Sun, Sea, Software, and The Start-Up Nation

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Abstract

This paper provides an examination of Israel's software sector, the drivers behind its success, and the challenges the new decade will deliver to it. It follows by assessing what policy-making strategies can be applied to close these gaps, making use of multi-disciplinary approaches from the world of engineering and technology management, and how these strategies serve as a template for industrial innovation.

Keywords: Israeli Innovation, Policy Gaps, Elite Cyber Intelligence Units, Industrial Innovation Policy-making, Innovation Systems, Software Companies, Policy Recommendations.

1   Introduction

The rise of Israeli innovation can be described as nothing short of a miracle. Celebrating 70 years of existence in 2018, with a population of 9.1 million, finding itself in a constant state of war and security threats while situated in a sea of enemies with no natural resources, Israel has the 3rd most companies listed on the NASDAQ (after the U.S and China) and is home to the largest number of technology startups per capita[1]. Throughout this paper, we will tackle Israel's strengths in the Software and IT Industry, and examine the institutions and elements of the nation's overall innovation system.

The path will take to assess these findings is as follows: we will begin by sharing an overview of Israel's software and IT industry and its history in the context of Israel's founding and economic growth, as well as its current status, the future expectations for the industry's growth and evolution, and the critical challenges it will face in the coming years. Next, we will explore the organization of the innovation system, including Israel's key innovation actors making up the software sector (both the country's internal and external partners). One of the major drivers of the Israeli software ecosystem stems from one such actor: the Israeli Defense Forces. Mandatory military service with the IDF, and the development of elite cyber intelligence units such as Unit 8200, have been essential in the military-industry partnership, specifically in the software industry. This partnership will be discussed in depth in this Innovation Organization section.

Next, we will look into the launch paths of software companies and how they have been strengthened by specific policy packages, for example through government financing, incentive structures for private investors, and targeted education changes to adapt to the growing needs of the software sector. The Israeli government, from its inception, has recognized this sector as a powerful growth engine for the economy, especially for a country with little natural resources and alternative export capacities, and as such has put in considerable investment to generate capital market reforms, build public tech incubators, and translate the successes of the IDF in the cybersecurity space into commercial growth. The following section will identify institutional and policy gaps, and help add color to how agency programs and funding might be used to overcome the sector's current challenges. Despite presenting strong numbers in the sector's size and its market share relative to the global stage, this decade will be critical in understanding the gaps in the current ecosystem.

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1. Senor and Singer 2011.

As such, our final section, having presented an assessment of these gaps, will explore an array of national and other policies that can be implemented to meet these demands.

After these various perspectives, we will have the tools to understand what makes the software sector of the Startup-Nation incredibly unique, most notably through the technical and cultural impact of the IDF, pairing these ideas with various examples of successful Israeli startups that helped define the growth and ingenuity of the software sector. The Israeli Software/ICT Industry has been propelled forward due to the strong influence of internal actors, with the most significant driver of innovation and progress being the military. However, despite the contributions of the military in laying out a strong foundation for the success of this industry, the country must respond to challenges the software ecosystem is facing through specific policy initiatives to sustain long-term growth and a presence on the global technological advancement stage

2 Technology Overview

Israel's software sector began with the founding of the state in 1948 with the IDF's establishment of the Science Corps, an agency in the army dedicated to developing arms, explosives, and electrical appliances to support the country's military needs[2]. At the same time, World War II resulted in an influx of highly educated refugees fleeing Nazi Europe[3]. Within the first few decades of its inception, Israel had seen 2 major wars and by the late 1960's it became apparent that it needed to be at the forefront of developing military RD to guarantee its security. Military communication networks, advanced electronics, and cybersecurity software spurred the first examples of civilian spin-off startups building military technology within the private sector scope. In 1993, the first commercially viable firewall software was developed by a team of Israeli computer scientists at Check Point technologies. By 1996, Check Point held a 40 percent market share of the worldwide firewall market, making it the market's leader. Gil Schwed, Check Point's Chairman and CEO, began developing the idea while a soldier in Unit 8200, Israel's premier intelligence unit (and largest military unit), equivalent to the United States' NSA. During his service, Shwed worked on securing classified networks, which also gave rise to Check Point's second product- the world's first VPN. Many other company directors were closely connected to the IDF as well. Dorit Dor, who served as the VP of Products, spent an 8-year career in the IDF as a career cyber-spy, winning the Israel Defense Prize the same year the firewall was released for her contributions to the defense of the State. Schwed's co-founder Marius Nacht, graduated from the elite IDF physics and mathematics training program nurturing RD standouts, Talpiot. Israel continued to see an exceptional growth rate of engineers, higher than that of the U.S, which was propelled by continued immigration waves from the Soviet Union. By the 1990s, the defense industry began to downsize, resulting in thousands of skilled engineers leaving the military, such as the founders of Check Point, taking several years of intensive technical training and bringing it to the civilian marketplace. This was also marked by the adoption of the personal computer across the state. By 1997, Israel led the Middle East with the highest penetration of PCs in private homes. This extremely high penetration, nearly equivalent to the U.S, would have a large impact on growing Computer Science education programs and preparing top students to begin careers in programming and software by middle school.

