to address these challenges and maintain Israel's leading position in the global race for technological leadership in AI.

Bio-Convergence

The Future of Medicine

The field of bio-convergence could potentially become one of the Israeli high-tech industry's most substantial engines of growth. The Israel Innovation Authority is working in collaboration with additional entities to expand its operations in order to create a competitive ecosystem to help advance this field in Israel.

רשות החדשנות
Israel Innovation
Authority



Bio-Convergence – The Future of Medicine

In recent years, global health and medicine have been undergoing a revolution driven by two main factors: first, the global health systems and bio-pharm industry crisis caused by a sharp increase in health expenditures and in the development costs of new medicines. The second factor relates to recent technological breakthroughs in the fields of engineering, biology and medicine. This revolution is fostering a new multidisciplinary industry that is based on the synergy between different technologies from the fields of biology and engineering known as "bio-convergence".

The Innovation Authority believes that the Israeli innovation ecosystem has substantial potential to transform the country into a world leader in this developing field. The Authority is striving to create the conditions to enable the growth and success of the bio-convergence industry in Israel.

Global Health System Crisis

Global health expenditure continues to rise dramatically and is expected to reach 10 trillion dollars by 2022. The main causes behind this phenomenon are increased life expectancy that leads to an aging population alongside increased frequency of chronic disease such as cancer, heart disease and diabetes.[1] Today, approximately 50% of the population in the US are considered chronically ill and these patients account for about 85% of the total expenditure on healthcare services.[2]

Early and efficient medical intervention and diagnosis can prevent or delay most chronic diseases. The health system has therefore undergone significant change in recent years and today pays greater attention to early, efficient intervention and preventative medicine.

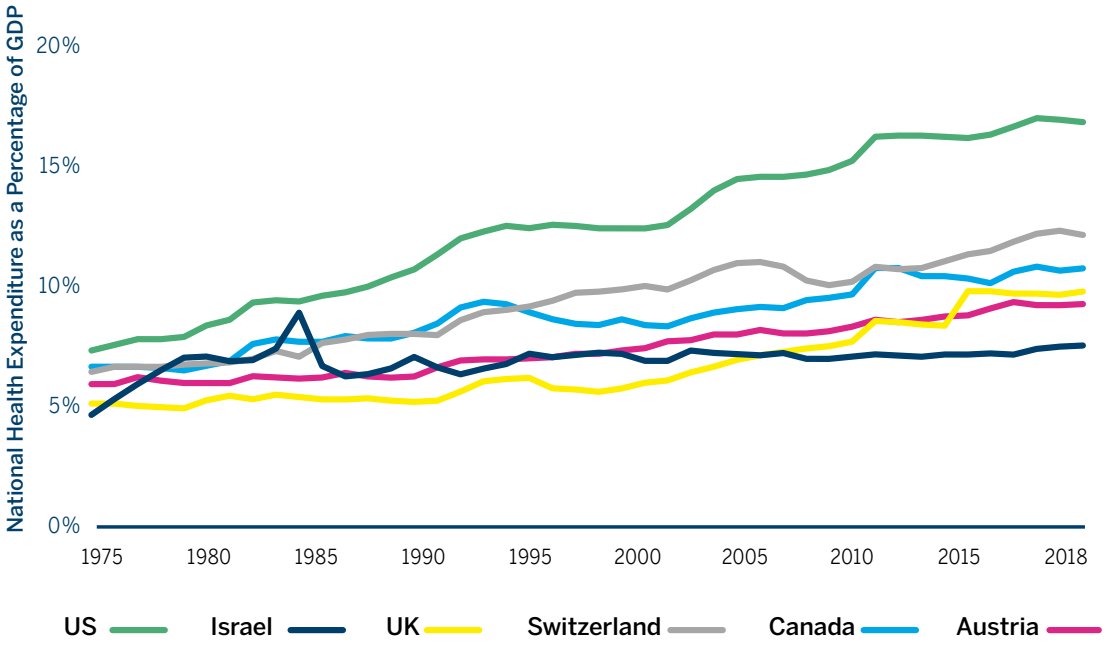
Technological breakthroughs and a combination of innovative genetic and digital technologies can assist in identifying and contending with the complexities inherent in chronic diseases. Furthermore, they help identify the "dormant" stage of these diseases to preempt outbreak of symptoms. Accordingly, health systems continue to make the transition from a model whereby success is measured by the number of patients being treated (Volume Based Model) to a model that measures success by the quality and efficiency of the treatment (Value Based Model) and that is also expressed by the ability to avoid medical treatments. This transition, necessary for both governments and service providers and by the patients themselves, is driving the need for technological innovation that can meet the new challenges and needs of the health system.

Western governments invest huge sums to improve and enhance health systems that burden public expenditure. A global comparison of national health expenditure as a percentage of GDP between 1975-2018 is presented in Fig. 6.1 below. The comparison between Israel, USA, UK, Canada, Switzerland and Austria reveals that health expenditure as a percentage of GDP in these countries has almost doubled, and in some cases, increased even more.

1 https://www2.deloitte.com/content/dam/Deloitte/global/Images/infographics/lifesciences-healthcare/gx-lshc-hc-outlook-2019-infographic.pdf

2 Joseph C. Kvedar, "Digital Medicine's March on Chronic Disease" , Nature Biotechnol 2016

Figure 6.1: National Health Expenditure as a Percentage of GDP – 1975-2018



Source:
OECD STAT

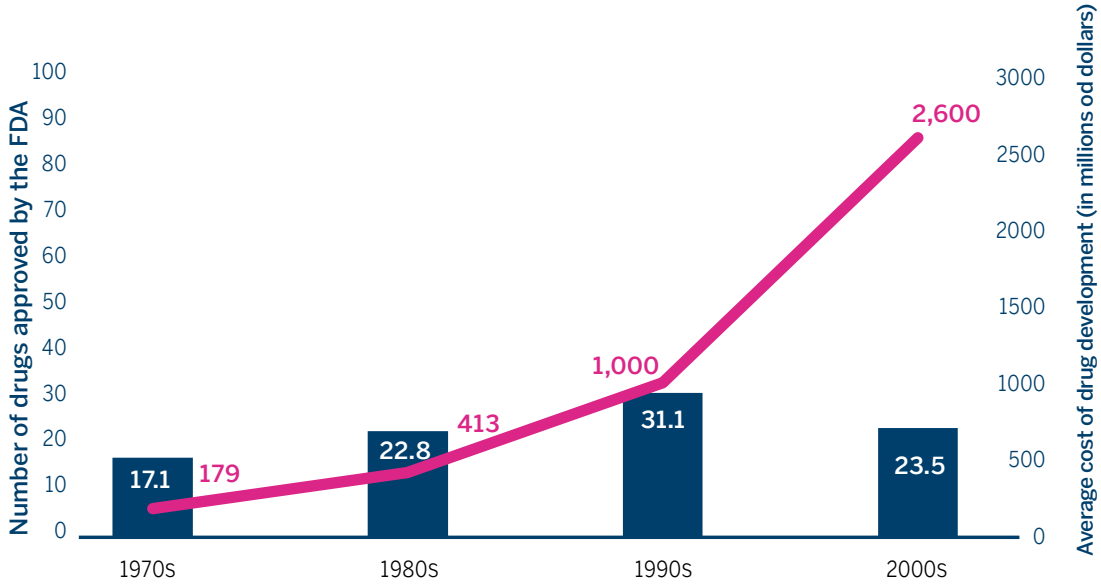
The Bio-Pharm Industry

The pharmaceutical industry is currently facing a major challenge. Costs of developing a new drug have increased markedly in recent years and the return on investment of drug development has nosedived accordingly. Fig. 6.2 shows how in 1970 the cost of developing a new drug stood at an average of 179 million dollars, a cost that almost doubled every decade. This reflects a 15-fold increase as by the beginning of the 21st century, the average cost of developing a new drug had reached approximately 2.6 billion dollars. The diagram also shows that despite the rising costs, there was no significant growth in the number of drugs authorized, which generally remained constant at a few dozen each year.

As a result, the return on the development cost of a new drug has declined dramatically. According to a Deloitte report that examined 12 large public corporations, the return on development cost in 2010 stood at approx. 10% while in 2018, this figure dropped to about 2%.[3]

3 Deloitte UK Measuring Return on Pharma Innovation Report, 2018

Figure 6.2: Development Cost of Drugs vis-à-vis Their Authorization in the US



Source: An Innovation Authority adaptation of data from: Biology-inspired Micro-physiological System Approaches to Solve the Prediction Dilemma of Substance Testing

These challenges obligate health systems and the bio-pharm industry to undergo drastic changes, to identify and develop precise, personalized and effective medical solutions. The attempt to contend with these challenges has given rise to a new multidisciplinary industry known as bio-convergence that is based on connecting various technologies from the fields of biology and engineering. This industry is expected to form the future base of medicine and to reshape the global health industry.[4]

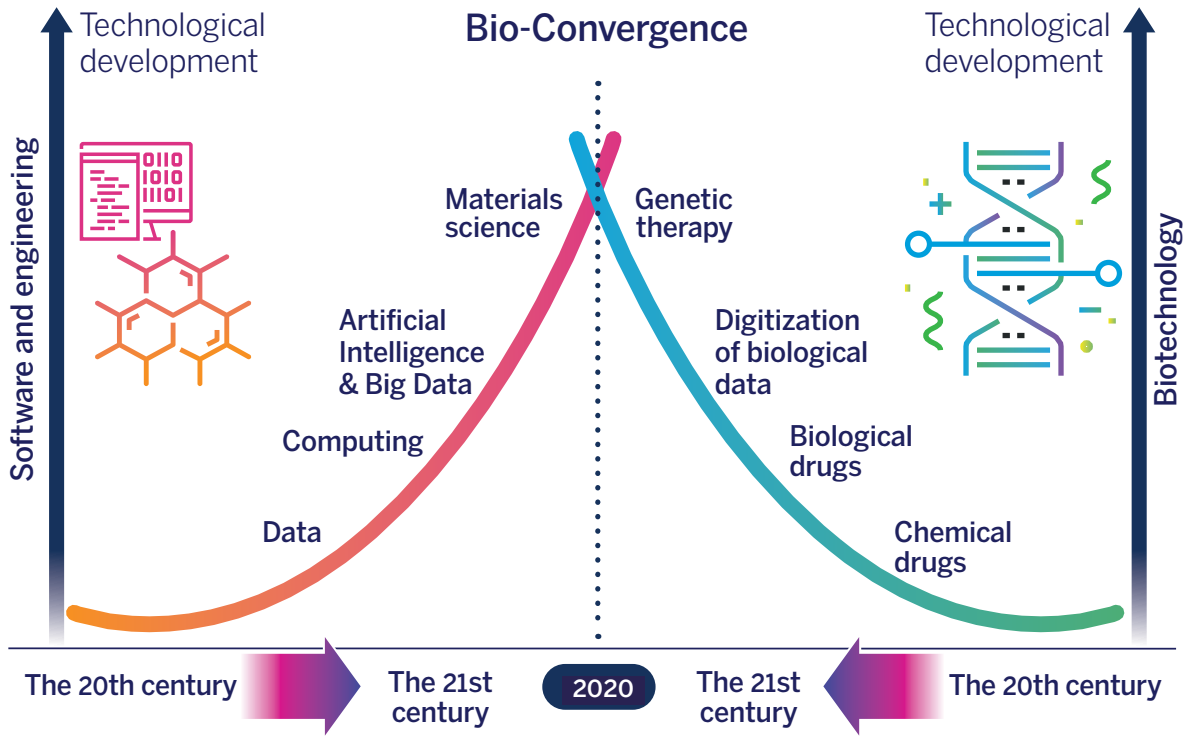
The Bio-Convergence Revolution

Technological breakthroughs achieved in recent years enable to connect and combine fields in a way that was previously impossible. The genomic revolution, the dramatic decline in the cost and increased speed of DNA sequencing alongside Artificial Intelligence and Big Data are today leading to the development of advanced diagnostic technologies that are based on protein-level, genomic and clinical data.

