

BACKGROUND PAPER

Digital Dividends

Best Practices and Lessons Learned in ICT Sector Innovation: A Case Study of Israel

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Acknowledgments

The purpose of this report is to describe the environment for internet entrepreneurship in Israel and analyze how government policies have contributed to the development of a vibrant ecosystem that spurred a high rate of technological innovation and entrepreneurship. The objective is to draw conclusions from Israel's growth experience that can inform developing countries. This report is a companion paper to the World Bank's *World Development Report 2016* on the theme of 'Digital Dividends'.

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The report can be accessed in electronic format at

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Executive Summary and Key Findings

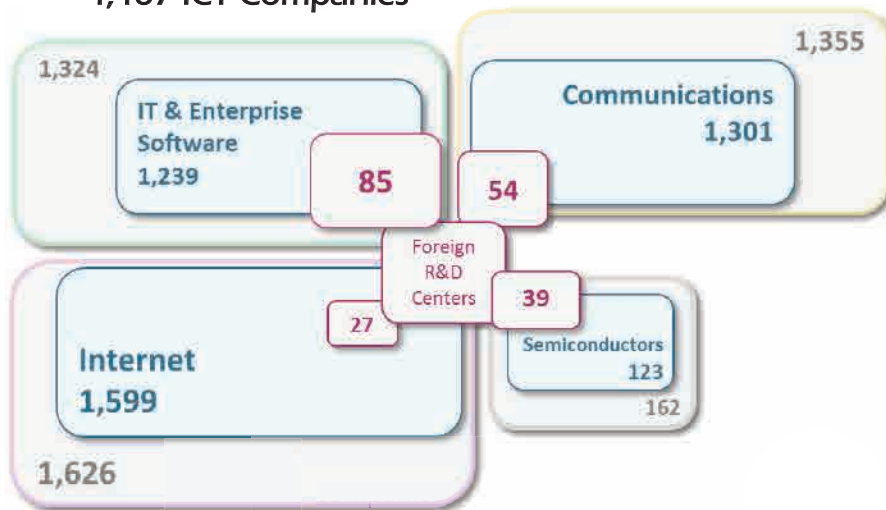
- It has been the Israeli government's explicit goal to position Israel at the core of the knowledge economy. The origins of the country's information and communication technology (ICT) sector in the early 1970s focused on information technology and enterprise software, communications and the internet. The government lay the foundations for private industry to support innovation and made heavy investments in building much-needed human capital. Skilled human resources are strategic assets in the knowledge society and the quality of human capital was essential to innovation and economic growth. The Israeli higher education system, supported by the government, contributed greatly to the success of Israel in the high-tech arena.
- The role of the government in advancing the economy of Israel illustrates how a well-thought-out and efficient government intervention can contribute to the establishment of capability in ICT. As we show in chapter 2 and throughout the report, there is broad agreement as to the significant role played by the government in the emergence and development of Israel's vibrant and dynamic high-tech sector, of which the ICT industry is an important part.
- Government policies helped to release astonishing development of Israel's ICT sector as well as the whole of its high-tech industry. Starting at the end of the 1980s and into the early 1990s, Israel took advantage of the arrival of skilled immigrants from the former Soviet Union, high educational levels, investment in defense technology and a culture of innovation to cultivate the ICT sector to a "Start-Up Nation" level. (See figure ES1 for an overview of the scope of Israel's high-tech sector.)
- The Israeli ICT ecosystem was built gradually in the Tel Aviv and Haifa areas, both close to leading academic institutions: The Technion-Israel Institute of Technology and Tel Aviv University. Companies in this ecosystem are export-oriented. It was difficult for ICT companies to grow because the distance from their customers in the United States and Europe. The solution was to move marketing and headquarters out of Israel, closer to customers. Research and development (R&D), however, stayed in Israel to take advantage of its human capital. As the ICT sector grew, multinational companies seeking innovative technology bought small Israeli start-up companies and established local R&D centers. Today there are 298 multinational companies in Israel with R&D centers, including IBM, Intel, Apple, Cisco, Motorola and Microsoft.
- Many of the companies in the ecosystem are software companies. One area that stands out is cybersecurity. About 200 Israeli companies specialize in cyber-security, accounting for US\$3 billion worth of anti-hacking exports in 2013. One-quarter of the world's venture-capital-funded cybersecurity start-ups are Israeli. The country is investing major resources in a comprehensive cybersecurity development complex, CyberSpark, in Beersheba. A leading company in the field is Check Point.

- Founded in 1993 and now Israel's biggest high-tech firm, Check Point pioneered FireWall-1 and lists all Fortune and Global 100 companies as customers for its award-winning ZoneAlarm solutions against hackers, spyware, and identity theft.
- In chapter 4 we describe in several case studies how start-ups have developed within the ICT ecosystem. One insight is that entrepreneurs had practical experience from working in a large company in the industry or from military service. They are also skilled at networking and focused on their target. They usually start their companies after identifying an unmet need in the marketplace that requires a solution. Check Point and Wix, two of the case studies, are examples of this approach.
- There are lessons for emerging markets and developing countries to be gleaned from the Israeli experience. The key to innovation is the capability to establish and cultivate a culture in which young people are not afraid to establish their own start-ups. This requires capable human capital as well as a supportive business environment. Attracting citizens or residents from abroad (for example, from Australia, Canada, Germany, and the United States) who are experienced in the particular industry and in academia could be a good starting point.
- Chapter 5 compares Israel with Singapore. It analyzes both distinctive and generic ingredients that make Israel the "Start-Up Nation." The objective was to see which of these models could be used by other countries to build their own high-tech industry. There are three key ingredients: (i) single-minded dedication to engineering; (ii) emphasis on world class education, above all excellence in math as a foundation for educating engineers; and (iii) establishment of infrastructure that will support the growth of high-tech industry.
- The closing chapter deals with lessons that emerging markets and developing countries could employ to develop their own ICT sectors. An important lesson is to adopt an entrepreneurial focus on growing an innovation ecosystem. In Israel the three major drivers behind the high-tech community are strong universities, a vibrant start-up community, and access to capital. Obvious but important lessons for entrepreneurs is that they must know their market, aim at an unmet need and must establish a cohesive team made of smart and knowledgeable people who are dedicated and focused on their target. Through hard work, the right networking and mentoring, many eventually succeed.

Snapshot of Israeli ICT 2013 ^(a)

- Major Engine of Growth

Israeli High-Tech
4,467 ICT Companies ^(b)

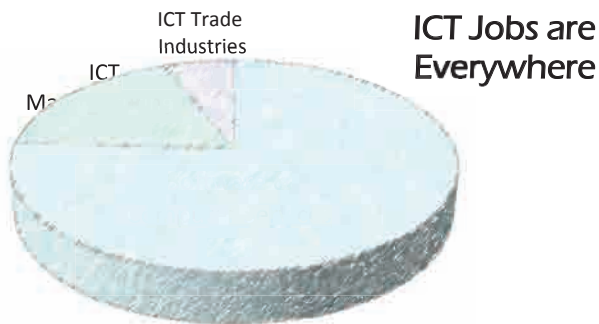


Performance 2013

GDP of ICT – 11.1%
of the Israeli total
business sector GDP
(= NIS 69.5 billion ^(c)
≈ US\$19.25 billion)

**Amount of capital
raised in 2013
by ICT companies
US\$1.6 billion**

**US\$ 4.25 billion
spent on R&D in ICT**



- ▶ Direct Jobs = 185,000 (full-time equivalent)
- ▶ Annual average earnings of ICT workers with 3-5 years of experience: US\$ 89,000-US\$ 116,000

Export in 2013

**Export of ICT
Sector – 16.4%**
of total goods and
services exports
(=NIS 56 billion ^(c) /
≈ US\$15.5 billion)

ICT Exits in 2014 ^(d)

**IT & Enterprise
Software
US\$ 1.96
billion**

**Communications
US\$ 1.42
billion**

**Internet
US\$904 million**

**Semiconductors
US\$1.4 billion**

29

17

28

23

Exits

(a) Sources: IVC & CBS;

Data are for 2013 or the most recent year available

(b) December 2014

(c) At 2011 prices

(d) Israeli High-Tech Exits include
M&As and IPOs

1 Background and Sources for the Development of the ICT Sector in Israel

A Brief History of Israel's Science, Engineering and Technology Innovation

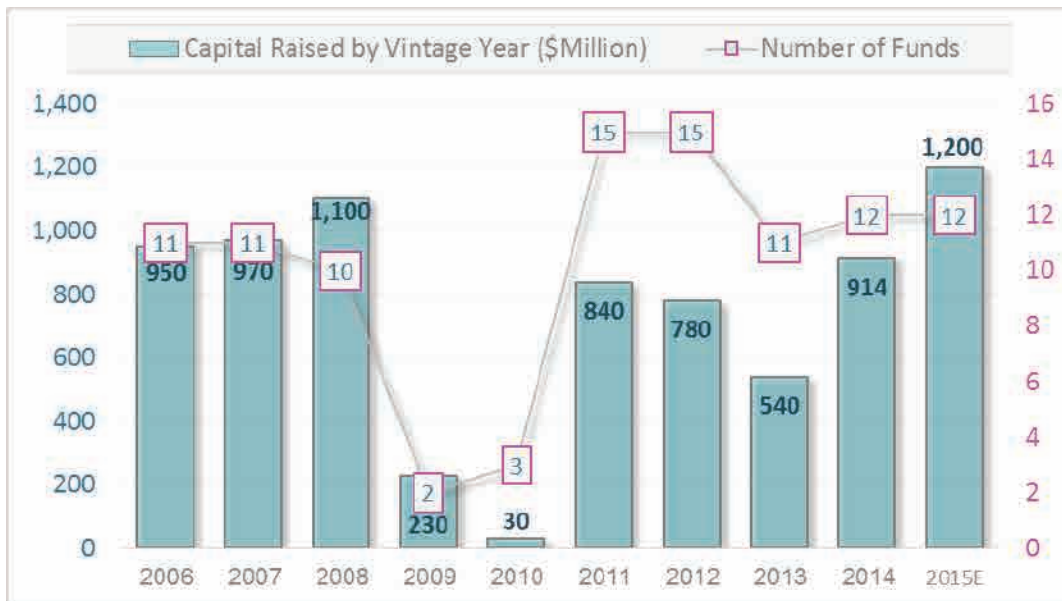
Israel's information and communications technology (ICT) advancements evolved from geo-political needs. Defense-related research and development (R&D) had significant impacts on the start of Israel's industrial sector, higher educational system in science and engineering, research community, and the composition of the ICT industry work force. The government invested large sums to develop solutions for the defense-oriented equipment and capabilities. Demand from this buildup for highly skilled workers, scientists, and engineers affected public resources allocated to universities and research institutions and, accordingly, the content these institutions emphasized as they expanded.

However, not all investment in this area stems from the defense sector. Multinational companies account today for a significant portion of the research spending in the Israeli industry. Corporations such as Intel, IBM, Google, Cisco, Motorola, Philips, Apple, and many others have brought in large sums of foreign direct investment (FDI) and set up research centers in Israel in order to take advantage of the local talent. Other companies were created after the acquisition of Israeli start-ups.

Due to government incentives and the availability of skilled human capital, Israel has turned into an attractive location for R&D operations of leading multinationals. Funding from abroad constitutes a major portion of Israel's total business enterprise R&D funding. Recent data from the Organization for Economic Co-operation and Development (OECD) and Israel's Central Bureau of Statistics (CBS) data^{1,2} show that the share of foreign multinational investment in Israel's gross expenditure on R&D (GERD) stands at 50.7 percent, as compared to no more than 25 percent in other OECD countries¹. Israeli business invests 45.3 percent of the total business sector expenditure on R&D.

The capital market's financing of innovation in Israel is instrumental in the growth of Israeli ICT and the high-tech sector as a whole. Figure 1.1 shows the funds raised by the VC industry since 2006. It is also estimated that this will have reached about US\$1,200 million in 2015.

Figure 1.1 2014 Venture Capital Funds Raised, 2006–15 (in US\$ millions)



Note: 2015 amount is estimated.

Sources: IVC, 2014. The IVC High-Tech Yearbook 2014, Tel Aviv: IVC Research Center.

IVC, 2015. The IVC High-Tech Yearbook 2015, Tel Aviv: IVC Research Center.

Economic Context

Israel's population stands at 8.309 million as of January 2015.³ The economy grew by 2.6 percent in 2014. Gross domestic product (GDP) at purchasing power parity (PPP) per capita—the value of all final goods and services produced within Israel in current PPP dollars for the years 2011, 2012, and 2013—was US\$30,193, US\$31,648, and US\$32,505 respectively (Table 1.1).

Table 1.1 GDP and GDP per Capita, Israel and Selected Countries (in US\$)

	2009	2010	2011	2012	2013
GDP (millions, current PPP US\$)					
Israel	204,849	219,275	234,391	250,197	261,858
GDP per capita (current PPP US\$)					
Israel	27,379	28,773	30,193	31,648	32,505
Switzerland	49,553	51,577	54,849	56,388	57,443
U.S.	46,930	48,307	49,732	51,435	52,985
Denmark	39,625	41,812	43,319	43,565	43,797

	2009	2010	2011	2012	2013
Italy	33,893	34,396	35,494	35,334	35,041
Spain	32,804	32,361	32,678	32,774	33,112
Greece	30,429	28,901	26,675	25,462	25,586
Korea	28,393	30,465	31,327	32,022	33,062
Portugal	26,217	26,924	26,932	27,204	27,804

Source: OECD, 2016. Level of GDP per capita and productivity. [Online] Available at: https://stats.oecd.org/Index.aspx?DataSetCode=PDB_LV

Note: GDP = gross domestic product; PPP = purchasing power parity.

The export of goods and services rose in 2014 by only 0.6 percent after a 1.5 percent increase in 2013 and a 0.9 percent increase the year before.⁴ Industrial exports excluding diamonds rose in 2014 by 2.4 percent following a decline the year before of 2.8 percent. More than 50 percent of Israel's export derives from the high-tech and life-science industries. GDP in 2013 was US\$250 billion and grew by 3.3 percent in 2014. Israel is ranked first of all OECD countries by expenditure on R&D as a percentage of GDP (4.27 percent), demonstrating innovation, development, and creativity. The OECD expenditure on R&D was 2.28 percent of GDP.⁵

Government Policies and Initiatives for the ICT Sector in Israel

The Israeli Science, Engineering, Technology and Innovation (SETI) ecosystem involves the activities of the government, research universities and institutions, medical centers, industry, and not-for-profit research organizations. There is no umbrella organization that coordinates all SETI activities and sets overall policy.

In 1969 Israel established the Office of the Chief Scientist (OCS) within the Ministry of Economy to help build its high-tech industry. The OCS is the major policy-making body outside of the university system. Under the OCS are functional frameworks for funding research and innovation such as the R&D Fund, the Technical Incubators Program⁶, and the Magnet (consortia) Program⁷. It includes operative frameworks such as the Israel-Europe R&D Directorate, which manages the Israeli side of the Seventh Framework Program for R&D (FP7), Horizon 2020, as well as the Israeli Industry Center for R&D (MATIMOP), which manages all international R&D relations including European programs (other than FP7 and Horizon 2020) and bilateral agreements with countries, regions, and international corporations.

In Israel, government policies toward the supply side (for example, connectivity, equipment production, higher education, and research) and the demand side (for example, skills development, cybersecurity, and privacy) have had a significant effect on the ICT sector.

The Council for Higher Education (CHE) is the source of statutory authority in the university-based research system, even though its authority is limited by the universities' high level of autonomy. Under the CHE are the Planning and Budgeting Committee (PBC), which makes funding decisions; and the Israel Science Foundation, an autonomous body organized as a nonprofit organization funded mostly by PBC and responsible for competitive grants for Israeli scientists.

Israel has pursued progressive liberalization in the communications and information technology subsector. Reforms have included privatization, with the sale by the government of its controlling interest in Bezeq, Israel's incumbent fixed-wire line service provider, in 2005; adoption of a regulatory regime suitable for a multi-operator environment; and competitive local exchange carrier (CLEC) licenses for infrastructure, transmission, data (broadband) and telephony services. A wireless tender carried out in 2010 led to the entry of two new infrastructure-based operators and an ongoing process for the development of a wholesale market in fixed communications. Regulatory functions are exercised by the Ministry of Communications. The Communications Law of 1982, known as Communications Law (Telecommunications and Broadcasting), 5742-1982, empowers the minister of communications to enact legislation concerning all relevant telecommunications services and equipment, including technical specifications and type approvals.⁸

On March 2, 2008, the Ministry of Justice submitted a statement on intellectual property protection in Israel to the Office of the United States Trade Representative (USTR) as part of USTR's annual Special 301 review process. In the submission the government of Israel defended its intellectual property law regime as adequate, effective, and in conformance with all relevant international obligations and requested removal of Israel from any intellectual property watch list maintained by USTR under the Special 301 process.

The government of Israel maintains that its intellectual property law regime, including acquisition, maintenance, and enforcement of intellectual property rights, is modern and effective and exceeds uniform minimum standards set forth in multilateral treaties regulating large aspects of intellectual property standards. Intellectual property law provides for monopolies limited in time and scope with respect to, inter alia, inventions, trademarks, and works of copyright, such as computer software, films, and recorded music.

Analysis of the ICT Ecosystem for Entrepreneurship in Israel

The main players in Israel's national research and innovation system, responsible for policy-making, formulation and governance, are the OCS in the Ministry of Economy, responsible for industrial R&D, and the Planning and Budgeting Committee of the Council for Higher Education, responsible for academic R&D. Since 2011, the Ministry of Finance has become more involved in policy formulation. The involvement of the Finance Ministry has helped to increase the cooperation and coordination among all entities involved in innovation policy, including the OCS and the Planning and Budgeting Committee. An additional key player is the Ministry of Science, Technology and Space, which funds numerous thematic research centers (regional R&D centers) and is also responsible for international scientific cooperation. The National Council for Research and Development works under the auspices of the Ministry of Science, Technology and Space. It is responsible for devising policy and advising the government.

Israel has a strong innovation and entrepreneurial culture. According to Frenkel and Maital (2014)⁹ and Kon et al. (2014)¹⁰, one of the key factors influencing the high innovation level of the Israeli ICT ecosystem is the unique innovation culture or social climate that involves a level of risk taking, a "no-giving up" mentality, and no fear of failure.

Case Studies of Successful ICT Start-Up Companies

Samuel Neaman Institute (SNI) has studied five successful ICT companies in order to examine their trajectory, beginning with their start-up activity, their receipt of OCS or "angel" support, and the venture capital investment that helped these companies grow and succeed in the global market.

We have used the following criteria to choose the proposed companies for profiling.

Main Sector: ICT (Israeli company, foreign R&D center)

Subsector: Information, communications, semiconductors, internet, software, IT, and enterprise software

Foreign R&D Center: Semiconductors, IT, and enterprise software

Status: Privately held or publicly traded (on NASDAQ, NYSE, TSE, AIM, etc.)

Revenue Growth: We checked to see whether the company had revenue and if that revenue has been growing over the years.

Number of Employees: 1-20, 21-50, 51-200, 200+

Year of Establishment: Before 2012

OCS Support: Received OCS support

Data for the selection process was taken from an IVC database that Samuel Neaman Institute was licensed to use.

The Following Companies Were Chosen: Check Point, Wix, Silverbyte, Ceragon Networks, and Shadow.com.

Benchmarking and the Distinctive Ingredients that Make Israel a "Start-Up Nation"

We chose to compare Israel's ICT environment with Singapore's. In 1982 Israel and Singapore had similar GDP per capita. In 2012, Singapore's was twice that of Israel and its GDP was 1.31 of Israel's. The GDP of Israel in 2012 was US\$249 billion and that of Singapore was US\$327 billion.

We chose Armenia and Poland as countries in which the ICT ecosystem ingredients could be replicated and adjusted to local contexts.

Conclusion and Lessons for the Emerging and Developing Countries

The Israeli innovation ecosystem was created only 25 years ago (around 1990). There are currently 6,521 high-tech companies and 298 foreign R&D centers in the IVC (Israel's Venture Capital) database. Of those, 4,467 are in the ICT sector. These companies and R&D centers make up the base frame of the Israeli smart ecosystem.

A mix of government incentives, policies and skilled human capital provided fertile ground for fast-paced sector growth over a relatively short period of time. Several key ingredients can be replicated in developing countries.

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Notes

¹ OECD. (2013), "Expenditure on R&D", in OECD. , OECD Factbook 2013: Economic, Environmental and Social Statistics, OECD Publishing, Paris.

DOI: <http://dx.doi.org/10.1787/factbook-2013-60-en>

² Central Bureau of Statistics (CBS), Israel. 2010. "National Expenditure on Civilian Research and Development, 1989–2013."

http://cbs.gov.il/webpub/pub/text_page_eng.html?publ=36&CYear=2013&CMonth=1
January 28, 2015.

³ CBS. "Society and Population: Population and Demography." May 2016.

http://www.cbs.gov.il/reader/cw_usr_view_SHTML?ID=629 >.

⁴ "Economy Grew by 2.6% in 2014, While per Capita Growth Rose by Just 0.7%," Haaretz, January 1, 2015, <http://www.haaretz.com/israel-news/business/.premium-1.634809>.

⁵ Zetelny, I. 2014. "The Israeli Hi-Tech Industry," EY Israel, January 2014, <https://ec.europa.eu/jrc/sites/default/files/events/20140120-tto-circle/jrc-20140120-tto-circle-zetelny.pdf>

⁶ Israeli Office of the Chief Scientist (OCS), n.d. The Technological Incubators Program. [Online] Available at: <http://www.incubators.org.il/article.aspx?id=1703>

⁷ Israeli Office of the Chief Scientist (OCS), n.d. The MAGNET Program. [Online]

Available at: <http://www.magnet.org.il/article.aspx?id=847>

⁸ "Type Approval"- is defined as approval which is given in accordance with this Law to a model of Terminal Equipment for the purpose of connecting it to the General License holder's telecommunications network, including a said approval attesting that the primary characteristics of the Terminal Equipment in respect of which the approval is given correspond to a model of Terminal Equipment in respect to which a prior Type Approval had been given.

⁹ Frenkel, A. and Maital S. (2014). Mapping National Innovation Ecosystems: Foundations for Policy Consensus. Edward Elgar Publishing.

¹⁰ Kon, F., Cukier, D., Melo, C., Hazzan, O. and Yuklea, H. (2014). A panorama of the Israeli software startup ecosystem: Technical report. <http://www.scribd.com/doc/226012989/A-Panorama-of-the-Israeli-Software-Startup-Ecosystem>

2 The Role of Government: Policies and Initiatives for the ICT Sector in Israel

Introduction

This chapter highlights the important role of the government in the emergence of Israel as a high-tech power, encouraging and supporting the capacity of the private sector to compete in international markets.

It has been the Israeli government's explicit goal to position Israel at the center of the knowledge economy. This goal has been achieved through close collaboration between government and business, with government involvement focused but limited and ready to withdraw as soon as the private sector was able to continue on its own.¹ The government's readiness to withdraw its intervention has mitigated the risks of government failures such as capture or corruption, which in other countries may have undermined the transparency of innovation support programs.

Israel's economy has seen rapid growth since the early 1990s. This is in part due to the influx of highly educated and skilled Eastern Europeans after the fall of communism in 1989 and increasing foreign investment, especially in the high-tech industry.

Significant components of government action have taken the following forms:

- a. Heavy investment in education, reinforced by large-scale immigration to provide the necessary human capital
- b. Effective investment incentives favoring foreign investors to build industrial momentum
- c. Investment in R&D as a proportion of GDP (4.4 percent in 2008 and 4.2 percent in 2013), higher than that of any other industrialized country²
- d. Incubator and venture capital programs to convert research into cutting edge businesses
- e. Heavy investment in defense technologies

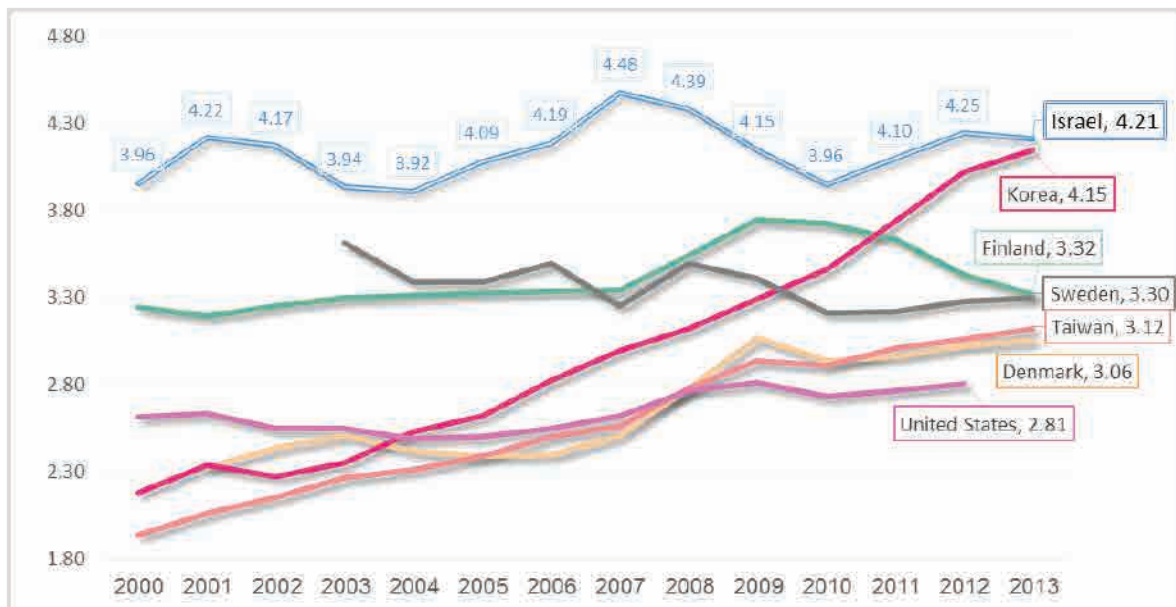
Alongside these interventions, Israel has made important strides in laying the foundation for macroeconomic stability. Inflation fell sharply from the runaway levels seen in the mid-1980s and wide-ranging reforms were put in place aimed to reduce the scale of the public sector and the role of the state in the allocation of resources and, more generally, to support the modernization of the economy.