As the commercial software marketplace continued to expand, the impact of highly-trained veterans could be soon beyond cyber software. Moy Avisarr and Alon Geri, former Air Force officers, adapted their work with flight simulators into a neurosurgery simulator known as the Selman Surgical Rehearsal Platform, giving surgeons the ability to rehearse difficult procedures using 3D images from patient's CT and MRI scans.

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2. Cohen 2002.
3. *Israeli High-Tech Sector* 2020.

In the last decade, bringing us to the current state of the software sector, Israel's presence in the software world (including digital, IT, and internet), has increased by 400 percent, exporting primarily to the U.S. Israel is active in driving the next revolution of the IT market, Software as a Service, producing over 100 software companies engaged in cloud computing and internet consumer services. The Israeli software sector receives more than one-third of all foreign investment into Israel. It has brought to the world the internet firewall, cellular billing, voicemail, and internet messaging[4]. As we will later discuss in the analysis of the innovation system's framework, the country also hosts some of the most prominent technological multinational corporations, including the RD facilities of Microsoft, Intel, IBM, SAP, Cisco, and HP.

Given the sector's current-day successes, it is imperative to understand what the future of Israeli software will look like, and how we can expect it to grow and evolve. In a trend beginning in 2019, the country is looking to make the transition from being the Start-Up Nation to Scale-Up nation: more startups will be looking to go public, while on the flip-side achieving earlier rounds of funding[5]. In addition, there will be a rise in Artificial Intelligence and Machine Learning startups, and in parallel Digital Health investing in software companies will see a set of expansions. However, alongside these predictions, the industry faces critical challenges, which we will discuss in greater depth in a later section. As an overview, the biggest obstacles to the sector's exponential growth will be the scale-up challenge and the difficulty current software startups are facing in reaching maturity, and a substantial human capital shortage that will only be solved by diversifying the communities which have access to careers in engineering, programming, and mathematics.

3 Innovation Organization

The software sector in Israel is centered around the Startup, which is what we will define as our framework's core unit. The backbone of this core unit is the Entrepreneur, who is influenced by 3 main contributing factors: the Entrepreneur's Family, Society, and Culture. Culture is guided by the demographic features responsible for nurturing the individual's unique entrepreneurial spirit- origin, race, religion, and gender. These categories and their place within Israeli society all contribute to forming the founding team's identity and mission.

Israel's Software startups are structured to have little room for hierarchy, including between the CEO and CTO, who lead management, and tech and product development, respectively. Additionally, the executive team is made up of several VP's who cover product development, RD, marketing, and sales. It is common to see at least 1 founder from a Computer Science background, often beginning their career in a cyber intelligence unit. Most of the successful software startups in Israel are launched by entrepreneurs who have built around 3-4 previous companies and are close to the ages of 30-45. This age has grown over the years as the software sector continues to develop.

As we continue with our framework, the next piece of the puzzle is to understand the technologies that the Startup unit creates. Israeli software startups look towards several key tools in developing software products: they rely on open-source software as a foundation, and will often deploy structured strategies for improving software development practices. These include automated software testing, continuous integration, and incremental and iterative development. In the case of the software sector, in particular, Israeli companies are quick to target the global market and can do so with greater ease as software can be expanded more efficiently, most notably in the case of mobile phone applications and internet services.