Fig. 6.3 presents the multidisciplinary technological breakthroughs that have occurred over recent decades in the fields of engineering and software alongside those in biotechnology. The combination of these fields creates bio-convergence.

4 Convergence-The-Future-of-Health-2016-Report, Cambridge, Massachusetts 2016

Figure 6.3: Technological Breakthroughs in Biotechnology and Engineering Paving the Way for Bio-Convergence



Source: Innovation Authority

Two of the other fields developing alongside biotechnology are that of gene therapy, which is at the cutting edge of personalized healthcare, and synthetic biology that is based on the genetic engineering of biological systems for medical purposes. These fields are based on a combination of innovative technologies such as DNA sequencing, creation and writing of new genes, among others by using CRISPR technology,[5] behavioral modeling of specific genes, and precise measurement of gene behavior.

Apart from engineering, the Innovation Authority is witness to other multidisciplinary combinations that are based on engineering technological breakthroughs. These technologies include for example, miniaturization of electronic components combined with tissues and engineered "living" materials, smart biosensors, communications, and 3D printing of tissues. All these constitute the foundation of the technological innovation engine termed bio-convergence.

The 2018-2019 Innovation Report[6] included a chapter on personalized healthcare and its potential. The bio-convergence revolution is the next stage of this trend and enables personalized healthcare, not only on the patient level but also on the molecular level so that treatments will be adapted to the disease type down to the level of the individual cell.

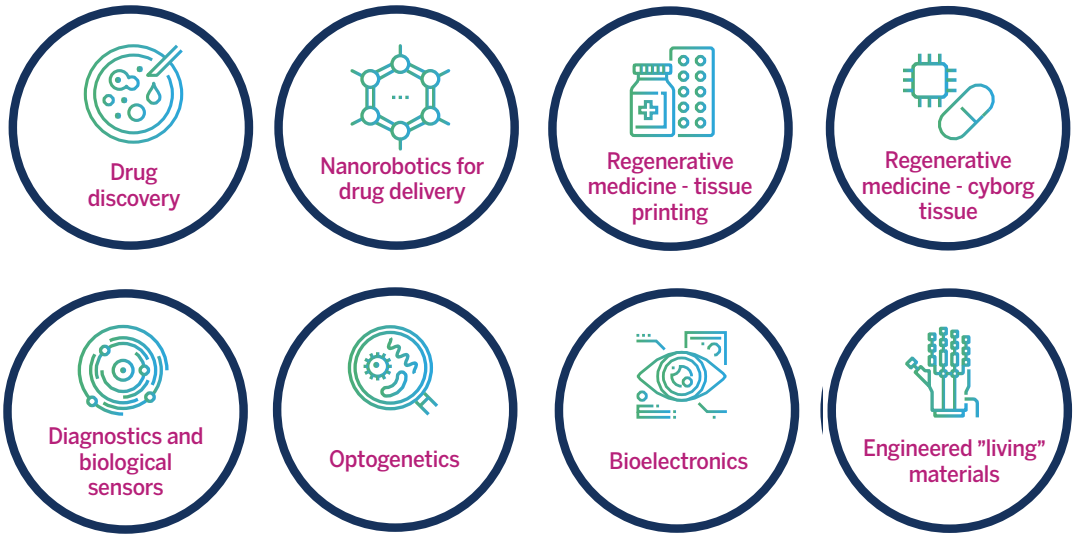
5 CRISPR technology enables to cut out a section of damaged DNA and replace it with a sound section

6 https://innovationisrael.org.il/InnovationRapport18

For example, an individual personalized treatment will be based not only on diagnostic tests but also on a combination of miniature biological sensors that continuously monitor viruses, bacteria and cancerous cells etc. The results of these tests will allow early detection of disease and administration of preventative treatment. Furthermore, smart nano-robots will allow precise delivery of treatment to damaged cells without harming heathy cells.[7]

Figure 6.4 presents examples of multidisciplinary technologies in the bio-convergence field:

Figure 6.4: Examples of Multidisciplinary Bio-Convergence



- **Nanorobotics for drug delivery:** One of the main challenges in the pharmaceuticals field today is the need for more efficient and precise delivery of drugs to the diseased area and specific cells. Nano-robots engineered from biological systems (such as DNA, cells or bacteria) for drug delivery to target cells are delivery systems that can store in them other drugs and materials, react to the external surroundings to identify the signal for unloading the drug, and release it in a controlled manner and at the appropriate time and location.

- **Therapeutics Discovery:** The need for innovative research models that will enable precise forecasting of disease development among patients has become necessary in order to improve treatment precision and efficiency. Furthermore, innovative engineering solutions enable to streamline, accelerate and even lower the costs of development of new drugs and to assist the quick and precise furthering of personalized healthcare. For example, the "organ-on-a-chip" technology enables to grow human tissue with the function of a specific organ (kidney – filter, heart – pump etc.) in a separate environment (a plastic chip for example). A new drug can be tested on this organ, thereby accelerating and lowering the costs of testing new drugs.
  These innovative micro-physiological systems that combine profound knowledge of biology, biopharma and advanced engineering technologies enable the testing of new drugs. From their preliminary stages, the tests are adapted to human tissue to better simulate the progress of the disease's development in humans. This process markedly improves the ability to identify efficient drugs and to significantly reduce the use of lab animals, an ability that is important as most drugs that successfully pass the animal testing stage fail when tested on humans.[8,9]

7 Torreya: The Future of the Global Pharmaceutical Industry, 2017

8 "Why most animal models are bound to fail", Pandora Pound and Merel Ritskes-Hoitinga

9 https://wyss.harvard.edu/technology/human-organs-on-chips/

- **Regenerative Medicine:** In the bio-convergence era, innovative tissue engineering technologies will change the treatment of damaged organs. This field will be based on innovative 3D Tissues Bio Printing technologies that allow to "build" new organs at individual cell resolution using new nanomaterials. This field also combines the production of "smart" hybrid implants, made of biological materials and electronic components (cyborg tissue) that integrate into the tissues. These technologies will, in the not so distant future, enable us to replace damaged organs and tissues with new tissues that possess enhanced qualities. This is yet another field in which Israel is a center of cutting-edge research and a base for pioneering companies.

- **Biological Sensors and Diagnostics:** One of the major healthcare challenges of the 21st century is to reduce the use of antibiotics in order to limit the evolution of bacteria that are resistant to antibiotics. This requires improved capability to distinguish between a bacterial and a viral infection. Biological sensing is a new and developing technology that combines biotechnology and nanotechnology. The biological sensing uses biological molecules such as antibodies, enzymes and nucleic acids, and bacteria to discover and identify specific materials. The biosensors are genetically engineered biological molecules which constitute a fusion between a sensor and the reporting system. This technology enables the creation of identifying components for almost any material and its advanced development towards faster and more sensitive, specific, and efficient sensors.

- **Optogenetics:** An innovative technology that combines genetic engineering and technologies from the world of physics such as high-speed and precise pulses of light and the use of optic fibers. Optogenetics aims to precisely activate specific neurons in the brain using light.

- **Engineered "Living" Materials:** Engineered materials made up of living cells that create or comprise the material itself or regulate its functional performance. For example, it is possible to create "living" materials (for medical devices and other needs) that possess the characteristics of biological systems: replication, self-healing and regulation, response to the surroundings and self-sustainability.

- **Bioelectronics:** A field of multidisciplinary research that combines elements of chemistry, biology, physics, nanotechnology and materials science. This field leverages new technological capabilities that allow to combine biomolecules with electronics in order to develop a wide range of functional devices.

Global Development of Bio-Convergence

Multidisciplinary academic research combining engineering with biology has existed for many years, both in Israel and around the world. Recent years have witnessed an acceleration in this field reflected by the establishment of research institutions and new models in various centers worldwide. Some American examples of this phenomenon are the WYSS Institute at Harvard University,[10] the KOCH Institute at MIT,[11] the BIO-X[12] and Bio-Design programs initiated at Stanford University,[13] and the Weill Neurohub Institutein San Francisco.[14] These institutes combine biology researchers from different fields and scholars from the fields of mathematics, physics, computer science, and engineering with the aim of accelerating the development of innovative treatments.

10 https://wyss.harvard.edu

11 https://ki.mit.edu

12 https://biox.stanford.edu

13 http://biodesign.stanford.edu

14 https://www.ucsf.edu/news/2019/11/415906/weill-neurohub-will-unite-ucsf-uc-berkeley-u-washington-find-new-treatments

Other countries outside the US are also investing significant resources to advance multidisciplinary research in this field. For example, institutes such as KIST,[15] and KAIST[16] in South Korea, that combine brain science, materials, and life sciences with institutes in the fields of nanorobotics, nanoelectronics, and diagnostics. The British CRUK Institute for cancer research is another example of a recently established multidisciplinary academic model.[17]

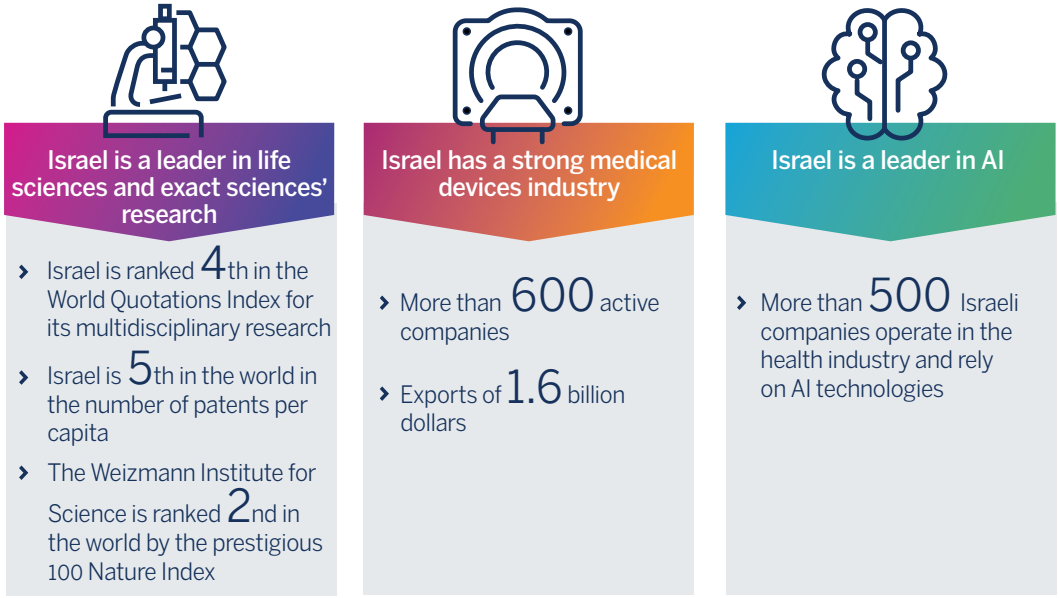
Bio-convergence is still in its industrial infancy however the large pharmaceutical companies have recently identified its potential. These companies are starting to search for innovative solutions that combine engineering and biopharma by establishing collaborations with different technology companies. For example, in 2016, the giant British pharmaceutical company GSK and the Google subsidiary Verily invested 715 million dollars in the foundation of a joint initiative in the field of bioelectronics aimed at developing treatment for chronic diseases.[18] This joint initiative, called Galvani Bioelectronics, focuses on development and commercial application of medical treatments that are based on electric nerve stimulus.