The Role of Government in Achieving Global Competitiveness

As a general-purpose technology, ICT holds the potential of transforming economies and societies, addressing some of the most pressing issues of our time and supporting inclusive growth. Over the past 25 years, ICTs have become more powerful, more accessible, and more widespread, playing a key role in enhancing competitiveness, enabling development, and bringing progress to all levels of society.³

The Israeli government realized early on that the ICTs could become a growth engine for the economy. Consequently, through the adaption of incentive laws, supporting the creation of VC funds, and establishing the Office of the Chief Scientist (OCS) within the Ministry of Economy, it supported the building of that sector and the creation of an ICT ecosystem. As a result, Israel consistently scored the highest level of Gross Domestic Expenditure on R&D (GERD). Figure 2.1 describes GERD for Various Countries as a Percentage of GDP for the years 2000–2013. Countries such as the Republic of Korea, Finland, Israel, Estonia, Armenia, and Poland also based their national competitiveness on ICT products and services.

Figure 2.1 GERD for Various Countries as a Percentage of GDP, 2000–13



Source: OECD, "Main Science and Technology Indicators," www.oecd-ilibrary.org/science-and-technology/data/oecd-science-technology-and-r-d-statistics/main-science-and-technology-indicators_data-00182-en.

Note: GERD = gross expenditure on research and development.

The spread of ICTs also had wide-spread societal impact, especially on less privileged segments of society. For example, farmers in developing countries benefited from new ICT services such as real-time information about commodity prices and weather, sensors that inform them about soil and field conditions, and easy money transfers. The effectiveness of governments has increased as a result of their ability to provide citizen-centric online services and involve citizens in governance. ICTs have become key enablers of business, employment creation and productivity growth. For these reasons, ICTs have significant potential for supporting inclusive growth as well as increasing the competitiveness of the economy.

In 2014 Israel retained the 27th position in the *Global Competitiveness Index Report*,⁴ the same ranking it held in 2013. The country's main strengths remained in its capacity for innovation (3rd), which rests on innovative businesses that benefit from the presence of research institutions (3rd), support by the government through public procurement policies (9th), and a favorable financial environment for start-ups (availability of venture capital is assessed at 9th place).

Table 2.1 describes the network readiness and global competitiveness ranking of Israel over the past three years.

Table 2.1 Network Readiness and Global Competitiveness for Israel

a. Network Readiness Index

2015 rank (percentile out of 148)	2014 rank (percentile out of 144)	2013 rank (percentile out of 142)
21 (Top 14%)	15 (Top 10%)	15 (Top 11%)

b. Global Competitiveness Index

2014–15 rank (percentile out of 144)	2013–14 Rank (percentile out of 148)	2012–13 rank (percentile out of 144)
27 (Top 19%)	27 (Top 18%)	26 (Top 18%)

Sources: Dutta, S., Geiger, T., & Lanvin, B. (2015). The global information technology report 2015. In World Economic Forum

Bilbao-Osorio, B., Dutta, S., & Lanvin, B. (2014). The global information technology report 2014

Bilbao-Osorio, B., Dutta, S., & Lanvin, B. (2013). The global information technology report 2013

Schwab, K. (2014). The global competitiveness index, 2014–2015. In World Economic Forum

Schwab, K. (2013). The global competitiveness index, 2013–2014. In World Economic Forum

Schwab, K. (2012). The global competitiveness index, 2012–2013. In World Economic Forum

Israel's program has been particularly geared toward "sector-neutrality," meaning that the government did not "pick winners."⁵ The case of the Technical Incubators Program⁶, described later, is an illustration of such an approach, since it has provided, and still provides financing and support to ventures in the early pre-seed stage, when the funding gap could prevent many of them from moving forward from the idea phase to the project phase that is attractive to private investors or venture capitalists.

The market-friendly nature of government intervention in Israel has resulted in considerable flexibility and dynamism, permitting specific policies and instruments to evolve over the years and adapt to what were perceived as the most pressing needs of the time. An example is the array of programs put in place by the government to encourage R&D at different points along the life of a project over the years since 1990.

It was also market considerations (export to international markets) that led Israeli policy makers to concentrate on innovation and R&D. Israel lacks natural resources. Consequently, the government realized that Israeli comparative advantage resided in its qualified human capital rather than in its relatively scarce natural resources and land. The national market was too small and limited to sustain national industries and the political situation prevented selling to neighboring countries. Therefore, the target inevitably had to be the international market, requiring a focus on innovative products that could be sold to the international markets. These unfavorable structural parameters—market size and the adverse political geography, including the geopolitical environment—served as catalysts to spur the development of an industry that ultimately would not depend for its success on these two factors.

In Bloomberg's 2015 ranking of the world's 50 most innovative countries⁷ - which is an annual ranking of countries that measures performance in research and development, technical education, and patents - Israel has been ranked number five.

Israel did especially well in the R&D category, with the country ranking second in GDP expenditure on research, as well as on the percentage of the labor force with advanced degrees and the number of research professionals per million populations. Israel ranked fourth overall in both those categories.

The study measured country rankings in six areas: R&D, manufacturing, the number of high-tech companies located in each country (the total number, not adjusted for population size), the number of students enrolled in postsecondary education programs, the number of PhDs working in R&D, and the number of patents per capita.

Education

In a small country with limited natural resources, the government has long recognized the importance of investing in human capital for its development. Building on a strong cultural heritage stressing excellence in education, universities began to be established

in the 1920s. With the founding of the state of Israel in 1948, the government focused its attention and resources on the development of its educational and scientific research establishment. By the early 1970s, there were seven university-level centers of teaching and research: The Technion–Israel Institute of Technology in Haifa, the Weizmann Institute for Scientific Research in Rehovot, Hebrew University in Jerusalem, Tel Aviv University, Bar-Ilan University, Haifa University, and Ben Gurion University in Beer Sheba.

While traditional universities have not changed greatly, with about 30 percent of students receiving degrees in sciences and engineering, the growing demand for higher education from 1985 to 2015 has been met by liberalizing higher education to allow private colleges, and by recognizing degrees granted by technical schools accredited by the Ministry of Education.⁸

From 1990 to 2010, higher education in Israel was on the rise. In the 1989/90 school year, 88,800 students studied in 21 Israeli academic institutions. In 2010/11, 297,800 students (including 46,000 Open University students) studied in 66 Israeli academic institutions, an average annual growth of 5.9 percent. This increase is primarily a result of the establishment of academic colleges during the 1990s and early 21st century. The year 2010 marked an end to the rise in the number of students beginning their first degree studies. However, an increase was seen in the number of students enrolled in second degree programs. According to Israel's Central Bureau of Statistics (CBS), 60 percent of Israeli young adults continue on to first degree studies. This percentage is significantly higher than in 2000 (48 percent).⁹

This establishment of academic colleges provided the trained managers and workers needed by a rapidly expanding high-tech industry. Furthermore, attempts have been made from time to time to reprioritize various professional streams within Israel's system of higher education. For instance, in the early 1990s industry leaders saw the need to retrain many of the graduates from the top universities in electronics and computer science. Task forces were created and a major boost was given by the universities to these particular areas. There have been fairly successful attempts to shift the priorities of career work streams within the public university system to reflect the most pressing needs of industry, particularly the high-tech sector, because of its perceived growth potential and its contribution to the GDP.

► ICT in Education in Primary and Secondary Schools

The continuous and increasingly rapid development and implementation of computer and other information technologies over the past few decades is a distinct feature of modern societies. In the digital age, ICT plays a key role in creating and exchanging knowledge and information around the globe that affects citizens' everyday life in many areas—at school, in the workplace, and in the community. Knowledge about, access to, and use of ICT are vital for participating effectively in society in the information age. Acquiring and mastering ICT skills—computer and information literacy (CIL)—has become a major component of citizens' education. This is capably described in “Preparing for Life in a Digital Age,” a report by the IEA International Computer and Information Literacy Study.¹⁰

Israel adopted a strategy based upon the alignment of interests and common objectives set by government, industry, and educators on the subject of computer sciences and ICT studies. The evolution of the Israeli curriculum was first comprehensively set out in a seminal article from 1995 by Professor Judith Gal-Ezer,¹¹ with a subsequent “Model” for High School education¹² by Professors Orit Hazzan, Judith Gal-Ezer, and Lenor Blum based on their experience evolving the Israeli curriculum from ICT into computer science two decades ago.

According to the report “Computing at School International comparisons—Version 5, November 2011,” Israel undertook a major review of computing at school at the turn of the century, and now has the most rigorous computer science high school program in the world.¹³

An important component that embeds learning in schools for students and teachers is the Machshava Israeli National Computer Science Teaching Centre. Founded in 2000 by the Israeli Ministry of Education, Machshava is considered the professional home for all Israeli computer science teachers. The center activities are organized around five major themes:

1. Helping to create a professional community of computer science teachers
2. Fostering the professional leadership of computer science teachers
3. Supporting, assisting, and consulting academic computer science education groups, and computer science teacher educators and researchers
4. Collecting and distributing computer science education knowledge and experience
5. Researching and evaluating computer science teachers' needs and the center's activities

To this end, the Ministry of Education has adopted the concept of the International Association for the Evaluation of Educational Advancement's venture, the International Computer and Information Literacy Study (IEA-ICILS),¹⁴ which focuses on how to teach

students computer and information literacy. This literacy is the ability of the individual to use computers in research and to learn creativity and effective communication at school, at home, and in the community.

Immigration

Immigration has always been a central feature of the development of the state of Israel, as Jewish populations from many countries brought diverse talents and capacities, motivation and the creativity of a pioneering movement. The collapse of the Soviet Union combined with the explosion of information and communications technologies in the late 1980s also gave the Israeli ICT industry a major boost.

Between 1990 and 2009 approximately 1.25 million people immigrated to Israel, about 80 percent of whom originated in the former Soviet Union. In 2009, immigrants from the former Soviet republics accounted for 45 percent of Israel's total immigrant population.¹⁵ Many of these immigrants held advanced degrees and technical training, often bringing with them ambition, innovative approaches to problem solving, and a strong scholastic tradition. This immigration increased the population by a fifth and strengthened its general educational level.

This wave of immigrants included more than 100,000 scientists and engineers, giving Israel the highest number of engineers per capita in the world—140 per 10,000 employees, more than twice the level of the United States and Japan, the second and third ranking countries. It was a significant challenge for Israel to absorb this amount of migrants, and the government set up retraining and business development programs to facilitate the process. With the rapid expansion of the industry, skilled immigrants were quickly integrated. This expansion also attracted highly trained and experienced Israeli engineers, many of whom had previously emigrated to the United States and Europe, but who now saw the opportunity to set up research centers for their foreign employers or start-ups of their own in Israel.

► Work Permits for Israel

A foreign national who has been assigned to work in Israel must obtain a work permit and an appropriate entry visa prior to entering the country. Israeli law generally provides for only one type of work status, relating to the employment of foreign professionals and nonprofessionals alike: the B-1 visa category.

There are a few areas, such as nursing care for old people, for which foreign workers can relatively easily obtain a permit of up to 63 months. Additional fields for which it is relatively easy to obtain a work permit are agriculture and construction. The following

describes the process of getting a B-1 visa by professionals for a period longer than three months.

Specialist Work in Academic Fields over three Months

In 2005, the Ministry of Interior clarified the procedure by which foreign experts who engage in professions requiring a higher academic education (e.g. Engineers for Research and Development Teams, Auditors, Senior Executives, and other Senior Supervisors) can obtain a work permit.

The process of obtaining a work permit type B-1 involves four separate bureaucratic steps:

1. Submission of a detailed application for a Work Permit to the Ministry of Interior describing the project, the need for expertise, conditions of employment, and more. The application must comply with regulations and meet strict requirements of the Ministry of Interior.
2. Application for a B-1 work visa to the local office of the Ministry of Interior, to be cabled for processing from the Israeli consulate in the applicant's country of origin.
3. Issuance of a temporary B-1 Work visa by the Israeli consulate in the applicant's country of origin prior to entering Israel.
4. Following the applicant's entry into Israel, he or she will be issued a B-1 work visa for the entire period of the work permit. This step takes place at border control at Ben Gurion Airport, or after entry at the relevant office of the Ministry of Interior.

The prevailing wage for an expert is double the average wage in Israel.

Work permits of this kind are typically valid for a period of up to one year from the date of approval of the application. The employer may apply for an extension of the permit for a further period. In general, the maximum stay and work in Israel is up to five years and three months after beginning work in Israel.

A work permit of this type is valid for a single entry only, and therefore the employer should see to the issuance of a work permit that is valid for multiple entries that will allow the expert to enter and depart Israel during the period of the work visa, without having to re-process the visa at the consulate. The duration of the process is 2-3 months.

Working in Israel for any period of time without a permit and B-1 visa in the foreign expert's passport is a criminal offense. The employer and managers will face criminal penalties and fines, and the expert will be deported, without the ability to return for a period of 10 years.

Investment Incentives and Capital Market Reforms

One significant area of government intervention has been in the policies encouraging domestic and foreign capital investment in Israel. The investment incentive package had its origins in the Law for the Encouragement of Capital Investment (LECI), adopted in 1959 to attract private investment—especially in the remote and less developed areas of the country—and to foster business initiatives, employment, and exports.

The law, revised on a number of occasions to take into account new technological and economic developments, did not explicitly favor the high-tech or any specific industrial sector, but rather encouraged ventures with high value-added and marketing capabilities in local and international markets. The importance given to both new and existing projects varied according to the specific geographical zone; the contribution to exports had to be more substantial for the central areas, zones C and B, than for the peripheral zone A, for which the contribution to local employment was valued more. Enterprises, both Israeli and foreign-owned, that were deemed eligible by the Israeli Investment Centre—a department of the Ministry of Economy that is in charge of the law's administration—gained the status of Approved Enterprises or Beneficiary Enterprises. They were thus in a position to benefit from government grants—up to 24 percent of tangible fixed assets—and/or tax benefits in various forms, depending on the geographical location and the percentage of foreign ownership.

Beyond the stated goal of LECI to promote private initiative and internationally competitive products, the market-friendly character of the law can be seen in its attempt to provide institutional underpinnings to the initiatives of private investors, and to share with them the higher risk associated with the development or expansion of a venture, addressing in this way the market failures inherent in the preliminary stages of investment.

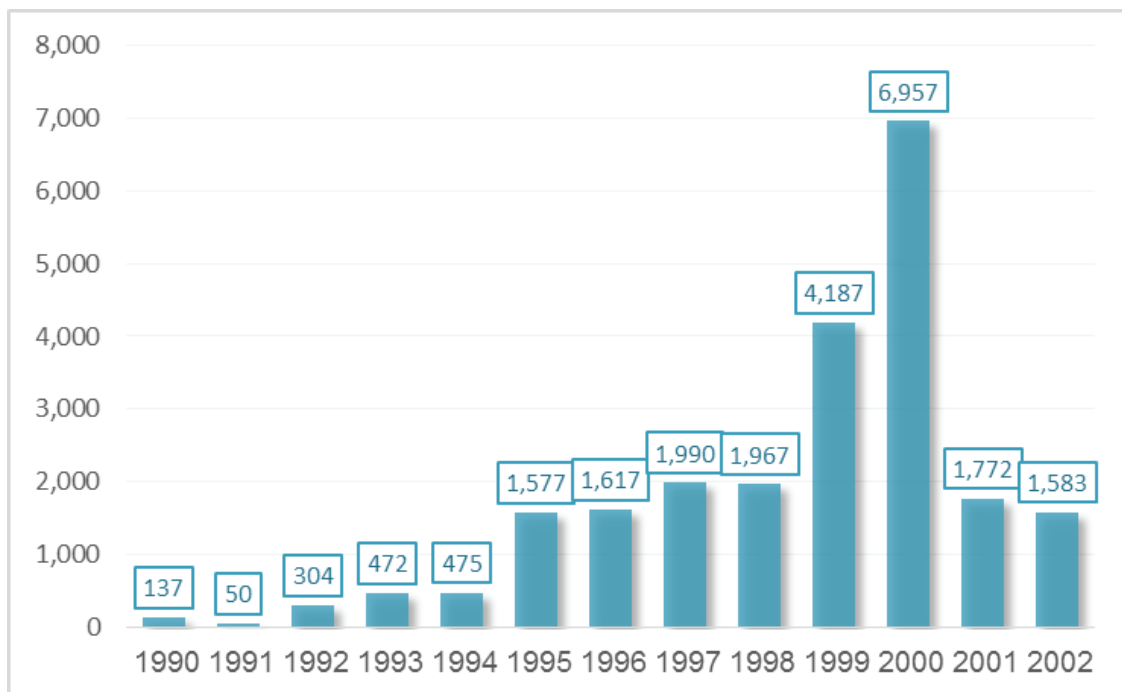
LECI deliberately introduced a bias in favor of foreign investors, which took the form of preferential tax treatment with respect to national investors. It was thought that a favorable tax regime and the relative abundance of well-trained engineers and scientists would strengthen the attractiveness of Israel as a location for multinationals. The policy was based on a specific rationale: Multinationals would not only create employment in Israel, but they would also bring with them the technology, know-how, operating procedures, managerial skills, and exporting channels that the nascent Israeli industry needed. In other words, the idea was to leverage the spillovers deriving from the operations of the multinationals in Israel for the development of the local high tech industry.

Foreign Direct Investment (FDI)

The government's strategy worked well: international investors flocked to Israel during the 1960s and 1970s, including high-tech giants such as IBM, Motorola, and Intel, and were followed by many others.

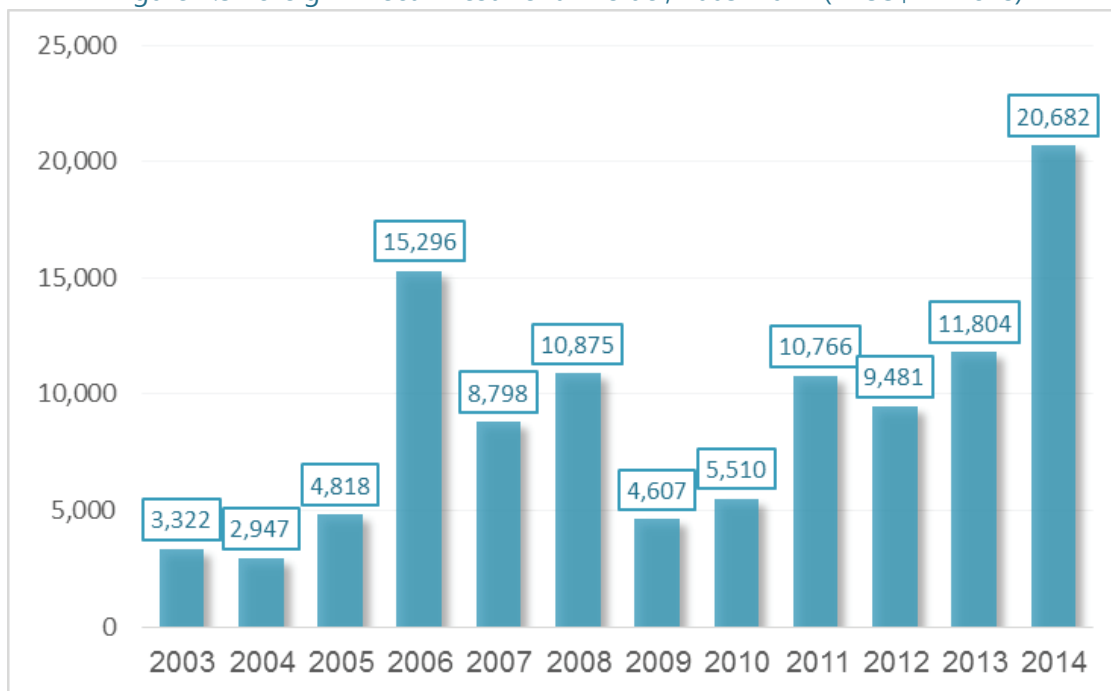
Figure 2.2 shows the evolution of FDI from 1991 to 2002 period and Figure 2.3 shows the inflow of FDI from 2003 to 2014.¹⁶

Figure 2.2 Foreign Direct Investment in Israel, 1990–2002 (in US\$ millions)



Source: UNCTAD, FDI/TNC database. United Nations Conference on Trade and Development (UNCTAD), Foreign Direct Investment (FDI)/Transnational Cooperation (TNC) database.

Figure 2.3 Foreign Direct Investment in Israel, 2003–2014 (in US\$ millions)



Source: United Nations Conference on Trade and Development, n.d. FDI Statistics Division on Investment and Enterprise. [Online] Available at: <http://unctad.org/en/Pages/DIAE/FDI%20Statistics/FDI-Statistics.aspx>

This process has been facilitated by a number of reforms in the capital markets that considerably improved the efficiency of the Israeli financial system. These reforms included deregulation, the elimination of a host of administrative restrictions and interventions, and the separation of capital market funds from banks. Reserve requirements, which had ranged well over 30 percent in the late 1980s, had fallen to an average of 4 percent by the end of the 1990s. This in turn contributed to a marked narrowing of interest rate spreads. Undue segmentation of the credit markets was sharply reduced; for instance, the share of mortgage credit allocated by the government fell from 70 percent in the mid-1980s to less than 25 percent by the end of the 1990s. Even sharper drops took place with respect to other forms of credit.

The reforms also saw a sharp reduction in the share of obligatory investments in government bonds by pension and provident funds. Provident funds, the largest institutional investor segment in the Israeli economy, were allowed to invest a much larger share of their holdings in equities and other financial assets. Alongside these efforts aimed at deregulation, there was also significant streamlining and modernization of the stock market, with continuous trading and short clearing periods against a background of fairly sound securities legislation.

There are ongoing efforts to broaden the range of financial instruments offered to the public, to ensure equal tax treatment of different classes of investors and/or savings instruments, and to encourage more long-term savings. The modernization of the financial sector is thought to have played a strong supportive role in the development of the ICT industry. To the extent that these reforms were driven by a desire to improve market efficiency, they made it easier for emerging companies to obtain funding under more favorable circumstances. Parallel progress in bringing inflation levels down to international levels also contributed to the creation of a more stable macroeconomic environment, conducive to private sector activity in a more predictable climate.

Foreign investors in the ICT sector have typically used one of two options to establish a presence in Israel: they have either set up operations directly, or adopted a strategy of mergers with, or friendly take-overs of, small local companies. As shown in Table 2.2, foreign investors have focused on the installation of research and development facilities. Microsoft built its first R&D facility outside the United States in Israel; Cisco has its first R&D center outside the United States in Israel; and Motorola's R&D center in Israel is its largest in the world. Those foreign companies were taking advantage of Israel's skilled engineers and its track record for innovation and problem solving.

The contribution made by multinationals to the development of the Israeli high-tech industry is generally viewed as positive, given the many spillovers to the local economy, such as easier access to the international financial and business markets, improved export channels, and the transfer of know-how and managing/marketing skills from the personnel of multinationals to local companies.

Some have argued that the above competitive advantages have been a mixed blessing for the Israeli economy, in that research facilities do not generally make the same contribution to job creation and exports as manufacturing plants and act as a drain on Israeli brain power that could otherwise be used by local firms.

