Possible Effects of the Change in Foreign Currency Aid on the Structure of the Israeli Defense Companies

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Introduction

In September 2016, the Memorandum of Understanding (MOU) was signed between the governments of Israel and the United States for a $38 billion American defense aid package under the Foreign Military Funding (FMF) Program for the period 2019-28 (hereafter "the new aid agreement").[1]

Ostensibly, the new aid agreement is the largest ever granted to Israel by the United States. Yet, compared with previous FMF agreements, it introduces a number of changes that are likely to have harsh consequences for the local defense industry, Israel's preservation of armament knowhow, and for the Israeli economy as a whole. In particular, the new aid agreement reduces substantially the amount of aid money which Israel's Ministry of Defense can convert into Israeli shekels (NIS) under the FMF and use for defense-related procurement from local defense companies.

In this article we estimate and assess the resilience of Israeli defense companies to the worsening conditions implied by the changes in the new aid agreement. Based on an exclusive and comprehensive database containing 603 Israeli defense companies, we analyze the structure of the industry and

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suggest a model of resilience.[2] Moreover, the validity of the resilience model is assessed by comparing its predictions to the results from interviews and questionnaires filled by 50 senior executives in Israel's defense industry.

Our findings point to key factors that can help predict the resilience of a defense company to the expected decline in local procurement by the Ministry of Defense. These factors include a company's size, sector, technological level, physical location, and extent of cooperation with American businesses. For example, the study projects a drop in revenues and profits among small defense companies with fewer than 250 employees, especially in the metal, electronics, and rubber sectors. The study concludes that the likely long-term consequences of the changes introduced in the new aid agreement include a decrease in the competitiveness and technological knowhow of Israeli defense companies, a change in the structure of the defense industry, and acceleration of the processes of consolidation within the industry.

The article is structured as follows: a brief review of the new aid agreement is presented in part A, followed by an analysis of Israel defense industry in part B. Part C introduces the resilience model, while part D applies the model to defense companies and evaluates its validity by comparison with assessments made by senior executives in the industry. Part E summarizes and concludes our findings.

Part A – The MOU for American Defense Aid to Israel: 2019-2028

In September 2016, the US administration led by President Barack Obama signed a new multi-year FMF aid agreement with the Israeli government. The agreement, which applies to the 2019-2028 period, is the third in a series of 10-year aid agreements between the two countries and reflects the continued commitment of the US to maintaining Israel's military standing. Table 1 provides key differences between the new aid agreement and its predecessor.

The most immediate economic effect of the restrictions introduced in the new agreement relates to the gradual reduction in the ability of Israel's Ministry of Defense to convert dollar aid into shekels. As illustrated in Figure 1, the amount of aid dollars that can be converted into shekels – and thus be used for local defense procurement – will decrease gradually until it is totally eliminated by the end of the period (2028). Compared with 2018,

this is a loss of $1.2 billion a year of aid money that the Ministry of Defense would not be able to use for local defense procurement.

Table 1: Comparison of the 2019-2028 aid agreement with the 2009-2018 aid agreement

	The 2009-2018 aid agreement	The 2019-2028 aid agreement	Additions in the 2019-2028 aid agreement
Total financing	$31 billion	$33 billion	Over the coming decade, the two sides will endeavor to prevent changes or additions to the American aid in foreign currency to Israel.
Financing the joint anti-missile defense program	$1.49 billion (an additional $4.513 billion was approved)	$5 billion	Under certain conditions, additional aid can be requested.
Total permitted to be converted into NIS	$7.846 billion	$5.65	Israel is obligated to report in detail the NIS usage of the converted money. The conversion percentage becomes zero in 2028.
Fuel procurement in the US in foreign currency aid	$4 billion	Cannot be purchased	Continued purchase of fuel in foreign currency aid was allowed only during the first year of the new agreement (2019).
VAT spending[3]	$3.934 billion (equivalent value in NIS)	$5.61 billion (equivalent value in NIS)	

Sources: Sharp (2018); Zanotti (2018)

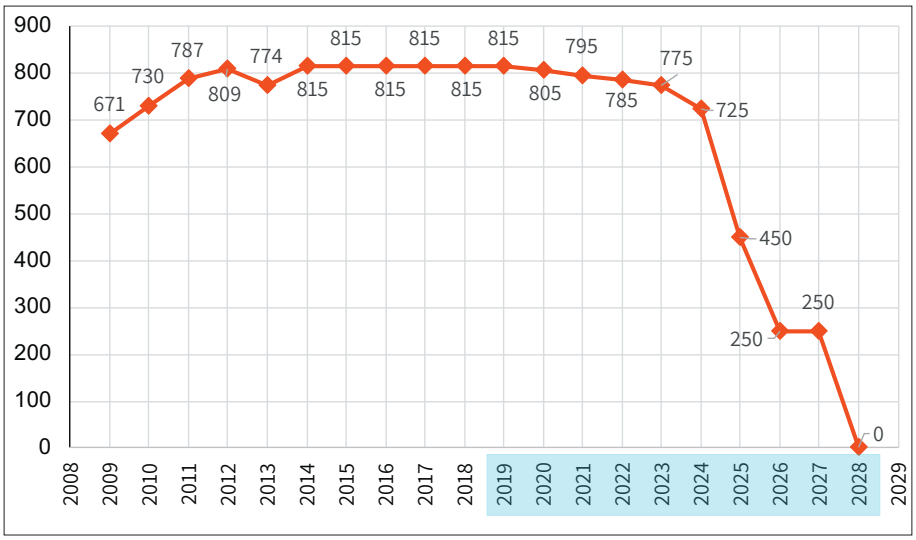

Figure 1: The gradual reduction in conversion of aid in foreign currency to NIS, as determined in the 2019-2028 aid agreement (US$ millions)