Funding is the next component of the framework: it is responsible for bringing the technology to life as it serves as the bridge between building computer programs and initiating the product and customer development, as well as provides resources to launch marketing and production services.

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4. Melamed.
5. Bino 2020.

Public sector funding, as we will explore in a later section, is based on government programs that offer tax incentives as well as direct RD funding for growing companies. In the private sector, we see Venture Capital, Angel Investing, and Financial Markets. Some government programs link the 2 of these sources of funding. For example, *Yozma*, launched in 1993, offered tax incentives to external investors as doubled private investments with government funds and RD grants with backing from the Ministry of the Economy.

Next, both incubator and accelerator programs have been essential in growing the sector's entrepreneurial spirit. Israel relies on a model of incubators which consists of a long-term program, between a year or 2, which functions as a private organization but is funded in large part by the government. There exist around 20 or so of these in the country, the first having been launched in the 1990s. Although they don't specialize in software, the majority of companies that are produced in these incubators skew towards the software sector. These incubators are meant to give founding teams the resources to get through the early stages of development, such as through mentorship, a physical space, and administrative support. Accelerators are shorter-term and focus on growing a startup's business model for 4-5 months. These are primarily run by VC firms, universities such as the Technion Institute of Technology, and established companies such as Microsoft and Google[6].

However, the most prominent part of the software ecosystem framework, which is embedded into almost every other branch, is the military. The IDF's hi-tech units such as Unit 8200, MAMRAM (central computer unit), and other elite programs such as *Talpiot* and *Psagot* introduce two powerful platforms into the software sector. Graduates of such units enter the industry with advanced technical skills, developed via practice experience in the military. These skills might include securing large enterprise systems and data centers, granting exposure to complex software infrastructure which lets these graduates hit the ground running when beginning their careers after their service. The next platform is the large network of highly skilled professionals who might either provide extensive consultation or co-founding teams for new ventures.

Logz.io, an open-source log analytics software company providing real-time insights to businesses to help them scale, was made up of a founding team that carried with them tools they had developed during their service, tools which proved to be very valuable in developing the software company. Tomer Levy and Asaf Yigal, the company's founders, discussed the value of leading teams and groups in a fast-paced, unpredictable environment at the age of 18[7]. Their services were instrumental in exposing them to complex problems and thereby teaching them how to delegate authority, build trust across teams, and create adaptive strategies to accomplish their goals.

The constant security challenges the country faces, and the importance of being self-reliant on building strong defense systems have been key drivers in creating such strong military technological RD units. These units have allowed for the diffusion of computerization and IT skills in Israel.

The academic ecosystem has also brought the software sector success. Software research began in the 1960s by scholars from the Technion and the Hebrew University. Today, more than 1/3 of higher education graduates hold degrees in engineering and technology fields, and the Technion and Tel-Aviv University are both ranked in the top 20 for computer science programs in the world. The strength of these academic institutions has allowed for tight collaboration with international companies, accelerators, and research innovation centers.

The last partnership we see tied to the software ecosystem is the presence of multinational corporations. Israel has more than 300 RD centers, operated by the world's leading technology organizations such as Apple, Google, Intel, Microsoft, HP, IBM, and eBay. Additionally, expenditure on RD as a percentage of yields in foreign, multinational companies is among the highest (17 percent, compared to 1.7 percent in the U.S).

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6. Kon *et al.* 2014.
7. Mitchell 2016.

The above elements combine to share what the building blocks of the software sector in Israel are. They are sealed together by the nation's values and cultural traits, as well as the complex nature of its existence. Since its birth, the nation has faced threats to its existence from its neighbors. As pointed out by one entrepreneur: "There's an inherent risk of being in Israel, for example, we receive threats from Iran all the time, if you live with the risk of destroying your country, the risk of starting a company is nothing." The Israeli entrepreneur's ability to disregard the status quo and question the rule book is what allows all the pieces outlined in the above framework to create a thriving software startup ecosystem.