Table 2.2 Multinational Companies with R&D Centers in Israel (Partial List)

R&D center	R&D center sector (IVC classification)	Number of R&D centers in Israel	Establishment year in Israel	Number of employees in Israel	Key innovations/ technologies/products
Apple	Semiconductors	3	2011	500	Development of hardware and chips for iPhone and iPad
General Motors	Miscellaneous technologies	1	2011	60	Autonomous vehicles; human machine interface; connected vehicle
Yahoo!	Internet	2	2008	50	Time Traveler application; smart advertising (market segmentation)
Google	Internet	2	2007	250	Google Autocomplete; Live Results; Google Related; Google Instant; Google Analytics
SanDisk	Semiconductors	3	2006	700	Trusted Flash technology; digital cameras (with Zoran); solid state drivers
Samsung	Semiconductors and communications	2	1999	250	Galaxy camera; eye-tracking system for Galaxy S4 smartphone
HP	Miscellaneous technologies	4	1994	5,700	Enterprise Swarm; automatic print quality inspection; semantic automation from screen capture; HP Indigo Photo Enhancement Server
Qualcomm	Semiconductors and communications	3	1993	260	Wi-Fi technology and the next generation of wireless local-area network connectivity; mobile enterprise security technologies; Qualcomm Snapdragon Mobile Development Platforms; digital pen and gestures based on ultrasound technology
Microsoft	IT and enterprise Software	2	1989	800	Business Intelligence in the Cloud and in Office; XBOX Analytics; building a novel real-time recommendations platform for the Microsoft entertainment business
Intel	Semiconductors	5	1974	10,500	Pentium M microprocessor Sandy Bridge and Ivy Bridge family of processors
IBM	IT and enterprise software; semiconductors	3	1949	1,000+	ECO-2000 Optimized Crew Scheduling System; WebSphere Content Discovery Server; mobile shopping app

Sources: Lemarchand, G. A., Leck, E., & Tash, A. (2016). Mapping research and innovation in the State of Israel (Vol. 5). UNESCO Publishing. Note: As of 2016 there were more than 270 foreign R&D centers active in Israel.¹⁷

In addition to creating state-of-the-art R&D centers, companies such as Intel and Motorola have established manufacturing facilities, which rapidly became among the largest private employers in Israel. In 2003, Intel was employing more than 6,000 workers at several plants scattered around the country (Haifa, Jerusalem, Kiryat Gat, Petach Tikva, and Yakum) and has developed into one of the top Israeli exporters, with

a volume of US\$1.6 billion in 2003, equivalent to 13 percent of total Israeli electronic exports. By December 2014, Intel had 10,500 employees and exported US\$4.5 billion. The links between Intel and Israel are particularly strong, as evidenced by a rapid ramping up of multibillion dollar investments, mainly to expand capacity at existing plants, some of which have become world leaders of research and innovation.

► MNCs and Exit Activities in 2015

According to IVC-Meitar Exits Report, Israeli high-tech exit activity¹⁸ accelerated for the first six months of 2015. It amounted to US\$5.29 billion in 54 deals. This is the highest half-year in a decade, second only to the exceptional first half of 2012, which totaled US\$8.33 billion. Most of the exits were via merger and acquisition, and only 6 percent of the total were due to initial public offerings (IPOs). The following table describes the top ten. This performance is an evidence to the vibrant ICT sector in Israel. Table 2.3 describes the top ten exits in H1-2015.

Table 2.3 Top 10 Exits, First 6 Months of 2015 (in US\$ millions)

Company	Exit Value (US\$ mill)	Buyer	Field
FUNDtech	1,250	D+H	Software
Borderfree	450	Pitney Bowes	Internet
Comverse	272	Amadocs	Communications
Comverse	175	Tech Mahindra	Communications
Travel Fusion	160	Ctrip	Software
Annapurna	360	Amazon	Semiconductors
Panaya	230	Infosys	Software
Redbend	200	HARMAN	Software
eXelate	200	Nielsen	Internet
WatchDox	100	BlackBerry	Software

Source: IVC, "\$5.29 Billion in Exits for Israel's High-Tech Industry in H1/2015: 76% of 2014," IVC-Meitar Exits Report, H1/2015, http://www.ivc-online.com/Portals/0/RC/Exits/IVC-Meitar_Exits_PR-H1-2015_PR_Final.pdf

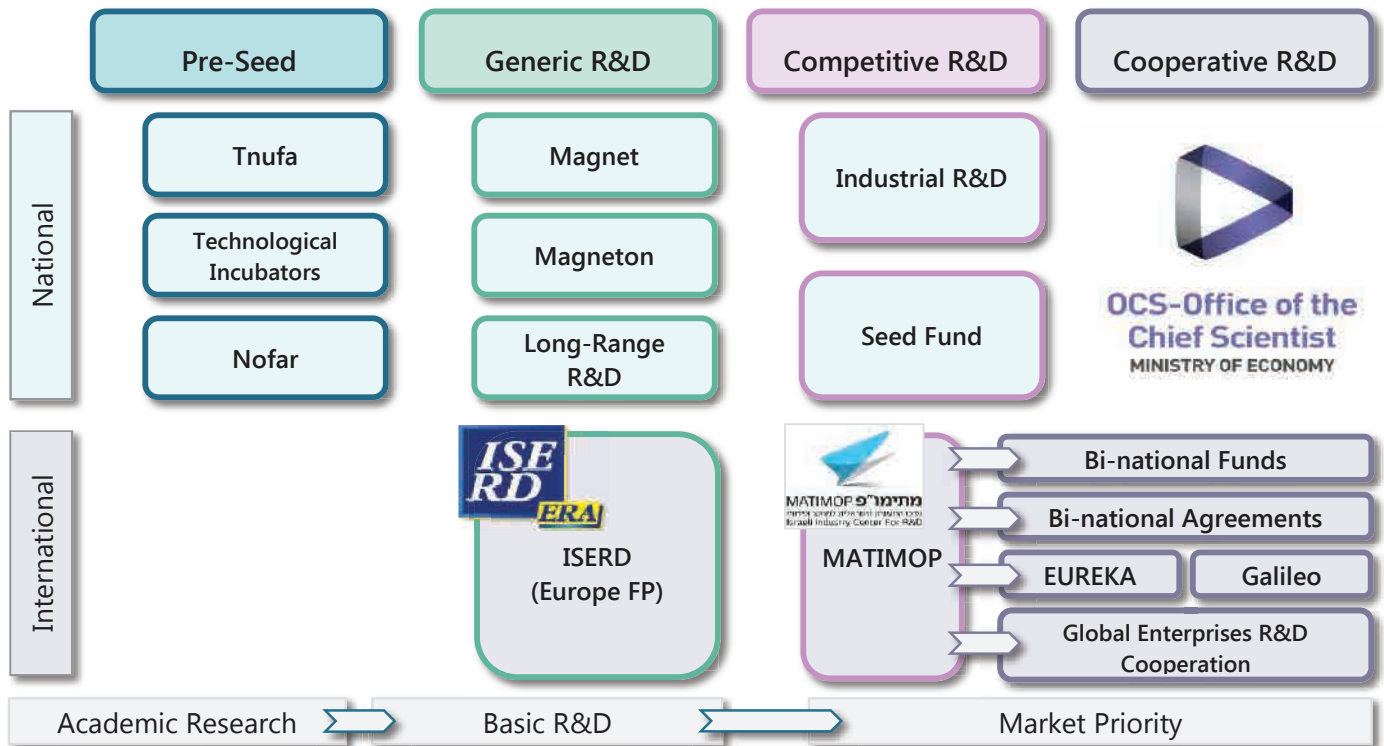
Government Support for R&D

Government support for R&D in the form of a coherent body of policies and programs began somewhat later than the policy of incentives to private investors. By then, the

economy and the flow of immigrants had slowed after two decades of strong growth. The need to define a new development strategy was seen as a top priority. Building on considerations similar to those that had motivated the policy on investment incentives—notably, the abundance of a highly skilled labor force, a culture of technological and scientific excellence, and the scarcity of natural resources—the government decided to actively promote the development of a science-based sector by subsidizing private-sector R&D projects.

An early precursor to this had been the creation in the late 1960s of the OCS at the Ministry Economy. The OCS administers and grants government funds for R&D and operates on the premise that the business sector alone is incapable of carrying on an optimal level of R&D for market growth, thus under such conditions government involvement through support of industrial R&D is needed as described in Figure 2.4.

Figure 2.4 OCS Ministry of Economy Support Programs for R&D



Source: Samuel Neaman Institute, based on OCS data and publications.

The Office of the Chief Scientist (OCS), n.d. R&D Incentive Programs. [Online] Available at: http://www.economy.gov.il/Publications/Publications/DocLib/RnD_IncentivePrograms_English.pdf

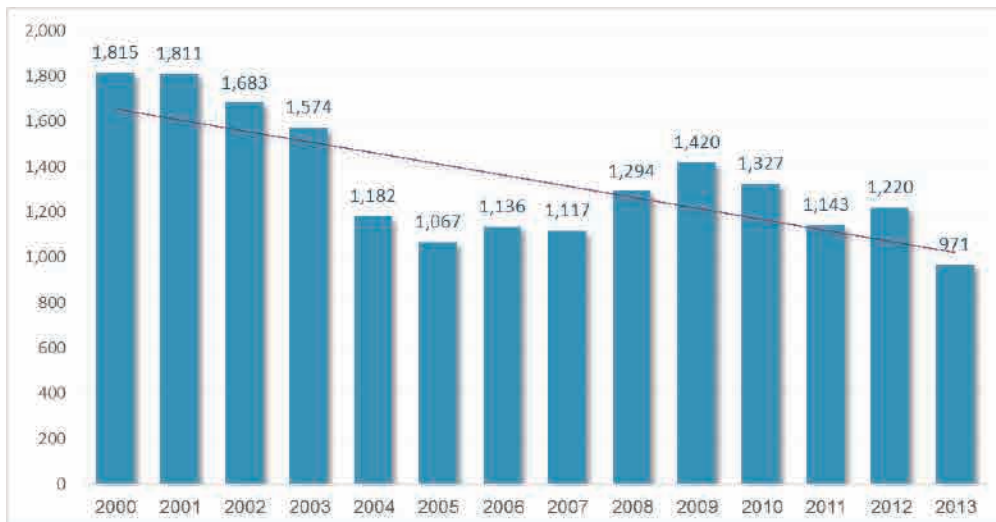
R&D is considered a fairly risky investment. As a result, R&D investment by the private sector can be scarce—a serious obstacle to the goal of maintaining Israel's competitive edge in applied innovation. The government's willingness to share in this risk greatly aided the OCS, empowered by the Law for the Encouragement of Industrial Research

& Development–1984 (R&D Law). The OCS oversees all government-sponsored support of R&D within Israeli industry. It operates through the R&D Fund as well as a gamut of domestic and international programs, agreements, and collaborations. The OCS supports hundreds of projects annually, ranging from incipient concepts within a pre-seed framework, to incubator and start-up companies, to autonomous industrial R&D enterprises.

The R&D Fund is the main instrument of the R&D Law. It gives partial financing of 20 to 50 percent to “approved R&D programs”—programs lasting one or more years that will result in the development of a new product or a significant improvement to an existing product. The development may also lead to a new industrial process or to a significant improvement in an existing industrial process. Support for the beta site stage of a project can also be accredited as part of the R&D expenditure and is recognized as an important and integral part of the R&D process. The annual budget of approximately NIS 1.5 billion (~US\$375 million) supports R&D of hundreds of companies through various programs.¹⁹ The interventions of the OCS take in the whole spectrum of the innovation process, including trying to make up for market failures when it appears necessary to overcome potential bottlenecks in private initiatives or funding.

In the past decade, OCS grants have been reduced both in scale and in their share of the state budget. Figure 2.5 shows the OCS budget for the years 2000–13. (A trend line has been introduced to show that the OCS budget for those years had been reduced.)

Figure 2.5 R&D Budgets for All OCS Support Programs, 2011 Prices (in NIS millions)²⁰



Source: Knesset Research and Information Center, 2013. Budget Analysis Office of the Chief Scientist in the Ministry of Economy (in Hebrew). [Online]. Available at: <https://www.knesset.gov.il/mmm/data/pdf/m03561.pdf>

The international program of the OCS responds to a different set of considerations. The relative strength of the Israeli high-tech sector lies in the R&D phase. Its weaknesses, however, are limited expertise and skills in international marketing due to the country's geographical remoteness (in 2013, ICT exports were 16.4 percent of total exports) and the small size of its companies.²¹ These two factors indicate the importance of establishing links and formal mechanisms for cooperation with companies in target markets.

In that spirit, the fostering of contacts with foreign companies to undertake joint R&D, manufacturing, and marketing has been an important focus of government R&D policy. Many incentive programs have been established to promote this goal, among which the most notable are binational funds (such as the Israel-US BIRD Foundation), parallel funding agreements, and participation in the European agreements offering partnering services (EUREKA, the Sixth and Seventh Framework Programs for R&D, known as FP6 and FP7). Currently Israel participates in the EU Horizon 2020 R&D Program. The OCS is assisted in the implementation and administration of these agreements by MATIMOP, which was created to serve as the national hub for encouraging the participation of Israeli enterprises in bilateral and multilateral programs for industrial R&D.

► National Authority for Technological Innovation

Encouraging growth, increasing productivity, and promoting technological innovation in the industry in Israel is important. To accomplish all these activities in today's fast-moving market requires an agile and flexible organization. This led to an amendment of the Law for the Encouragement of Industrial Research and Development, passed in 1984.

On June 21, 2015, the government of Israel approved a structural change in the OCS, with the OCS becoming the National Authority for Innovation. The Chief Scientist in the Ministry of Economy will be the head of the new administration.²²

The main objective of the new Innovation Authority is to encourage innovation for inclusive growth. This will eventually lead to increases in productivity and in promoting technological innovation and R&D in the industry as a whole (including traditional industries) and in services sector in Israel that are crucial for the Israeli economy.

More operational flexibility will be important given the new, multifaceted mission of the new innovation administration. Whereas the mission of the OCS so far has been focused on creating an innovation ecosystem, the new mission will be to pursue two goals simultaneously:

1. Maintain Israel's position in an increasingly competitive global innovation marketplace.
2. Inject innovation into all sectors of the Israeli economy.

International Support

International support programs include binational funds for competitive R&D, enabling joint R&D programs with foreign counterparts. A partial list of Israel's joint R&D programs appears in Table 2.4.

Table 2.4 Joint Binational R&D Programs Supported by Israel (Partial)

Fund Name	Countries	Website
BIRD	Israel-USA	www.birdf.com
CIIRDF	Israel-Canada	www.ciirdf.ca
SIIRD	Israel-Singapore	www.siird.org.il
BRITECH	Israel-Britain	www.britech.org
KORIL	Israel-Korea	www.koril-rdf.or.kr
VISTECH	Israel-Australia (Victoria)	www.business.vic.gov.au

In addition, numerous international R&D agreements with countries such as Austria, Belgium, Ireland, Germany, Holland, France, Hong Kong, and China, provide access to sources of national funding. Israeli companies participating in these programs are entitled to receive R&D grants from the OCS.

Innovation: Technology Incubators

The OCS initiated the Public Technological Incubator Program (PTIP) in 1991 in the wake of the large influx of immigrants from the former USSR, many of whom were scientists and engineers.²³ The Technological Incubators Program was a government response to a market failure situation. In this context market failure was defined as an early stage, high-risk, innovative technological company that cannot raise money from the private sector.

Technological incubators are support organizations that give inexperienced entrepreneurs an opportunity to develop their innovative technological ideas and set up new businesses in order to commercialize them. The goal of the incubators is to support novice entrepreneurs at the earliest stage of technological entrepreneurship and help them implement their ideas and form new business ventures. Each incubator is structured to handle 10 to 15 projects simultaneously and provides assistance in the following areas: determining the technological and marketing applicability of the idea,

drawing up an R&D plan and organizing the R&D team, raising capital and preparing for marketing, and providing secretarial and administrative service, maintenance, procurements, accounting and legal advice²⁴. The 1991–98 incubators program involved some 500 graduating companies with a 50 percent success rate²⁵.

The primary goal of this program is to transform innovative technological ideas in their early, high-risk stages into viable start-up companies capable of raising money and operating on their own.

Additional goals of the technological incubators program are to:

1. Promote R&D activity in peripheral and minority areas.
2. Create investment opportunities for the private sector, including for venture capitalists.
3. Transfer technologies from research institutes and implement them into the industry.
4. Enhance the entrepreneurial culture in Israel.

The program is subject to the R&D Law with regard to manufacturing, royalties, and Intellectual Property rights.²⁶

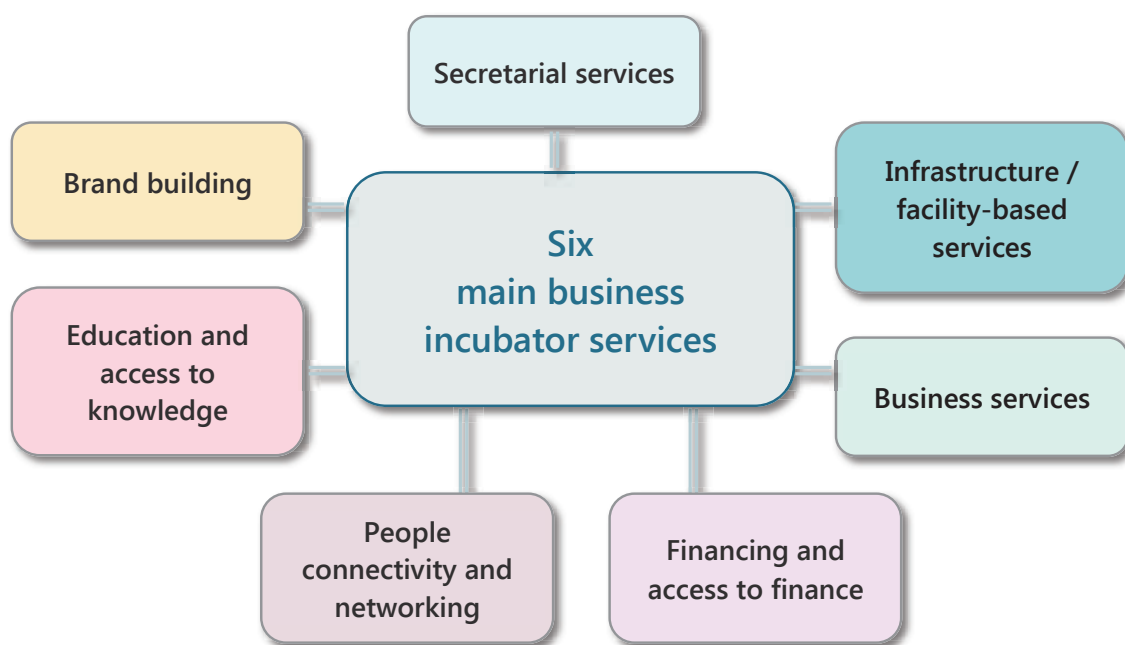
The annual government budget of the Technological Incubator Program is about US\$50 million. The government support to each technological incubator is as follows:

- Average budget of project: US\$500K
- Government grant: 85 percent of budget
- Incubator's investment: 15 percent of budget
- Payback: 3 percent royalties from revenue
- Support duration: two years
- Extended support to biotech, pharmaceutical, and clean-technology projects

The Incubator offers the entrepreneurs the following services, as described in Figure 2.6.

- Appropriate facilities and infrastructure for R&D
- Financing
- Central administrative services (secretarial, accounting, legal, commercialization)
- Management and technical assistance
- Professional and business guidance
- Connections to potential customers, partners, and investors
- Internet synergies

Figure 2.6 Services Offered by Israel's Technology Incubators



Source: Samuel Neaman Institute, based on OCS data

► Fields of Activity

The incubators operate in all fields of R&D, especially in life science (including medical devices), clean technology, and ICT. Out of about 180 incubated companies, about 40 percent are medical device companies, about 10 percent are biotechnology and pharmaceutical companies, about 15 percent are clean technology firms, about 30 percent are ICT companies, and about 5 percent are in other areas such as machinery and materials. Many of the medical device companies are ICT firms, since they use electronic circuitry that includes computer hardware and software.

► Results

From 1991 to the end of 2013, the government supported over 1,900 companies with a total cumulative government investment of over US\$730 million.²⁷ Over 1,600 companies had matured and left the incubators. Of these graduates, 60 percent have successfully raised private investments. By the end of 2013, about 35 percent of the incubators' graduates were still up and running. The total cumulative private investment in graduated incubator companies surpassed US\$4 billion. This means that on every dollar the government invested in an incubator company, the company raised an additional five to six dollars from the private sector.

► Conclusion

Policy makers in OECD countries recognized early after World War II the need for supporting R&D due to the market failures in its generation (spillovers and information asymmetries), likely to results in suboptimal levels of investment in R&D. Later on policy makers realized that the risk of government failures needs also to be taken into account and followed policies to mitigate them. In Israel the process began in the 1970s. Government R&D support boosted industrial output. The total effect of successful R&D consists of both a direct effect on the firm that conducted the R&D and an indirect effect on other firms (spillover); the study shows that the total return to the economy from government R&D support is high with spillovers coming mainly from medium to large firms.²⁸

Notes

- ¹ Dutta, S., A. Lopez-Claros, and I. Mia. 2005. *The Global Information Technology Report: Leveraging ICT for Development Israel—Factors in the Emergence of an ICT Powerhouse*. Basingstoke: Palgrave Macmillan [http://www.augustolopez-claros.net/docs/GITR2006_32Israel_ltr.pdf]
- ² Central Bureau of Statistics (CBS), Israel. 2014. "A Moderate Increase in the National Expenditure on Civilian R&D, in 2013." CBS Media Release 229/2014, 25 August. [http://www.cbs.gov.il/reader/newhodaot/hodaa_template_eng.html?hodaa=201412229]
- ³ World Economic Forum. 2015. *The Networked Readiness Index 2015: Taking the Pulse of the ICT Revolution*. Geneva: World Economic Forum. [<http://reports.weforum.org/global-information-technology-report-2015/1-1-the-networked-readiness-index-2015-taking-the-pulse-of-the-ict-revolution/>]
- ⁴ Porter, M., J. Sachs, and A. Warner. 2014. *The Global Competitiveness Report 2014–2015*. Geneva: World Economic Forum [http://www3.weforum.org/docs/WEF_GlobalCompetitivenessReport_2014-15.pdf].
- ⁵ Trajtenberg, M., 2000. R&D Policy in Israel: An Overview and Reassessment. [Online] Available at: <https://tad.colman.ac.il/paper-all/11160.pdf>
- ⁶ Israeli Office of the Chief Scientist (OCS), n.d. *The Technological Incubators Program*. [Online] Available at: <http://www.incubators.org.il/article.aspx?id=1703>
- ⁷ The Bloomberg Innovation Index. 2015. [<http://www.bloomberg.com/graphics/2015-innovative-countries/>]
- ⁸ Dutta, S., A. Lopez-Claros, and I. Mia, I. 2005. *The Global Information Technology Report*.
- ⁹ CBS. 2011. "Higher Education in Israel: Selected Data for the Opening of the 2011/12 Academic Year." CBS Press Release. 293/2011. November 20. [http://www.cbs.gov.il/reader/newhodaot/hodaa_template_eng.html?hodaa=201106293]
- ¹⁰ International Association for the Evaluation of Education Achievement (IEA). 2013. *Preparing for Life in a Digital Age: The IEA International Computer and Information Literacy Study International Report*. Amsterdam: IEA. [http://www.iea.nl/fileadmin/user_upload/Publications/Electronic_versions/ICILS_2013_International_Report.pdf]
- ¹¹ IVC, 2012. *The success mode of Israel innovation technology*. [Online] Available at: [http://embassies.gov.il/nicosia/NewsAndEvents/Documents/Doing%20Business%20with%20Israel%20\(Erich\).pdf](http://embassies.gov.il/nicosia/NewsAndEvents/Documents/Doing%20Business%20with%20Israel%20(Erich).pdf)
- Gal-Ezer, J., Beerli, C., Harel, D., & Yehudai, A. (1995). A high school program in computer science. *Computer*, (10), 73-80.
- ¹² A Model for High School Computer Science Education: The Four Key Elements that Make It! Hazzan, O., Gal-Ezer, J., & Blum, L. (2008, March). A model for high school computer science education: the four key elements that make it!. In *ACM SIGCSE Bulletin* (Vol. 40, No. 1, pp. 281-285). ACM.
- ¹³ *Computing at School: International Comparisons* Jones, S. P. (2011). *Computing at School. International comparisons*. Retrieved May, 7, 2013.
- ¹⁴ IEA. 2013. *ICILS 2013: International Computer and Information Literacy Study*. Amsterdam: IEA [http://www.iea.nl/icils_2013.html]
- ¹⁵ CBS. 2010. "Population of Israel 1990–2009: Demographic Characteristics." [http://unstats.un.org/unsd/wsd/docs/Israel_wsd_brochure.pdf]
- ¹⁶ United Nations Conference on Trade and Development. 2014. "Inward and Outward Foreign Direct Investment Flows and Stock, Annual, 1970–2013." Accessed via Knoema.

[<http://knoema.com/UNCTADFDI2014Sep/inward-and-outward-foreign-direct-investment-flows-and-stock-annual-1970-2013>]

¹⁷ Invest in Israel, 2016. Israel is where companies come to shine. [Online]

Available at: <http://www.investinisrael.org.il/>

¹⁸ Exit activity is the method by which a venture capitalist or business owner intends to get out of an investment that he or she has made in the past. In other words, the exit strategy is a way of "cashing out" an investment.

¹⁹ Office of the Chief Scientist (OCS), Israel. 2014. "R&D Incentive Programs."