The Setpoint Medical corporation[19] is another pioneer in the use of bioelectronics to treat neurological diseases and is based on a combination of immunology, brain science, and electronic engineering. Several companies are leading the field of synthetic biology in the US, including Zymergen and Ginkgo Bioworks.[20]

Israeli Leadership in the Field of Bio-Convergence

Bio-convergence requires a multidisciplinary knowledge base that combines research and development capabilities alongside leadership in the fields of engineering, life sciences, and medical devices. An Innovation Authority examination revealed that the Israeli innovation ecosystem is well placed to assume a leading role in this field. Figure 6.5 presents the main strengths of the Israeli innovation ecosystem, which places Israel in an excellent starting position to become a world leader in this field.

Figure 6.5: Strengths of Israeli Innovation Ecosystem in Bio-Convergence



15 https://bsi.kist.re.kr/our-research/biomicrosystems/

16 https://kis.kaist.ac.kr/

17 https://www.icr.ac.uk/our-research/centres-and-collaborations/strategic-collaborations/convergence-science-centre

18 https://www.fiercebiotech.com/medical-devices/gsk-and-google-s-verily-create-715m-joint-venture-bioelectronics

19 https://setpointmedical.com/

20 https://cen.acs.org/articles/94/i45/Ginkgo-Bioworks-Zymergen-scale-synthetic.html

- **Israel is a leading center of research in the field of life sciences** and exact sciences and is ranked fourth in a global index measuring the average number of quotations per articles published in multidisciplinary research.[21] Israel is ranked in the top five countries for the number of patents per capita,[22] and the Weizmann Institute of Science was ranked second in the world in the prestigious '100 Nature Index'.[23] Israel is also home to world-leading clinical research centers.[24]

- **Israel has a strong medical device industry** that includes more than 600 companies,[25] exports of approximately 1.6 billion dollars,[26] and R&D centers of the world's leading medical devices companies (Medtronic, General Electric, Philips and others).

- **Israel is a leader in the field of Artificial Intelligence** (see Chapter 5 in this report), including a flourishing digital health industry of more than 500 companies, most of which are based on Artificial Intelligence.

The combination of these strengths together with proven multidisciplinary development capabilities and research makes the Israeli innovation ecosystem one of the most attractive in the world for building an innovative bio-convergence industry. There are already Israeli researchers and companies with unique cutting-edge technologies in this field. The Innovation Authority can currently identify approximately 80 innovative companies operating in the field of bio-convergence.

Examples of companies that rely on technologies in the field of bio-convergence:

- **Nanorobotics for Drug Delivery:** Nano-Ghost[27] is a nanometric drug delivery system developed by Prof. Marcelle Machluf from the Technion. The system is capable of homing in on cancerous tumors and precisely delivering the treatment to the cancerous cells without harming the surrounding healthy cells.

- **Therapeutics Discovery:** One of the companies active in this field is Anima Biotech[28] that developed a unique multidisciplinary platform for discovering new therapies combining advanced optics, Artificial Intelligence and molecular biology. There are also a range of Israeli developments in the "organ-on-a-chip" field. One such company is Tissue Dynamics, which developed a unique microfluid platform that imitates the proper physiology of human tissue such as liver, brain and engineered human tissue that enables to study the mechanism of a new therapy and identify its level of toxicity.

- **Regenerative Medicine:** The Precise-Bio company[29] has developed a revolutionary technology in the field of tissue printing and engineering that enables printing at the resolution of an individual cell. The company is regarded one of the leaders in this field and is the first in the world to implant a printed cornea in a para-clinical trial and to demonstrate complete functionality of the engineered organ. The company is made up of multidisciplinary teams of engineers and biologists from different fields such as cell biology, materials science, physics, chemistry and 3D printing.

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21 https://www.scimagojr.com/countryrank.php?order=cd&ord=desc&min=600&min_type=it&area=1000

22 https://www.luzzatto.co.il/images/publications/israel-national-technological-innovation-report-2016-hebrew.pdf

23 http://www.weizmann.ac.il/WeizmannCompass/sections/briefs/weizmann-ranked-2-globally

24 https://en.globes.co.il/en/article-newsweek-ranks-israeli-hospital-in-worlds-top-ten-1001278994

25 IATI Report, 2019

26 Export Institute Data, 2018

27 https://drugcelltherapy.net.technion.ac.il/home/stoxosomes/

28 https://www.lionways.com/portfolio/anima

29 https://www.precise-bio.com

- **Diagnostics:** The MeMed corporation[30] has developed a unique platform that is capable of precise distinctions between bacterial and viral infections. The technology combines a smart algorithm, machine learning, systems engineering and molecular biology to decipher the reaction of the immune system. MeMed's development is based on complex technological capabilities and includes multidisciplinary teams of software, systems and data-science engineers alongside experts from the fields of molecular biology and biochemistry.

Transforming Israel into a World Bio-Convergence Leader in the Next Decade

The Innovation Authority identifies bio-convergence as possessing the potential to become one of the next significant growth engines of Israeli high-tech. This industry can advance the establishment of companies that will contribute significantly to the Israeli economy and to high productivity employment. It can also become an innovation engine to create economic growth and shape the healthcare of the future, both in Israel and around the world.

Israel has an opportunity to become a leading player in the bio-convergence industry thanks to its strong technological base and other vital fundamentals including strengths in physics, engineering, data science, leading research in life sciences and the ability to integrate all these fields.

Global pharma companies come to Israel primarily because of digital technologies and are starting to consider basing their bio-convergence development here. R&D centers specializing in multidisciplinary developments in this field have yet to be established around the world, thereby giving Israel a unique opportunity to position itself as a world leader in this field and to attract new global investment and players.

Furthermore, there is a good chance that bio-convergence companies will stay and continue their development in Israel (in contrast to classic pharma companies). This is because of their close "similarity" to medical device and high-tech companies that combine several fields, and which can build a knowledge base and infrastructures that are unique to Israel.

Alongside the high potential of this field, the bio-convergence industry, being still at the outset of its development and characterized by high regulatory, clinical and financial risks, also faces many challenges.[31] The Innovation Authority has a broad range of collaborations with other entities including the Council for Higher Education, the Administration for the Development of Weapons and Technological Infrastructure, the Ministry of Health, The Ministry of Science and Technology, and Digital Israel. This cooperation, that creates a competitive ecosystem supporting the advancement of the bio-convergence field in Israel, will focus on the following areas:

- **Encouraging excellence in multidisciplinary research** via investment in infrastructures, grants and specially designated study programs.
- **National programs for translational research** and the creation of new mechanisms and models to improve applied research and commercialization in order to cultivate new companies in this field.
- **Special programs** to support the foundation of new multidisciplinary startup companies.
- **Development of programs for training human capital** highly proficient in research and development, and training of human capital to manage bio-convergence companies.

30 https://www.me-med.com

31 Convergence-The-Future-of-Health-2016-Report, Cambridge, Massachusetts 2016

- **Creation of Patient Funds - capital financing mechanisms** that will enable ongoing financing in this industry's typically lengthy stages of development. These mechanisms will allow companies to traverse the "valley of death" (from prototype to product) and achieve significant revenues.

- **Encouragement and promotion of global collaborations** via bilateral programs and by attracting foreign companies to invest in bio-convergence research and development in Israel.

Figure 6.6: Policy Tools to Promote Bio-Convergence

In summary, the Innovation Authority expects bio-convergence to reshape the field of medicine in the coming decade. The Authority believes that Israel's position as a leader in research and development combined with its scientific excellence and multidisciplinary capabilities, give the Israeli innovation ecosystem the potential to transform the country into a world leader in this field. Due to the long maturation periods characteristic of the bio-convergence field, the Authority considers government support to be vital in order to create the conditions that will facilitate its future growth and success.

Academic-Industrial Breakthroughs Using Disruptive Innovation

Prof. Donald Ingber – Founding Director of the Wyss Institute for Biologically Inspired Engineering, Harvard University

Academic studies in engineering and different scientific fields are the source of many technologies that changed the world as we know it – computers, information technologies, communications, biotechnology, medical devices. However, many obstacles separate academia and industry and slow the progress of technological innovation and its translation to products. The problem is not a new one – academic entities are wonderfully creative and a source of technological innovation but also tend to focus on scientific publications and teaching. In contrast, it is usually exceedingly difficult to develop innovation in large companies and organizations, much like the attempt to divert a large ship from its course. Since its foundation 11 years ago, the Wyss Institute for Biologically Inspired Engineering at Harvard University has developed a new model for applied technological innovation. This model uniquely combines academic and industrial approaches to translate scientific research into commercial products. As a result, the Institute has succeeded in overcoming the obstacles that exist in academia and connect it to the industry.

In the past, industry registered many successes by applying basic engineering principles to solving problems in other areas. The Wyss institute was founded in 2009 based on the acknowledgement that we are now in the "biological era". The Institute's approach is that we possess extensive knowledge about the way in which nature builds, controls and creates, so that we can leverage these biological principles and develop engineering innovations. This principle, called "biologically inspired engineering", is the one by which the institute operates every day.

The Institute's mission is to discover the foundations of biological processes which nature uses to construct living systems and to harness these insights to develop engineering innovations inspired by biology. These innovations will, in just a short period of time, have a dramatic influence on healthcare and on the quality of life for each and every one of us. However, in light of the insight that applied developments cannot be achieved quickly solely by founding a superb research institute, we also decided to develop a new organizational model that would ensure that the revolutionary discoveries would be exported from the lab and help bring about truly global changes.