4   Matching Launch Paths to Policy Packages

To expand our understanding of the software startup ecosystem, this section aims to explore the launch process for new software technology and startup companies. The process is primarily twofold. Initially, the Israel Innovation Authority (previously known as the Office of the Chief Scientist) will make an investment using public funds. One example of such a program is the Tnufa National Pre-Seed Fund. This is a risk-free grant that supports entrepreneurs in developing innovative technology. The fund assists not just Israeli entrepreneurs, but also those of other nationalities, as long as the entrepreneur is a visa holder and they are engaged in developing technology in the ideation phase. Upon visa approval, they can apply for the fund as long as the company's operations are based in Israel. The funding provides recipients with up to 60,000 USD and does not require repayment (both in the form of debt or equity). The BIRD (Binational Industrial Research and Development) Foundation, a similar government program, dedicated towards U.S-Israel joint ventures, offers up to a million dollars to companies with such cross-Atlantic founding teams

Beyond this initial seed grant, the next stage of the launch process is in establishing private partnerships and funding. The Yozma program introduced briefly in the previous section, represents a government initiative that aids companies in the form of private partnerships. Before its launch in 1993, private funding for new ventures was very limited, especially for new risky high-tech ventures. The basic objective of the program was to encourage entrepreneurs to seek venture capital funding, and vice-versa create incentives for venture capitalists to take on more investment projects. This was done through the government doubling the investment provided by a private source, prompting the growth of Israel's VC industry.

It is common in the software space to also acquire seed investments from angel investors, or friends and family, in addition to some of the government programs mentioned above. These investments tend to be between 25,000-250,000 USD and target prototype development and the creation of the software's initial infrastructure. The goal of this prototype is to acquire the company's initial users and finalize the product's market fit. If these initial experiments are successful, they can be used to acquire funding from VCs, typically in the range of 1 to 5 million USD. Israeli software companies seek this funding from international markets usually (over three-quarters of VC funding comes from International VCs), but over time the presence of VC funds in Israel has shown significant growth. International funding is nevertheless crucial: studies were done on the growth of Israeli companies, using annual sales and number of employees as a marker, reveal that those which received funding from only foreign investors saw much greater growth than those receiving funding from both Israeli and international VC's, and significantly more than those receiving funding from only Israeli investors.

As Israeli software companies begin scaling, their cost structure adopts a similar structure to that of U.S-based software companies. The two types of expenses include operating expenses as well as non-operational costs. RD and Sales and Marketing make up the bulk of operating expenses. RD, which requires around 10-20 percent of the software startup's revenue, goes to testing configurations and making decisions regarding the infrastructure's operating system (OS). Sales

and Marking is another 15-25 percent of their revenues. In the software space, due to the marketing being extremely saturated as competition increases, this percent often surpasses RD. Customer service costs are included in this, as software companies often struggle to retain customers, and thus invest a large number of expenses on Customer Success Management and churn prevention (preventing users from discontinuing their use of the product). Non-operational expenses include capital costs (physical resources such as buildings and computers), overhead costs (costs that go to operational tasks not directly involved in delivering the product, such as software testing and processing time for installation)[8], and employee costs (hiring, training, and retaining staff)[9].

As we have discussed, the military, through indirect policy packages, has had a large influence on the growth of the software sector. One critical reason for this is that the IDF has a policy of allowing property rights or patents on technologies developed under its sponsorship to remain in the hands of the inventors, regardless of whether they were completing their service during the time any in the technology development process[10]. The implication of this is that it is a very straightforward process for new technology to be transferred to the civilian market after the completion of an individual's service. In the context of a startup's launch path, this means that the entrepreneur's ideation and potentially initial prototyping phase can occur well before they've acquired seed funding. Military service functions as a sort of early-stage incubator program. As discussed earlier, this launch path was true for the founders of Check Point, as Shwed explored the initial ideas for a stateful firewall when working on securing classified networks during his service with Unit 8200.

MAMRAM, the IDF's main programming, software engineering, and computer users training unit, also releases highly skilled and creative labor into the software sector. Graduates of the program, of which there are about 300 a year, are provided with extensive advanced training and enter the workforce as highly-trained programmers by age 20[11]. They are engaged in projects with extremely difficult financial and time constraints. The unit also exposes its soldiers to situations requiring strong leadership, preparing them to create their ventures after their service. Some of the unit's areas of responsibility include the development of a closed intranet, the IDF's system network, computer abuse enforcement, and the integration of the IDF's backend system to the cloud. The creation of the unit also allows Israel to have a unique institution dedicated to creating, gathering, teaching, and diffusing knowledge of software as a professional activity in addition to private companies making revenue.