[http://www.economy.gov.il/Publications/Publications/DocLib/RnD_IncentivePrograms_English.pdf]

²⁰ A trend line has been added.

²¹ CBS. 2014. "ICT Sector Estimate for 2014: 4% Increase in GDP." CBS Media Release 212/2014. 12 August

[http://www.cbs.gov.il/reader/newhodaot/hodaa_template.html?hodaa=201529212]

²² Israel Ministry of Foreign Affairs, 2015. Government approves National Authority for Technology and Innovation. [Online]

Available at: <http://mfa.gov.il/MFA/PressRoom/2015/Pages/Government-approves-National-Authority-for-Technology-and-Innovation-21-Jun-2015.aspx>

Prime Minister's Office, 2014. Government decision 2032 on 28.09.2014 (in Hebrew). [Online]

Available at: <http://www.pmo.gov.il/Secretary/GovDecisions/2014/Pages/des2032.aspx>

Israel Trade & Economic Office, Embassy of Israel, 2016. Israel Economic Mission to UK. [Online]

Available at: <http://itrade.gov.il/uk/2016/02/29/national-authority-for-innovation-established/>

²³ OCS. 2015. "Technological Incubators Program: Incubators Information."

[<http://www.incubators.org.il/category.aspx?id=576>]

²⁴ Frenkel, A. and Maital S. (2014). Mapping National Innovation Ecosystems: Foundations for Policy Consensus. Edward Elgar Publishing.

²⁵ Trajtenberg, M., 2000. Innovation in Israel 1968-1997: A Comparative Analysis using Patent Data, Science, Technology and the Economy Program STE-WP-5. [Online]

Available at:

<http://www.neaman.org.il/Neaman2011/Templates/ShowPage.asp?DBID=1&TMID=581&LNID=1&FID=646&IID=7829>

²⁶ IATI. July 2015. "Israel Advanced Technology Industries: Incubators."

[<http://www.iati.co.il/category/30/incubators>] < Israel Advanced Technology Industries >

²⁷ OCS. July 2015. "Technological Incubators Program."

[<http://www.incubators.org.il/category.aspx?id=606>]

²⁸ Ministry of Economy, Israel. 2008. "The Impact of Government Support to Industrial R&D on the Israeli Economy."

Lach, S., Parizat, S., & Wasserteil, D. (2008). The impact of government support to industrial R&D on the Israeli economy. Informe final. Tel-Aviv: EGP Applied Economics Ltd.

For more information on the Technological Incubators Program, please visit its website:

www.incubators.org.il/article.aspx?id=1703.

Also see the Samuel Neaman Institute report, "Public vs. Private Technological Incubator Programs: Privatizing the Technological Incubators in Israel"

<http://www.neaman.org.il/Neaman2011/Templates/ShowPage.asp?DBID=1&TMID=581&LNID=1&FID=646&IID=7872>

3 Analysis of the ICT Ecosystem for Entrepreneurship in Israel

In this chapter, we describe the Israeli ICT ecosystem, which is part of the larger innovation ecosystem in Israel. As a country described as the "Start-Up Nation,"¹ there is considerable interest in the system and forces that drive Israel's entrepreneurship. We give an overview of Israel's Silicon Wadi and the change in the structure of the ICT industry. Next we describe the ICT market and its transformation, including privatization and regulations. Then we describe the financing of start-ups and innovation within the ICT market. We continue by describing the telecommunications, semiconductors and components, software, and internet industries, which are important parts of the ICT industry. Finally, we describe internet usage, cybersecurity, and e-government, all of which are crucial to the success of ICT industry.

Overview of Israel's Silicon Wadi

Silicon Wadi (Hebrew for "Silicon Valley") is an area with a dense concentration of high-tech industries in Israel, similar to Silicon Valley in the United States. Silicon Wadi is considered second in importance globally only to its Californian counterpart. The area covers much of the country, although concentrations of high-tech industry can be found especially in the area around Tel Aviv. High-tech clusters can also be found in Haifa and Caesarea. Lastly, there are high-tech parks in Jerusalem and Beer Sheba, in towns such as Yokneam Illit, which is close to Haifa, and Israel's first "private city" - Airport City - near Ben-Gurion International Airport.

Israel as an ICT Cluster

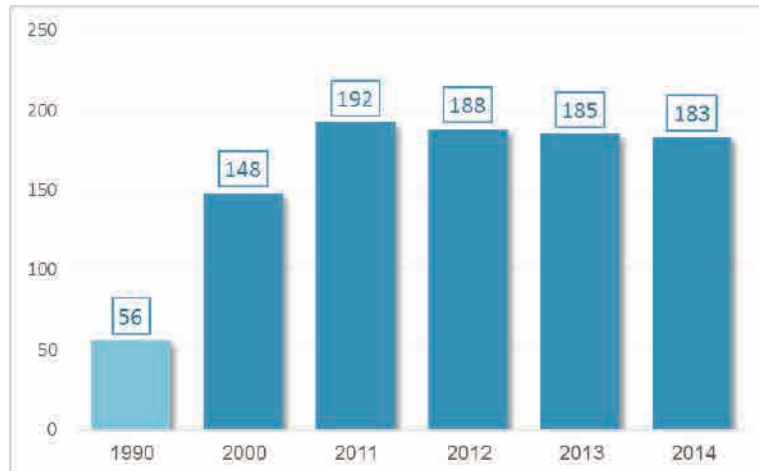
By the end of the 1990s Israel was generally acknowledged to have developed a cluster of high-technology industries. *Wired* magazine, ranking locations by the strength of cluster effects, gave the Israeli high-tech cluster the same rank as Boston, Helsinki, London, and Kista in Sweden, second only to Silicon Valley. The entire Israeli high-tech industry is close enough together, geographically, to be considered one cluster. Almost all high-technology activity is located in the densely populated areas of metropolitan Tel Aviv, Haifa, and Jerusalem. Some secondary areas with additional activity are in Beer-Sheva, Kiryat Gat where Intel has a large state-of-the-art Fab, and in the Western Galilee-Misgav region and the city of Karmiel.

At the core of the Israeli ICT cluster are developers in software, data communications, electro-optics, hardware design, and internet technologies, including cybersecurity software. Related successful high-technology industries include medical technology, biotechnology, agricultural technology, materials technology, and military technology, all of which use ICT in their final products.

In 1999 Israel was the largest foreign destination of U.S. venture capital flows. Leading US technology firms such as Cisco, Intel, and Lucent acquired Israeli start-ups for their technologies. In the year 2000 foreign investors made acquisitions of Israeli high-tech firms totaling US\$12 billion. In 2013 total acquisitions totaled US\$9.66 billion, in 2014 they totaled US\$6.9 billion and new start-ups raised US\$3.4 billion.²

The economic importance of the Israeli cluster may be illustrated with a few figures. By 2000 the Israeli ICT industry generated about US\$15 billion in export revenues. That number represented about a third of all Israeli exports. ICT exports contributed 36 percent to GDP growth in 2000. In 2000 the industry employed 148,000 people, approximately one-third of whom were scientists and engineers. In 2014 the industry employed 183,000 people. Israel had a higher share of employment in ICT industries among OECD nations. Figure 3.1 illustrates the rate of employment in 1990–2014.

Figure 3.1 Employment in the ICT Sector in Israel, 1990–2014 (in thousands)



Sources: CBS, n.d. ICT Sector Estimate for 2014. [Online] Available at: http://www.cbs.gov.il/reader/newhodaot/tables_template_eng.html?hoda=201529212

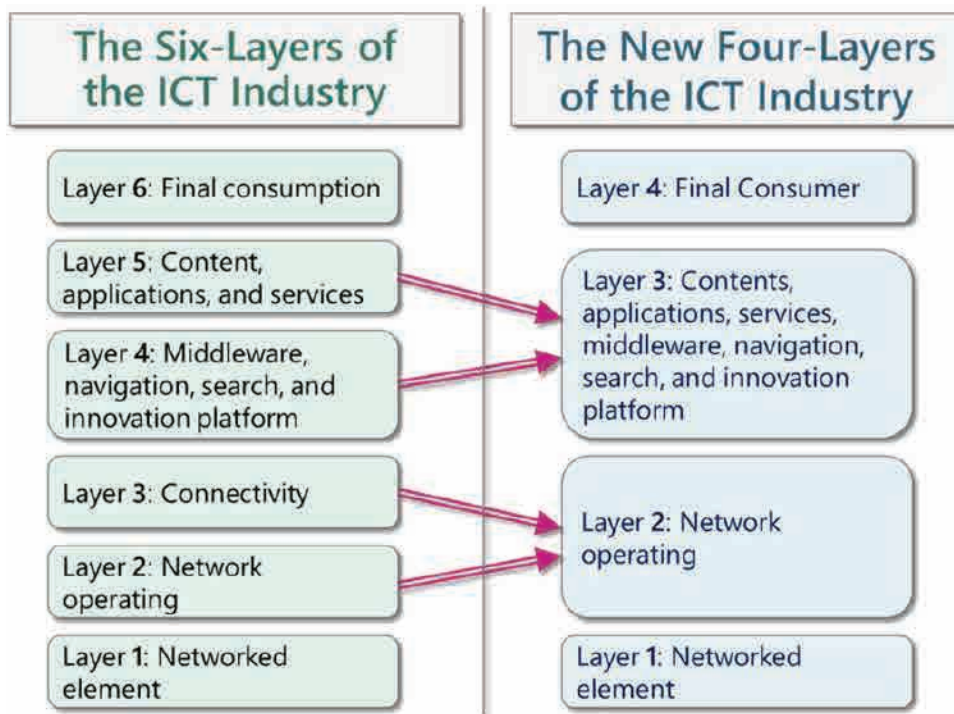
CBS, 2002. Information and Communication Technologies. (in Hebrew). [Online] Available at: http://www.cbs.gov.il/www/statistical/ict_h.pdf

In 2000, near the peak of the high-tech boom, Israel had more than 2,000 high-tech firms, and new ones were forming at a high rate. Today there are 4,467 companies in the ICT sector alone.³ Figure 3.2 describes the transformation that occurred in the industry.

Connectivity became vertically integrated, leading to many mergers and acquisitions. The advance of the internet influenced the structure of the new ICT ecosystem. Activities such as browsing / navigation (typified by Google), which were in layer four of the six-layers of the old ICT industry model, are today connected to the provision of content, application, and services.

The process of merging Layer 4 (middleware, navigation, search, and innovation platform) with Layer 5 (content, application, and service) in the six-layer model to obtain Layer 3 in the new four-layer model gave rise to many new start-ups in the Israeli ICT sector. Waze, a company that integrates the internet with wireless technology and smartphones to provide a new navigation service, is such a startup.

Figure 3.2 Transformation in the ICT Industry



Source: Samuel Neaman Institute, based on information received from companies in the ICT sector

The architectural structure of the four layers includes, among other things, the final consumers, platform, content and applications providers, network operators, and networked element providers.

Competition among firms increased the buying of innovative start-ups by large companies. This is seen in the successful exits of new companies and acquisitions by large technology firms from China, Republic of Korea, the United States, and elsewhere through 2014 and early 2015.

In 2013, the share of the ICT sector in Israel's GDP was 12.5 percent, which was US\$19.28 billion in 2011 prices. Exports reached US\$15.5 billion in 2013 and US\$17.9 billion in 2014 as described in Figure 3.3.

The following describes the ICT Sector Total Output, Gross Value Added and Export in 2013. All are at 2011 prices:

- **ICT sector total output**

In 2013 total output was NIS 124.603 billion (US\$34.509 billion), and the estimate for 2014 is NIS 128.948 billion (US\$36.040 billion).

- **ICT sector gross value added of the total GDP in the economy**

In 2013 value added was US\$19.251 billion, representing about 7.9 percent of GDP, and the estimate for 2014 is US\$20.269 billion, representing about 8.1 percent of GDP.

- **ICT sector exports of the total exports of goods and services in the economy**

In 2013 ICT exports reached US\$15.505 billion, representing about 16.4 percent of the country's total exports, and the estimate for 2014 is US\$17.913 billion, representing about 18.5 percent of the total exports, as described in figure 3.4.

The following is a summary of the sector achievements in the 2013 year.⁴

- In 2013, the gross value added of ICT in total GDP amounted to NIS 69.511 billion at 2011 prices (US\$19.251 billion)⁵ and comprised 11.1 percent of the total business sector GDP of the Israeli economy.
- During 2013 employment in the ICT sector stood at 185,000. This represents a decrease of 2 percent in the number of jobs in comparison to 2012, and its share of the total job market in Israel was approximately 5 percent.
- Average compensation per ICT job in 2014 increased by 5.3 percent compared to 2012. An increase of 3.2 percent was recorded in ICT manufacturing industries, an increase of 6.3 percent was recorded in ICT services, and an increase of 2.5 percent was recorded in ICT trade industries.
- In 2013, exports of the ICT sector amounted to NIS 55.985 billion at 2011 prices (US\$15.505 billion). The share of ICT in the total exports of goods and services in the economy was 16.4 percent, compared with 17.8 percent in 2012.

Note that these data presented by the Israel Central Bureau of Statistics are based on estimates of ICT industries, according to the new definitions by the OECD published in 2007,⁶ and are adjusted to the updated International Standard Classification of Industries (ISIC4).

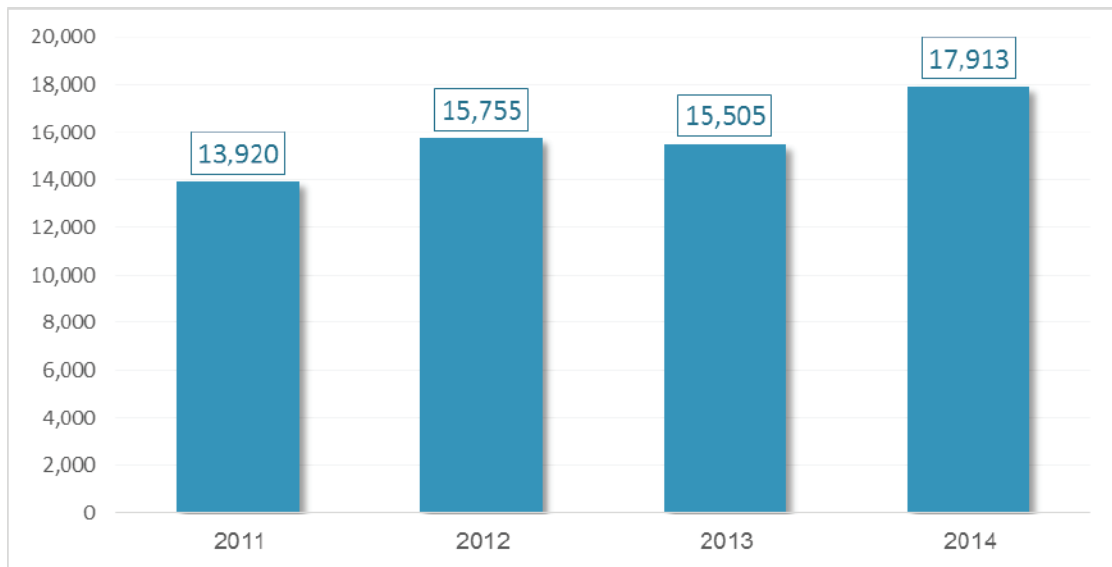
ICT is a major component of Israeli exports, and is estimated to be 18.5 percent of total Israeli export in 2014. Table 3.1 lists ICT exports for 2011–14.

Table 3.1 Total Israeli ICT Exports, 2011–14 (at 2011 Prices)

Year	2011	2012	2013	2014
Total ICT exports (in NIS millions)	49,808	60,752	55,985	64,092
Annual average exchange rate (BOI)	3.5781	3.8559	3.6107	3.5779
Total ICT exports (in US\$ millions)	13,920.24	15,755.60	15,505.30	17,913.30
ICT as a percentage of all Israeli exports	14.70%	17.80%	16.40%	18.50%

Note: BOI = Bank of Israel

Figure 3.3 Israeli ICT Exports, 2011–14 (in US\$ million at 2011 Prices)



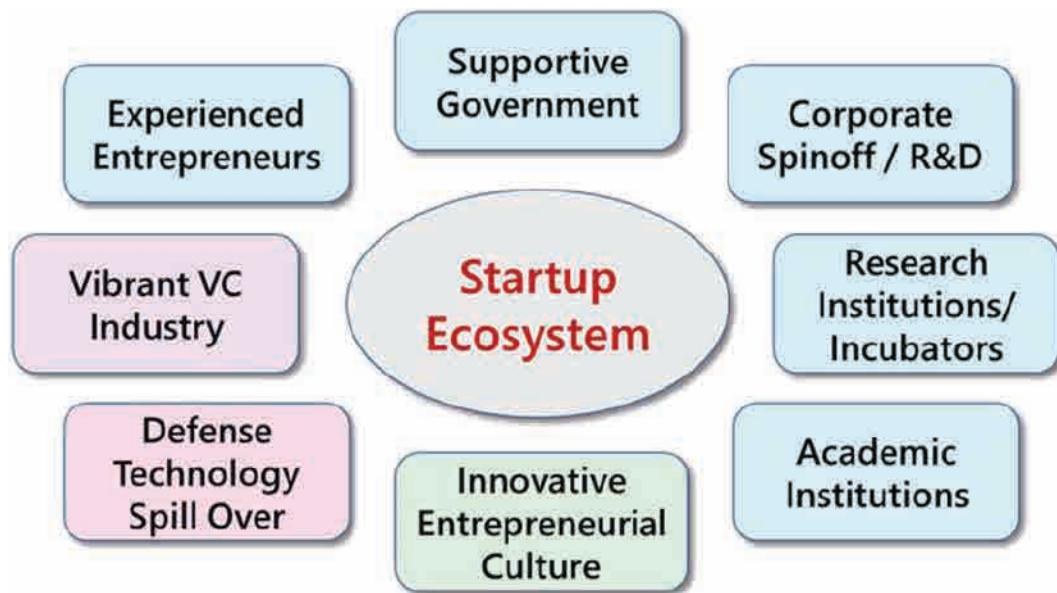
Source: CBS, "ICT Sector Estimate for 2014,"

http://www.cbs.gov.il/reader/newhodaot/tables_template_eng.html?hodaa=201529212

Long-term Conditions Favoring ICT Industry Growth

In order to build an innovative ICT industry, Israel had to establish and build an ecosystem to support it. The ICT ecosystem was based on eight main components, as described in Figure 3..

Figure 3.4 Israel's Start-Up Ecosystem



Source: Samuel Neaman Institute, 2015

The ecosystem in which the Israeli high-tech industry operates has six core components:

1. **Technological infrastructure:** The infrastructure is coupled with policy to encourage and support innovation. It includes the physical and virtual infrastructure required for the existence of a digital ecosystem.
2. **Human capital:** This refers to the enhancement of digital literacy in all parts of Israeli society and to the support for scientific and technological education.
3. **Funding and supporting:** This refers to the environment in which private business operates.
4. **Process infrastructure:** This refers to the government's four roles: client, service provider, regulator, and sponsor.
5. **Innovation:** This value is an encouraged hallmark in the industry.
6. **International operations:** This refers to the need, as a small country, to operate in an international environment to succeed.

The Domestic ICT Market in Israel

In this section we describe the Israeli technology market, including telecommunications, mobile, and broadband. We also provide a short description of the regulation process that transitioned Israel from a monopoly to a competitive market, which provided a tremendous push for the ICT ecosystem.

► Israel's Telecom, Mobile, and Broadband Markets

The Israeli communications market is characterized by fundamental technological and structural changes, large investments, and rapid development. Israel possesses a well-developed telecommunications market characterized by high penetration and a significant number of service providers. Regulation remains the responsibility of the Ministry of Communications, which has been encouraging competition through various regulatory mechanisms. Several operators have been licensed to provide voice over internet protocol (VoIP) services, which are usually referred to as voice over broadband (VOB) in Israel. Fixed network operators are required to allow VOB licensees access to their networks.

Telecom incumbent Bezeq continues to dominate the fixed-line market, and only one company, cable TV provider HOT Telecom, has had success in gaining a portion of the fixed-line market. HOT Telecom supplies bundled packages including cable TV, broadband, and fixed telephony. While several providers offer fixed telephony using VOB, Bezeq and HOT Telecom are the only fixed network operators in Israel.

In the broadband market, Bezeq is Israel's only asymmetric digital subscriber line (ADSL) network operator and HOT Telecom is the only cable network operator. The same duopoly can be seen in Israel's pay TV market, where HOT Telecom is the only provider of cable TV while YES TV, owned by Bezeq, is the only provider of satellite TV.

The Israeli broadband market is characterized by regulatory structural separation between the providers of the internet infrastructure and the internet access service. Thus, broadband users pay two separate bills: a physical connection bill to the broadband network operator and an internet access bill to the internet service provider (ISP). This system, however, is changing; unsuccessful in stimulating competition, the Ministry of Communications will remove structural separation in exchange for the creation of a viable wholesale market.

Although there are numerous ISPs in Israel, until recently Bezeq and HOT Telecom were the only two broadband network operators. A third company, Israel Broadband Company (IBC), launched wholesale services branded Unlimited in May 2014. IBC operates an FTTx network,⁷ using the fiber-optic infrastructure of its parent company Israel Electric Corporation.

Unlike the fixed-line market, Israel's mobile market is highly competitive, with five mobile network operators—Partner's Orange, Bezeq's Pelephone, Cellcom, HOT Mobile, and Golan Telecom—as well as a number of mobile virtual network operators. Cellcom is the mobile market leader, followed by Partner, which trades under the Orange brand name. All five of Israel's mobile network operators plus ISP 018 Xphone have applied to participate in a 4G LTE (fourth generation long-term evolution) public tender, which was scheduled for December 2014.⁸ However, following regulatory approval, Partner, Cellcom, and Pelephone have used existing or borrowed spectrum to launch LTE services ahead of the 4G auction.

Factors that have helped drive competition include full mobile number portability and regulatory barriers that prevent operators from linking sales of handsets to services or offering discounts to customers that commit to longer periods. Strong competition has led to operators focusing on mobile data and content opportunities as well as on costs, resulting in a number of infrastructure-sharing agreements.

► Key Developments in the Markets

Nine years after the start of privatization, the government altered its relationship to the markets considerably. It sold its final 0.97 percent interest in Bezeq. A net neutrality law covers fixed-line ISPs as well as mobile operators. The Ministry of Communications is developing a wholesale market, including bit stream access, lease of access segments, dark fibers, tubes, and transmission services. Israel's Antitrust Authority has given Bezeq conditional permission to merge with its satellite TV affiliate YES. The Ministry of Communication has published a network-sharing policy. Network sharing agreements have been set up between Partner and HOT Telecom and between Cellcom and Golan, among others.

Cellcom, Pelephone, Orange, Golan Telecom, Hot Mobile, and Marathon Mobile have all won spectrum in a 4G LTE auction concluded in January 2015. (As noted, following regulatory approval, Partner, Cellcom, and Pelephone have used existing or borrowed spectrum to launch LTE services ahead of the 4G auction.)

► Regulation

Israel possesses a well-developed telecommunication market characterized by high penetration and a significant number of service providers such as Bezeq, Bezeq International, Pelephone, HOT Telecom, HOT Mobile, Cellcom, 013 NetVision, Partner (Used to be Orange), 012 Smile, Golan Telecom, Rami Levi Telecom, and others.

Regulation remains the responsibility of the Ministry of Communication, which has been encouraging competition through regulatory mechanisms. Several operators have been licensed to provide VoIP services, which are usually referred to in Israel as

Voice over Broadband (VOB). Fixed network operators are required to allow VOB licensees access to their networks. Telecoms incumbent BEZEQ has traditionally dominated the fixed-line market, and only one company, cable TV and triple play provider HOT Telecom, had success in gaining a portion of the fixed-line market. However, with the opening up of the fixed-line market to wholesale rental in 2015 – alternative operators began to offer fixed services such as Internet, voice and television.

Facts and data on the evolution of Israel's ICT market, from the monopoly-based market it was until 1994 to the ultramodern multiplayer market it became by 2012, with a focus on structural and regulatory developments, could be found in the Ministry of Communications' report "Telecommunications in Israel 2012."⁹

► Regulatory Functions are Exercised by the Ministry of Communications

The Ministry of Communications encompasses a wide and diversified range of activities. Its responsibilities include: formulating telecommunications regulation and policy, developing telecommunications infrastructures, supervising Bezeq and other telecommunications service providers, supervising the Postal Authority, setting and auditing postal and communications tariffs, managing the electromagnetic spectrum' regulating and supervising cable television services and tariffs, and approving usage of telecommunications equipment in Israel.

The Communications Law of 1982 states that any license and change thereof must contribute to competition in the field of telecommunications and that to do so a licensee must fulfill certain prerequisites (requirements vary from one licensee to another).