Source: Sharp (2018)

Thus, under the new aid agreement it is more difficult to spend aid money locally, and more defense procurement is likely to be made from foreign suppliers, primarily from the US. Consequently, the cost of defense procurement is also expected to rise because local prices are generally lower and there are additional payments relating to increased purchases from the US. Further, under the new aid agreement, the Israeli Ministry of Defense can no longer use aid money to purchase fuel. It must therefore raise an additional NIS 1-1.15 billion a year from other sources to enable air force planes and other platforms to continue their regular activity.

To understand the specific implications of the changes in the new aid agreement to the local defense industry, we start by analyzing the structure of the industry.

Part B – Analysis of the Defense Industry in Israel

There is no formal definition for a defense company. A popular definition is that a defense company is a company that manufactures products for exclusive defense use (Flamm, 2000). This definition, however, is problematic for several reasons. First, some firms describe themselves as defense companies

although the proportion of revenue they generate from selling defense products is often minor. For example, in 2016, 43 of the 100 largest defense companies worldwide, in terms of revenues, derived less than 50 percent of their total annual revenues from selling arms.[4] Second, there are private companies that serve defense customers, for which no public information is available (e.g., the percentage of revenue they derive from the sales of goods for defense/military use). Third, there are many companies that serve defense customers, but the products they supply cannot be described as classic defense (such as weapons or ammunition).

Another popular definition for a defense company is one that makes combat platforms or end products for defense use (Dvir and Tishler, 2000). But this definition excludes firms that participate in the manufacturing value chain as subcontractors for arms manufacturers. This exclusion is problematic. Take Rotem Industries, for example. The firm, located near the Negev town of Dimona, is one of the few companies in Israel that specialize in the polishing of sapphire mineral. Sapphire has various uses in the electro-optics industry but is also useful in the manufacturing of certain missiles due to its resistance to pressure and to extreme temperatures. Indeed, in a 2014 interview, Yoram Sadan, the CEO of Rotem Industries, explained that: "A palm-sized dome which is installed in the head of an Israeli-made Python air-to-air missile is sold by Rotem for $10,000. Similar glass, incidentally, is used to manufacture highly pressure-resistant luxury watches, but Rotem focuses exclusively on the defense market."[5] Yet, according to the definition proposed by Dvir and Tishler (2000), Rotem Industries is not a defense company but a subcontractor to other arms manufacturers, such as the large Israeli defense company, Rafael Advanced Defense Systems. However, Rotem is likely to be severely affected by the amendments introduced in the new aid agreement, and in particular the gradual elimination of the ability to convert dollar aid to shekels for local use. For example, if Rafael decides to divert orders for the production and polishing of sapphire from Rotem to the US in order to utilize aid in a foreign currency, this would have severe consequences for Rotem. It would also reduce Israel's ability to preserve precious manufacturing knowhow.

Alternatively, Dvir and Tishler (2000) propose another definition for a defense company, namely, a company that is directly involved in development and/or manufacturing relating to armaments by government defense agencies.

Thus, a defense company is one that is actively involved, at some level, in the value chain of the local defense industry, regardless of the proportion of total revenue it derives from this activity. This definition distinguishes between companies that are directly involved in development and the production of arms – classified as defense companies - and others that provide goods and services with indirect defense uses. The latter may be supplying fuel, food, energy, catering, medical, and other services to the defense industry but are not classified as defense companies.

This study adopts Dvir and Tishler's (2000) definition of a defense company, as one that is directly involved in the development and production of armaments *for military use*. This allows us to identify and collect data on the companies that make up the local defense industry, and to analyze the structure of the industry and its vulnerability to the changes in the new aid agreement.

Shefi and Tishler (2005) conduct a similar analysis, using company size as their base. They suggest a hierarchal structure including four large companies and approximately 150 small firms. Dvir and Tishler (2000) offer an alternative method which is based on the defense company's technological development and experience in the defense market.

As an extension of both these studies, we analyze the defense sector in Israel based on the hierarchy of companies, their technological development, and the definition of a defense company as one engaging directly in the development and production of weapons.

Accordingly, our analysis is as follows: In the first stage, every defense company is assigned to one of four technology levels. Technology level 1 comprises companies developing and manufacturing a complete weaponry platform requiring access to a range of engineering technologies and capabilities. Companies at technology level 2 are those developing or manufacturing systems designed for integration into weaponry platforms. Companies at technology level 3 are developing or manufacturing sub-systems or services designed for companies at technology level 1 or 2. Technology level 3 supplements the value chain suggested by Dvir and Tishler (2000) and allows for a layer of firms that are employed as subcontractors by companies at higher technology levels.