In order to contend with this challenge, the Wyss Institute developed a new model that combines applied multidisciplinary research and innovation while deviating from traditional academic consensus by creating cross-organizational collaborations and studies. This new model included: the creation of a new organizational entity beyond the existing research institutions at Harvard University; development of a broader organization that includes academic institutes and hospitals connected to the Boston-Cambridge area ecosystem; recruitment of world-leading lecturers and researchers with entrepreneurial qualities to serve as central members of the organization; allocation of areas for collaborations between research groups in focused applied technology fields (as opposed to reliance on individual faculty members); recruitment of more than 40 scientists and engineers with industrial experience in research and development; recruitment of expert intellectual property lawyers and a business development team that includes institute entrepreneurs to lead advanced projects teams; and promotion of these commercial efforts via collaborations with clinical researchers, hospitals, corporations, venture capital funds and by founding new startup companies.

This unique approach to technological innovation and its application within academia generated more than 2800 requests for patent registrations, more than 30 new startup companies, and almost 60 licensing agreements.

Some of our breakthroughs are detailed below:

- Engineering development of a personalized trouser suit adapted for individual muscle and skeleton structure, intended for use by stroke patients with the aim of accelerating their rehabilitation and enabling them to walk properly. The first FDA authorization for sale of this technology was awarded to ReWalk Inc.

- Development of vaccination against cancer that is in initial stages of human clinical trials. This development led to the signing of a manufacturing agreement with the pharmaceutical corporation Novartis.

- Development of an "organ-on-a-chip" technology that is based on an advanced microfluid capable of replacing animal trials in the development of personalized drug therapy and healthcare. This is technology now being sold globally by Emulate Inc.

- Engineering development of a diagnostic system for hospitals that is based on a fluorescent genetic mapping system used within tissue in real-time. This development allows pathologists to identify abnormal expressions of proteins is histological samples. The system is marketed by the ReadCoor corporation.

- A device for treating septicemia that cleans the blood of infected patients, and that is marketed by Boa Biomedical Inc.

- CRISPR-based diagnostic systems currently being developed by Sherlock Biosciences.

Thanks to our model, we are continuing to create a continuous series of mature, or almost mature, innovative technologies for industrial collaborations and to transform them into products that meet market needs. The success of our application model is attracting international attention, and research institutes and many countries around the world are now seeking to develop similar models for collaborations. Many point to our unique location in the Boston-Cambridge area and to the renowned scientists and engineers who we have succeeded in recruiting, aspects which may prove difficult to replicate in other places. Despite these unique characteristics, I believe that pioneering innovation exists everywhere and that it is possible to replicate certain organizational elements of our model to achieve greater success in traversing academic-industrial boundaries.

Time will tell.

The Israel Innovation Authority in Action

The Parts that Comprise the Whole

In 2019, mission and customer oriented divisions of the Israel Innovation Authority took a variety of measures to advance the growth of the Israeli innovation ecosystem

Israel Innovation Authority in Action

The Innovation Authority endeavors to provide solutions for the various challenges facing the Israeli innovation ecosystem via 7 activity "Divisions". Each assignment- and client-directed Division offers a unique toolbox for the different challenges of the technological life cycle.

This chapter presents the Divisions' primary activities in 2019 and the way in which they translated the Authority's policy into action and individual policy tools.

Assignment - and Client-Directed Innovation Divisions

Societal Challenges

Growth

Start-Up

Technological Infrastructure

Advanced Manufacturing

International Collaboration

ISERD
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Israel-Europe R&I Directorate

Technological Infrastructure Division

The Technological Infrastructure Division focuses on R&D infrastructure, development of applied knowledge, transfer of knowledge from academia to industry, and the development of generic technologies alongside dual use R&D (civilian and defense).

The main programs of the Technological Infrastructure Division are: The MAGNET Consortiums (pre-competitive generic R&D), R&D Infrastructure Users' Association, Knowledge Direction and Transfer (KAMIN, NOFAR, Technology Transfer and MAGNETON) and Dual Use R&D (MEIMAD). The Division is also responsible for the Authority's activity in the National Infrastructure Forum for R&D (TELEM).

Main Activities in 2019:

About 300 R&D projects were examined and a total of approx. 325 million shekels was approved including:

- **10 projects of new** and ongoing MAGNET consortiums, for a total of **150 million shekels.**
- **170 knowledge direction projects**, for a total of **65 million shekels**.
- **50 knowledge transfer projects** (academic-industrial collaboration), for a total of **55 million shekels**.
- **15 R&D projects** in industrial application institutes, for a total of **7 million shekels**.
- **40 dual use R&D projects** (civilian and defense), for a total of **50 million shekels**.

Main Activities in Detail:

MAGNET Consortiums: Six new consortiums began operating as part of this program, aimed at advancing and developing groundbreaking technologies that will give Israeli industry a significant competitive advantage:

1. **The Graphene Consortium** – developing capabilities to manufacture and integrate graphene in the printed circuit board industry.
2. **The Smart Imaging Consortium** – identifying swift dynamic events in a wide field and sensor-level processing (in conjunction with the Administration for the Development of Weapons and Technological Infrastructure).
3. **Industrial Robotics** – developing robotic technologies for assembly of flexible and linear parts in small production batches.
4. **The Avatar Consortium** – technologies used in decision making of autonomous vehicles (in conjunction with the Fuel Choices and Smart Mobility Initiative at the Prime Minister's Office).
5. **The CIRCLE Consortium** – using recycled materials for plastic products.
6. **The Quantum Leap Consortium** – developing quantum sensor technologies (in conjunction with the Administration for the Development of Weapons and Technological Infrastructure).

Three additional new consortiums were also given organizational approval – Artificial Intelligence for wireless communication in 5G devices, smart planting – vegetative reproduction safety, and technologies for enhancing and improving precision of CRISPR systems.

Several changes were introduced during the year to the regulations of the MAGNET program consortiums and in its operation in order to streamline, simplify and adapt it to current industrial needs:

- Moderated guidelines relating to the inclusion of a partner that is a leading foreign corporation in its field, and that makes a marked contribution to the Israeli members of the consortium or association.

- Shortening the period of organization before setting up a new MAGNET consortium and introducing two Calls for Proposals a year.

- Including an Innovation Authority technological expert as a consultant to consortiums' new initiatives in order to improve the quality of the proposals and the chances of their approval.

- Simplification of a consortium's submission and operational procedure in a way that enables each member of the consortium direct communication (administrative and financial) with the Authority without encroaching on the members' principle of partnership.

Updates introduced during the year in **Technology Knowledge Direction and Transfer Programs (KAMIN, NOFAR, Technology Import, MAGNETON, and Application Institutes)** aimed at advancing applied R&D in academia and technology transfer from academia to industry:

The NOFAR and KAMIN programs were amalgamated in a single academic knowledge direction program and research committee. This was done to allow greater flexibility, operational efficiency, and comparability. Furthermore, the option of advance approval of a multi-year budget was made available (obviating the need for further submissions for subsequent projects), an expanded program of 36 months for drug development was designated, the option was given to add an accompanying corporation (that participates in financing and serves as a directive factor) at each stage of the project and not limited to only one year.

The objective of these changes (apart from operational efficiency) is to support effective and applied collaboration between academia and industry, ahead of commercialization of the developed knowledge.

Technology Knowledge Transfer Program (From Academia to Industry) was expanded and enables support in 3 different cases:

1. **MAGNETON** – transfer of knowledge from research institutes to industrial corporations in order to ratify knowledge developed in academia and to adapt it to meet market needs.
2. **Knowledge Import** – transfer of knowledge to an Israeli industrial corporation from a foreign research institute to bridge technological gaps for which Israeli academia has no answer.
3. **Ongoing MAGNET** – collaboration between a company from the consortium and a research institute interested in continuing generic R&D activity conducted in the consortium but which is yet to mature into product development.

12 projects were financed as part of the efforts to enhance the capabilities of the industrial application institutes, and it was decided to allow institutes to submit projects of knowledge direction while encouraging industry to collaborate with the institutes via the Advanced Manufacturing Division's MOFET program.

MEIMAD Programs: These programs aim to support dual use R&D – technologies that have a civilian commercial use alongside a defense sector use. The Technological Infrastructures Division has begun preliminary work to examine ways of improving the program and to bolster the contribution of the defense industry as one of the growth engines of the Israeli economy.

Start-Up Division

The Start-Up Division supports technological initiatives in their early stages. The Division employs a variety of unique tools in order to assist these initiatives develop the technological idea into a product, raise initial capital and progress to the next financing stage and to sales. The Division also strives to bolster the technological innovation ecosystem throughout Israel and in growing technological sectors which have potential to make a significant contribution to the economy.

The main programs of the Start-Up Division are: Tnufa (Ideation), Innovation Laboratories, the Incubators Program, Early Stage Companies, Technological Entrepreneurship in Haifa, Young Entrepreneurship Program.

Main Activities in 2019:

- **340 projects** of start-up companies' in early stages received a total of **430 million shekels.** The average grant for a start-up company was **1.3 million shekels.**
- Support was given for the establishment of **4 new incubators for promoting technological entrepreneurship in Israel's geographical periphery** – one in the food sector in Kiryat Shmona, and three others in peripheral areas in northern and southern Israel.
- **120 projects** received support as part of the Tnufa (Ideation) Program aimed at assisting new entrepreneurs.
- **5 innovation laboratories** helped 20 initiatives grow and prove feasibility. In addition, an operator for an innovation laboratory in the fields of environmental protection and sustainability was selected (the laboratory will begin operating in 2020), and preparatory processes began for selecting a franchiser to operate another laboratory in Beer Sheva for financial cyber defense.
- A franchiser was selected to promote technological entrepreneurship in Haifa in order to strengthen the city's entrepreneurial community and increase the number of high-tech companies operating there. The grant, for **25 million shekels**, will be awarded for a period of 4 years.
- As part of the Innovation Authority's Bio-Convergence Program strategy that will be implemented across all Authority Divisions, the support for Tnufa initiatives in this field was doubled. Furthermore, emphasis was placed on all the Start-Up Division programs promoting entrepreneurs and companies in these fields.

Main Activities in Detail:

During 2019, the Start-Up Division expanded its support for early-stage start-up companies. **It launched a program to encourage entrepreneurship in the periphery**– this program is aimed at promoting local entrepreneurship via specially designated laboratories that will promote and assist the establishment of R&D and commercialization start-up companies. Three entrepreneurial laboratories were selected that focus on Industry 4.0 – cleantech, agrotech, plastic and medical cannabis. The laboratories are expected to be established in Karmiel, the Bnei Shimon Regional Council and in Yeruham.