The Communications Law was amended in August 2001 to eliminate the existing cable television franchises and introduce a revised licensing regime. This allows use of cable infrastructure for the provision of telephony and advanced fixed-telecommunications services such as data communications and broadband internet access, in addition to multichannel subscriber television already provided by the franchises. In May 2003, a new amendment to the Communications Law allowed CLECs to compete in the fixed-telecommunications services without universal service obligation, effective as of September 2004. The Ministry of Communications subsequently issued a set of regulations to establish the terms of procedures to apply for such a license, called a Specialized Domestic license, and, as of 2012 five such licenses have been granted. The operators comprised over 30 percent of the fixed-telephony market as of 2012, with the cable incumbent, HOT Telecom, providing most of these lines.

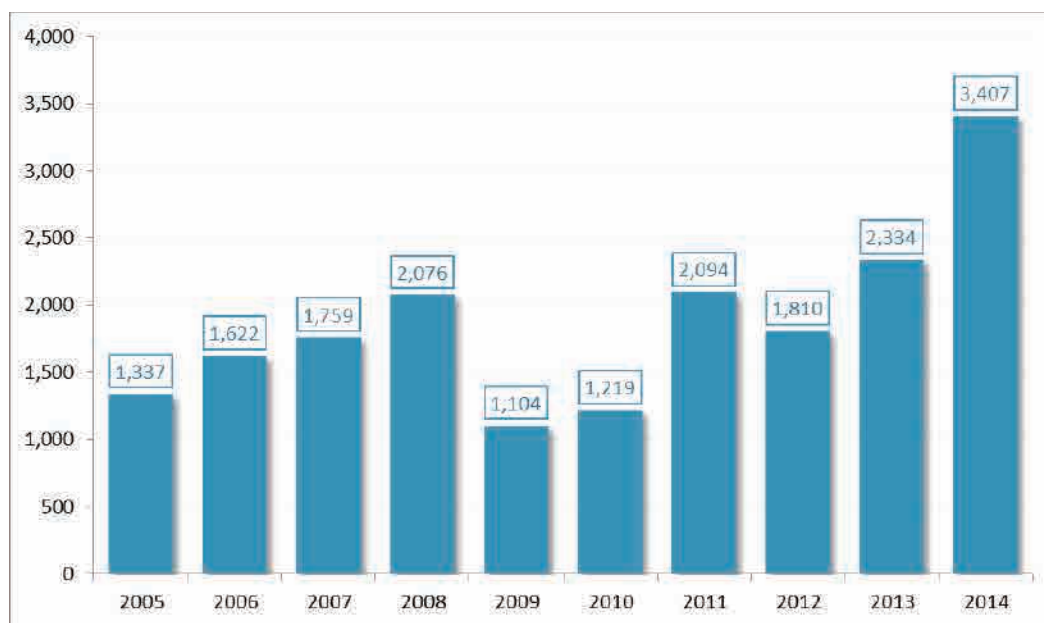
In 1984, the regulatory and operational functions in Israeli telecommunications were separated. All telecommunications facilities, which had until that time been

government operated, were transferred to the newly established Bezeq Company. Bezeq was granted a tightly regulated monopoly for the provision of telecommunications services. The rise of the ICT revolution in the 1990s, the interest of existing and potential carriers in using the new technologies to provide enhanced services, and a desire to confer the benefits of competition onto the consumer have led the ministry to initiate strategic amendments to the existing regulatory structure.

Financing Channels for the High-Tech and Innovation Industry

In 2014, Israeli high-tech capital raising set an all-time record as 688 companies attracted US\$3.4 billion.¹⁰ The amount was up 46 percent from US\$2.3 billion raised by 659 companies in 2013, and 88 percent above US\$1.8 billion invested in 563 companies in 2012. The average company financing round in 2014 was US\$5.0 million, compared to US\$3.5 million in 2013 and US\$3.2 million in 2012. Figure 3.5 describes the total capital raised by Israeli high-tech companies over the 2005-2014 period.

Figure 3.5 Total Capital Raised by Israeli High-Tech Firms (in US\$ millions)



Source: IVC High-Tech Yearbook, 2015

A breakdown of capital raised by Israeli high-tech companies in the ICT sector is depicted in Figure 3.6.

The software sector reached an all-time peak in 2014 as 155 companies attracted US\$737 million, well exceeding the former record US\$504 million for 2000. Sector investments were up 53 percent from the US\$483 million attracted by 115 companies

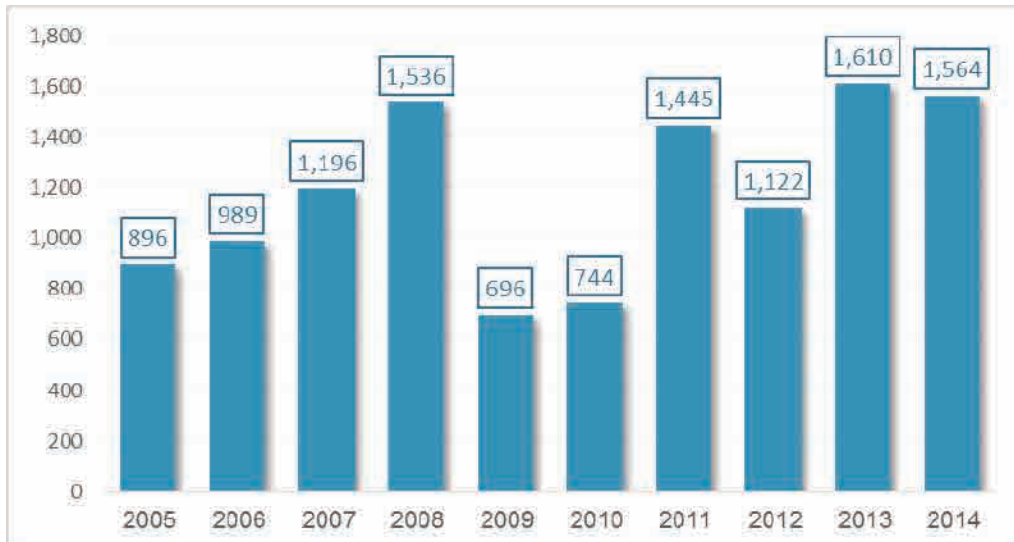
in 2013, and more than 2.5 times the US\$281 million raised by 93 software companies in 2012. The average financing round was US\$4.8 million.

The communications sector followed with 110 companies that raised US\$382 million, which was off 4 percent from US\$396 million invested in 115 companies in 2013, but 34 percent higher than the US\$285 million raised by 84 companies in 2012. The average financing round of communications companies was US\$3.5 million.

In the internet sector 169 companies raised US\$941 million. The amount raised was exceptionally high for the sector, even surpassing the US\$927 million registered in 2000. It exceeded the US\$515 million raised by 184 companies in 2013 and was up 150 percent from US\$382 million raised by 146 internet companies in 2012. The average financing round was US\$5.6 million.

In the semiconductor field, 20 companies raised US\$189 million, which is a decrease of 9 percent from the US\$207 million raised by 31 companies in 2013, but 10 percent above US\$172 million raised by 38 companies in 2012. The average financing round was US\$9.5 million.

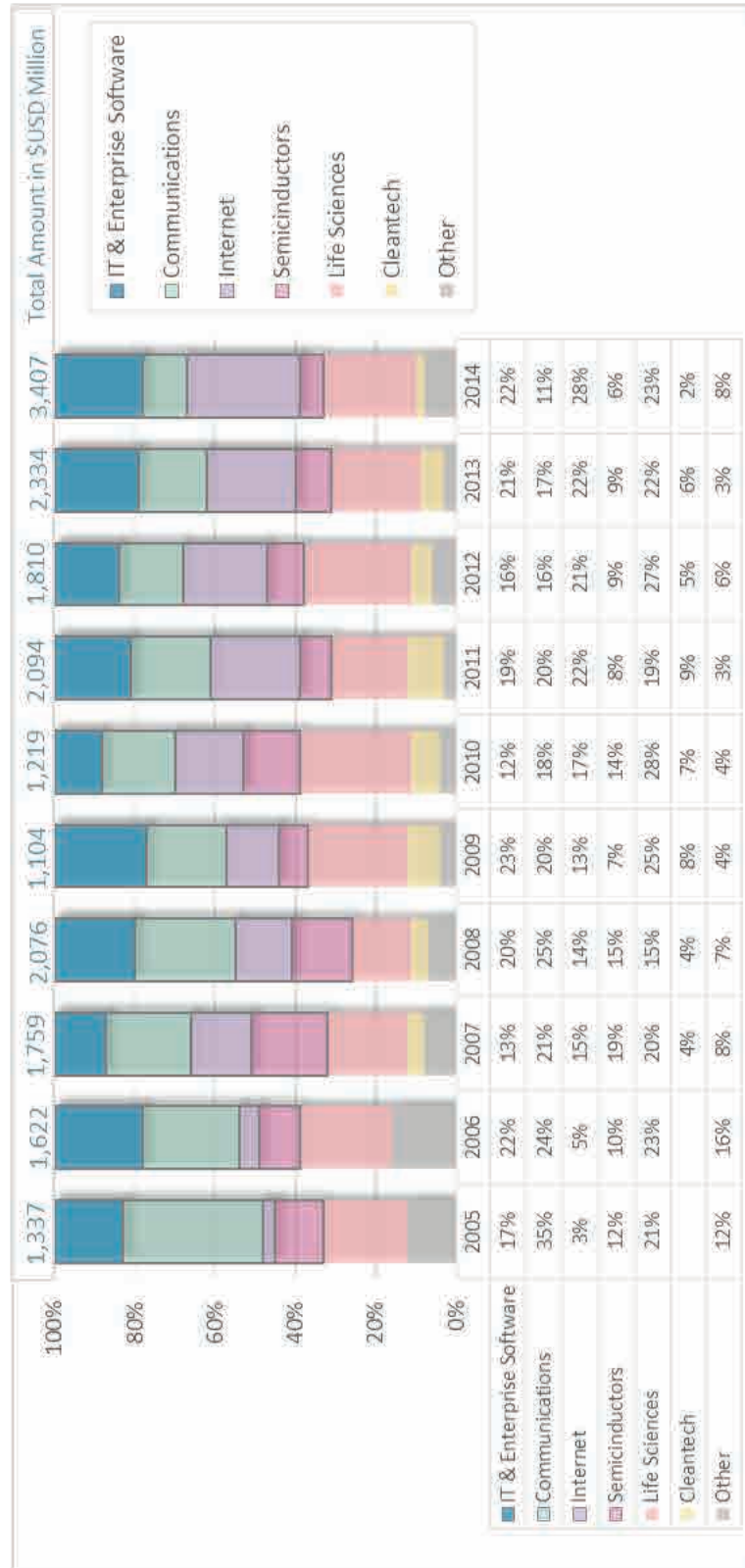
Figure 3.6 Capital Raised by the Israeli ICT Sector (in US\$ millions)



Source: IVC, 2015. The IVC High-Tech Yearbook 2015, Tel Aviv: IVC Research Center

A breakdown of the total capital raised in 2005–14 by Israeli high-tech companies according to sector is depicted in Figure 3.7.

Figure 3.7 Total Capital Raised by Israeli High-Tech Companies, 2005–14



Source: IVC, 2015. The IVC High-Tech Yearbook 2015, 19th ed. Tel Aviv: IVC Research Center.

Telecommunications, Semiconductors and Software Industry

The ICT industry in Israel represents some 4,467 companies and covers the fields of telecommunications, semiconductors and components, software, internet services, and cybersecurity. The following describes those segments and their relationship to the new four layer model of the ICT industry described above in Figure 3.2.

► Telecommunications

Many recognized telecommunications standards and protocols were developed and pioneered in Israel, and a versatile cluster of companies in all sizes and areas of expertise have emerged as a result.¹¹ Two examples are:

- a. WiMAX (Worldwide Interoperability for Microwave Access), which is a wireless industry coalition dedicated to the advancement of IEEE 802.16 standards for broadband wireless access (BWA) networks and
- b. VoIP and TDM over IP (TDMoIP), which is the emulation of time-division multiplexing (TDM) over a packet switched network (PSN).

Motorola has backed innovation in Israel for many decades, opening a local research center in 1964 and paving the way for more multinationals to follow suit. The company's Israeli office was responsible for the development of the Spirit, the first car phone with voice recognition. Telecom equipment giants Cisco and Alcatel Lucent, as well as telecom semiconductors leaders PMC-Sierra and Broadcom, have a prominent presence in Israel. Some of those companies also have a history of investments and acquisitions in the country.

Cisco made 11 acquisitions over the years with an overall disclosed value of over US\$6 billion, placing it as one of the top foreign acquirers of Israeli technologies. Over the years, the company acquired companies such as Infogear Technology for US\$308 million, P-Cube for US\$200 million, Sheer Networks for US\$122 million, and NDS for US\$5 billion. In addition, Cisco has been acting as a strategic investor for many telecom-related start-ups, investing in at least one venture per year since 2004. Among the company's prominent start-up investments are Celeno, Amobee (which was acquired in March 2012 by Singtel for US\$340 million), Compass EOS, and CTERA. Other global telecom companies that operate R&D centers in Israel include Avaya, Samsung (STRI - Samsung Telecom Research Israel), Polycom, and Sandvine.

The demand for high-bandwidth applications such as HDTV, the increasing usage of VoIP applications, and ever-growing rates of internet data traffic have all contributed to the telecom industry's most pressing need: increased capacity. While some service providers try to squeeze their legacy networks to the limit, other network operators are investing heavily in both fiber-to-the-home and fiber-to-the-node networks. In light of this, issues such as managing networks, providing support for new applications, and

creating innovative ways to better monetize subscribers and decrease operating expenses are becoming critically important. These challenges provide substantial opportunities for Israel's thriving telecom sector. Catering to the emerging needs of the global industry, many local telecom vendors leverage their vast experience in one domain to introduce solutions in adjacent fields, thus growing into multilayer telecom service providers. It is quite common to come across the same vendor in different telecom segments, such as:

- VoIP and video conferencing
- Ethernet access devices
- Carrier Ethernet and IP networking
- Optical networks
- IPTV, video, and broadcast
- Network and traffic management

► Semiconductors and Components

Israel has long been recognized as a leading force in the semiconductor industry. The semiconductor sector drives growth in many markets, including microprocessors, data and voice communications, wireless telephony, IP and networking communications, consumer products, automotive components, defense capabilities, and more, representing prime opportunities for investment and cooperation.

After reaching a bottom in the second quarter of 2012, semiconductor market growth resumed in the fourth quarter of 2012 and extended into the first quarter of 2013. This next wave of semiconductor demand was spurred by the launch of Windows 8 for tablets, increased enterprise IT spending, and next generation smartphones, tablets, and gaming platforms. The recovery accelerated into the second half of 2013 and beyond.

As the largest hub of fabless companies outside the United States, the Israeli semiconductor industry is well set to benefit from this growth. For example, Israeli companies are at the forefront of the memory chip sector. Notable developments include the USB (universal serial bus) flash drive, which was initially developed by M-Systems (acquired by SanDisk) and Saifun's (acquired by Sapnsion) nonvolatile memory that enables various types of devices (mobile phones, cameras, PDA, and set-top boxes, to name just a few) to retain stored information even without a power source.

There are dozens of Israeli companies that are developing semiconductors and components for different types of systems in the areas of mobile, telecom, storage, medical devices, defense, automotive, home networking, Radio-frequency identification (RFID), and others. Among them is Tower Semiconductor, a provider of

customized solutions in various complementary metal oxide semiconductor (CMOS) technologies, including digital CMOS, mixed-signal and radio frequency CMOS, and CMOS image sensors and power management devices. Tower's Revenue for the year ended December 31, 2013, amounted to US\$505.0 million, as compared to US\$638.8 million for the year ended December 31, 2012.¹²

► IT, Software and Internet in Israel

Israel is considered a vital player in the digital world. Increasing by almost 400 percent in a decade, Israeli software exports rose from US\$1.5 billion in 1998 to US\$8.5 billion in 2012. This software helps power everything from PC motherboard chips to cell phones and is deployed in business, consumer, and technical applications around the world.¹³

Israeli companies such as Amdocs, Check Point, Comverse, Mercury Interactive, Nice Systems, VocalTec, and some newcomers such as Wix have developed breakthrough software solutions, giving the industry—and the country—its reputation for innovation, creativity, and diversity. The country has attracted a great deal of attention from global technology leaders. Many companies, including HP, IBM, Microsoft, Oracle, and Sun have established operations and manufacturing centers in the country. Between 2010 and 2015, there was a burst of activity in the internet sector. This has resulted in a growing number of Israeli companies in internet-related areas making successful exits. At the end of 2014 there were 1,324 companies in the IT and enterprise software field and 1,626 companies in the internet field.¹⁴

► Start-up Companies and Superstars

The strength of the industry is reflected by its record of revolutionary solutions, including some of today's most common software solutions. Instant messaging, VoIP, voicemail, public key cryptography, internet firewall, and cellular billing are technologies were envisioned and developed by Israeli companies. They are used across many fields: telecommunications, finance, retail, healthcare, government, manufacturing, and more.

As a hub for emerging software technologies, Israel hosts R&D facilities for most of the world's large software vendors. Many of these centers, which support major product lines, were established through acquisitions of local companies. Others have established local R&D and manufacturing centers, which now play a significant role in their parent companies' operations. Multinationals with Israeli operations in software export more than US\$3 billion annually.

► Looking Forward to Tomorrow

The stream of innovation continues. Israeli companies are taking a leading role in developing IT security, cybersecurity solutions, cloud computing, business intelligence, virtualization, e-government, and internet applications.

More than 100 Israeli software companies are active in the cloud computing space—the delivery of business and consumer services over the internet, which is considered the next revolution in the IT market. These companies are delivering a wide range of solutions in areas such as IT security, IT management, Web applications, automated software quality, telecom applications, business intelligence, and enterprise application domains, especially CRM, ERP, collaborative applications, HR management, knowledge and content management, and industry-specific applications. Other notable fields of innovation include business intelligence, next generation information-centric security solutions, authentication, network security, IT management, application lifecycle management, content management, storage software, and others. In these fields and others, clusters of new Israeli companies are emerging, offering an unmatched variety, quantity, and quality of innovation.

Empowering Society: ICT and Internet Usage

An important aspect of the ICT industry in Israel, as well as the overall economy, is how the society as a whole is empowered by using the technology offered by the industry. In this section we describe internet usage in general as well as in the health and education systems.

► The Digital Economy Today

Mobility, cloud computing, social networking, sensor-nets, and big data analytics are some of the most important trends in the digital economy. Collectively these trends are making possible the future of “smart everything” (power grids, homes, business processes, energy, healthcare, transport, and government) as well as empowering businesses, consumers, and society at large. In OECD countries, the number of connected devices in households is projected to increase from an estimated 1.7 billion to 14 billion by 2022¹⁵.

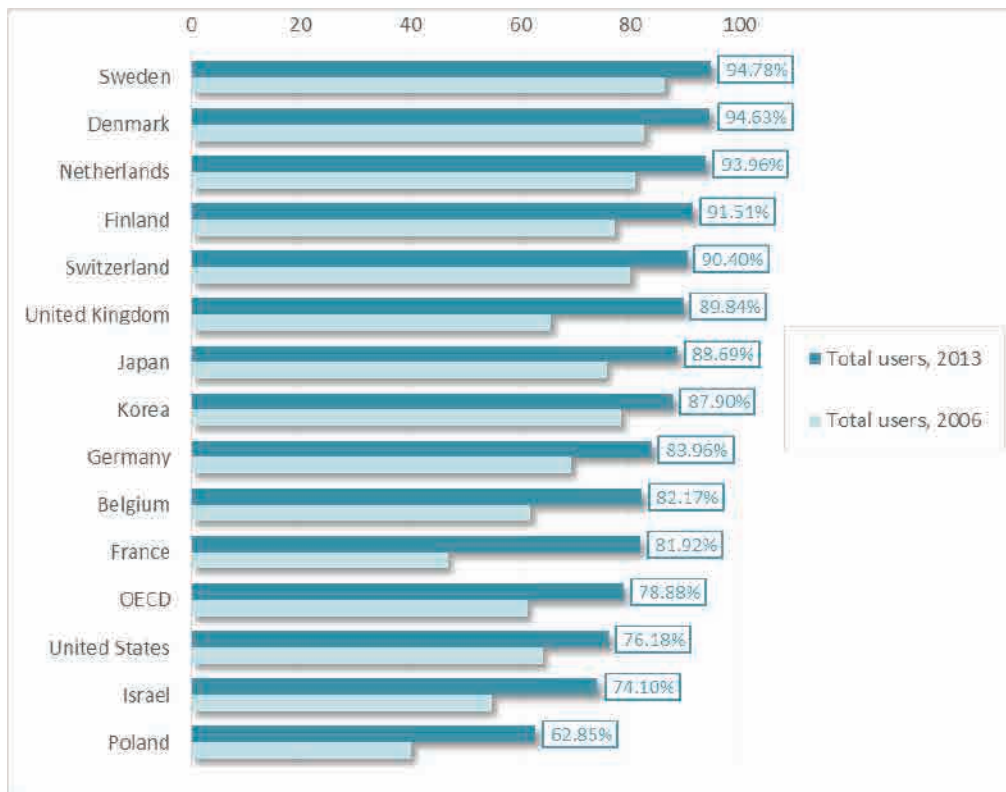
► Israel Internet Usage: Notes and Demographics

According to Internet World Stats, there were 5,928,772 internet users as of December 31, 2014, representing 74.7 percent of the Israeli population.¹⁶ About 90 percent of Israeli teens use the internet. In a report from July 14, 2009, the penetration rate of the

internet in Israel continues to rise, with 4.3 million users over the age of 13 at the end of 2008.¹⁷

According to a recent OECD report, on average, almost 80 percent of 16–74 year olds and 95 percent of 16–24 year-olds in the OECD use the internet, most of them on a daily basis.¹⁸ The report indicates that the total, daily internet users in Israel in 2013 as a percentage of 16–74 year-olds was 74.1 percent. Figure 3.8 shows Israel internet use in comparison to selected countries.

Figure 3.8 Share of 16–74 Year Olds Using the Internet Daily, 2006 and 2013



Source: OECD. (2014), OECD Science, Technology and Industry Outlook 2014, OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/sti_outlook-2014-en

Note: The Israeli society is heterogeneous; some groups use the internet intensively and some use it in a limited way.

► ICT and Health

Governments today have recognized the large-scale changes that are made possible by health ICTs, and in response they are developing approaches to leverage these technologies to pursue a range of health system reforms, such as primary care renewal and results-based financing. While the potential gains from greater use of these technologies have been apparent for years, most countries are still facing major implementation and adoption challenges. This highlights the large gap between what

is possible and what exists, with little known about how to fully leverage ICTs to improve the health and wellness of the population. Data on successful adoption and use across countries is therefore an essential learning tool for policy development in this area.

Ten pilot countries (Brazil, Canada, Finland, Germany, Israel, Korea, the Netherlands, Switzerland, the United Kingdom, and the United States) are currently testing the *OECD Guide to Measuring ICTs in the Health Sector*¹⁹ and broad implementation is expected in the near future.

► ICT Integration in Teacher Education: The Case of Israel

E-society, e-education, e-generation, e-learning, and other e-concepts reflect the new reality caused by rapid emergence of ICT in our lives. Taking into account the current and future needs of the e-generation, many countries try to reorganize their educational systems, defining the important abilities required in the 21st century: multiple literacies, expertise, innovation, critical thinking, and problem solving. The Israeli Ministry of Education plans accordingly.

Israel's MOFET Institute, which focuses on research, curriculum and program development for teacher educators, implemented a study²⁰ examining three aspects of ICT integration in teacher education in Israel:

- The policy of the Ministry of Education and of the colleges of education
- The implementation of ICT by faculty members
- The state of pre-service teacher preparation to teach using ICT

This study was conducted using mixed qualitative and quantitative research approaches. Research on policy issues was based on semi-structured interviews of 34 policy makers and academic managers in the Ministry of Education and Colleges of Education as well as on the analysis of various official documents.

Using UNESCO's Theoretical Framework for the evaluation of ICT Integration in educational systems,²¹ it can be stated that Israeli teacher education has passed the "e-readiness" stage (infrastructure establishing and achieving the basic ICT literacy among faculty and preservice teachers) and is moving on to the next, "e-intensity" stage, where the main efforts focus on developing innovative pedagogy, upgrading the curriculum, promoting organizational change, and supporting the further professional development of teacher educators.

Cybersecurity in Israel

Israel is considered one of the world's hubs of innovation and entrepreneurship in the information security field. The number of Israeli cybersecurity firms continues to increase. The Israeli National Cyber Bureau estimates that the number of active firms has doubled from 150 in 2010 to 300 in 2015.²²

Some of the more prominent Israeli cybersecurity companies are CyberArc (valued at an estimated US\$2 billion); Adallom (which has raised US\$50 million); and Cybereason (which recently raised US\$25 million from Lockheed Martin, among others).

A substantial number of Israeli cybersecurity companies were acquired by international corporations in recent years. The more notable acquisitions in 2015 were CyActive (acquired by PayPal), Intellinx (acquired by Bottomline Technologies), and Hyperwise (acquired by Check Point).