One thing that makes MAMRAM unique is it's extraordinarily strong alumni network. The MAMRAM Alumni Association sponsors programs specifically for the unit's graduates that act as accelerators for alumni CTO's and co-founders. Oren Dobronsky, a graduate of MAMRAM, and a serial entrepreneur and angel investor, has taken his success in founding 4 startups that specialize in complex computer programming and making early investments in several high-growth companies such as Houzz to the TechAviv Angels fund. This fund consists of 30 Israel technologists whose exits combine to more than 3 billion USD. Their goal is to identify, fund, and mentor Israeli startups in tech hubs across the U.S.

Besides providing a strong network and technical skills, entrepreneurs completing service in the IDF have taken more nuanced lessons from their military experience. For example, Wix is an Israeli company that adopted its scale-up and growth process from the military. Wix develops a website-building platform that allows users to create their websites without the use of programming or design skills. It was founded in 2006, and now reaches over 10 million users in 190 countries. Wix structures its departments to be modeled after the unit organization in the IDF, with each department functioning as its unit. This model has been the key to maintaining a small-company

8. Shields 2014.
9. *Using Business Model Canvas to Launch a Technology Startup or Improve Established Operating Model* 2018.
10. Breznitz 2002.
11. *Mamram.*

atmosphere although it continues to grow. Each unit stays small and empowered.

Note that the company received all investments from foreign VCs, in reference to the point made earlier regarding the importance of international investing teams. Four years after launching, it raised 10 million USD in Series C funding from several prominent VCs, including Benchmark Capital, Bessemer Venture Partners, and Mangrove Capital Partners. Wix went public in 2013, raising 127 million USD for the company, and has since been publicly traded on the NASDAQ.

The goal of this section was to highlight the common themes behind the launch processes deployed by companies in Israel's software sector, as well as the cost structure that is produced by successful funding. We also examined the specific policies that have allowed the sector to flourish, and the novel techniques combining public and private incentive systems to bring capital to growing software companies. Lastly, understanding the government's vision for the role of software as a growth engine for the economy enabled us to examine how the military, through indirect policies and programs, has been a large contributor in helping companies go from ideation to launch, both through formal technical skills and informal networks.

5   Identifying Institutional Gaps

The software sector in Israel has seen great successes over the past decades. We have spent the past several sections understanding the history, framework, and institutions that have made the entrepreneurs and companies what they are today. Against all odds, the software sector has turned Israel into the tech powerhouse it is today. However, this section will explore some of the gaps which will serve as obstacles to the sector's successes in the next few years. This will set the stage for proposing new policies in the remaining part of the paper.

The two most pressing challenges faced by the sector are (1) a national talent shortage in the type of labor required for software companies, and (2) the failure to see a large number of Israeli software startups mature and scale up before acquisition. The talent shortage manifests in two different ways. Software startups are struggling to acquire local talent as well as talent in target markets (markets where a company is launching its product and thus requires expertise and human resources in this area)[12]. On the local front, we see the country being home to over 6,000 startups, however, this number has been falling over the past few years because there is a lack of local developers. A key reason for this is the fact that the Israeli technology talent pool comes from a very select group in the population: university-trained male Jewish candidates. In the early days of the growth of the software sector, this undiversified pool of talent was sufficient, but the sector is now reaching a milestone where excluding such a wide portion of the population will impede the formation and scaling of local software startups. Professor Eugene Kandel, an Israeli economist, sums up the nature of this gap as follows:

> The high-tech industry is the country's most productive sector, and without the inclusion of dozens of thousands of new workers from diverse populations and geographies, this industry will continue to disengage from the Israeli economy – an outcome whose potential damage to the Israeli socioeconomic fabric cannot be underestimated.

The country relies on the development of hi-tech, of which the software sector specifically makes up a large part, to continue fueling the economy. As we will discuss later, adapting to this gap will require long-term changes in STEM education for a larger segment of the population. Currently, only a select few groups of young students are pushed to enroll in competitive and technical middle and elementary school programs, leading to the establishment of ethnic and gender discrimination by "tracking" children with certain demographics into vocational tracks. Part of the solution lies in integrating populations that are severely underrepresented in the hi-tech

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12. Luzzatto and Attorneys 2018.

industry, including residents of communities far away from the more developed areas of the country (Tel-Aviv or Jerusalem), ultra-Orthodox, minorities, and a portion of the population of women. Not only will addressing this problem help Israel address the talent shortage, but it will also provide an opportunity to reduce social gaps, leading to a more productive Israeli labor market.