Parallel to the three technology levels, an additional level is defined (designated with the number 16[6]), consisting of companies that provide

specific defense-related services to defense companies at all technology levels. Specifically, companies in technology level 16 provide defense firms with testing services and assistance with importing raw materials needed for defense production. We refer to companies in technology levels 1-3 as developers and manufacturers of defense products, and to companies in technology level 16 as providers of defense-related services. Table 2 outlines and defines our method for analyzing Israel defense industry based on our four technology levels.

In the second stage of analyzing and mapping the Israeli defense industry, various data were collected about the Israeli defense companies. In particular, information was collected on four elements identified as important in determining the resilience of a defense company to the changes introduced by the new aid agreement. The first element is diversification of sales, including whether the products of the company have dual use (military as well as civilian), diversity in customers, and diversity in products. The second element is the industrial sector in which the company operates, including the uniqueness of the products produced. The third element relates to whether the company has developed business cooperation with companies in the US. Such cooperation makes it easier for the Israeli company to utilize payments it received in US dollars under the new aid agreement. The fourth and last element is the geographic location of the company in Israel.

Additional data were gathered about the defense companies, including company size in terms of number of employees and the year in which it was founded. Altogether, 603 companies were identified as meeting the definition of a defense company and these were classified based on their technology level and other characteristics.[7] The following are several insights about the Israeli defense industry, gained from our analysis of the database.

Table 2: Mapping Israeli defense companies based on technology levels

Technology level	Characteristics	Types of products developed and produced by companies at this level	Utilization of payments received directly or indirectly from the Ministry of Defense in foreign currency under FMF
Developers and manufacturers of defense products			
1	Companies with the technological capability to develop and manufacture a complete weaponry platform from a broad range of disciplines and engineering technologies. Employ over 500 employees, mostly engineers, with a high ratio of revenue per employee, and advanced research and development capabilities.	Battleships; battle tanks; armored fighting vehicles; airplanes; missiles systems; etc.	These companies find it relatively easy to utilize foreign currency payments received from the Ministry of Defense.
2	Companies with the ability to develop or produce systems/services designed for integration into weaponry platforms or as part of other weaponry. Develop systems or products that integrate a limited number of engineering disciplines and have fewer than 500 employees.	Cannons and mortars; munitions; weapons and electronic systems that are installed on platforms including ships, airplanes, and tanks; electro-optic systems; hydraulic and electrical systems; etc.	These companies are limited in their ability to utilize foreign currency payments received from the Ministry of Defense.
3	Companies capable of developing or manufacturing sub-systems and services designed for companies at technology levels 1 and 2. The manufacturing processes involve a limited number of engineering disciplines.	Textile products; card assemblies; electrical cabling; metal casting; processing of metal and rubber products; software services; etc.	These companies find it relatively difficult or impossible to utilize foreign currency payments received from the Ministry of Defense (either directly or from other defense companies, when they act as subcontractors).
Providers of defense-related services			
16	Companies with no manufacturing or development facilities located in Israel. Provide services to defense companies at all other levels and do not employ many engineers.	Import services for raw materials; maintain local offices of overseas companies; testing services.	

B.1. Analysis of the defense industry – Technology level

Figure 2 displays the distribution of defense manufacturers in Israel according to their technology level. Seven of those companies fit the definition of a company at technology level 1, including: (1) Israel Aerospace Industries (I.I), (2) Elbit Systems, (3) Rafael Advanced Defense Systems, (4) Tomer Systems,[8] (5) Aeronautics, (6) Merkava Tank and APC Administration,[9] and (7) Israel Shipyards. Those are the largest defense companies in Israel in terms of revenues and number of employees, together operating 32 development and manufacturing sites (and/or subsidiaries) in Israel. There are 97 additional defense manufacturers at technology level 2, and the rest are at technology level 3.

As shown in Figure 2, level 16 companies, which provide defense-related services such as testing and importing to defense manufacturers at all technology levels, account for 14 percent of the Israeli defense industry. These companies are not directly involved in weapons systems development and production value chain and are therefore not included in the resilience model we developed.

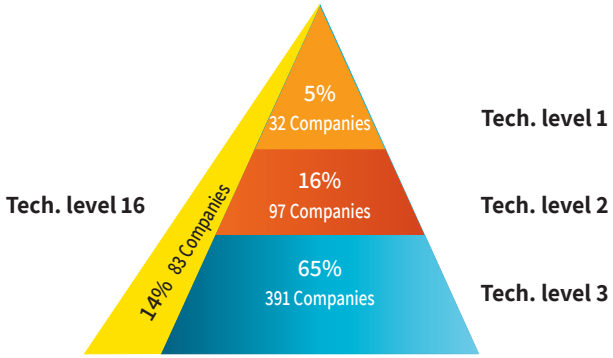

Figure 2: Division of the defense companies in Israel into four technology levels (2018)

B.2. Analysis of the defense industry – Company size (number of employees)

As of 2018, the Israeli defense industry directly employs 72,000 people. Most of this workforce (69,800 or 97 percent) is employed by developers and manufacturers of defense products (technology levels 1-3) and the

remaining (2,500) by providers of defense-related services (technology level 16). Figure 3 presents the number employed by developers and manufacturers of defense products, split into the three technology levels. Looking at Figure 3, it is immediately obvious that most of the workers are employed by the seven companies at technology level 1 (33,200 or 46 percent of the total).