Israel's success in developing innovative security solutions has also brought practically every major global security vendor to Israel to establish a local R&D presence, frequently following acquisitions of Israeli companies. These includes McAfee, CA, Cisco, Microsoft, Intel (McAfee), Websense, EMC (RSA), IBM, and others. A recent addition to this list is GE, which will soon open its first Israeli global research cyber lab.²³

► Israel's National Cyber Bureau

Established in 2011, Israel's National Cyber Bureau functions as an advising body for the prime minister, the government, and government committees. It recommends national policy in the cyber field and promotes its implementation, in accordance with the law and government resolutions (See Resolution No. 3611 of the government of August 7, 2011.)²⁴ The Bureau works to promote the national capability in cyberspace and to improve Israel's preparedness in dealing with the current and future challenges in cyberspace.

The National Cyber Bureau is charged with promoting three central areas in the cyber field in Israel:

1. Advancing defense and building national strength in the cyber field
2. Building Israel's lead in the cyber field
3. Advancing processes that support the first two tasks

► Activities of the National Cyber Bureau

The Bureau promotes many significant activities in various fields in cooperation with industry, academia, and the governmental sector.²⁵

In the field of cyber defense, it works on:

- Formulating a national defense strategy
- Establishing cross-industry and industry-specific regulation
- Promoting cybersecurity within the civilian and private sectors, in cooperation with other government offices
- Working toward the establishment of a national cyber situation assessment and the definition of the national cyber threat reference

In promoting the Israeli cyber defense industry, it focuses on:

- Establishing the Kidma (Advancement of Cyber Defense R&D) program to prioritize the cyber defense industry, in cooperation with the Chief Scientist of the Ministry of Industry, Trade and Labor, in the amount of NIS 80 million over two years beginning in 2013 (This sum has been increased to NIS 100 million.)²⁶
- Establishing the Masad (Dual Cyber R&D) program to promote national and defensive cyber technologies together, in cooperation with MAFAT (Directorate of Defense R&D in the Ministry of Defense), in the amount of NIS 10 million for 2012–13²⁷
- Encouraging investments by international companies in the state of Israel

German-Israeli cooperation will lead to the German-Israeli Platform for Defensive Cybersecurity Research.²⁸ The Israeli ambassador to Germany, Yakov Hadas-Handelsman, visited Fraunhofer SIT (Fraunhofer-Institut für Sichere Informationstechnologie or Security in Information Technology) in June 2015 to discuss the new cybersecurity research partnership between the institute and Israel. In cooperation with leading academic research institutions in Israel, Fraunhofer SIT will establish a cybersecurity innovation center in Israel. The main focus of the joint research activities is to bridge the innovation gap and accelerate the development of secure software, systems, and services. The cybersecurity research cooperation between Fraunhofer SIT and Israel aims at creating a network of excellence and producing new ideas for innovative cybersecurity.²⁹

Israel and e-Government

Modern society is an information society. Creating and developing this information society forms the heart of Israel's e-government vision. Israel's Ministry of Foreign Affairs and Ministry of Finance are responsible for all e-government projects in Israel.³⁰

In this section we discuss the government of Israel's e-government initiative and the use of this platform by the Israeli society. This is important as it will contribute to the competitiveness of the nation and the ease of dealing with government offices.

In May 2002, the government of Israel decided to launch an e-government project. It established a five-layer model of e-government that is the foundation from which the country will promote initiatives in the area of e-government.

► Five-Layers Model

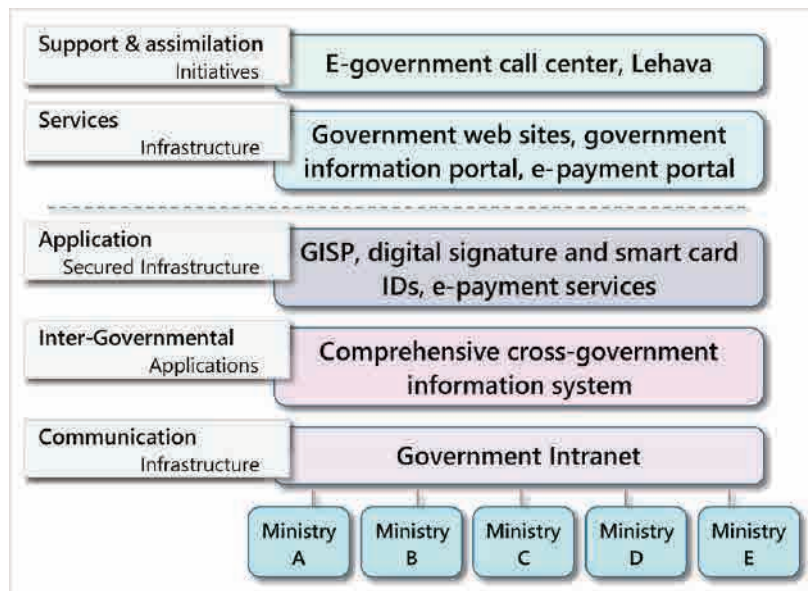
The computer unit in the General Accountant office, headed by Mr. Itzhak Cohen, worked for six years on launching the e-government project.³¹ Further back, activity in this area began at the start of 1997, with the nomination of the government's internet committee and the initiation of the "Tehila" project. Along the way, many projects and initiations were added. Toward 2002 a master plan was created and a government decision was passed to move forward and allocate resources for e-government services.

The master plan was based on the advanced e-government model, "the five-layer model," developed by the General Accountant computer unit. The five-layer model defines the e-government layout technologically and describes the entire system required for the realization of a full e-government vision.

The citizen is at the top of these layers. Lower levels contain infrastructure technologies. In spite of their relative distance from the end-user, they are the ones allowing the required functionality.

The aspiration for a seamless government, a fundamental organizational restructuring, and a full and convenient service to the citizen, require parallel handling in all five levels as described in Figure 3.9.

Figure 3.9 The Five-Layers Model of Israel's e-Government



Source: The Five Layers Model of e-Government, Ministry of Finance General Accountant Office, September 2002

Note: GISP = A GISP is a Certified Geographic Information Systems (GIS) Professional

The United Nations E-Government Survey 2014: E-Government for the Future We Want was completed in January 2014 and launched in June 2014.³² The theme of the 2014 report is particularly relevant to addressing the multi-faceted and complex challenges that our societies face today. The publication addresses critical aspects of e-government for sustainable development articulated along eight chapters.

In that report Israel ranks 17th globally and 1st in Western Asia. The Israeli government portal offers services geared towards citizens, the private sector and tourists wishing to visit the country, as well as students and members of the Jewish Diaspora. The portal also offers online forms and a forum for G2C and C2G interaction and discussions; many online payments can be made through the portal and a section teaching simple Hebrew phrases can be found on the main page.

The UN E-Government report of 2014 also gave a high mark to the government's online portal, Gov.il, describing it as "Very well organized." The report ranked Israel as the fourth-leading country in e-participation projects among Asian countries, a ranking gauging public participation in online government ventures.

Notes

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- ¹ Senor, D., & Singer, S. (2009). *Start Up Nation: The Story of Israel's Economic Miracle*. New York: Twelve, Hachette
- ² IATI - Israel Advanced Technology Industries. 2015. *Israeli ICT Industry Review 2015*. [<http://www.iati.co.il/files/files/IATI%20Israeli%20ICT%20Industry%20Review%202015.pdf>]
- ³ Central Bureau of Statistics (CBS), Israel. 2014. "ICT Sector Estimate for 2014." [http://www.cbs.gov.il/reader/newhodaot/tables_template_eng.html?hoda=201529212]
- ⁴ Ibid.
- ⁵ The annual average exchange rate of the U.S. dollar (Bank of Israel) for 2013 and 2014 was 3.6107 and 3.5779, respectively.
- ⁶ Organization for Economic Cooperation and Development (OECD). 2007. "Information Economy: Sector Definitions Based on the Standard Industry Classification (ISIC 4)." [<http://www.oecd.org/sti/sci-tech/38217340.pdf>]
- ⁷ Fiber to the x (FTTx) is a collective term for various optical fiber delivery topologies that are categorized according to where the fiber terminates.
- ⁸ For more on 4G LTE, see Verizon Wireless, "What is 4G LTE and Why It Matters," 2012, [<http://www.verizonwireless.com/news/article/2012/05/what-is-4GLTE-and-why-it-matters.html>]
- ⁹ "Telecommunications in Israel 2012" is available at the Ministry of Communications website, http://www.moc.gov.il/sip_storage/FILES/5/605.pdf.
- ¹⁰ UNESCO. 2015. "Mapping Research and Innovation in Israel," in UNESCO's GO-SPIN Country Profiles in Science, Technology and Innovation Policy.
- ¹¹ Ministry of Communications, Israel. 2013. "Telecommunications in Israel 2013—From Monopoly to Competition: 1994–2013." [http://www.moc.gov.il/sip_storage/FILES/5/605.pdf]
- ¹² Tower Semiconductor. May 14, 2015. Annual Report Pursuant to Section 13 or 15(D) of the Securities Exchange Act of 1934. [http://secfilings.nasdaq.com/edgar_conv_html%2f2015%2f05%2f14%2f0001178913-15-001676.html#ZK1516675_HTM_2]
- ¹³ Israel Export and International Cooperation Institute. 2010. "Israel Inspired by Innovation: Software Industry." [http://www.export.gov.il/UploadFiles/06_2011/SoftwareIndustry.pdf]
- ¹⁴ IVC Database [<http://www.ivc-online.com/>] <Data was retrieved from IVC Database under permission.>
- ¹⁵ OECD. (2014), *Measuring the Digital Economy: A New Perspective*, OECD Publishing, Paris. DOI: <http://dx.doi.org/10.1787/9789264221796-en>
- ¹⁶ Internet World Stats. May 12, 2015. "Israel Internet Usage and Telecommunications Report." [<http://www.internetworldstats.com/me/il.htm>]
- ¹⁷ As reported in *Globes*, July 14, 2009. The article was based on a survey by TIM/Teleseker.
- ¹⁸ OECD. 2014. "Measuring the Digital Economy: A New Perspective." [http://www.oecd-ilibrary.org/science-and-technology/measuring-the-digital-economy_9789264221796-en]
- ¹⁹ OECD, 2015. *OECD Guide to Measuring ICTs in the Health Sector*. [Online] Available at: <http://www.oecd.org/health/health-systems/Draft-oecd-guide-to-measuring-icts-in-the-health-sector.pdf>
- ²⁰ Goldstein, Olzan, et al. (2011, March). *ICT integration in teacher education: the case of Israel*. In *Proceedings of society for Information technology and teacher education international conference* (7–11 March, 2011), Chesapeake, VA: AACE (Vol. 5)
- ²¹ UNESCO Institute for Statistics. 2009. "Guide to Measuring Information and Communication Technologies (ICT) In Education." [<http://unesdoc.unesco.org/images/0018/001865/186547e.pdf>]

²² "Cyber Superpower: Sales of Israeli Companies—10% of the Deals Worldwide," The Marker, 2015 [<http://www.themarker.com/technation/1.2643488>]

²³ IATI. 2015. Israeli ICT Industry Review 2015.

[<http://www.iati.co.il/files/files/IATI%20Israeli%20ICT%20Industry%20Review%202015.pdf>]

²⁴ Advancing National Cyberspace Capabilities. Resolution No. 3611 of the Government of August 7, 2011. Israeli Prime Minister's Office

[<http://www.pmo.gov.il/English/PrimeMinistersOffice/DivisionsAndAuthorities/cyber/Documents/Advancing%20National%20Cyberspace%20Capabilities.pdf>]

²⁵ Prime Minister's Office, Israel. August 2015. "Bureau's Activities."

[<http://www.pmo.gov.il/English/PrimeMinistersOffice/DivisionsAndAuthorities/cyber/Pages/Activities.aspx>]

²⁶ Prime Minister's Office, Israel. August 2015. "The 'Kidma' Program to Advance the Cyber-Security Industry in Israel."

[<http://www.pmo.gov.il/English/PrimeMinistersOffice/DivisionsAndAuthorities/cyber/Documents/Kidma%20Program.pdf>]

²⁷ Prime Minister's Office, Israel. August 2015. "Masad" Program: Dual Cyber R&D."

[<http://www.pmo.gov.il/English/PrimeMinistersOffice/DivisionsAndAuthorities/cyber/Documents/Masad%20Program.pdf>]

²⁸ Fraunhofer-Gesellschaft. 2015. "German-Israeli Platform for Defensive Cybersecurity Research." [<https://www.sit.fraunhofer.de/en/news-events/latest/press-releases/details/news-article/deutsch-israelische-plattform-fuer-cybersicherheitsforschung/>]

²⁹ For further information on the Israeli Cyber Technology Cluster please refer to January 2016 Report by IVC Research Center Ltd. which can be found at http://www.ivc-online.com/Portals/0/RC/The%20Israeli%20Cyber%20Technology%20Cluster_final.pdf

³⁰ Israeli Government Portal [<http://mfa.gov.il/MFA/AboutTheMinistry/Events/Pages/e-Gov-in-Practice-seminar-to-be-held-in-June%2018-May-2009.aspx>]

³¹ Ministry of Finance General, Israel, Accountant Office. 2002. "e-Government in Israel: The Five Layers Model of e-Government." [<http://www.rashty.com/articles/5layers.doc>]

³² United Nations Department of Economic and Social Affairs. 2014. United Nations E-Government Survey 2014.

[https://publicadministration.un.org/egovkb/Portals/egovkb/Documents/un/2014-Survey/E-Gov_Complete_Survey-2014.pdf]

4 Case Studies of Successful ICT Start-ups

The Role of Failure and Success in Innovation: Two Case Studies

This chapter provides two case studies describing how innovative start-ups in Israel emerge from both great success and immense failure, and how those two experiences are equally fertile in spawning start-ups.

► Success

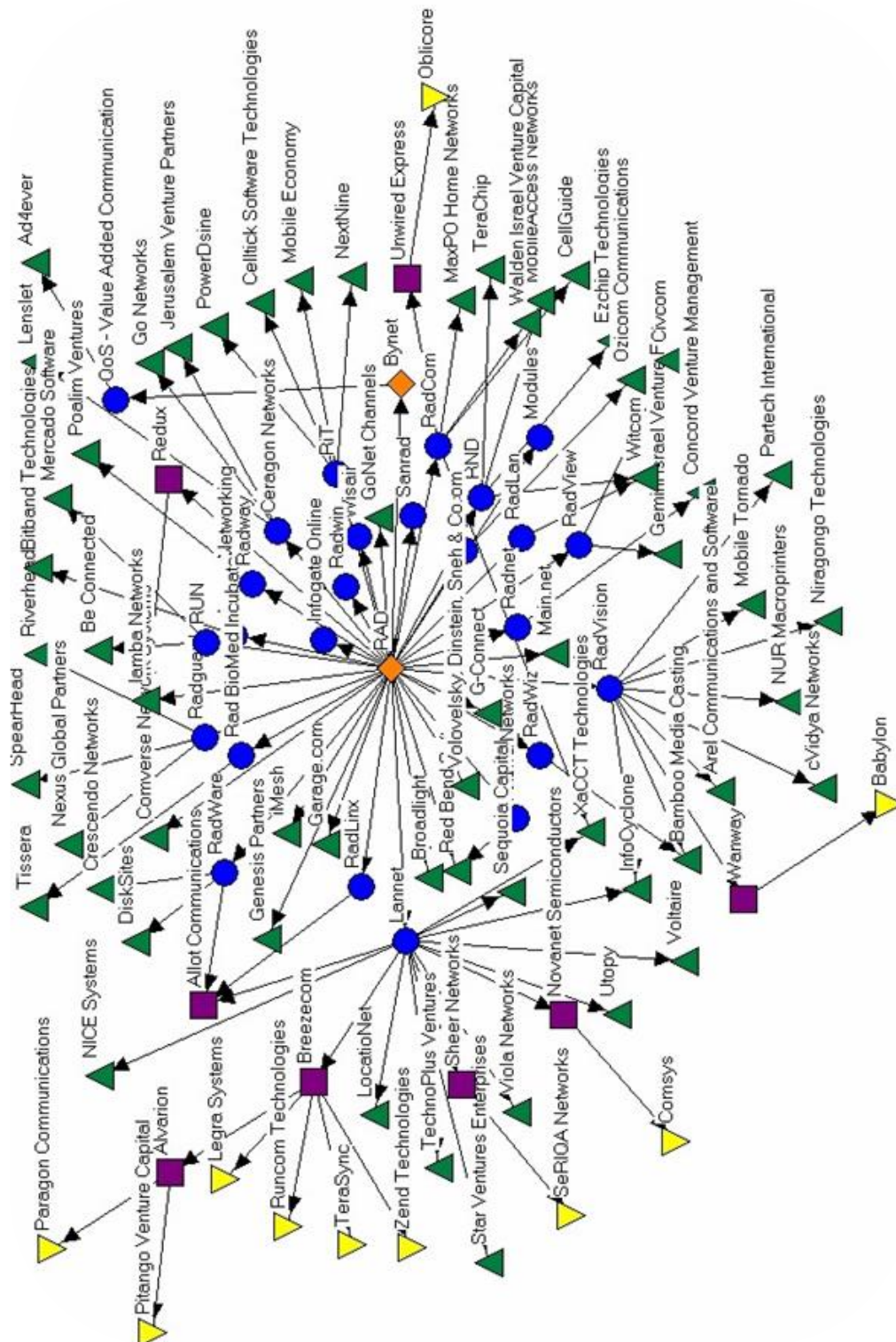
The RAD “cloud”: In the office of Yehuda Zisapel, cofounder of the RAD Group and a pioneer entrepreneur, an unusual graph is posted on the wall (see Figure 4.1).¹ It shows RAD Data Communications at the center surrounded by a cloud of dots, with each dot representing a start-up that RAD had helped create formally or informally. The dots are arranged in concentric circles, each with its color code like ripples in a pond. RAD is the company Zisapel founded in 1981 together with his brother Zohar. The RAD cloud or cluster comprises 128 companies. Though not all survive to this day, many are located not far from RAD’s home office in Ziv Towers on Raul Wallenberg Street in the high-tech area known as Atidim, in Ramat Hahayal, a northern Tel Aviv neighborhood. Together, all high-tech companies in Atidim account for 15,000 well-paid high-tech jobs and billions in export dollars. The success rate is 70 percent. Zisapel and his brother created the RAD cloud of companies starting over 33 years ago and are extremely proud of it. The RAD Group is today an Israel-based global family of independent companies that produce network and telecom software and hardware. It consists of 10 companies, four of which are traded on the Nasdaq stock market. The group’s total revenue in 2015 was about \$1.4 billion.

Yehuda Zisapel explains: “When a creative engineer approaches me, I encourage him or her to start a company. We first appoint a CEO. But from day zero, the infrastructure of the RAD Group creates a full-fledged company with all the necessary functions, in a sense outsourced. Little by little the new company hires its own. There is no holding company. Each company in the RAD Group operates independently, but under a common strategic umbrella. This decentralized approach keeps each business flexible and alacritous, but leverages synergies inherent in small entrepreneurial businesses. It is how RAD is big but manages to feel small. Whenever a market opportunity is identified that needs technology, a marketing approach or corporate culture that does not exist in any of the other companies, a new business is created. This has happened 128 times to create the RAD viral cloud.”

In their 2013 book, *The Evolution of a New Industry: A Genealogical Approach*, Drori, Ellis, and Shapira document six “genealogies”: of Telrad, ECI, Tadiran, Fibronics,

Comverse, and RAD.² Each of these companies spun off numerous other start-ups virally. During the period 1991–95, some 39 start-ups emerged from these six motherships, including 14 from Tadiran, a communications firm founded in 1932, and 13 from Fibronics, an early pioneer in fiber optics founded at the Technion. And the viral process is accelerating; 171 new start-ups emerged from the six founding firms from 1996 to 2000, and 222 during the years 2001–2005.

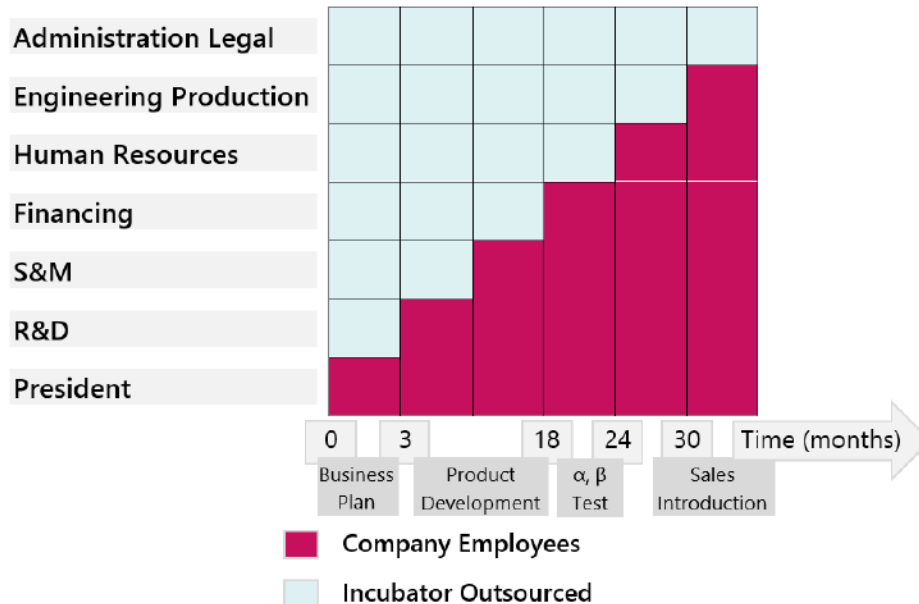
Figure 4.1 RAD Genealogical Map



Source: Frenkel, A., Israel, E., & Maital, S. (2015). The evolution of innovation networks and spin-off entrepreneurship: The case of RAD. *European Planning Studies*, 23(8), 1646-1670.

Yehuda Zisapel, RAD. Used with permission.

Figure 4.2 Start-Up Lifecycle



Source: Frenkel, A., Israel, E., & Maital, S. (2015). The evolution of innovation networks and spin-off entrepreneurship: The case of RAD. *European Planning Studies*, 23(8), 1646-1670.

Yehuda Zisapel, RAD. Used with permission.

► Failure

The Moran “cloud”: Dov Moran’s start-up, M Systems, pioneered the flash memory stick and was acquired by SanDisk for US\$1 billion. Moran next founded Modu, a start-up that sought to produce a modular smartphone. The company was underfinanced and eventually closed. The day it closed, Moran opened a new start-up, Comigo. Fifteen new start-ups emerged from the closure of Modu, including two founded by women. Why would anyone start a new business after losing a livelihood in a failed one? First, successful startup owners understand that entrepreneurship is risky, that most start-ups fail, that there is no shame or blemish in failure, and that failure is an efficient school for future success. Second, starting new businesses is far more interesting and challenging—and difficult—than working for old established ones, despite the risk.

Five Case Studies

We interviewed key personnel at five selected case study companies. The following are the six main areas in which questions were asked:

1. Company formation process
2. Finance and Fund-raising
3. Israeli government support and human capital
4. Reasons for success and failure
5. Exports, international markets, and globalization
6. Policy recommendations that could support the company's success

The case studies offer a brief description of successful ICT start-ups. We focused on the innovation and incubation process. The questions enabled us to describe the origin of the entrepreneurs and the start-up phase. The most important outcomes are the innovative team, the observation of the markets, and product definition that led the entrepreneurs to come with a solution to an unmet need in the marketplace. Other parameters that lead a start-up to succeed and are also covered in the case studies. The following companies were studied:

1. Check Point
2. Wix
3. Silverbyte
4. Ceragon Networks
5. Shadow.com

► Check Point

- Name of company: Check Point Software Technologies Ltd.
- Year of establishment: 1993
- Number of employees: 3,500
- Stage of company: Revenue growth
- Operational area: Software security
- Website: www.checkpoint.com
- Founders: Gil Shwed, Shlomo Kramer, and Marius Nacht
- Target markets: Check Point offers a complete security architecture defending enterprises' networks to mobile devices, in addition to the most comprehensive and intuitive security management.

About

Check Point provides customers with protection against cyber threats, reduces security complexity, and lowers total cost of ownership. Check Point pioneered the industry with FireWall-1 and its patented Stateful inspection technology, which constitutes the foundation for most network security technology today. The company develops new innovations based on the Software Blade Architecture, providing customers with flexible and simple solutions that can be customized to meet the security needs of any organization.

Company Formation Process and Fund-Raising

Check Point was established by the three entrepreneurs in 1993. They worked together during their military service. The vision of the founders was to “secure the internet.” At that time there were only a few dozen websites. The innovative idea of the entrepreneurs was to create a protective barrier between corporate networks and the external world (the internet) in such a way that the rate of incoming and outgoing data would not be slowed down. In addition, this barrier known as a firewall, would grant the user control over the type of incoming and outgoing data.

Upon the establishment of the company, the entrepreneurs raised US\$250,000 from private investors, and the initial development work was done in a garage operation. Since the internet began to develop at that time, there were other competitors with similar ideas; speed in design and time to market were crucial. By the end of first quarter of 1994, the company began to sell its product and meet customers' demand.