The second talent shortage surrounds talent in a company's target market. CyberArk, an information security software company founded in 1999, and the first company to implement the digital vault technology for securing digital accounts, recounts struggling with hiring American expertise when trying to launch in the U.S. The current CEO, Udi Mokady, recounts that the company faced a lot of difficulties in hiring seasoned American executives. He explains, "As an unknown Israeli company breaking into the U.S. market, we were not able to attract A-rated sales and marketing professionals. It took some time to gain momentum and learn how to attract local talent." This is a problem for many Israeli software startups as accessing foreign markets, mainly American markets, is a common starting point. Launching in such a specific, local market such as Israel can cause a company to strive for a product-market fit that will not scale globally, and Israel's population is simply too small to be a software startup's end goal, especially in the case of a software product when the technical feasibility of reaching a global audience is well-defined[13]. Yair Halevi, Chief Scientist of SundaySky, a company working to transform customer experiences with video-empowered technology, drives home the necessity of gaining executive talent to be successful in American markets: "Make a key U.S executive hire that can spearhead your expansion with the required field experience and executive leadership". Stronger networks need to form between tech hubs in Israel and across the U.S so that tech executives with American expertise can support early-stage Israeli software startups in reaching a wider audience base in the U.S.

Another pressing issue that the software sector in Israel must work to combat in the next decade is known as the "Scale Up Challenge". Since the inception of the startup community, thousands of hi-tech companies have been founded, with only 50 breaking a make valuation of 50 billion. Israeli companies tend to be sold to large corporations very early on, resulting in early-stage exits. The goal of addressing the Scale-Up Challenge is to build startups that can exit in a more mature stage. The reason why this is a prevalent gap in the current software ecosystem is that it hurts Israel's economy in the long run:

> A private sector consisting entirely of small, technologically advanced companies chasing an exit is damaging for the Israeli economy because it exports the country's most valuable know-how and hinders the development of large local companies[14].

Many early-stage exits reduce the capacity the software sector has to create jobs and also decrease the long-term tax payments larger companies bring back into the economy that fostered their initial creation. More mature exits have the capacity to produce development and social mobility opportunities for the rest of the population, whereas the current system, favoring early exits, brings benefits only to the serial entrepreneurs[15].

An additional contributing factor to the small number of mature software companies in Israel comes from the need to move operations to a larger market. As mentioned earlier, Israeli startups tend to look towards American markets very early on. CyberArk founders Mokady and Cohen abandoned the local market as soon as they raised their first major round of funding, setting up their headquarters in Massachusetts. This was essential for them to achieve a strong product-market fit, as it allowed their team to be immersed with American clients, businesses, and users and align product decisions accordingly. Mokady commented on this transition as follows: "We began selling to local Israeli companies but had a strong feeling we were developing a product and

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13. Karp 2016.
14. Daniely 2020.
15. Bussgang and Stern 2015.

go-to-market strategy that was missing the larger opportunity". The same was true for Yaron Samid, the founder of BillGuard. BillGuard is a personal finance security company that develops software to provide users with analytics for fraud detection. The team had trouble deciding between two different target markets- enterprise vs. consumer. After a year and a half, they realized that this was a question they could only answer with constant exposure and immersion in the American market. The move to New York allowed the company to determine that "consumers, rather than banks, were the primary customer of BillGuard's service, which helps customers identify fraudulent credit card charges". Today, with the company headquartered in New York, BillGuard still sees a lot of value in weekly interactions and conversations with partners, investors, and consumers that are based in the U.S. Unfortunately, this means that Israeli software companies see a migration to the U.S as a necessary milestone in their launch path. As these mature companies continue to leave the Israeli software ecosystem, this will have a long-term impact on the ecosystem's ability to sustain itself and grow in the future.

6 Proposed National and Other Policies

This section aims to gather some of the gaps we have addressed in the previous section and propose several policy recommendations to respond to them. To begin, human capital to fill roles necessary for the software sector- engineers, data scientists, product designers, and strategists- will be necessary to strengthen the entire production chain. In the case of human capital, this refers to both secondary and higher education systems. It also includes the connection these education systems have to military technology units, as these units can serve as an important vehicle for bringing in underrepresented populations to the technology space.