As part of the Authority's endeavors to promote innovation in areas beyond central Israel, a program to promote technological entrepreneurship in Haifa was launched in 2019. The program's goal is to increase the number of start-up companies and technological initiatives in the city. This will be achieved by: creating synergy and cooperation between principle city stakeholders (the municipality, academia, industry, business sector, and non-profit sector), bolstering the urban infrastructures and using Haifa's strategic assets, encouraging entrepreneurial independence, strengthening the Haifa entrepreneurial community and including minority populations (Arabs, ultra-Orthodox, women and Ethiopians), while branding and marketing Haifa as a center of entrepreneurship and innovation.

The goal of the Technological Innovation Laboratories Program is to create new technological ecosystems and advance early-stage high-tech companies by enabling access to technological infrastructures via multi-national corporations and cross-sector collaborations. In addition to the 5 active laboratories, competitive procedures were published in 2019 for the establishment of 2 new laboratories: one in the field of environmental protection and sustainability (in conjunction with the Ministry of Environmental Protection and the Ministry of Economy & Industry) that will be established in Haifa; and another in the field of financial cyber and fintech (in conjunction with the National Cyber Directorate and the Cyber Security and Emergency Department at the Ministry of Finance) that will be set up in Beer Sheva. The laboratories will begin operating in 2020.

The Early Stage Companies Incentive Program is intended for start-up companies interested in developing and advancing an innovative technological initiative and in penetrating the market by raising investments and capital from the private market. The Division granted a total of 300 million shekels to support 60 start-up companies this year while expanding its support for different sectors:

1. In conjunction with the Societal Challenges Division, and in order to increase the number of female entrepreneurs and their ratio in the Israeli innovation ecosystem, it was decided to award enlarged grants to female entrepreneurs.

2. The Division began collaborating with the Ministry of Agriculture and Rural Development to support agriculture technology that has a significant impact on agriculture, both in Israel and overseas. As part of the agricultural cooperation, 18 companies submitted requests for support for agricultural technologies, of which a total of 15.5 million shekels was approved and awarded to 10 companies.

3. Special guidelines were developed in conjunction with the Advanced Manufacturing Division for the support of early-stage companies from the traditional industry-technology and mixed-traditional sectors in order to provide a better response to manufacturing companies operating in these sectors.

Towards the end of the year, the Early-Stage Companies Program moved to the Growth Division in order to provide a single response for the different target audiences applying to the Authority.

Israel Innovation Authority – In Practice:
The First Company in the World to Grow Meat from Cattle Cells

As part of the Innovation Authority's endeavor to identify areas with potential that require state intervention, the Authority designated the promising field of food-tech and took action to promote it in various ways. To this end, the Authority supported the establishment of a unique incubator in this sector – 'The Kitchen' which opened in Ashdod back in 2015.

The start-up company Aleph Farms, founded in 2017 as part of the incubator, produces cultured meat based on cow cells that are similar in taste, structure and texture to traditional meat, all without physically harming a single animal. With the Innovation Authority's support, the company achieved a significant milestone that enabled it to raise 11.7 million dollars in 2019.

The company's technology is based on a process of renewal and reconstruction of cow muscle tissue. The company grows the cells extracted from the animal, isolating the cells responsible for the process and creates tissues that include fat, muscle and bone which make up the meat itself.

The company is interested in replacing the currently accepted method for manufacturing meat with a friendlier process that makes minimal use of resources. The cultured meat will preserve the meat's nutritional value but, because of the unique production method, will be defined as VEGAN.

Growth Division

The Growth Division strives to increase the economic value created in Israel from the growth of complete high-tech companies by:

- Supporting **groundbreaking high-risk innovation** as a technological growth engine in high-tech companies.
- Promoting **an attractive, competitive and advanced financing environment** and removing regulatory and financial obstacles to growth.
- Supporting **pilot programs** for innovative technologies and helping secure access to Beta sites and supportive regulation.
- Promoting **innovative regulation** in Israel and creating opportunities for the development and assimilation of technological innovation, both in high-tech and in the local economy.

The main programs of the Growth Division are: The R&D Fund, Generic R&D Program, The Pilots Program.

Main Activities in 2019:

In 2019 the Growth Division awarded a total of 580 million shekels for support of innovation, distributed as follows:

- **The R&D Fund:** 120 companies in 150 projects received total grants of 355 million shekels.
- **Generic R&D:** 21 large companies received a total of 100 million shekels via the Breakthrough R&D Incentive Program.
- **The Pilots Program:** 75 companies received 100 million shekels for conducting pilots for innovative technologies in a variety of Beta sites throughout Israel. This activity was conducted with the cooperation of 13 government entities that assisted with financing, supportive regulation and access to relevant test sites.
- **Multinational Companies' R&D Centers:** 30 million shekels were invested in the establishment of multinational companies' R&D centers in the fields of medical devices and digital health.

Main Activities in Detail:

During 2019, the Growth Division expanded its joint activity with regulators and various government entities in a number of avenues in order to promote a regulatory business environment that supports growth and innovation.

To this end, the Growth Division significantly expanded the activity in the **Incentive Program for Technologies Pilots** conducted in Israel, which began in 2018. This activity is based on collaborations with additional government entities. The expansion in 2019 was expressed in all aspects of the program and especially:

- **The Program's budget** that increased from 70 million shekels to 100 million shekels.
- **The number of companies and projects receiving support** that grew from 60 to 75.
- **The number of participating government entities** that grew from 5 to 13.

A list of the participating government entities appears in Diagram 7.1

Figure 7.1: Government Partners in the Pilots Programs

As part of the Pilots Program, the Growth Division has taken on a technological and innovation challenge issued by the Ministry of Agriculture: the streamlining of wholesale trade in fresh agricultural produce (see below for more details). Maintaining and expanding the Pilots Program constitutes a central component of the Division's 2020 work plan.

Another route towards an innovation-supportive financial-business environment was formulated together with the Israel Securities Authority that helped the Division launch a new program aimed at supporting the building of high-tech investment capabilities and expertise among Israeli institutional investors. The program aims to encourage institutional investors to become more significant players in the Israeli high-tech investment field in a way that markedly improves the diversity and scope of the financing capabilities to high-tech companies in the growth stage and that will help Israeli institutional investors build advanced investment capabilities in high-tech and the digital economy.

In 2019 the Growth Division also collaborated with several regulatory entities to identify sectors in which the business regulatory environment supporting innovation can be improved and to formulate relevant operative recommendations. Among the recommendations proposed were the removal of obstacles and encouragement of organic and non-organic growth. Advancing the recommendations and activating the Program to Encourage Investment of Institutional Investors are another central objective of the Division's 2020 work plan.

The Israeli Center for the Fourth Industrial Revolution was one of the steps implemented as part of the increased collaboration with regulators and various government entities and in order to advance technological regulation that creates and assimilates technological innovation in high-tech and in the local economy. The center, established in 2019 in conjunction with the World Economic Forum, is called C4IR (see further details below) and constitutes yet another central component of the Division's work plan for 2020.

Furthermore, as part of the organizational change at the Innovation Authority, it was decided that from 2020 the Early Stage Incentive Program will be transferred from the Start-Up Division to the Growth Division. This change was implemented to enable a seamless and uniform processing of applications and assistance to companies that start their growth at an earlier stage. The Innovation Authority believes that creating a fluid process will enhance the Authority's ability to assist companies to grow and become complete technology companies. Initiation of this program, during which grants of 300 million shekels are awarded, also constitutes one of the central elements of the Growth Division's work plan for 2020.

Establishment of the Israeli Center for the Fourth Industrial Revolution – World Economic Forum

The world is in the midst of the fourth industrial revolution – a period during which technological breakthroughs and industrial disruptive technologies are blurring geographical borders and challenging existing regulatory frameworks. Technologies such as Artificial Intelligence, Blockchain and autonomous transportation are rapidly changing our lives but also creating new risks and opportunities and raising ethical issues. Government regulation, that is required to provide a solution to these challenges, is generally struggling to keep up with the rapid pace of change.

In order to help government regulation to adapt to the rapidly changing technology, the World Economic Forum founded a network of Centers for the Fourth Industrial Revolution. This network aims to create and share knowledge, experience and best practices related to innovative technologies' regulation, via collaborations between governments, leading corporations, private sector and experts from around the world.

The C4IR network began operation in San Francisco in 2017 and operates centers in China, Japan and India. Alongside the official centers, there are other countries that joined as 'Affiliate Centers' including South Africa, Colombia, Brazil, the UAE, Norway and Saudi Arabia.

In January 2019, as part of Government Resolution No. 4481, it was decided that the State of Israel would join the C4IR network and the Israeli Center for the Fourth Industrial Revolution was therefore established in January 2019 as an Affiliate Center in the C4IR network.

Participation in the network will enable to advance the readiness of the Israeli market to new technologies, specifically innovative disruptive technologies that will significantly influence life in Israel. The Israeli center will work with local regulators to assist them in adopting flexible and innovative regulations that are suitable for technological developments and that allow for the promotion of innovation, research and improved services while preserving public interests (such as safety and privacy).

The Innovation Authority believes that creating a flexible, innovative regulation environment that is adapted to technological developments provides a significant opportunity to advance an innovation ecosystem for growing technologies. This environment is necessary for the Israeli high-tech industry to be able to maintain its leading technological position in these fields but also to enable the State of Israel to provide its citizens with the tremendous benefit promised by technological progress.

The Israeli Center is in its initial stages of examining the main fields expected to influence the future of the State of Israel. The Center is currently establishing collaborations with the Ministries of Transport, Health and Justice, and its coordinating team is developing cooperation in the fields of Artificial Intelligence, information economics, and the regulation of autonomous tools.

Israel Innovation Authority – In Practice: Establishment of Trading Rings for Fresh Agricultural Produce

The Innovation Authority and the Ministry of Agriculture are working together to advance innovation in the fields under the auspices of the Ministry. At the beginning of 2019, the two entities identified the less than optimal operation of the "wholesale market" (the wholesale segment in the trade of fresh agricultural produce) and understood that technological innovation could significantly improve this segment's efficiency.

A joint process with the Ministry of Finance resulted in the development of a technological solution model based on support for the establishment of online trading rings for fresh agricultural produce. Such trading rings, if successful, can lead to a revolution in the ways fresh agricultural produce is purchased, priced, sold and supplied by implementing optimization, automation, and mechanization processes of the logistics, trade and pricing operations.

For the Ministry of Agriculture, an advanced process such as this is aimed at shortening and expediting the supply chain, improving price transparency and streamlining the trading mechanism. As a result of this process, the payment to the farmer will increase, the final consumer price will decrease, and food waste will be reduced.

For the Innovation Authority, this process is aimed at advancing an innovative field of technology that has great commercial potential, both in Israel and, based on the local pilot trial, worldwide.

In light of these goals, a Call for Proposals was launched this year as part of the Support for Pilots Program whereby technology companies were invited to submit proposals for the establishment of an online digital trading ring for fresh agricultural produce.

