

**Armaments After Autonomy:**  
**Military Adaptation and the Drive for Domestic Defense Industries**

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## **Abstract**

State investments in domestic defense industries are one of the most puzzling trends in international relations. Over 60 states devote scarce assets to such industries. Economists contend that these investments waste resources because most states could procure their weaponry more cost-effectively from international markets. Political scientists, furthermore, claim that the resulting over-production of armaments fuels arms races. Why then do governments cultivate domestic defence industries and what benefits do they provide? I argue in the following pages that the answers to these questions are distinct. Fears about supply security frequently spur states to begin developing arms industries and elites' technonationalist beliefs often sustain their defence-industrial investments. Defence industries' primary national security value, however, lies in their hitherto unappreciated contribution to states' military adaptation capacity. Since warfare is unpredictable, victories are oftentimes won by whichever side adapts faster to battlefields' unexpected realities. Even small defense industries, within these circumstances, boost states' capacity for military adaptation. Cases drawn from Israel's, South Africa's and Iraq's experiences demonstrate both military adaptation's role in driving governments to sustain their investments in domestic defense industries as well as the complementary impacts of supply security and technonationalist considerations.

## **Introduction**

State investments in domestic defense industries are one of the most puzzling trends in international relations. Over 60 states devote scarce assets to such industries. Economists contend that these investments waste resources because most states could procure their weaponry more cost-effectively from international markets. Political scientists, furthermore, claim that the resulting over-production of armaments fuels arms races. Why then do governments cultivate domestic defence industries and what benefits do they provide? I argue in the following pages that the answers to these questions are distinct. Fears about supply security spur states to begin developing arms industries and elites' technonationalist beliefs often sustain their defence-industrial investments. Defence industries' primary national security value, however, lies in their hitherto unappreciated contribution to states' military adaptation capacity.

Experts traditionally contended that supply security motivated states' defense-industrial investments. According to this argument, exporters occupy a superior position to importers

because the former can use their position as suppliers to coerce consumers into modifying their foreign policies. If such is the case, defense-industrial autonomy is a prerequisite for states to pursue their interests. Distinct, yet oftentimes coexisting with supply security concerns, are leaders' technonationalist impulses. At military technonationalism's core lies the belief that states' global rankings are defined by their ability to develop weaponry. Technonationalism oftentimes ideologically coincides with visions of the developmental state, wherein government promotes industrialization through technology's one-way importation and indigenization.

Supply security and technonationalism provide, at best, incomplete explanations for defence-industrial investments since weaponry's growing cost has rendered self-sufficiency illusory for all but the largest states and stymied many technonationalist projects. Why then do governments continue to support domestic defense industries?

I argue that the answer lies in two hitherto under-appreciated dynamics. First, states can achieve a measure of supply security—that is insurance against the risk of exporters curtailing arms supplies—by developing the capabilities needed to upgrade their existing weaponry. Secondly and interrelated to this pursuit of a limited degree of supply security are domestic defense firms' underappreciated contribution to military innovation. Warfare is inherently unpredictable and militaries are regularly surprised by adversaries' weaponry and unexpected environments. Success under these circumstances hinges on militaries' adaptation capacities and even modest defense industries contribute substantially by tailoring weaponry for specific tasks. Providing engineers and technologists skilled at countering unanticipated threats therefore constitutes one of a defense-industrial base's major wartime contribution to national security.

This study tests military adaptation's ability to account for states' defense-industrial investments against the dominant supply security and technonationalist hypotheses. Cases, to this end, are drawn from post-1973 Israel. I first assess the factors that originally motivated

Israeli governments to invest in domestic defense industries and evaluate Israel's evolving degree of self-sufficiency. I next analyse Israel's defense industries' role in bolstering its land forces and, most particularly, how they contributed to Israel's responses to enemies' new anti-tank capabilities. I then examine two further medium-sized, middle income states that waged lengthy wars, yet possessed different arms acquisition capacities, to ascertain whether lessons drawn from Israeli cases are generalizable.

### **Supply Security**

The desire for secure weapons supplies long motivated states to develop defense industries. Even Adam Smith argued that governments should cultivate arms industries rather than exposing them to markets' vagaries. Smith postulated that governments should protect arms factories from market forces—particularly imports—because states' security depends on their possessing reliable sources of weaponry.<sup>1</sup> Smith's analysis prefigured later generations of defense economists who argue supply security's primacy.<sup>2</sup> Although differing on details, supply security's proponents contend that domestic arms production permits greater foreign policy autonomy and is economically feasible for many states.