Three segments of the population should be targeted for integration into the software sector: the ultra-Orthodox, the Arab-Israeli community, and women. For the ultra-Orthodox, policies outside of the military must be deployed, as the ultra-Orthodox are exempt from military service. This, along with the fact that almost half of the community receives no more than a primary school level of education in non-religious subjects (which includes STEM subjects), makes their integration a large challenge: only 3 percent work in technology. One solution to consider is developing organizations to support the ultra-Orthodox in finding employment in software companies. In addition to this, partnerships with large tech companies such as Facebook, Google, and IBM to develop technical training courses run by engineers at these companies could also yield positive results, especially for courses teaching programming and software engineering. Providing an option for shorter, more vocationally focused degrees in Computer Science for both seminary graduates and ultra-Orthodox women would strengthen the pipeline as well. To support ultra-Orthodox entrepreneurs, establishing funds that go specifically to companies founded by ultra-Orthodox founders would ensure that there is funding set aside to integrate entrepreneurs from this segment of the Israeli population.

The Arab-Israeli community is another segment that is severely underrepresented and could help solve the talent shortage gap, especially since the Arab middle class is growing rapidly. Similar solutions would apply for this group as well: sponsoring placement agencies, providing training courses and boot camps, and preparing students for interviews.

Bringing more women into the software space is a global challenge that should also be tackled with education policies and programs. Increased investment in coding programs for girls in middle high school has been very successful in the U.S. These investments can be used to create non-profit organizations cyber-focused military-sponsored which provide school programs for girls. Because cyber military units provide such a direct path to a successful career in software, coursework, and boot camps specifically to train women to pass entrance exams for these units would decrease the barriers to access women currently face in completing their service in these units.

Supporting startups in reaching later-stage exits requires a very different set of policies and

programs. In examining public resources for funding during the launch path discussion, we see that most government support has been focused on earlier stage financing (pre-seed and seed). New mechanisms to provide later-stage venture capital could prevent startups from agreeing to early-stage acquisitions. There are a few mechanisms that could be used to increase the availability of later-stage funding. First, creating government-owned venture capital funds or co-investment funds- is the most straightforward option. Another idea is to co-invest with other institutional partners (banks, insurance companies) in other Israeli venture capital funds to support them in making more later-stage investments (Series C, D, E). The final idea is to invest at one more level removed: government investment in funds that invest in Israeli venture capital funds. This approach, by adding a middleman, prevents the government from having to decide on what venture capital team to invest in.

New programs, such as the private-public matching program, but dedicated to forming partnerships with private investors who invest primarily in later-stage companies would also increase funding opportunities for software companies looking to scale. An exact matching program is one option. Another option is to provide downside protection for the private investors such that the private investors are guaranteed to get their money back before the government does. Lastly, another incentive structure where the government equity is limited in its upside, while the downside will be equally shared between the government and the private investors, could offer private investors a less risky avenue for later-stage investments.

7 Conclusion

Throughout this paper we have examined the evolution of Israel's software sector, beginning with the IDF's establishment of the Science Corps, reinforced by the arrival of highly educated immigrants and several decades of wars and security threats demanding special investment in military RD, and arriving at the launch of hundreds of successful companies and technologies such as the first commercially viable firewall, often originating from cyber needs discovered during an individual's military service. We have also assessed the Israeli software ecosystem framework, centered on the startup, and tied to the entrepreneur's connection to Israeli values and culture, and brought to life with the IDF's elite cyber-intelligence units such as MAMRAM and Unit 8200.

Next, we defined the launch path of a software startup in the Israeli ecosystem, and its scale-up process from ideation to seed funding to larger investments, detailing the presence of both government funding and programs and private investors, and the crucial nature of foreign funding and resources. This portion also touched on how the IDF's deep roots in Israeli hi-tech have impacted how maturing companies structure themselves, how entrepreneurs take their military experiences to the software startup arena both via technical skills, ideas, and mindset, and how the cohesiveness and tribal nature of Israel's network, even in hubs across the globe, is present due to the IDF.