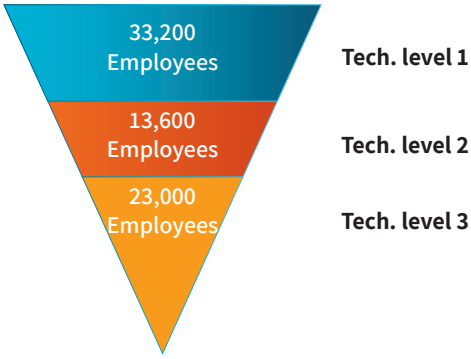

Figure 3: Number of employees in Israel's defense industry by technology level (2018)

Notes to Figure 3: Technology levels 1-3 encompass companies that develop or manufacture defense products. Together these companies directly employ 69,800 workers. In addition, companies in technology level 16, which provide defense-related services, employ 2,200 workers. Thus, a workforce of 72,000 is directly employed by the Israel defense industry.

Data for 2018 also reveal that the number of employees in defense companies located in peripheral Israel (mainly in the country's north) is 15,500 (about 22 percent of the total employed by the defense industry). Moreover, approximately 60 percent of peripheral defense companies are in the metal and electronics sectors, employing, on average, 100 workers each. Indeed, about half of all those working in the industry are employed by defense companies that are located in peripheral areas.[10] As discussed later, defense companies in peripheral areas, especially those at technology level 3 (such as the metal and electronics sectors), are particularly vulnerable to the tightening of the terms in the new aid agreement for converting foreign currency to local currency.

B.3. Analysis of the defense industry – Industrial sectors

Figure 4 displays the distribution of defense companies across industrial sectors. Some sectors, namely electro-optics, IT communication and software, and systems integration, are engineer-intensive.[11] These sectors are usually highly innovative, which improves their ability to adapt to dynamic environments. Indeed, Amit and Zott (2010) argue that technological innovation can explain a firm's ability to cope with economic and other changes. Wessner (2005) asserts that key to the survival and growth of innovative firms is their ability to constantly react to changes in the market and in customer requirements. An OECD report from 2016 finds that a highly educated workforce and extensive expenditure on research and development explain Israel's impressive growth in entrepreneurship (OECD, 2016).

At the other extreme are more traditional sectors that are not engineer-intensive, such as metal, rubber, textiles, and materials, electronics, machinery, and general services.[12] Companies in those sectors find it more challenging to compete in the manufacturing of defense products against competitors in countries characterized by low personnel costs.

Figure 4 shows that the bulk of the defense companies in Israel operate in the traditional, low-tech and non-engineer-intensive manufacturing sectors (e.g., metal), which means that they find it more difficult to innovate and adapt in order to cope with dynamic environments.

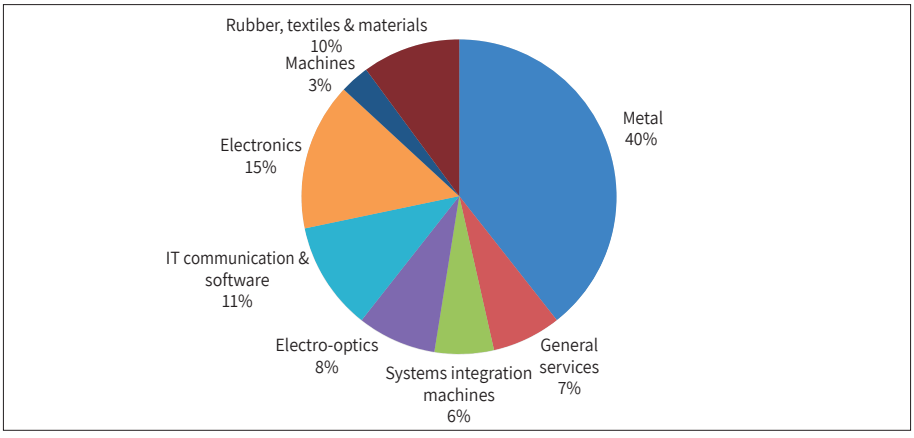

Figure 4: Distribution of Israeli defense companies across industrial sectors (2018)

B.4. Analysis of the defense industry – Geographic location

Soon after Israel gained independence in 1948, defense companies popped up across the country, mostly near the densely populated cities of Tel Aviv and Haifa. Figure 5 displays the geographic distribution of defense companies as of 1960.

Figure 5: Geographic distribution of defense companies across Israel, as of 1960

Note: The map indicates a 40-kilometer radius around the cities of Tel Aviv and Haifa.

Having clusters of defense companies has clear advantages, for the exchange of knowledge, reduction in transportation costs, and other reasons. However, during the 1980s and 1990s, defense companies started to spread to the periphery, driven by improved infrastructure and the dispersal of the population. Moreover, the government encouraged companies to move to the periphery by providing benefits for those located in national priority areas.[13] Figure 6 presents the proportion that each sector within the defense industry represents, as of 2019, in national priority areas.