Eighteen initiatives submitted proposals and after 3 months of in-depth evaluation, the Innovation Authority and the Ministry of Agriculture approved total support of 20 million shekels for 5 different projects. The support will be given incrementally (according to compliance with designated milestones) over a period of 24 months.

This process, based on a focused Call for Proposals as part of the Support for the Pilots Program, has many advantages:

- The 5 initiatives propose different and diverse solutions for the problem. The Pilots Program allows to advance with the process without choosing a "single winner" in advance, thereby enabling market forces and innovation to operate freely.
- The Pilots Program allows the five initiatives to receive assistance and support from the regulator (the Ministry of Agriculture) in a way that enables them to improve their product and shorten the time and effort needed to receive regulatory approvals and start the practical demonstration.
- The pilot's success will expose the companies to global business potential. An Israeli company capable of presenting a successful significant-scale pilot will have an advantage in penetrating international markets, this in response to the demand arising in other countries that are also seeking technological ways of improving trading processes of fresh agricultural produce.

The project to establish an online trading ring for fresh agricultural produce is an example of the Pilots Program's potential to serve as a unique new policy tool for providing a response to the institutional challenges in Israel, based on assimilating innovative technology.

The Innovation Authority is checking the possibility of using this policy tool for other institutional challenges, specifically those involving a technological solution with economic potential in Israel and abroad.

Societal Challenges Division

The Societal Challenges Division is active in two sectors: development of skilled human capital for high-tech and the promotion of technological R&D that is directed at solving public and social challenges.

The main programs in the development of human capital sector: Coding Bootcamps, Back to Tech, High-Tech Specialization, Advanced Technology Studies Workshop, Early Stage Companies – Ultra-Orthodox, Minorities and Women (in conjunction with the Start-Up Division).

The main programs in the public-social R&D sector: Gov-Tech (Mimshal-Tech), Grand Challenge Israel - GCI (Etgar) and Assistive Technology for the Disabled (Ezer-Tech.)

Main Activities in 2019:

- 7 training programs operated as part of the **Coding Bootcamps Program** with a total of **250 graduates** who were trained for the high-tech industry.
- More than **500 experts** came to Israel via the **Innovation Visas Program for Foreign Entrepreneurs**.
- **45 innovative projects** received total support of **33.5 million shekels** via **the Gov-Tech (Innovation for Public Sector Challenges) Program**.
- **12 innovative projects** received total support of **8.9 million shekels** via the **Assistive Technology for the Disabled (Ezer-Tech) Program**.
- **14 innovative projects** received total support of **7.1 million shekels** via the **The Grand Challenges Israel (Etgar) Incentive Program**.

Main Activities in Detail:

Development of skilled human capital for high-tech: As part of the Innovation Authority's endeavor to remove obstacles hindering the growth of Israeli high-tech, the Societal Challenges Division is striving to increase the supply of skilled personnel for high-tech professions. These efforts are undertaken by developing infrastructures and tools, and via cooperation with industry, private sector and other government parties.

2019 was the first year of full operation for the programs chosen during a competitive procedure for the Coding Bootcamps Program – non-academic programs aimed at training people with high proficiency such as academic science degree graduates, for development positions in high-tech. The program was structured so that the remuneration awarded to the training entities it supports depends on the graduates' successful integration into the high-tech industry in high-salary development positions. The program also incentivizes the integration of women and other under-represented populations in high-tech. During the first pilot year, 250 graduates were trained in programs supported by the Authority. Furthermore, the coding bootcamp market in Israel has expanded to more than 1,000 graduates a year.

The High-Tech Specialization Program, launched in 2019, provides a response to the challenge of the unrealized human capital potential of "juniors" finishing relevant academic studies but finding it difficult to integrate into the industry due to lack of practical experience. A survey conducted by the Innovation Authority in conjunction with SNC reveals that 40% of high-tech companies don't hire "junior" developers and engineers without experience. The program encourages companies to hire juniors by granting financial support to build specialists' programs within the company that are adapted to their needs.

The Advanced Technology Studies Workshop was also launched in 2019 to contend with the growing shortage of experts in advanced technology fields and to contribute to Israeli leadership in these fields. The program supports the creation of a joint framework for a group of high-tech companies that will provide their employees with advanced training while working in the industry. At the end of 2019, **the first Call for Proposals was published as part of this program for proposals in the field of Artificial Intelligence (AI)**. The Authority assisted the Population Authority in activating an expert visa for high-tech. This is a new visa category that was created in 2018 in cooperation with different government entities in order to enable Israeli hi-tech companies to employ foreign experts with unique knowledge. So far, more than 500 foreign experts have joined the industry via these visas.

The Back to Tech Program provides assistance to Israeli technology professionals returning to live in Israel, helping them re-integrate into the local high-tech industry by connecting them with employers as well as creating a community and knowledge platforms.

Together with the Start-Up Division,[1] the Societal Challenges Division launched a special program to extend increased support to early-stage companies led and owned by women. The program aims to increase the number of female entrepreneurs and bolster the success of their initiatives. This step received a positive response and there has already been a marked increase in the number of requests submitted by women. This program joins others granting expanded support to **projects led by Arabs and Ultra-Orthodox entrepreneurs** which this year awarded 25 million shekels to more than 10 such projects. All the programs include an intensive marketing and access program and maintain a dialogue with the ecosystem's other stakeholders.

The Division also endeavors to present data and insights on the subject of skilled human capital for high-tech, specifically via partnership with Start-up Nation Central for publishing the 2019 High-Tech **Human Capital Report**.

The Division is also cooperating with various government entities, among others via participation in the steering committee of the **SheCodes Project (for the integration of women in high-tech)** of the Department of Labor in the Ministry of Labor and in the steering committee of the **Masa-Tech Project (for the integration of people recognized as Jews according to the Law of Return) run by the Prime Minister's Office**.

Together with the Department of Labor, the National Economic Council and the Budgets Department of the Ministry of Finance, the Division holds a quarterly **employers' forum** in order to learn and receive vital input from the market regarding participants' training programs.

1 As mentioned above, as part of an organizational change at the Innovation Authority, it was decided that from 2020 the Early-Stage Companies Support Program will be transferred from the Start-Up Division to the Growth Division

Technology R&D that Provides a Response to Public and Social Challenges

The Division operates 3 main support programs in this area:

1. **The program to encourage innovation for public sector challenges - Gov-Tech (Mimshal-Tech)** that operates in conjunction with the Digital Israel Initiative in the Ministry of Social Equality.

2. **The Assistive Technology for the Disabled Incentive Program (Ezer-Tech)** that operates in conjunction with the Funds Division of the National Insurance Institute.

3. **The Grand Challenges Israel Incentive Program (Etgar)** that operates in conjunction with the Agency for International Development Cooperation in the Ministry of Foreign Affairs.

The Division launched the Tech for Impact conference for the first time this year together with the partners in each program where the support strategy for projects with public and social impact were presented together with the program details and success stories. The conference also offered an opportunity to connect the sector's entrepreneurs, investors and government representatives (the "clients" of the public sector). A comprehensive list of projects receiving support from the impact tracks was published with the aim of encouraging continued investments.

The Division was partner to the writing of the first Social Finance Israel report that reviewed the Israeli impact industry and was launched at the OurCrowd conference. The Division also participated in the Israel Impact Summit of TechForGood and ACTO that aims to strengthen this sector in Israel and attract foreign investors.

Extensive marketing activities were undertaken throughout the year together with various partners, including **more than 12 public meetings with entrepreneurs and a series of webinars**. These activities aimed to increase the scope and quality of the initiatives applying for support and focusing the entrepreneurs on the significant challenges defined in the Calls for Proposals. As a result, there was an increase in the quality and relevance of the requests and **a 25% increase in submissions to the Gov-Tech (Mimshal-Tech) Program**. Most of these were in the sectors of health (about a third), education, local government, the Council for Higher Education, and welfare.

An **impact assessment pilot** of the Division's programs was conducted in 2019: a new criterion of social impact for evaluating the requests was added and training was provided for the submitters and evaluators.

The successful companies in the first Call for Proposals of the 2019 Grand Challenges Israel program **were presented at the international Grand Challenges conference** led by the Gates Foundation which was held in Ethiopia in October 2019. The aim of the conference was to promote innovation in the field of health and sustainable development in developing countries.[2] This program has been operating since 2014, was relaunched in 2018, and has awarded support to 27 projects so far.

2 For further details see https://gatesopenresearch.org/posters/3-1569

The Innovation Authority – In Practice: Serenus.AI

The Israeli start-up company Serenus.AI received support as part of the Gov-Tech (Mimshal-Tech) Program in order to develop innovative technology based on Artificial Intelligence that aims at improving the decision-making process prior to medical procedures.

Studies published in recent years reveal that a significant percentage of medical treatments and procedures are unnecessary and life threatening. In the US alone, an estimated 35% of operations are defined as superfluous and 30% of antibiotic prescriptions are issued unnecessarily with more than 7 million cases of hospitalization deemed medically unnecessary. This reality harms the patients' health, creates hospital overcrowding and wastes resources valuable to the health system – resources that could have been channeled to saving lives and improving the medical system. Beyond the cost of the treatments themselves, there are additional expenses some of which are imposed on the patients themselves, including the loss of workdays, financing treatment of medical complications etc.

The system, developed with the assistance of the Innovation Authority, is an innovative pioneering computerized system that uses Artificial Intelligence, and which is used as a professional tool that contributes to enhancing the decision-making process prior to medical procedures. The system is based on the latest medical guidelines, recent studies in each field, and models of machine learning that are built with the help of leading physicians in a range of specialized fields. The system aims to allow a computerized examination of each medical case vis-à-vis the latest information in the relevant field while evaluating each patient's relevant medical data and history.

Use of the tools offered by the system enables both the physician and the patient to make informed decisions about whether to perform a certain procedure, while possessing a full understanding of the risks involved on the one hand and the conservative therapeutic alternatives on the other. Similar to a smart instruction book, the Serenus.AI system serves as a valuable auxiliary tool, however the final discretion on whether to perform a medical procedure still remains in the hands of the physician. The patients' data fed into the system is anonymous and their privacy is maintained.

The company is focusing initially on indicating elective invasive operations that endanger patients' lives and impose high costs on health systems.