We highlighted the sector's biggest challenges in the coming decades, most notably, a talent shortage aggravated by the exclusiveness of military service in units that serve as feeders to careers in tech, and a failure of the software company to consistently produce mature companies that do not exit at an early-stage through acquisition or move operations such that the company's success benefits an external economy. And in the most recent section, we shared potential solutions for solving the shortage in human capital and the Scale Up challenge through investment in populations traditionally underserved in exposure to technology and new forms of investments with unique incentive structures to increase access to late-stage funding, respectively.

These discussions, as well as the integration of various companies from the software and IT sector (Check Point Technologies, the Selman Surgical Rehearsal Platform, Logz.io, Wix, CyberArk, BillGuard) into our analysis of the software ecosystem, has cemented the fact that the sector has risen to prominence, both on a national and global scale, due to the military acting as a driving actor. In the web of actors, including academia, the government, multinational corporations, and

the military, the military has emerged as advantageous in its ability to provide young people with technical skills through training and hands-on experience, as well as create a strong network of other highly skilled and ambitious professionals. It has laid a strong foundation for a thriving software ecosystem, but as the needs of the sector continue to evolve, specific policies must be used to target and seal the framework's gaps.

Investment in the education pipeline, both linked to the military and independent of it depending on the segment of the population, and policies to support later-stage investments in an effort to extend the maturity of software ventures, are both paths we propose exploring to take the strong foundation that currently exists and augment it to prepare for the next decade of challenges.

The Israeli software system is incredibly unique and is what it is today due to a combination of Israeli family values, a population built off of immigrants, the military, conflict, an extraordinarily unique culture, technology, government funding, angel and VC investment, incubators, accelerators, and universities. It has the capacity to teach other developing startup hubs how to flourish under difficult constraints, and how to use its reality of being in a constant state of conflict, as well as unique cultural elements such as assertiveness, a disdain for hierarchy, and the status quo, and tight-knitedness, to power its success. The world will now look towards it to determine whether it can take these lessons, and pair them with the obstacles it faces down the road, to continue dominating the software sector and being undeterred in building technology that can make the world a better place. Throughout this paper we have examined the evolution of Israel's software sector, beginning with the IDF's establishment of the Science Corps, reinforced by the arrival of highly educated immigrants and several decades of wars and security threats demanding special investment in military RD, and arriving at the launch of hundreds of successful companies and technologies such as the first commercially viable firewall, often originating from cyber needs discovered during an individual's military service. We have also assessed the Israeli software ecosystem framework, centered on the startup, and tied to the entrepreneur's connection to Israeli values and culture, and brought to life with the IDF's elite cyber-intelligence units such as MAMRAM and Unit 8200.

Next, we defined the launch path of a software startup in the Israeli ecosystem, and its scale-up process from ideation to seed funding to larger investments, detailing the presence of both government funding and programs and private investors, and the crucial nature of foreign funding and resources. This portion also touched on how the IDF's deep roots in Israeli hi-tech have impacted how maturing companies structure themselves, how entrepreneurs take their military experiences to the software startup arena both via technical skills, ideas, and mindset, and how the cohesiveness and tribal nature of Israel's network, even in hubs across the globe, is present due to the IDF.

We highlighted the sector's biggest challenges in the coming decades, most notably, a talent shortage aggravated by the exclusiveness of military service in units that serve as feeders to careers in tech, and a failure of the software company to consistently produce mature companies that do not exit at an early-stage through acquisition or move operations such that the company's success benefits an external economy. And in the most recent section, we shared potential solutions for solving the shortage in human capital and the Scale Up challenge through investment in populations traditionally under-served in exposure to technology and new forms of investments with unique incentive structures to increase access to late-stage funding, respectively.

These discussions, as well as the integration of various companies from the software and IT sector (Check Point Technologies, the Selman Surgical Rehearsal Platform, Logz.io, Wix, CyberArk, BillGuard) into our analysis of the software ecosystem, has cemented the fact that the sector has risen to prominence, both on a national and global scale, due to the military acting as a driving actor. In the web of actors, including academia, the government, multinational corporations, and the military, the military has emerged as advantageous in its ability to provide young people with technical skills through training and hands-on experience, as well as create a strong network of

other highly skilled and ambitious professionals. It has laid a strong foundation for a thriving software ecosystem, but as the needs of the sector continue to evolve, specific policies must be used to target and seal the framework's gaps.

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