At that time the company won best of show title at the INTEROP Exhibition in Silicon Valley and received an indication that the product was important and relevant, with great potential.

Check Point is a company without debt (beyond the initial US\$250,000 raised). Its funding sources are ownership purchase (share offerings) and sales. The company maintains a positive cash flow at all times. Carefully planned work, cost control, and maintaining a positive cash flow are key values of the company since its inception.

Check Point's management made an initial decision not to use the funds from the OCS programs for their R&D operations. The main reason was the OCS requirement to repay the grant through royalties from sales, as well as the desire to stay focused. The company's management expected that income will be higher than external funding. However, in 1998 the company participated in the OCS MAGNET program for two years. In addition, the company received the title of "Approved Enterprise" by the government after having met the criteria for benefits under the Encouragement of Capital Investments. Today, the company has no direct funding or subsidies or other kind of help from the government.

The Advantages and Disadvantages of Establishing a Company in Israel

Advantages

- Entrepreneurship, innovation, and creativity: The company was staffed with workers chosen for their entrepreneurial function and the ability to think with an open mind, as well as knowledge on penetrating the market and reaching the right individuals in the marketplace. All these elements facilitated the establishment of the company and its successful development.
- Cognitive flexibility in thinking: Selected workers (Israelis or Internationals) are capable of rapid response, allowing them to overcome obstacles and to improvise solutions.
- Efficiency and devotion: Team work and joining around a common goal and working hard in order to achieve goals and show results are encouraged. All this is done through effective thinking that is ultimately cost-effective.

Disadvantages

- Since its inception, Check Point chose to have an organizational structure in accordance with global approaches in order to penetrate international markets. This translated into building an Israeli senior management team while retaining a global team of Israeli, U.S., European, and Eastern European staffers. This method offered advantages by allowing the company to recruit the most suitable people globally, without being limited to a particular country. However, a common corporate culture requires building trust, which can be created through personal contact and requires investment in terms of travel, accommodation and schedule adjustments. In addition, it requires instilling a set of shared values and common interests. This is a challenging task to accomplish with 3,500 employees worldwide.
- As a global Israeli company, Check Point needs to invest more effort in bringing an acquired American company to Israel than vice versa.

Reasons for Success

- The concept, product, and solution to the problem were simple, innovative and responded to an unmet need. Check Point's product gave a solution to the user, who did not require knowledge and understanding of the code.
- The market at the time was booming; Check Point entered at the right time.
- The people who were selected to lead the organization, the common goal, the organizational structure, and a mix of local and international employees were key to the growth of the company while keeping a leadership position in the marketplace over time.

Operating in International Markets

Since its inception, the company viewed itself as an international company, targeting international markets with an emphasis on the US. To this end, Check Point set two key principles that still hold today:

- Simplicity: Clients can work with the company's products at any time and in any language.
- Type of sale: A third party (partner or reseller) sells the products to end users using a B2B model. This helps in overcoming cultural and language gaps and at the same time provides a comprehensive understanding of the markets.

Today Check Point is a global company with 50 locations worldwide. The company provides technical support in every country in which it operates and employs sales staff all over the world. The central R&D work and majority of the corporate management team are in Israel.

► Wix.com

- Name of company: Wix.com (NASDAQ: WIX)
- Year of establishment: 2006
- Number of employees: 1,000 (800 in Israel)
- Stage of company: Revenue growth
- Operational area: SAS and internet
- Website: www.wix.com
- Founders: Avishai Abrahami, Nadav Abrahami, and Giora Kaplan
- Target markets: Nontechnical individuals, small businesses

About

Wix.com is a cloud-based web development platform with more than 71 million registered users worldwide. Wix was founded on the belief that the internet should be accessible to everyone to develop, create, and contribute. Through free and premium subscriptions, the Wix Editor and App Market enable businesses, organizations, professionals, and individuals to take their businesses, brands and workflow online and manage an integrated digital presence.

Company Formation Process and Fund-raising

Wix is the brainchild of its three founders, Avishai Abrahami, Nadav Abrahami, and Giora Kaplan, who served together in the Israel Intelligence Unit 8200. In 2006 they raised seed money from private investors to establish a start-up in the field of data. As

part of establishing the company and constructing a website, the three founders discovered that creating their own website was difficult and costly. It was this agonizing experience that led them to build a platform that empowered anyone to create their own website with no coding or design skills needed, for free.

Wix provides hundreds of customizable website templates and a drag-and-drop website builder. Users can add functionalities such as social plug-ins, e-commerce, contact forms, email marketing, CRM, billing, ERP modules, and community forums using a variety of Wix-developed and third-party applications. Wix is built on a freemium³ business model, earning its revenues through premium upgrades. Users must purchase premium packages in order to connect their sites to their own domains, remove Wix ads, add e-commerce capabilities, and buy extra data storage and bandwidth, among other things. The company attracts more than 1.5 million new users each month and has an increasing number of premium subscriptions.

Wix is backed by VC investors. In November 2013, Wix had an initial public offering on NASDAQ, raising about US\$127 million for the company and some of its shareholders. In 2015 the company filed a request to the Ministry of Finance to establish a development center of 100 employees in Beersheba. The request was accepted and confirmed and 25 percent of the employees' salaries in Beersheba facility will be paid by the government.

The Advantages and Disadvantages of Establishing a Company in Israel

Advantages

- Educated human capital is available. As a company that wants to grow and become a major Israeli company, Wix needs to recruit leaders in their field. The company is considered today as one of those sought after by Israeli high-tech workers as a place of employment.

Disadvantages

- It can be difficult for an Israeli public company to raise money from investors. U.S. companies enjoy greater trust in return than Israeli companies. In addition, limited access to investors adversely affects efforts to raise capital.
- There are many regulatory difficulties in Israel that growing companies must face. Rules for listing on the Tel Aviv Stock Exchange (TASE) are different from and more difficult than rules for listing on U.S. exchanges, which makes listing on the TASE almost impossible for companies traded on U.S. exchanges.
- Israeli law makes it difficult to bring foreign workers to Israel. This hampers a global company that wants to bring workers from other countries in order to help the company learn and understand foreign markets.

Reasons for Success

The company does not employ sales people—it uses its nonpaying clients to advertise Wix. The company's name appears on the site built by a customer. Nonpaying customers serve as the company's marketing persons and create free traffic to Wix site. Approximately 50 percent of Wix's subscriptions are from free traffic sources.

Wix offers the necessary tools for managing and promoting a small business in one internet platform. It offers ERP, finance, and analytics modules support in social media and mobile presence. The platform also supports scheduling, billing, payments, logistics, management of inventories, invoices, shipments, possibility for coupons, newsletters, merchandising, and e-mail marketing.

- The business and marketing model has proven successful in generating cash. Results of Q2 2015 show collections of US\$57.4 million and adjusted Earnings Before Interest, Taxes, Depreciation and Amortization (EBITDA) of US\$3.5 million.
- Wix is a leader in its technology and succeeds in staying ahead of its competitors.
- Employees enjoy a friendly corporate culture.

Operating in International Markets

Wix.com is a leading cloud-based web development platform with more than 65 million registered users worldwide from 190 countries. Wix was founded on the belief that the internet should be accessible to everyone to develop, create, and contribute. Wix's headquarters are in Tel Aviv, with offices in San Francisco, New York, and Miami in the United States, Vilnius in Lithuania, and Dnepropetrovsk in the Ukraine.

► Silverbyte

- Name of company: Silverbyte
- Year of establishment: 1992
- Number of employees: 70
- Stage of Company: Revenue Growth
- Operational area: IT & Enterprise Software: Enterprise Applications
- Website: www.silverbyte.com
- Founders: Avi Moscona, president and cofounder, and Amnon Zusman
- Target markets: hotels, restaurants, hospitality companies

About

Silverbyte is a supplier of management technology software solutions to the hotel and hospitality industry. The company holds about 75 percent of the Israeli market.

Silverbyte's Optima Line platform can be operated either as a system installed at the customer's premises or as cloud software. Optima Hotel Management Software represents a unique solution for hotel groups connected to the leading online global reservations systems.

Company Formation Process and Fund-Raising

The founders previously worked in senior positions with large defense organizations and decided to start a company in the field of hospitality software. As part of a strategic move, MER Telecommunication entered as a partner and bought some of Silverbyte's shares. This enabled the company to develop a complementary product that helped in marketing the main platform.

The company has been profitable over the past 20 years of operations thanks to its technological leadership and command and control of details. In addition, the company is monitoring the dynamic and changing environment in which it operates and rapidly responds to changes in the marketplace.

In 2000 the company received a grant from the Office of the Chief Scientist to further develop its Optima Platform. At its inception the company did not seek to raise money from outside investors. The founders used private and family funds to run the company and grew with the market. They used credit lines from one of the banks in Israel. This was part of management's philosophy to keep control and manage the company according to its values.

The Advantages and Disadvantages of Establishing a Company in Israel

Advantages

- The Israeli market needed a local company that understand technology as well as the local culture.
- Israel's knowledge workers are creative and open to new ideas. They challenge other ideas and sometimes disagree with others, thus creating a fruitful dialogue.
- Corporate culture in Israel is non-hierarchical, which contributes to creativity and innovation.
- Israeli companies often enjoy a good reputation.
- The government encourages exports by giving tax deductions to companies that have significant levels of exports.

Disadvantages

- Israel's location, which is far from the key markets, is a disadvantage in terms of marketing internationally.

- Today the company is using local agents to sell in foreign markets. However, the company is aware that in order to increase its growth rate through exports, it will need to establish overseas offices.

Reasons for Success

- Silverbyte invests in research and development because of changes in the marketplace. A significant percentage of income is reinvested in R&D, leading to technological innovations and creativity. This approach enables the company to introduce innovative products or high quality and high rates of customer satisfaction.
- Listening to customer experience and being ready to change are key to the success of the company.
- It is the company's policy to recruit talented employees that are motivated and have the ambition to succeed.
- There is an open channel of internal communication, and management cares about feedback from its personnel. Turnover of employees is extremely low. More than 50 percent of the employees and managers of the company are women, and the company attributes its success to this attribute.
- The company embraces a positive attitude to criticism and failure. It is customary to say in the company that the truth resides in the smallest detail and understanding the importance of auditing and investigations of faults and failures. This approach allows management to draw sound conclusions, quickly apply corrections, and receive real-time reports from the workforce.

Operating in International Markets

Silverbyte exports its products to 25 countries, including the United States, Germany, Belgium, the United Kingdom, Spain, Russia, Switzerland, Philippines, and South Africa, to name a few. Revenues from exports are significant.

► Ceragon Networks

- Name of company: Ceragon Networks
- Year of establishment: 1996
- Number of employees: 430 in Israel; 1,000 international
- Stage of company: profitability growth
- Operational area: communications
- 2014 revenues: US\$371 million
- Website: www.ceragon.com
- Founders: RAD Group and entrepreneurs

- Target markets: Fixed and mobile communications service providers, telecommunication network operators, mobile service providers

About

Ceragon Networks is a provider of high-capacity microwave Ethernet and TDM wireless backhaul and front haul equipment to wireless service providers as well as private businesses. The company offers Short-Haul and Long-Haul high capacity, point-to-point microwave systems in licensed spectrum (6–42 GHz) as well as sub-6 GHz and V-band (70–80 GHz) spectrum range.

Ceragon provides wireless backhaul and front haul solutions that enable mobile operators and other wired/wireless service providers to deliver 2G/3G, 4G/LTE and other broadband services to their subscribers.

Today Ceragon's solutions are deployed throughout a customer base of over 430 mobile service providers and hundreds of private networks in over 130 countries. The company's solutions support all wireless access technologies, delivering more capacity over longer distances under any given deployment scenario. Customers of Ceragon depend on the company expertise and partnering approach to provide wireless backhaul solutions that meet today's needs while guaranteeing a comfortable and cost-effective path to future requirements.

Company Formation Process and Fund-Raising

The company was established as part of the RAD Group. Its products and services are based on technology used by the entrepreneurs during their military service. In light of the growth in the telecommunication market, they wanted to use that technology and adapt it to the civilian microwave communication market. The company experienced significant growth during the high-tech boom of the communications market in the early 2000s. Ceragon Networks was first listed on the NASDAQ on September 6, 2000 (symbol: CRNT). As a result of the 2001 economic crisis and weakening in its markets, sales decreased and the company was forced to reduce its workforce and restructure its operations in order to improve its profitability. In 2007 Ceragon released the first packet-based microwave platform in the industry, the FibeAir IP-10 platform, which awarded the company with the Best of WIMAX World Award in the category of Industry Innovation. In 2011 the company acquired Nera Networks in order to expand its market share in Africa and Latin America. In 2013 Ceragon launched its IP-20 platform—a single platform serving all radio transport technologies. This Software-Defined Networking (SDN)-ready platform contains a product line for wireless backhaul that is powered by a common software-defined engine, marking a strategic milestone for the company. Today the company's goal is to continue growing through sales and the acquisition of companies abroad.

Using OCS Funds

In 2000, the company used OCS funds for development. However, it was decided later not to use the OCS programs due to "a rolling loan" effect that did not fit with the company's management philosophy. In 2014 the company joined two OCS MAGNET consortia on top of its yearly approved generic plan. This enables the company to be involved in developing new core technologies and share knowledge with other participating companies.

Reasons for Success

- Over years of operation, the company has been able to change direction after the collapse of some markets and enter new growth markets in accordance with the changes that have happened in the industry.
- The company's ability to maintain its technological leadership in relation to its competitors has underpinned success.
- Innovation in production processes, and not just in technological R&D, enables the company to have affordable and competitive production.

International Marketing Activities

The company has established a sales network scattered across 51 countries. About 45 percent of production is undertaken in Israel, with the remaining 55 percent divided among three global production centers.

As a multinational company, the biggest challenge faced by Ceragon is recruiting people abroad and overcoming cultural differences that exist for an Israeli company operating in foreign markets.

As an Israeli company operating and competing in the international market, the most important indicator for success is the quality of its products.

► Shadow Technologies

- Name: Shadow Technologies
- Year of establishment: 2013
- Number of employees: 15
- Stage: R&D
- Market and field of operation: Internet
- Website: www.shadow.com
- Founders: Eli Mashiah and Israel Mazin
- Target markets: End users

About

The company is developing a search engine platform, Shadow, which helps to collect and summarize what people say about any topic, product, or person on review sites, social networks, and news sites. The platform enables web surfers to express their views, votes, and opinions on anything. Shadow also provides a platform for business owners to create and maintain their business pages, update information, and respond to users' comments. Shadow summarizes reviews from numerous sources into a small set of key statistics.

Company Formation Process and Fund-Raising

The idea for the start-up was born when the entrepreneurs noticed that there is an increasing importance to "what people say on all sorts of things" during the process of decision making before purchasing.

The two founders of Shadow have worked together before and have a shared record of success. In 1990 they established a company in the field of information security (Memco Software). It merged in 1998 with Platinum Technology Corporation and in 1999 was acquired by Computer Associates. The two founders recruited others to their new start-up in order to develop the concept and establish a cohesive team to lead the company. The previous success enabled the entrepreneurs to invest their own capital and in addition they raised funds from private investors. By 2015, the company has raised US\$3 million.

The company did not use any funds from the Office of the Chief Scientist or other government support.

Advantages and Disadvantages of Establishing a Company in Israel

Advantages

- Workers were chosen for their creative thinking, flexibility, and innovative thinking.
- There is good networking and communication among technology companies in Israel.
- Many successful new companies in the internet sector have been established, creating a large pool of people who understand the field well, which strengthens the flow of ideas.

Disadvantages

- The costs of R&D personnel are high. Most of the development is done in Israel and parts are outsourced to personnel in developing countries in order to reduce development costs.
- There is difficulty in recruiting skilled workers with the experience in working and managing lean software development activity.⁴

- There is increased competition for creative, open-minded, and knowledgeable people.

Reasons for Success

The company builds on the experience of people who know a particular technological field. Business networking has helped in promoting the platform and increasing prospects for future investment. The fact that the company was able to raise money from private investors was helpful. Using advanced technologies and around them building good technological and professional relationships with large companies was key. In addition, the company was able to purchase another company whose technology contributed to the development of the Shadow product.

Possible Reasons for Potential Failure

One of the problems faced by a company targeting the end consumer market is the difficult and dangerous chasm known as Death Valley. Many internet companies fail at this transition is between the seed stage and the next round of raising investment money from a VC. To succeed the company must prove itself in terms of traffic and number of internet users.

It is difficult to do so if you are an Israeli internet company. It would have been much easier if the company were located in Silicon Valley, where many opinion leaders, relevant knowledge, and extensive networking exist.

Operating in International Markets

Shadow has developed technologies to suit the worldwide market. However, currently most of the efforts are focused on the U.S. market.

Conclusions

Whether or not to use OCS grants is an individual company decision. Some companies did not use them because of bureaucratic issues involved in the process of applying and receiving the various grants. The decision is also highly dependent on the technological field and current trends in the industry. For example, the cybersecurity field is currently a popular field and it is relatively easy to raise more "attractive" money from different sources as compared to the funds from the OCS. Moreover, it is the policy of some companies such as Check Point and Shadow not to use the OCS grant.

In order to incentivize high-tech companies located in the center of Israel to open R&D branches in peripheral zones like the southern and northern parts of Israel, the government offers a program through which it subsidizes manpower salaries. Wix took

advantage of this opportunity and decided to open a new R&D branch in the Negev area, where it will employ 100 engineers.

The Tel Aviv Stock Exchange (TASE) is in decline. The number of public companies listed on the TASE fell by 27 percent, from 654 in 2007 to only 475 in 2014. Up to a fourth of current listed firms are thinking of delisting. TASE is fading, with both falling turnover and lower numbers of listed firms, according to Yossi Beinart, chief executive officer of TASE, who spoke at the first Israel Growth Conference, held on June 1, 2015 at the TASE offices. Ceragon is an example of a company that was listed on the TASE in late 1990s and later, in 2000, was also listed on NASDAQ. Today the company enjoys the duality. Since then regulations have become stricter, requiring companies to face complex issues in comparison to other stock exchanges. Wix as a newly growing company was listed only on NASDAQ and not on TASE because of regulations that made it difficult for their management.

From all the above case studies the following should be pointed out:

- A company must respond to a real unmet need in the market.
- None of the companies are me-too companies.⁵ In other words they have a unique response to an unmet need in the market.
- A cohesive team is a key to success.
- High-level human capital that is creative, innovative, hardworking, open minded, and experienced is essential.

Notes

¹ The example is based on Frenkel A., E. Israel, and S. Maital. 2015. "The Evolution of Innovation Networks and Spin off Entrepreneurship: The Case of RAD," *European Planning Journal* 23 (8): 1646–1670 [<http://www.tandfonline.com/doi/abs/10.1080/09654313.2014.998171>]

² Drori, I., Ellis, S., & Shapira, Z. (2013). *The evolution of a new industry: A genealogical approach*. Stanford University Press.

³ The word fermium is a combination of the words free and premium.

⁴ Lean Software Development (LSD) is basically a process that enables to optimize the development using minimum possible time with optimal use of human capital in order to get the best robust result at minimum cost

⁵ The "me-too" label is applied when a company enters a crowded market of highly visible competitors. A company's me-too product is one that is designed to be similar to a very popular product made by another company in the marketplace.

5 Learning from the Ingredients that Make Israel a “Start-Up Nation: Replicability to Emerging and Developing Nations

What are the ingredients that made Israel a start-up nation? Are they distinctive or are they generic? If the ingredients are generic, how can emerging and developing countries replicate them? To address these questions: (i) we compare Israel to Singapore, an innovative high-income economy that has also sought to promote an entrepreneurial ICT culture but followed a different path than Israel; (ii) we analyze the absorptive capacity and the readiness to replicate innovation support programs in two countries—Poland, an emerging economy, and Armenia, a developing one.

A prerequisite for the successful replication of Israel’s experience in a developing country is sufficient absorptive capacity. World Bank studies of absorptive capacity in Eastern Europe and Southern Africa show that there are important complementarities between innovation and absorptive capacity. “For a country to be able to reap the benefits of increased access to international technological knowledge, it requires some minimum prerequisites. The ability for firms to absorb technology to a large extent depends on the skill levels of its labor force and the managers. In addition, R&D has proved to be increasingly important to technology absorption in addition to ‘new to the world’ innovations.”¹

The World Economic Forum’s *Global Competitiveness Report 2014–2015* classifies countries by their stage of development.² Singapore and Israel are classified in stage three, the innovation-driven stage of development. Poland is in transition between stages two and three, and Armenia is in stage two, the efficiency-driven stage. In the rest of this chapter, we present the Israeli success ingredients, briefly introduce the Polish and Armenian economies and innovation cases, and finally discuss the replication examples of success ingredients in each of these two countries.

► What are the Ingredients that Made Israel a Start-Up Nation?

This chapter analyzes the ingredients of the Israeli experience in order to distil lessons for developing countries. We identify ingredients that could be replicated in and adjusted to the conditions of other economies in contrast to distinct ingredients that are hard to replicate, such as the spillovers from defense to civilian R&D or the immigration of scientists and engineers from the former Soviet Union.

A key success ingredient is the important role that the Israeli government played in subsidizing the emergence of the private sector. The government’s intervention allowed the private sector to develop so that today the economy is driven by the private sector with strong orientation toward international markets.³ The emergence of the private sector was no small feat for a country that was originally founded on a

socialist ideology and dominated by state-owned and union-owned companies. A brief description of the other ingredients follows:

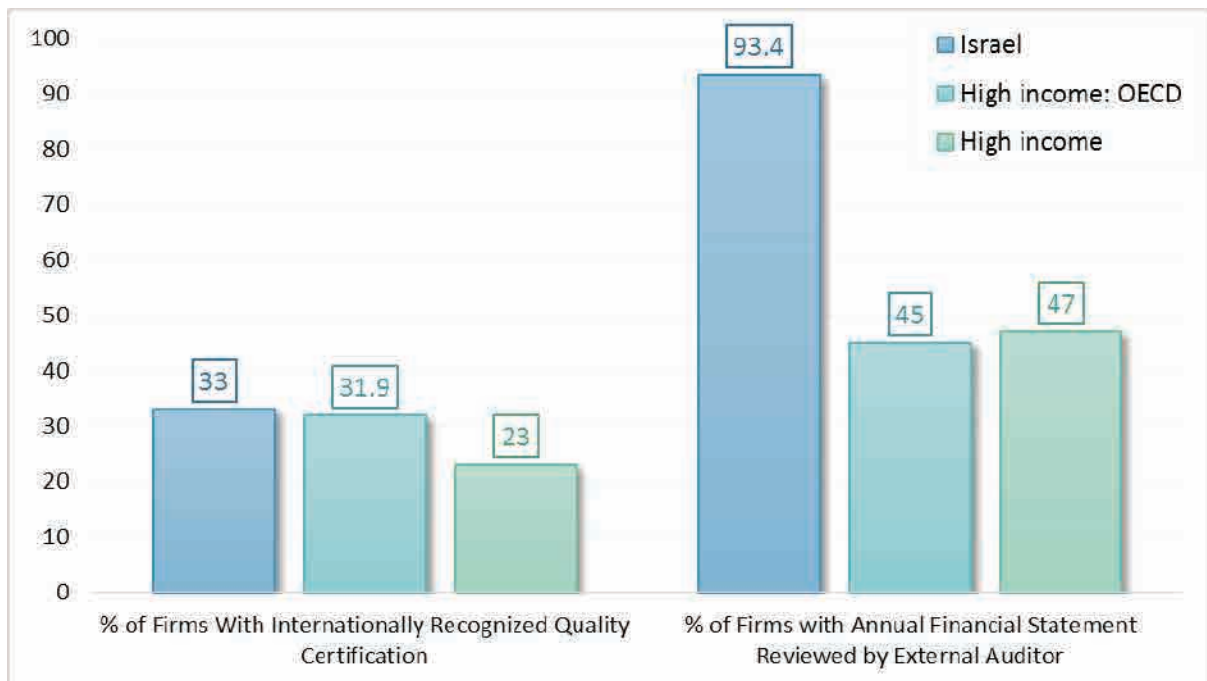
1. The birth of the Israeli R&D-based industries is attributed to the country's strong defense sector after the 1967 War and to defense R&D cooperation with the United States, Germany and France. The close synergy has another success ingredient: Israeli defense industries have traditionally focused on components, electronics, avionics, and other systems. The development of these auxiliary systems has also given the high-tech industries an edge in civilian spinoffs in security, electronics, computers, software, and the internet sectors.
2. The availability of a skilled workforce is another success ingredient of the Israeli ICT sector. Public investment in higher education facilitates the training of high-quality engineers and scientists and is vital for supporting research in universities. Novel ideas, technologies, and inventions originating from universities benefit the high-technology sector through academia-industry partnerships and can be utilized for the creation of new products and processes.
3. Another key ingredient is Israel's national innovation ecosystem, which includes the legal framework introduced by the R&D Law and government support programs via the OCS. The legal framework and the OCS programs are amenable to replication. Impact analysis studies evaluating the results of these programs have been conducted and could be useful for assessing the modifications required in the programs' replicability to other environments.
4. Immigration was also integral. In a global economy, international networking becomes a key competitive advantage. Israel has benefited from immigration of skilled populations from the diaspora, who contributed to the development of highly ranked research universities. Since 1990, large-scale immigration from the former Soviet Union included a high share of scientists and engineers.
5. Investment incentives such as the Law for the Encouragement of Capital Investment were introduced in Israel when international trade agreements were less stringent than today and countries such as Korea subsidized capital investment. Today, massive subsidization of capital investment is more problematic.
6. Openness and transparency of information is another success factor in the development of an ICT sector and the inclusiveness of other sectors. The government should ensure that there is access to information concerning technology, markets, and more.
7. Availability of finance is crucial for the success of the high-technology industry. This should be available on a competitive basis in academia and in all the stages of the innovation process, starting with the pre-seed stage even before a start-up company is established.
8. A culture of risk-taking, audacity, and an out-of-the-box mentality are essential. In Israel, personal strength stemming from a solid inner-core of decisiveness is considered a crucial aspect of a mature identity. Daring or *chutzpah*, independence, self-confidence, and assertiveness are highly respected in Israel. Social and

professional structures are non-hierarchical and workers are encouraged to debate, question, provide constructive criticism and speak their minds.