Advanced Manufacturing Division

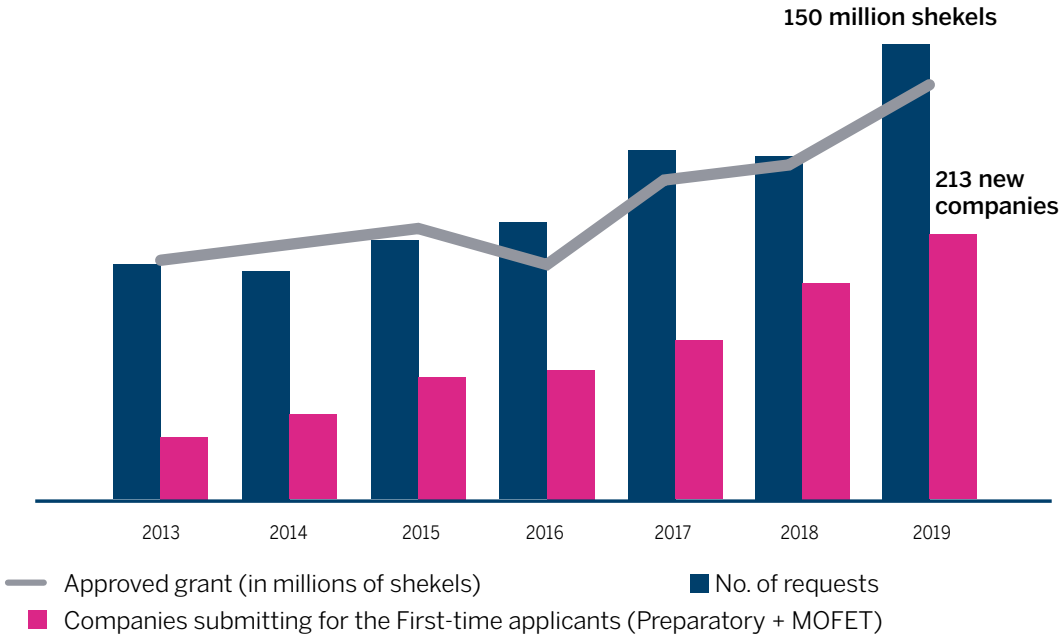
The Advanced Manufacturing Division strives to strengthen manufacturing industry and increase its competitiveness by encouraging processes of R&D and technological innovation.

The main programs of the Advanced Manufacturing Division are: the R&D Preparatory Incentive Program and MOFET (R&D in the Manufacturing Industry).

Main Activities in 2019:

- An increase of **48% in the number of requests** submitted to the MOFET Program – from 194 requests submitted by manufacturing factories in 2018 to 288 requests in 2019.
- **206 programs** received a total of **143 million shekels** in MOFET support - the average grant was **695,000 shekels**.
- **90 companies** submitted programs accompanied by a technology expert for the R&D Preparatory Incentive Program. The grants awarded in 2019 totaled **5.7 million shekels**.
- **213 requests** were submitted by new companies that had not previously made a submission (MOFET and the Preparatory Program). This figure constitutes 60% of all submissions.
- More than half the grants approved in the Division's programs were allocated to companies operating in the periphery.
- **8 Calls for Proposals** were issued for MOFET of which 2 were opened in conjunction with government ministries that generated 58 submissions to the MOFET Program.

Figure 7.2: Funding the Advanced Manufacturing Sector in 2013-2019



The R&D Preparatory Program supports the guidance of manufacturing companies in structuring their R&D foundations. In this program, a manufacturing accompany is assisted by a technology expert it chooses and who accompanies the company in building its R&D program. The program has 4 secondary tracks:

1. **Preparation for assimilating R&D processes.**

2. **Assessment of technological feasibility.**

3. **Developing solutions for flaws in the production process.**

4. **Improved production process and adoption of Industry 4.0 technologies.**

Intense fieldwork to promote the program's exposure, including conferences and professional tours to factories throughout the country led to 90 additional companies utilizing the R&D Preparatory Program in 2019. During the year, 24 companies receiving support as part of the R&D preparatory Program succeeded in composing a comprehensive and innovative R&D program that was submitted to the MOFET Program.

MOFET (R&D in the Manufacturing Industry) – a program aimed at encouraging production-oriented industrial factories to advance and assimilate technological innovation processes, including improvement and development of innovative products, existing products or production processes. Requests are submitted for implementation of R&D programs by production companies in order to improve their competitive advantage in the local and global markets using technological innovation.

206 industrial companies received support from the MOFET Program in 2019. More than half of them are companies operating in Israel's geographical periphery. Industry is encouraged to submit requests via a number of channels including presentation of the incentive programs at 60 conferences around the country, mainly in peripheral areas, together with academia, the Ministry of Economy, the Manufacturers' Association, and other entities. In addition, the Innovation Authority held a special conference on the subject of advanced manufacturing which brought together industrial companies and technology companies that offer relevant solutions in the fields of smart factories and advanced manufacturing. During this year's conference, which attracted 150 participants, many new contacts were established that furthered programs aimed at assimilating solutions for smart factories.

In addition, the Division is issuing focused Calls for Proposals for support of technological innovation in specific industrial sectors. As part of this initiative, the Division, in conjunction with the Manufacturers' Association and industrial application institutes, issued Calls for Proposals to manufacturing companies in the automotive, cosmetics, packaging, aviation, and other sectors.

The Division also cooperated with government ministries in focusing on unique Calls for Proposals: one aimed at encouraging R&D to improve the nutritional value of industrial food and enhancing food security and public health was issued together with the Ministry of Health as part of the national Program for Active and Healthy Living; and another aimed at encouraging submission of R&D and pilot programs to streamline the construction industry, improve materials and enhance safety was issued together with the Ministry of Construction and Housing.

In an attempt to encourage the establishment of Israeli factories or production lines that use advanced technology, the Division conducted a joint program (for the second year) together with the Authority for Investments and Development of the Industry at the Ministry of Economy and Industry. The aim of the program is to bridge over the "Death Valley" between R&D and small-scale production. This program is part of a broader strategic approach aimed at encouraging the development of innovative production processes among companies developing tangible products and creates a continuous sequence of government support from the R&D stage until the establishment of an industrial factory in Israel. 10 companies that were found suitable for this track, received approval and began operating to establish a production line.

The Authority is acting to create a continuous sequence of support for industrial companies, from the initiation stage until they become a manufacturing industry company. For example, 2019 saw the launch of the **Early-Stage Industrial Companies** Program together with the Start-Up Division that aims to assist start-up companies developing a tangible product in the traditional or mixed-traditional industries. This support included incentives and unique budgetary grants awarded to innovative start-ups planning to establish a production line in Israel. We also strengthened the Division's support for **pilot programs in the fields of food and construction** as part of the Pilots Program together with the Growth Division. Furthermore, in cooperation with the Technology Infrastructures Division, we encouraged industrial companies that are partners in the **MAGNET Program** to develop breakthrough technology in their field.

International Collaboration Division

The International Collaboration Division operates in conjunction with all the Divisions of the Innovation Authority to create a competitive advantage for Israeli companies and entities in global markets. This objective is achieved by promoting international R&D collaborations, support in adapting products to markets in developing countries, assistance in business development and in penetrating new markets.

The main programs of the International Collaboration Division are: Bi-National Funds, Bilateral Programs for Parallel Support, and programs for cooperation with multinational corporations.

Main Activities in 2019:

- **75 companies received grants as part of the Bilateral Parallel Support and Cooperation** with Multinational Corporations Programs. The average grant for these companies was **650,000 shekels** per project.
- **39 companies** received total grants of **70 million shekels** for projects as part of the **Bi-National Funds Program**.
- **12 bilateral technological collaboration agreements** were signed.
- A change was undertaken in the Division's structure and tools including the establishment of the Developing Markets Department and the Planning Unit and the expansion of the variety of supported collaborations.

Expanding of the variety of partners for binational cooperation supported by the Innovation Authority: the variety of partnerships that Israeli companies can enter into was expanded in 2019 in order to support the Authority's strategic goals and to promote a range of collaborations between Israeli high-tech and innovation focal points around the world. Israeli companies can now submit a request for supported collaboration with any type of entity, including international entities, research institutes, investment funds, private foreign companies, local authorities, hospitals and global non-profits.

New bilateral collaboration agreements that enable pilots and R&D activity: as part of the bilateral collaborations, an agreement was signed in 2019 with the Fukuoka Municipality in Japan that enables Israeli companies to conduct technological pilots in the field of smart cities in Fukuoka. This is a novel agreement. It is the first collaboration with a potential partner possessing significant capability to undertake widespread assimilation and trial of technological solutions. This collaboration focuses on pilots for companies in advanced stages of product development. Success in the pilot program will enable them faster and easier market penetration.

Furthermore, as part of the effort to help Israeli companies execute pilots (demonstration and test-runs of technologies) in the global market, a collaboration has been established between the Innovation Authority and Mayo Clinic and Jefferson University Hospital in the US. This collaboration aims to allow Israeli companies to conduct international R&D and pilot activities at the American facilities in order to increase their exposure and encourage adoption of Israeli technological solutions in the American health system.

As part of these collaborations, Israeli companies can receive up to 50% support for the project from the Innovation Authority. Research institutes provide services, infrastructures, and expertise. The collaboration with these important entities has the potential to mature into commercial agreements with the entities themselves in addition to other local companies.

As part of the work plan for 2020, the Division plans to identify opportunities for further similar agreements while placing emphasis on agreements that can advance companies in the field of bio-convergence currently at the focus of the Authority's work plan.

Organizational change in the Division's structure – establishment of a Developing Markets Department: The Global Collaboration Division's structure was changed in 2019 with the addition of a designated department for developing markets that is also responsible for the area of international development. This change was implemented in order to realize the economic potential of these markets. The role of the new department is to provide Israeli companies with access to the developing markets and it is therefore charged with increasing their familiarity with these markets and with their active players, including local companies, investors and global financial and development institutions. In addition, the department is also responsible for identifying and striving to remove the obstacles faced by Israeli companies seeking to export innovation to these markets.

Figure 7.3: Distribution of Requests for Support in R&D between the Different Departments

Name of Desk	% of Requests Received in 2019
Developing Markets	15%
North America	32%
Europe	33%
Asia Pacific	20%

Alongside financial support, the International Collaboration Division offers companies a variety of additional tools to help advance collaborations and penetrate global markets. Among the tools offered are virtual seminars, local and overseas training, delegations to promote Israeli innovation abroad, B2B (Business to Business) events and business development tools for Israeli companies. During 2019, the Authority hosted more than 20 delegations, over 1,000 business meetings and initiated delegations to new geographical areas such as Africa.

The Innovation Authority – In Practice: Artificial Intelligence for Diagnosing Tuberculosis

Thanks to Innovation Authority support via the Israel-India Fund, Zebra Medical Vision corporation has created a strategic collaboration with the largest health supplier in India, Apollo Hospitals, which has over 10 thousand beds in more than 70 hospitals. As part of this collaboration, Zebra Medical Vision operates an Artificial Intelligence tool for imaging used for swift, efficient and low-cost automatic diagnosis of tuberculosis. This tool could potentially revolutionize the diagnosis and treatment of tuberculosis for millions of people in India and around the entire developing world.

The World Health Organization (WHO) estimates that there are 3.6 million undiagnosed tuberculosis patients every year who do not receive proper treatment. While optimal treatment of tuberculosis begins in its initial stages, carriers of the disease at an early stage may arrive at a clinic showing only slight or even no symptoms, and therefore will not be diagnosed as carriers. Furthermore, the regular process for identifying the disease in its early stages succeeds in only 50% of the cases.