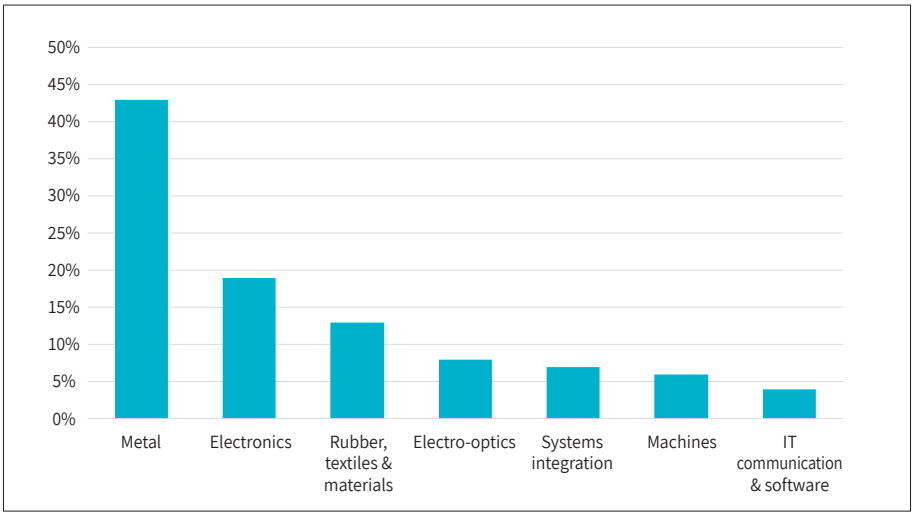

Figure 6: The relative share of each industrial sector within the defense industry in national priority areas (2019)

As can be seen from Figure 6, engineering-oriented companies are conspicuously absent from the periphery. Most of the engineers in the defense industries work in companies at technology level 1, located in the vicinity of Tel Aviv and Haifa. Metal and electronics companies, on the other hand, have a prominent presence in national priority areas of low socioeconomic ranking.[14] This pattern can be explained by the characteristics of the labor force required by companies at different technology levels. In particular, manpower in the periphery is characterized by low levels of expertise and education, enabling low-technology companies that are located in those areas to pay relatively low wages and maintain reasonable profit margins. Indeed, access to workers with a level of education suitable for low-tech production is positively correlated with the socioeconomic conditions in the location where the company is located.[15]

Another factor that can explain the high proportion of low-tech enterprises in national priority areas is government subsidies to encourage such patterns. These incentives include land subsidies and deductions on municipal taxes for enterprises distant from central Israel. Moreover, low-tech production-oriented companies, such as in the metal and materials sectors, require large areas to install machinery and store raw materials. In national priority areas, located away from central Israel, the cost of land is relatively low, which

supplements government subsidies and incentives in reducing the cost of operations and attracting low-tech defense companies to the periphery of Israel.

Interestingly, despite the benefits granted to companies located in a peripheral area, our resilience model predicts that companies located in national priority areas are particularly vulnerable to the unfavorable changes introduced in the new aid agreement. Specifically, according to our model, these companies are particularly sensitive to the gradual reduction in the amount of dollar aid money which can be converted into the local currency to be used for defense procurement. In the next section we introduce our model.

Part C – The Resilience Model for Predicting the Probability of the Survival of Defense Companies under the New Aid Agreement

The resilience model aims to predict the ability of a defense company to survive over the coming decade, given the changes in the new aid agreement. The model is based on four key factors that CEOs of defense companies identified as crucial, assuming gradual reduction in shekel-based orders by the Ministry of Defense. The first factor is varied sales (VS), included to measure diversity in revenue sources. The second factor is the industrial sector (IS), included to measure the complexity of the operation, technology level, and competition. The third factor is the existence of business cooperation with a US company, for utilizing aid money in dollars (American business cooperation – ABC). The fourth factor is the company location (L), included due to differing cost structures, as discussed in the previous section.

The VS factor measures diversity in sources of revenue and is expected to have a positive effect on resilience. Specifically, a company is expected to be less reliant on orders from Israel's Ministry of Defense if its revenue comes from different customers or products or if it exports a substantial proportion of its output. To measure these aspects, VS is constructed as a weighted index of three coefficients. The first coefficient of the VS index is allocated a weight of 60 percent and measures the dual use of the company's products for both civilian and military purposes (dual use). For example, a missile manufacturer, the products of which are used exclusively for defense, will receive a 0 ranking for dual use of the company's products. In contrast, a manufacturer with products that have defense as well as civilian uses will receive the value of 1 for the component dual use. The second

coefficient of the VS index is allocated a weight 30 percent and measures the diversity in customers in terms of the mix of customers from Israel and from overseas (customer diversification). A company with customers both in Israel and overseas is more resilient to a reduction in orders from the Ministry of Defense compared to a company which sells in Israel only. The third coefficient of the VS index is allocated the remaining weight of the index, 10 percent, and measures the diversity in the products manufactured by the defense company (product diversifications). A company with a broad range of products is versatile and hence is expected to be able to cope relatively well with a reduction in orders from the Ministry of Defense.

The IS factor will also affect a defense company's resilience. Belonging to an industrial sector characterized with a highly qualified labor force implies that it is more difficult to replace the local company with a US firm in order to make payments in dollars. Moreover, having highly qualified labor implies that the company finds it relatively easy to innovate and develop technological responses to occurring challenges. For example, it can develop unique products that will give it a competitive edge. To measure these characteristics, the IS factor is constructed as a weighted index of two coefficients. The first coefficient, allocated 60 percent of the total, is the level of sectoral innovation. We use engineer-intensity as a measure of innovation. Specifically, we analyzed 1,282 job offers published by defense companies on their websites during April-October of 2018. Based on this analysis, an innovation rank was awarded to each industrial sector. The second coefficient, given the remaining 40 percent of the IS index, is the uniqueness of products. A unique product is a product that is difficult to obtain from local or overseas competitors, usually due to relatively complex manufacturing and development processes. Examples include the digital land army command and control system produced by Elbit Systems, the Merkava tank, or the polished sapphire domes for missiles produced by Rotem Industries.