These ingredients are used in the next section for comparison with Singapore and the following section. The ingredients are also being used in the analyses of Armenia and Poland, to explore whether their innovative and absorptive capacity suffice to learn from Israel and Singapore.

Figure 5.1 presents the innovation capability of Israel with respect to high-income OECD countries and high-income countries in general. From the figure we can see that Israel scores well.⁴

Figure 5.1 Innovative Capabilities of Israel with Respect to OECD Countries



Source: The World Bank Group, 2015. Israel Country Profile 2013.

<http://www.enterprisesurveys.org/~media/GIAWB/EnterpriseSurveys/Documents/Profiles/English/israel-2013.pdf>

Comparison with a Similar Country: Singapore

We compare Israel to Singapore, an innovative high-income economy that has promoted an entrepreneurial ICT culture, like Israel, but followed a different development path. Both Singapore and Israel place high in innovation rankings. In the Bloomberg Innovation Index⁵, Israel and Singapore rank fifth and eighth, respectively.

However, the two countries differ significantly in their GDP per capita (in current US\$): in 2013 Israel's was US\$36,050 and Singapore's US\$55,182.⁵

Bloomberg's 2015 ranking of the world's 50 most innovative countries takes a straightforward approach to the question, focusing on six tangible activities that contribute to innovation. These six activities are: R&D, Manufacturing, High-Tech companies, Education, Research Personnel, and Patents.

A 2015 *Harvard Business Review* essay illustrates the similarities between Singapore and Israel: both benefitted from skilled immigration and both have mandatory military conscription. The Singaporean National Framework for Innovation and Enterprise (NFIE) drew inspiration from a joint program between Israel and the United States called the Binational Industrial Research and Development Foundation. NFIE eventually helped bring a flood of diverse investors into Singapore by offering to put up 85 percent of the capital in a start-up.

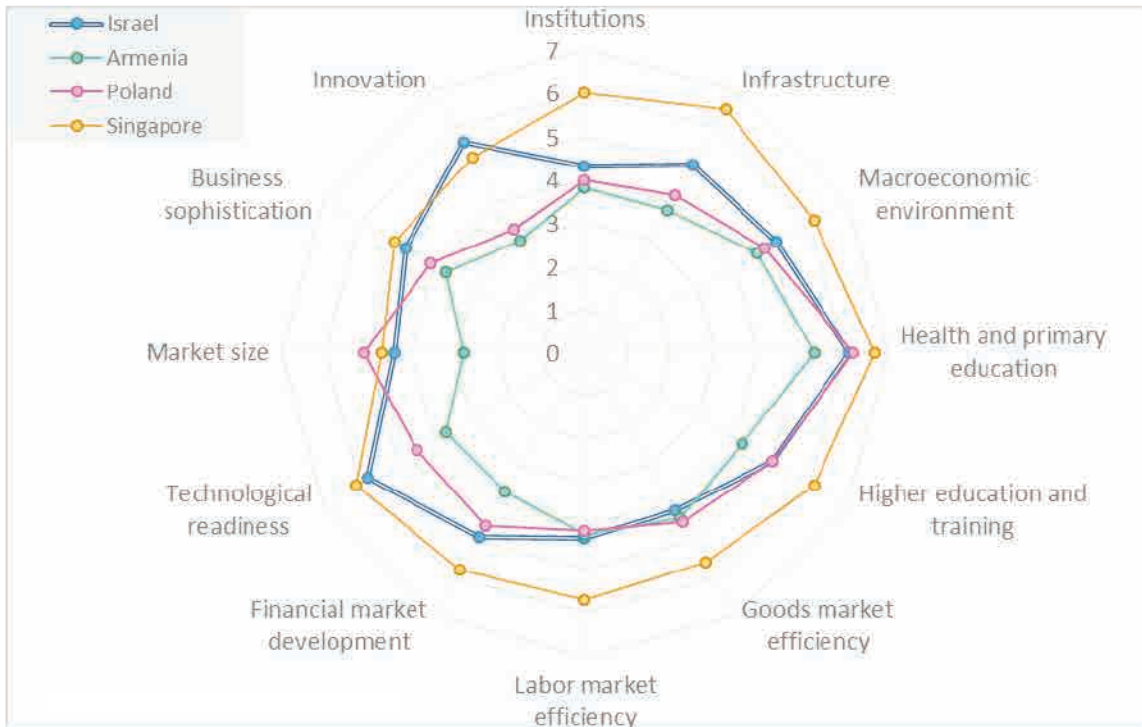
A study by Deloitte and Trigger-Foresight⁶ consulting, funded by Google Israel, compared the impact of Israel's tech economy on the country's overall economy to the same situation in Singapore. Israel, according to the study, is a world leader in the size of its "internet economy," but its internet economy has not translated into economic benefits for the non-ICT sectors, as it has in Singapore. The GDP for both countries was similar throughout the 1980s—but then Singapore's GDP took off, leaving Israel behind.

The different performance of these two economies could be related to the productivity differences in the non-ICT sectors. The productivity in the non-ICT sectors in Israel has shown low performance while ICT flourished. The local R&D in the ICT sectors seldom had any impact domestically. Despite the proximity, there hardly were any innovation complementarities with the rest of the economy.⁷ Most of the investments in ICT in Israel focus on ICT manufacturing companies, while there is insufficient investment in ICT technologies in traditional and mixed-traditional technology sectors. Other countries such as Singapore understand that the more significant economic advantages of ICT come from sectors that utilize, rather than produce, ICT. International experience indicates that investment in ICT in traditional industries and in the services sector may lead to improving efficiency of these industries. For example, in the United States the services sector was the primary contributor to GDP growth in the past decade, in large part due to its adoption of advanced ICT (see, for example, Walmart). The 2008 report "Israel 2028: Vision and Strategy for Economy and Society in a Global World"⁸ concludes that Israel can learn three key lessons from Singapore's experience. First, it could have a single-minded dedication to engineering. Second, it could place emphasis on world-class education, above all excellence in math, as a foundation for educating engineers. In fact, Singapore ranks near the top in

Programme for International Student Assessment (PISA) international tests in science and math. Third, it could develop excellent infrastructures.

The comparison between Israel and Singapore is illustrated in figure 5.2.⁹

Figure 5.2 Global Competitiveness Index: Israel, Singapore, Poland, and Armenia



Source: Samuel Neaman Institute Processing based on tables 5, 6, 7 on pages 16-20 of Schwab, K., & Sala-i-Martin, X. (2015). World Economic Forum's Global Competitiveness Report, 2014-2015. Retrieved from: http://www3.weforum.org/docs/WEF_GlobalCompetitivenessReport_2014-15.pdf

5.1 Replication in Poland and Armenia

In this section, we identify ingredients that could be replicated in and adjusted to the conditions of Armenia and Poland in contrast to distinct or unique ingredients that are difficult to replicate.

Both Poland and Armenia have experienced transitions from a planned economy to market economies since the 1990s. Since the collapse of communism in 1989, Poland's economy has grown by more than that of any other country in Europe and was the only European economy to avoid a recession during the global crisis in 2008. Poland is located next to the EU's biggest economy, Germany, and is used as a springboard for doing business in the Central and Eastern Europe. Poland joined the European Union

in 2004 and still receives significant aid from the EU as “structural funds,” partly as grants to small and medium enterprises (SMEs) and start-ups.

The Armenian economy is landlocked and disadvantaged in trade and transport due to strained relationships with neighbors Turkey and Azerbaijan. Its main trading partner is Russia and it joined the Russian-sponsored Eurasian Economic Union rather than link with the EU as its neighbor Georgia did. Although the share of high-tech in total exports was less than 3 percent in 2012, the IT industry is one of Armenia’s fastest-growing sectors. Armenia has a long history as a science hub of the former Soviet Union.

Armenia benefits from close ties with the Armenian diaspora’s scientific communities, entrepreneurs, and investors. Israel’s development is perceived as a model by many in Armenia: Israel prospered in spite of its closed borders with hostile neighbors, and it did so by developing high technology exports of nontangible goods like ICT, which bypass the distance from markets. Many Armenians expect their diaspora to fulfill an active role in the ICT, education, and tourism sectors. For example, according to Noubar Afeyan, an entrepreneur and venture capitalist based in Boston, MA, Armenia does have a large network of people in the diaspora who are engaged in venture capital and can be called upon. Yet he believes that a large state-driven, state-managed venture capital effort is bound to fail.¹¹ Expat communities of migrant workers from developing countries could play this role also if they are not diaspora communities per se, e.g. ICT professionals among Caribbean populations in the US, Canada and the UK take an interest in the sector’s development at home.

Innovation support programs and instruments in Poland and Armenia have been inspired by various long-standing programs in other countries. For example, programs such as matching grants for R&D, SMEs, and start-ups have been pioneered by government agencies such as the U.S. Small Business Innovation Research (or SBIR) program, the Finnish Funding Agency for Innovation (TEKES), the Singaporean Ministry of Trade and Industry, and the Israeli OCS and the Israel Small and Medium Enterprises Authority.

Innovation support in Poland is funded mostly by the EU’s Operational Program for the Innovative Economy and is managed by the Ministry of Economy and implemented by the Polish Agency for Enterprise Development.¹² Another key agency supporting innovation is the National Center for Research and Development (NCBIR), which is the implementing agency of the Minister of Science and Higher Education. An example of the learning process between Israel and Poland is the collaboration in 2010 between the Israeli MATIMOP (see chapter 2) and the Polish NCBIR to support joint R&D projects involving parties from both countries. Another example is the establishment of the fund Giza Polish Ventures I, with investments of the Israeli Giza Venture Capital and the National Capital Fund, owned by the state-owned Bank Gospodarstwa Poland.

Unlike Poland, Armenia cannot rely on the EU to support its innovation system. Bilateral aid from donors is limited, and Armenia's budget is hardly in a position to provide generous support to innovation. One modest but important innovation support instrument has been inspired by the Israeli incubators experience: the Enterprise Incubator Fund (EIF). The EIF is a technology business incubators and consulting company established in 2002 within the framework of the World Bank's Enterprise Incubator Project. The design of the EIF was based on a "Feasibility Study for the Establishment of Technological Incubators in Armenia (1999–2001)," funded by the World Bank and implemented by the Israeli consulting company BSA.¹³

Conclusion

This chapter analyzes both the distinctive and generic ingredients that make Israel a "Start-Up Nation". The objective was to see which of these could be used by other countries to build their own high-tech industries. The conclusion is that while some ingredients of the Israeli and perhaps the Singaporean experience, such as the defense and historical legacy, might be difficult to replicate, major ingredients such as human capital, a helpful legal framework, R&D, and infrastructure can be used as models of learning and replication.

Notes

¹ Fostering technology absorption in southern African enterprises. World Bank, 2011., (pp. 34).

² Schwab, K., & Sala-i-Martin, X. (2015). World Economic Forum's Global Competitiveness Report, 2014-2015. Retrieved from http://www3.weforum.org/docs/WEF_GlobalCompetitivenessReport_2014-15.pdf

³ Lopez-Claros, A., & Mia, I. (2006). Israel: Factors in the Emergence of an ICT Powerhouse. Global Information Technology Report 2005–2006, 89-105.

Chicago Trajtenberg, M. (2009). 26. Innovation policy for development: an overview1. The New Economics of Technology Policy, 367.

⁴ World Bank. 2013. Israel Country Profile 2013. Washington, DC: World Bank [<http://www.enterprisesurveys.org/~media/GIAWB/EnterpriseSurveys/Documents/Profiles/English/israel-2013.pdf>]

⁵ Bloomberg, 2015. Bloomberg Innovation Index. [Online] Available at: <http://www.bloomberg.com/graphics/2015-innovative-countries/>

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- ⁶ Google Israel, Trigger-Foresight and Deloitte Brightman Almagor Zohar, 2013. Promoting Innovation and Growth Through Information and Communication Technologies. [Online] Available at: https://ennovate.withgoogle.com/uploaded-files/AMIfv95SEVnwHJGtwoPU7u6_yXIf-fMoie3k4jHw0aF0GOSe94gKqIjZkBq7bSZPbBY9ItivEAtwzQR8H-4PxuMXrDFF0QCEO8aZGyWyAS6wlr_dCF62sykN13Z99pJ4Yehi6E8uLldB8OYUS0iM8IJmc_Tsij3JZRGKbNkR7kLo3os_AaTzUcA
- ⁷ Teubal, M. 2013. "Promoting High Technology Entrepreneurship in Israel," [http://www3.grips.ac.jp/~gist/en/events/document/gistseminar_52_2.pdf]
- ⁸ Brodet, D. (Ed.). (2008). Israel 2028: Vision and Strategy for Economy and Society in a Global World. US-Israel Science and Technology Commission and Foundation.
- ⁹ The Global Competitiveness Index (GCI), published by the World Economic Forum, provides twelve pillars that presents how each country compares to other economies along different dimensions of economic competitiveness, including innovation and some of its driving factors.
- ¹⁰ World Economic Forum. 2015. The Global Competitiveness Report 2014–2015. [<https://www.weforum.org/reports/global-competitiveness-report-2014-2015>]
- ¹¹ Interview with Noubar Afeyan by Itzhak Goldberg, June 13, 2014, Yerevan.
- ¹² Kapil, Natasha, Marcin Piatkowski, Ismail Radwan, and Gutierrez, Juan Julio Guitierrez. 2013. Poland—Enterprise Innovation Support Review: From Catching Up to Moving Ahead. Washington, D.C.: World Bank [<http://documents.worldbank.org/curated/en/2013/01/17291471/poland-enterprise-innovation-support-review-catching-up-moving-ahead>]
- ¹³ Interviews with Itzhak Goldberg of the World Bank and Benjamin Bachrach of BSA Israel, The Speaker, November, 22, 1999.

6 Conclusions and Lessons for Emerging and Developing Countries

The World Bank's Growth Commission (2008)¹ chaired by Nobel laureate Michael Spence wrote in the chapter on "The Art of Policy Making" that "It is relatively easy to identify the shared characteristics of the high-growth cases and easy to appreciate their collective importance. But it is hard to know how to replicate these characteristics." Similarly, it is easier to identify the success ingredients of innovation success cases like Israel than to replicate them. In chapters 1–5 of this report we identify the ingredients of the Israeli case, and in this chapter we address the challenge of replicating these ingredients in other countries. To conclude this report, we (i) sum up the development of Israel's ICT and innovation and (ii) highlight the lessons for emerging and developing countries.

The conditions for the development of the "Start-Up Nation" have been growing since the 1980s, when there was an adjustment in the government's attitude toward the private sector from socialist ideas and preferential treatment of state-owned and union-owned enterprises in the 1950s to liberalization, openness in foreign trade, and a strong market economy. Israel's economy became a hub of technological innovation. "Its companies have developed voice mail, an ingestible video camera that fits inside a pill, the USB disk on key, and many more important and ubiquitous products."² The lesson from this history for developing countries, some of which have undergone conflicts and instability, is that success is possible in spite of a difficult history and a precarious political situation.

The innovation ecosystem model that we describe in this case study is based on two key economy sectors:

- The research sector, which is driven by research universities
- The commercial sector, which is driven by the private sector

The players in this innovation ecosystem include physical resources such as funds, equipment, and facilities as well as human capital, such as students, faculty, staff, industry researchers, and industry representatives. Both are crucial to the ecosystem's success. The institutional entities participating in the ecosystem include the universities, transfer technology offices at universities, some of the colleges, business schools within the universities, business firms and enterprises, venture capitalists, industry-university research institutes, government supported Centers of Excellence within the universities, the military, and, last but not least, the government and local economic development and business assistance organizations and funding agencies.

In this report we identified several ingredients that explain the success of the Israeli innovation model and the emergence of the "Start-Up Nation." Some of these

ingredients are distinct or unique to the Israeli culture. Yet many are generic and thus can be replicated in other countries. As they have been discussed in detail in the previous chapters, we list them briefly below.

► Lessons and Ingredients that Could Be Learned and Replicated

1. Investment in education (primary, secondary, and tertiary) is a key enabler in the development of high-tech industry. Expenditures by government on tertiary education are essential to support research universities that will not only generate basic research but produce engineers and scientists. This human capital is the most important asset in establishing an ICT sector.
2. Taking advantage of the diaspora is important. Expats who acquired advanced degrees and experience in the West and come back to their home countries can generate development of a high-tech economy in developing countries.
3. Connectivity (whether over the internet or mobile phones) is increasingly bringing market information and financial services to those who need them. The experiences of the successful start-ups studies in this report (for example, Wix and Shadow) show that the mobile platform is emerging as a powerful way to extend economic opportunities and key services to millions of people.
4. Encouraging innovation and business expenditures on R&D through good governance is essential. This will, eventually, lead to investments by the private sector.
5. A national innovation ecosystem, the climate in which innovators and entrepreneurs operate, is a necessary albeit partial condition for replicating the success of the Israeli model. The ecosystem must be complemented by research universities, a skilled labor force, R&D investment, entrepreneurial spirit, and a risk culture.
6. Government interventions in Israel were designed to not hamper the emergence of the private sector. First, business expenditures in R&D are about 85 percent of total R&D investment. Second, privatization of the country's incubators started in 2000. This development was due to the rapidly growing private venture capital industry that traditionally did not fund such projects. As of 2015, there were 24 private technological incubators that were partially supported by the Office of the chief Scientist (OCS). Third, the OCS's support programs are designed to avoid crowding out of private funds that would have been used to finance the project had the government support not been granted.³ Developing countries could learn from the OCS how to design such instruments.
7. From the beginning, the OCS did not try to pick "winners" but rather responded to market demand.⁴ The OCS followed neutrality up until 10–15 years ago, when more targeted policies in biotechnologies and nanotechnologies were initiated. The Israeli policy shifted from horizontal toward thematic R&D support, now with specific domains and sectors under its scope.⁵ In the early stages of the development of the innovation economy in Israel, neutral policies proved

successful, and the lesson from this sequencing of policies is that governments in developing countries might consider avoiding sector targeting (picking winners) in the early stages of building their innovation economies.⁶

8. International cooperation with academia and industry is essential for the success of the Israeli model. To enhance internationalization of R&D, governments should support for example, binational R&D funds that will choose projects on a competitive basis. Admittedly, some of the ingredients that allowed Israel to internationalize are distinct and hard to replicate: (i) spillovers from defense R&D⁷ and (ii) a supportive diaspora, well represented in the international R&D community. As noted in chapter 5, the lesson from comparing Armenia to Israel is that while some ingredients of the Israeli model, such as the military and historical legacy, might be hard to replicate, major ingredients such as human capital, legal framework, R&D and infrastructure can be models of replication.
9. The development of the ICT sector in Israel has been export-led and only recently did Israel realize the consequence of a lack of diffusion of ICT to other sectors of the domestic economy. It is now actively changing policy. Larger countries may choose a combination of export- and domestic-led strategies but undoubtedly the pressures and discipline of international competition are essential for innovation. Not surprisingly, a small country like Armenia followed an export-led development of its ICT sector from its inception.

► Technology Absorption Versus Innovation

In chapter 5 we used the examples of Poland and Armenia to illustrate absorption of knowledge from Israel and other developed countries. A key conclusion is that absorptive capacity in emerging and developing countries is a prerequisite for the replication of innovation from a developed country. Absorption capacity can be built by a committed and long-term government investment in education and R&D, to name just these two examples, as is illustrated by the Israeli experience. Investments in education and R&D are non-distinct but rather generic ingredients that can be replicated.

Israel's innovation model consists primarily of "new-to-the-world" innovation. The discussion in chapter 5 shows that in developing countries, technology absorption is a critical stage. In emerging markets such as China, India, and Russia, technology absorption takes a more dominant role than new-to-the-world innovation.⁸ As argued in chapter 5, knowledge flows from Israel to Poland or Armenia depend on the latter countries' absorptive capacity. This capacity, as Aghion and Haravel articulate,⁹ can be built by investment in R&D, which creates a capacity to assimilate and exploit new knowledge. Israel's investment in R&D relative to its GDP is the highest in the world, and for other countries to absorb and replicate its innovation model, high investment in R&D will be needed.

Information technology is becoming a fundamental enabling infrastructure of the competitive new business regime. ICT is a critical part of what enables the organization and coordination of global production networks and the integration of global supply chains. Dahlman posits several implications for developing countries: “The enabling environment consists of the government regulations and institutions that facilitate the operation of business and the economy. It includes the basic institutions such as government rule of law, efficiency of capital and labor markets, ease of setting up or shutting down business. It also includes the ability of the government to create consensus and the ability to help people who fall through the cracks in the system.”¹⁰

► Lessons for Entrepreneurs in Emerging and Developing Countries

While most of our recommendations are oriented to policy makers, the interviews with the entrepreneurs and CEOs of start-ups and their staff in chapter 4 lead us to some recommendations for start-ups in emerging and developing countries:

1. Your product must provide a solution to an unmet need, in the domestic market or abroad. Therefore, you as an entrepreneur should understand the target market well.
2. Entrepreneurs must be people who are not afraid of risky long-term projects. Policy makers need to cultivate a culture in which such entrepreneurs can thrive and prosper. The culture involves risk taking, audacity, and an out-of-the-box mentality. Daring, audacity, and assertiveness need to be encouraged and respected.
3. In the view of the entrepreneurs, the optimal management model requires that the Israeli CEO stay close to the development center in Israel, that is, close to the heart of the new company. This is in contrast to the conventional advice of venture capitalists and views in the literature that an export-oriented industry such as ICT cannot grow far from their main customers, that the “solution is outward migration, moving headquarters abroad.”¹¹ Indeed the CEOs of Check Point and of Wix, for example, have stayed in Israel and hired people in their main target markets.

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- ¹ Spence, M. (2008). The Growth Report: Strategies for Sustained Growth and Inclusive Development. Commission on Growth and Development Final Report, Washington, DC.
- ² Uri Goldberg. 2012. "What's Next for the Start-Up Nation? A Blueprint for Sustainable Innovation." [<http://www.amazon.com/Whats-Next-For-Startup-Nation/dp/1477241205>]
- ³ Lach, S., Parizat, S., & Wasserteil, D. (2008). The impact of government support to industrial R&D on the Israeli economy. Informe final. Tel-Aviv: EGP Applied Economics Ltd.
- OECD (2011), "Policies to Support Eco-innovation in Israel", Free document, Environment Directorate, OECD. <http://www.oecd.org/environment/consumption-innovation/48354947.pdf>
- ⁴ "Innovation Policy for Development: An Overview." 2005. Tel Aviv University, NBER, and CEPR. [<http://www.tau.ac.il/~manuel/pdfs/Innovation%20Policy%20for%20development.pdf>]
- ⁵ "Israel Policy Profile." 2012. KETs Observatory–European Commission [<https://ec.europa.eu/growth/tools-databases/ketsobservatory/sites/default/files/policy/ISRAEL.pdf>]
- ⁶ Trajtenberg, M., 2000. R&D Policy in Israel: An Overview and Reassessment. [Online] Available at: <https://tad.colman.ac.il/paper-all/11160.pdf>
- ⁷ Lopez-Claros, A., & Mia, I. (2006). Israel: Factors in the Emergence of an ICT Powerhouse. Global Information Technology Report 2005–2006, 89-105. [http://www.augustolopez-claros.net/docs/GITR2006_32Israel_ltr.pdf]
- ⁸ The distinction between the two is that innovation is new to the world while technology absorption is new to the country
- ⁹ Aghion, P., & Jaravel, X. (2015). Knowledge spillovers, innovation and growth. The Economic Journal, 125(583), 533-573.
- ¹⁰ Dahlman, C. (2007). Technology, globalization, and international competitiveness: Challenges for developing countries. asdf, 29. Chicago
- ¹¹ Dutta, Lopez-Claros, and Mia. 2005. The Global Information Technology Report.