The Israeli corporation Zebra Medical Vision initially gained exposure in India via the Bridge to Innovation Program that was launched by the Innovation Authority in 2017. As part of this program, a meeting was held in India between Israeli companies and potential Indian partners. At the beginning of 2019, with the joint financial support of the Innovation Authority and the Indian Department of Science and Technology via the Israel India I4f Fund, the company signed on an agreement for the widescale assimilation of its diagnostic system in all health services provided by Apollo Hospitals, with an emphasis on outlying and rural areas that currently lack sufficient coverage.

This collaboration represents the largest and most widespread assimilation of Artificial Intelligence ever undertaken in India and may serve as a potential breakthrough in the diagnosis of tuberculosis, providing an important stride forward in the treatment of the disease and the millions of patients who suffer from it worldwide.

In September 2019, Zebra Medical Vision announced another new cooperation agreement, this time with Medsynaptic Pvt Ltd. an Indian PACS company that specializes in a distribution and display system of medical imaging and that develops unique IT solutions in the health services field.

ISERD – The Israel-EU R&D Directorate – Horizon 2020 Program

ISERD is responsible for implementation of Israel's partnership with the European Union in the European R&D Horizon 2020 Program – the world's largest R&D framework program. ISERD operates via the Innovation Authority and other steering committee members from the Council for Higher Education-Planning and Budgeting Committee, Ministry of Science, Ministry of Finance, and the Ministry of Foreign Affairs.

ISERD's main programs: SME Instrument for Industry, ERC for Academia and Multinational Consortiums for Industry and Academia. The European Research and Development Program is made up of programs that enable companies and researchers to submit a request for individual or consortium grants via open or specific-subject Calls for Proposals. The program also offers an array of financial tools operated via the European Investment Bank (EIB) and the European Investment Fund (EIF).

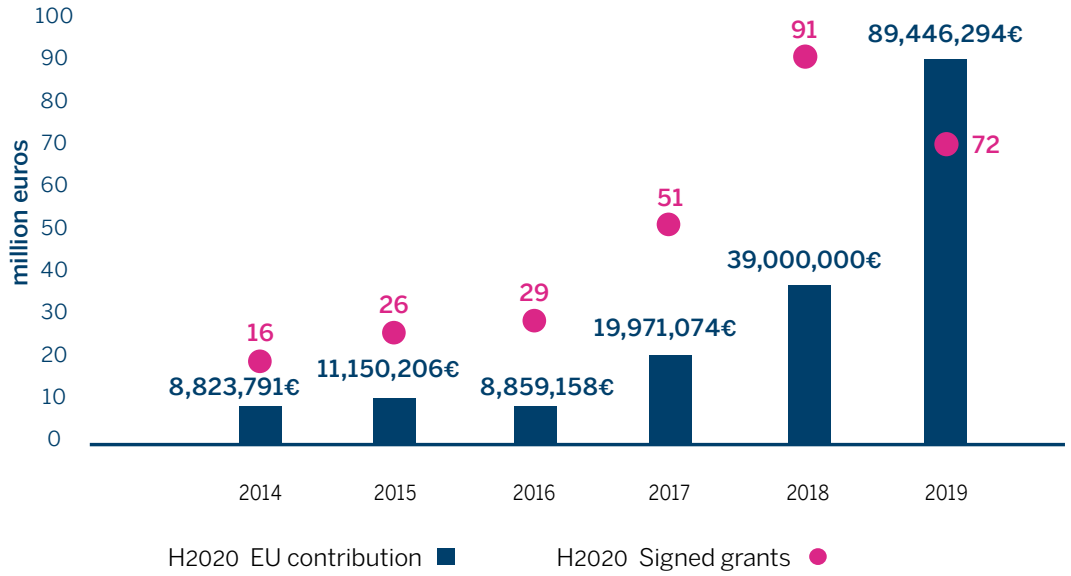
Main Activities in 2019:

- **77 outstanding Israeli companies** were awarded **72 grants** totaling **89 million Euros** during 2019.
- For the first time, in 2019 grants were also awarded as investment in companies' shares and **9 Israeli companies** received such offers.
- As part of the financial tools employed via the European Investment Bank, Israeli financial entities received an additional allocation of **483 million dollars** in 2019 for extending loans to Israeli growth companies.
- Two Israeli companies received a total of **37 million Euros** in loans directly from the European Bank.
- Two Israeli venture capital funds received investment of **35 million dollars**.

EIC Accelerator (formerly: the SME Instrument Program): this is a financing tool that supports small and medium-sized companies interested in launching an innovative product, technology or process. In order to increase the number of companies that succeed in gaining financing via this tool, ISERD began efforts in 2019 to locate potentially successful companies from among the range of companies that apply for grants from the Innovation Authority. In addition, ISERD offers an assistance mechanism for submitting the request and passing the different selection stages, including help with required costs, and consultancy in conducting preliminary "dummy interviews".

These activities were an important factor in the sharp increase in the number of companies receiving support and in the scope of grants awarded to Israeli companies via the program. As Diagram 7.4 shows, the grants awarded to companies via the program in 2019 were 2.4 times higher than the total awarded in 2018 and rose from 39 million euros to 89 million euros. A further reason for the increased scope of grants awarded is the change instigated in the program which enables a company to receive a larger grant that also includes equity investment.

Figure 7.4: Grants to Israeli Companies in the SME/EIC ACCELERATOR



ERC is another program aimed at financing breakthrough studies of outstanding scientists. The program extends support to all research fields and helps to preserve Europe's best researchers. The ERC program is a central element of Horizon 2020. In 2019, an increase of 50% was recorded in excellence grants awarded to young researchers by this program – from 22 winners and 34 million euros to 34 winners and 53 million euros.

The Consortiums Program supports multinational R&D projects (at least 3 countries) in unique fields and encourages collaborations between players from industry, academia and other entities. Between 2016-2018, there was an increase of 44% in the number of consortiums with Israeli participation – from 90 consortiums to 130 consortiums.

Diagram 7.5 presents the results of Israeli participation in the program until now (from 2014-2019*):

Figure 7.5: Israeli Participation in Horizon 2020

Submitted participations		11,426
Successful participations		1,631
Success by sector	Industry	710
	Universities	794
	Others	127
Submitted proposals		9,847
Successful proposals		1,340
Success rate		13.6%
Value of Israeli grants 971.1 M €	Industry	315.3 M €
	Universities	634.1 M €
	Others	21.7 M €

* 2019 results are not final

The Innovation Authority – In Practice: Extending Food's Shelf Life

The NanoPack consortium, led by the Technion and including 18 participants from several academic institutions and leading industrial companies in Israel and European countries is a success story. The consortium was awarded 7.7 million euros by the Horizon 2020 Program in order to develop anti-microbial packaging solutions for perishable foods based on natural nanomaterials. These materials prevent the outbreak of disease caused by food and will also reduce food waste due to rapid food spoiling.

NanoPack's packaging materials will extend the shelf life of food by 20%-25% while preserving its taste, nutritional value, color and other qualities. As a result, fresh food can be stored for longer without it changing its taste or aroma and without the need to add preservatives to the food itself. The NanoPack consortium aims to develop and operate experimental lines in operative industrial environments in order to create anti-microbial polymer layers on a commercial basis that will be accepted by both retailers and consumers.

The added value for the food industry will be enjoyed by consumers who will benefit from reduced waste and enhanced food security. The food industry will also benefit from longer shelf life that will, in turn, allow food producers to enter new, previously inaccessible global markets. In addition, food packaging manufacturers will be able to adopt new food packaging while using existing production lines, thereby allowing them to offer significant added value and higher profit margins.

Gaining support for the project as part of the Horizon 2020 Program was an important milestone in advancing the project – both thanks to the guarantee of significant funding and also, by virtue of connections established with a range of leading European industrial and retail companies. These contacts will examine the product's suitability and its integration/inclusion in the European regulation and supply chain.

Results of the High-Tech Index Indicators

Sub index of start-up companies:

1. **Net new companies:** This sub index represents the net change in the amount of Israeli companies operating in the high-tech sector; meaning, the amount of new Israeli high-tech companies after deducting the amount of Israeli high-tech companies that shut down.

2. **Amount and value of capital raised by companies:** The amount and value of financing rounds that Israeli high-tech companies raised from all investors – venture capital funds, angel investors, and other investors.

3. **Amount and value of exits:** The monetary value and amount of exits by Israeli high-tech companies after deducting exits valued at over one billion dollars. An exit is defined as both an IPO (Initial Public Offering) and an M&A (Merger and Acquisition).

4. **Capital raised:** Total funds raised per year by Israeli venture capital funds. This figure is an indicator of projected future investments by those funds in Israel.

	Actual value			Normalized value		
Indicator \ Year	2017	2018	2019	2017	2018	2019
Net new companies	452	370	365	-0.07	-0.88	-0.93
Value of capital raised by companies (in millions of dollars)	6098	7850	9075	5.64	8.64	10.73
Amount of financing rounds	1055	1147	1096	2.37	3.05	2.67
Value of exits (in billions of dollars)	7.37	4.59	10.26	0.59	-0.55	1.77
Number of exits	143	123	136	2.18	0.92	1.73
Capital raised (in millions of dollars)	2018	3346	1283	2.95	6.1	0.70

Sub index of mature companies:

1. **High-tech output:** The sum total of output in commodities sectors and the output of software and R&D sectors after deducting communications services.

2. **High-tech employees**: The number of people employed by the high-tech sector, excluding those employed by the communications services sector.

3. **High-tech exports:** Total high-tech exports in services and industry.

4. **BlueTech Index:** The Tel Aviv Global-Blue-Tech Index, which is comprised of all shares included in Technology and Biomed sectors. The data is calculated as an average of end-of-day indices for the year.

5. **Value and amount of secondary offerings:** The number and size of public funding rounds performed by Israeli high-tech companies whose securities are registered for trade (secondary offerings). These variables depict the continued growth in the value of public Israeli companies.

6. **Value and amount of high-tech acquisitions:** The value and amount of transactions, mergers and acquisitions by Israeli high-tech companies where the acquired company is not necessarily Israeli or technological.

	Actual value			Normalized value		
Indicator \ Year	2017	2018	2019	2017	2018	2019
High-tech output (in millions of shekels, current prices)	151,249	161,901	175,750	3.02	3.69	4.55
High-tech employees	277	296	319	4.21	5.59	7.24
High-tech exports (in millions of dollars)	42,229	45,203	45,765	2.63	3.17	3.27
BlueTech Index – yearly average	368.6	373.1	371.6	0.97	1.05	1.02
Number of secondary offerings	20	22	16	0.55	0.78	0.08
Value of secondary offerings (in millions of dollars)	433	483	514.5	-0.50	-0.45	-0.42
Number of high-tech acquisitions	64	54	69	0.79	-0.10	1.23
Value of high-tech acquisitions (in millions of dollars)	1029	3144	1690.671	-0.85	-0.23	-0.66