The third factor in the resilience model, American business cooperation (ABC), measures the existence of cooperation with an American firm, because having such cooperation will make it easier for the Israeli company to receive payments in dollar aid money. Such companies are therefore in a good position to cope with the gradual reduction in the amount of aid money which may be converted from dollars to shekels.

Lastly, the fourth factor, location (L), is also expected to influence companies' ability to cope with the changes in the new aid agreement. While locating in the periphery provides benefits relating to government subsidies and lowers operating costs, these advantages are dwarfed compared to the convenience of being in central Israel. Indeed, locating near the big cities of Tel Aviv or Haifa provides good access to high-quality personnel, professional management and proximity to technology level 1 companies.

Together, the four factors (VS, IS, ABC, and L) make up the explanatory variables in the resilience model. The weight of each one was determined based on the company's technology level and its importance, as judged by 50 senior defense industry executives who were interviewed on a one-on-one basis. The following equation presents our resilience model:

$$\textbf{Resilience factor} = \alpha^{*}\textbf{VS} + \beta^{*}\textbf{IS} + \gamma^{*}\textbf{ABC} + \delta^{*}\textbf{L}$$

where:

- α is the weight of varied sales (VS), made up of three coefficients (dual use, customer diversification and product diversification),
- β is the weight of the industrial sector (IS), made up of two coefficients (innovation and uniqueness of products),
- γ is the weight of cooperation with a US company (ABC), and
- δ is the weight of the company's geographic location(L).

The value of α, β, γ and δ is given in Elfassy (2019).

In the next section we present the results of the model. We also validate those results by comparing the model's predictions with those made by the industry executives. Specifically, a questionnaire was distributed to 50 executives to record their opinions on the resilience of their own and other defense companies. Moreover, to gain further insights into the implications of the changes in the new aid agreement and about the resilience of defense companies to those changes, the executives were also interviewed on an individual basis.

Part D – Applying and Evaluating the Resilience Model, Validation, and Insights

D.1. Results

Applying the resilience model to 519 defense companies generated a rating for each company ranging from 1 (indicating high resilience) to 0 (low resilience).[16] The average value of the resilience measure for each technology level was calculated and compared to the average value assigned by 50 industry executives.

Using a questionnaire, the executives were given a list of 40 defense companies spanning the three technology levels. They were asked to rate the likelihood of each company continuing to generate profits by 2028, given its sensitivity to the changes introduced in the new aid agreement. The executives were also instructed to rate only companies they are familiar with, and with which they had business connections.[17] A total of 980 ratings were obtained from the 50 participating CEOs.

The resilience averages obtained from the model and from the executive questionnaire were averaged across the three technology levels and are compared in Figure 7.

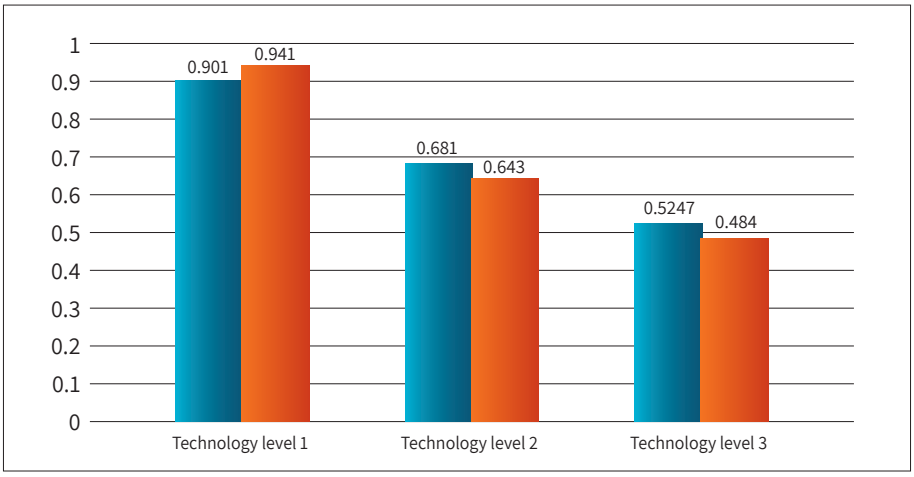

Figure 7: Average value of the resilience measure across the three technology levels – A comparison of results obtained using the resilience model (lighter columns) with results obtained from the questionnaire distributed to industry executives (darker columns)

This figure yields two clear insights: First, there is a high correlation between the ratings produced by the resilience model and those provided by the defense industry executives. This result is reassuring and reinforces the validity of the resilience model. Second, there is a substantial difference in the resilience ratings between the three technology levels. In particular, the values of resilience produced by the model for companies at technology level 1 are substantially higher than those of companies at lower levels of technology.

Figure 8 displays the average resilience rankings for 519 defense companies in Israel, across industrial sectors. The results produced by the model were compared to those obtained from the industry executives. Again, we see a high positive correlation between the model's results and those from the executives' questionnaire. Engineer-intensive sectors (systems integration, IT communication and software and electro-optics) have a higher resilience measure compared with production-oriented sectors.

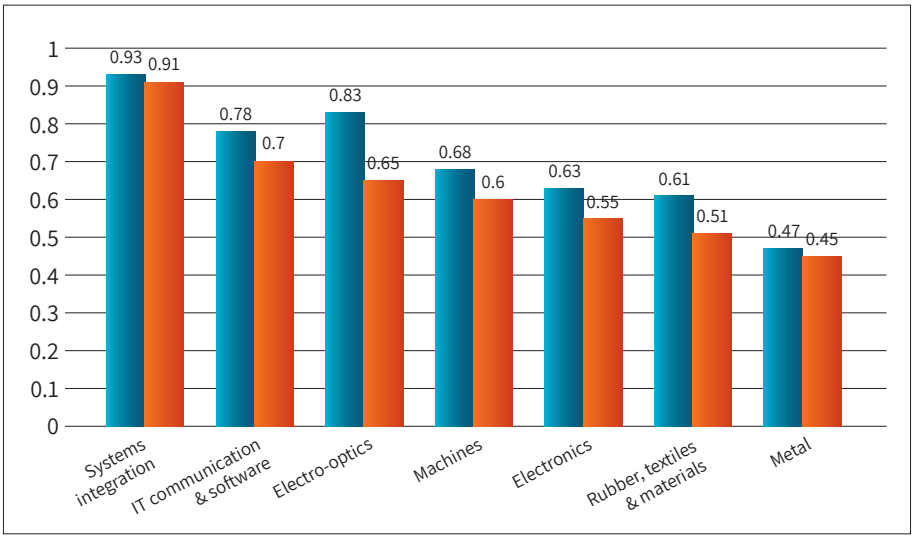

Figure 8: Resilience measures according to industrial sector: Results of the resilience model (lighter columns) and ratings by industry executives (darker columns)

The results support our argument above that a highly qualified labor force is an indication of innovation and contributes to the company's resilience.

Indeed, we check and find positive correlation between the industrial sector's innovation score and the company's resilience measure ($r=0.8766$, $p<0.01$).[18] Thus, companies in high-technology, engineer-intensive industrial sectors tend to have higher resilience values than firms in low-technology, production-intensive industrial sectors.

D.2. Insights from our interviews with industry executives

Table 3 presents information about the 50 industry executives who filled out the resilience ranking questionnaire and who were also interviewed. The information is averaged across the three levels of technology, giving the average CEO's level of knowledge about the new aid agreement and the average years of management experience.[19] A value of 9 denotes a high level of knowledge, a value of 6 a medium level of knowledge, and a value of 3 a low level of knowledge. A CEO's seniority is based on the number of years served in senior positions in the defense industry.

Table 3: Executives' knowledge of the 2019-2028 aid agreement and seniority according to their company's technology level

Technology level	Average knowledge level of CEOs	Average seniority of CEOs
1	8.45	15 years
2	6.46	14.5 years
3	4.06	17.8 years

As seen in table 3 there is a strong positive correlation between the company's technology level and the executive's knowledge about the new aid agreement ($r=0.71$, $p<0.001$). Most of the executives at technology level 1 said that they were personally involved in preparations to enable their companies to deal with the changes introduced in the new aid agreement. Preparations include improvement to infrastructure facilities of American companies that cooperate with Israeli companies and participation in political and professional committees to discuss the topic and its implications. In contrast, most of the executives from companies at technology level 3 said that they had little or no information about the new aid agreement, and that they were exposed to details about the new aid agreement mainly from the general media. It

is also worth noting that seniority is not a significant factor influencing executives' level of knowledge about the new aid agreement.

Part E – Summary and Conclusions

The new MOU on security between the governments of Israel and the US sets the framework for American defense aid to Israel in 2019-2028. The changes therein, compared to previous agreements, reflect the Obama administration's policy. It also aligns with the attitude of the Trump administration, which endeavors to halt the decline in American production capacity caused by globalization and the opening of markets over the past two decades. The main implication of the new aid agreement for Israel's defense industry is that emerging from the decision to reduce the amount of foreign aid that can be converted into local currency for defense procurement from local producers.

This study analyzes 603 defense companies based on objective data as well as subjective information, which was collected using questionnaires distributed to industry executives. The information was used to develop, apply and validate a model for predicting the resilience of defense companies over the next decade, given the worsening conditions that emerge from the new aid agreement. In-depth interviews with the CEOs who filled out the questionnaire were also conducted to yield further insights on the implications of the new aid agreement to Israel defense industry.

The findings indicate that the local defense industry is likely to face declining profitability and increasing risk of failure in the coming years, as results of the changes in the new aid agreement. Given those changes, the Israeli Ministry of Defense is expected to substantially cut back its procurement in shekels, threatening the survival of particularly small defense companies at technology levels 2 and 3 in the metal, rubber and materials, machinery, and electronics sectors. The risk is exceptionally high for companies in the electronics and metal sectors in the periphery, which may be forced to cease operations due to substantial drop in orders. It is also likely that some of the companies will change their target market from defense to civilian. Furthermore, gaps were identified in the level of knowledge amongst executives in companies at low technology levels regarding the 2019-2028 aid agreement, as well as in their perception of the risk posed by this agreement.

To conclude, an active and productive defense industry contributes directly to Israel's national security. The terms of the new MOU on security between Israel and the US expose the defense industry to a challenging situation in which the industry could lose its edge over its competitors around the world in technology and innovation. In the long term, the loss of Israel's leading position in technology may negatively impact the standing and performance of its defense force. In particular, it may lead to a loss of its technological advantage in weaponry, erode Israel's national security, and reduce the revenues and profits of local defense companies. This situation is also likely to harm the technological advantages and future technological development of the Israeli economy.

Moreover, barring a change in government policy, the new aid agreement is likely to increase the dependence of the Israeli defense establishment on American arms. The local defense industry will experience a gradual decline, coupled with growing reliance on the US for preserving Israel's technological and operational edge. The Israeli government must, therefore, address the fundamental question of whether its defense industry should be exposed to free-market forces like those experienced by the local textile industry in the 1970s and 1980s. Alternatively, the government could classify the defense industry as a national resource that is essential for Israel's national security, similar to resources such as energy and water. It appears that the answer to this question is clear; thus, effective action should be taken to preserve the defense industry.

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Notes

1 The first 10-year MOU on Security was signed in 1998. It is often referred to as Foreign Military Funding (FMF) or American Aid in Foreign Money.

2 The dataset on the Israeli defense industry is from Elfassy (2019).

3 The calculation is for the annual amount of the grant, excluding the proportion converted to shekels, multiplied by the annual percentage of VAT For 2019-2028, a VAT rate of 17 percent was calculated. The Value Added Tax Law–1975 requires payment of tax on goods imported to Israel, https://www.btl.gov.il/Laws1/00_0022_000000.pdf. To the authors' best knowledge, there is no exemption from VAT for procurement under the FMF Program.

4 SIPRI Arms Industry Database 2002-2016.

5 "Rafael and Rotem Industries negotiating cooperation over Rotem's Crystals Division," https://tinyurl.com/syv7bgg, July 3, 2014.

6 The number 16 was selected randomly in order to distinguish this level from manufacturing levels 1, 2, and 3.

7 The companies' data were gathered from unclassified sources, such as the companies' websites.

8 Tomer Systems was founded as a government company in 2018, after the sale by the government of parts of the business of Israel Military Industries (IMI) to Elbit Systems.

9 The Merkava Tank and APC Administration is an agency of Israel's Ministry of Defense, which is responsible for the development and production of the Merkava tank and several armored fighting vehicles for the IDF.

10 The peripheral areas, particularly in the south and north of Israel, are considered to be national priority areas.

11 Two points to note: First, the "systems integration" sector includes companies at technology level 1 with high engineering integration capabilities. Second, to assess

the engineer-intensity of the various sectors, we analyzed 1,282 job offers published by defense companies in 2018, checking their specifications regarding the education level required. The demand for employees with higher education, particularly in the engineering professions, is dominant in sectors including systems integration, electro-optics, and IT communication and software.

12 Two remarks: First, the sector "general services" includes companies at technology level 16 that do not have development or production facilities in Israel but provide defense-related services such as testing and importing. Second, our analysis of job offers revealed that demand for academic education as a threshold condition was not common in sectors including the metal, rubber, textiles and materials; electronics, and general services.

13 A national priority area is an area declared by the Israeli government as a preferential area to be granted a set of economic incentives. A national priority area is based on a number of criteria including the level of security threat, geographic location, age of the settlement, and the socioeconomic status of the community. National priority areas are classified as areas A1, A2 and B.

14 Israel's Central Bureau of Statistics divides the localities among Israel into 10 socioeconomic clusters, ranked according to the average level of income and the average level of education of the residents of the same locality. Localities in cluster 1 have the lowest socioeconomic ranking and localities in cluster 10 have the highest socioeconomic ranking.

15 See Central Bureau of Statistics 2016 report no. 67 (https://tinyurl.com/ycut3tca). The report finds that in 47 communities with a majority population from socioeconomic clusters 3-6, men's average gross monthly wage was NIS 8,737 (2013 values) and the proportion of high school graduates holding matriculation certificates was 48 percent. In communities from socioeconomic clusters 7-10, men's average gross monthly wage was NIS 14,725, and the proportion of high school graduates holding matriculation certificates was 82 percent.

16 Israel's defense industry includes 519 developers and manufacturers of defense products. The 84 companies at technology level 16 were not included in the analysis.

17 It is important to note that the executives filling the questionnaire received no information about our categorization of the defense industry along technology levels.

18 As previously noted, the sectoral innovation score was obtained by analyzing 1,282 job offers published by defense companies in 2018, checking their specifications regarding the level of education required.

19 To gauge the level of knowledge of CEOs about the new aid agreement, they were asked the following question: "Could you tell me what you know about the Israel-US 2019-2018 agreement?" Based on the answer, CEOs were assigned a knowledge score. Poor level of knowledge regarding the new aid agreement was given a score of 3. A basic level of knowledge regarding the new aid agreement (e.g., regarding

future reduction in the amount of aid money permitted to be converted into shekels or about the increase in the annual financing budget) was given a score of 6. A high level of knowledge about the new aid agreement (e.g., familiarity with the changes in currency conversion; the increase in the annual budget; and cancelation of the option to purchase fuel in the US) as well as taking active steps to prepare the company for dealing with those aspects of the agreement, were assigned a score of 9.