In foreign policy terms, arms exporters can threaten to suspend deliveries as a means of coercing importing states into adopting their favoured policies. Contemporary examples abound, with India, Iran, Israel, Pakistan and Turkey all having been embargoed by their principle

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<sup>1</sup> Fanny Coulomb, 'Adam Smith: A Defence Economist', *Defence and Peace Economics* 9/3 (1998), 299-316.

<sup>2</sup> Ethan Kapstein, *The Political Economy of National Security* (New York: McGraw-Hill, 1992), 1-11.

suppliers.<sup>3</sup> These embargos negatively impact states' power even when they rapidly locate alternative suppliers because weapons are designed to last for decades, but regularly require spare parts and upgrades. Suppliers' decisions to curtail spare parts and upgrade contracts therefore negatively impacts states' ability to use their existing weaponry even if they acquire new systems from different suppliers. Iran's American-built aircraft, for example, suffered grave serviceability problems after the 1979 Islamic Revolution, while Egypt struggled to keep its Soviet-designed aircraft operational through the 1980s, even though both countries swiftly located substitute suppliers.

Arms suppliers, in other cases, leverage supply cut-offs to placate third parties. Germany's refusals to sell submarines to Taiwan, for example, ingratiated it with China.<sup>4</sup> Great powers also renege on commitments to export weaponry when they need the systems themselves. The British government, for example, commandeered battleships built for export during the First World War and the United States requisitioned aircraft bound for foreign customers during Second World War.

Importing states are thus vulnerable to exporters' decisions. Various motivations drive, in turn, suppliers to cut off their clients, including: coercing them into changing policies, currying favour with third parties, and re-appropriating weapons for their own use. Producing weapons is, therefore, the only guaranteed manner of acquiring them. Governments consequently built armaments domestically even when the costs were high. During the 19<sup>th</sup> century, for example,

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<sup>3</sup> A. Sampson, *The Arms Bazaar* (London: Hodder and Stoughton, 1977), 311-12.

<sup>4</sup> Richard Bitzinger, 'Taipei's Arms Procurement Dilemma', *Asia-Pacific Security Studies*, 3/4 (2004), 3.

Spain, Italy and China all produced foreign-designed warships and artillery on their territory despite the costs being significantly higher than importing the same systems.<sup>5</sup>

Economists during the Cold War postulated that the costs of supply security were decreasing and that even small states could achieve meaningful levels of it.<sup>6</sup> Expert opinion postulated that states could progress from importing armaments to autonomously producing them by ascending a metaphorical “ladder of production.” This import substitution process consisted of: first domestically maintaining imported weapons, then manufacturing foreign-designed systems, before finally developing indigenous weaponry.<sup>7</sup> Governments’ embrace of this policy drove small and medium states to increase their production of armaments four-fold between 1970 and 1990, and propelled the number of developing states producing armaments from four in 1945 to 50 in 1985.<sup>8</sup>

Observers have, however, grown sceptical of this quest for self-sufficiency. Technological progress is driving weapons costs upwards at a rate of 6-10% per annum, which exceeds the 2% growth rates sustained by highly-performing mature economies.<sup>9</sup> Defense-industrial supply chains have, meanwhile, globalized to the extent that even American weapons depend heavily on imported components and the import content of British-built weaponry

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<sup>5</sup> Clive Trebilcock, *The Vickers Brothers: Armaments and Enterprise* (London: Europa, 1977), 119-41.

<sup>6</sup> Emile Benoit, *Defense and Economic Growth in Developing Countries* (Boston: DC Heath, 1973).

<sup>7</sup> Keith Krause, *Arms and the State: Patterns of Military Production and Trade* (Cambridge: Cambridge UP, 1992), 153-71.

<sup>8</sup> Robert Rosh, ‘Third World Arms Production and the Evolving Interstate System’, *Journal of Conflict Resolution*, 34:1 (1990), 57-73.

<sup>9</sup> David Kirkpatrick, ‘Trends in the costs of weapon systems and the consequences’, *Defence and Peace Economics*, 15/3 (2004), 259-73.

exceeds 40%.<sup>10</sup> Great power's growing dependence on foreign inputs casts doubt on whether any state can still achieve self-sufficiency. Scholars, indeed, predict that these dynamics will drive most states to replace inefficient domestically-produced weapons platforms with cost-effective imports.<sup>11</sup>

Even though states' pursuit of supply security through self-sufficient defense industries is proving illusory, domestic defense industries may nonetheless insulate states from exporters' decisions to suspend deliveries. The means for accomplishing this lies in even modest defense firms' ability to update imported weapon systems. Although few states can efficiently produce the full gamut of armaments—including armored vehicles, combat aircraft and warships—many more can refurbish and improve the foreign-built platforms they already possess. This capacity offers a measure of security should states be embargoed since they could thereafter modernize their existing weaponry, ensuring that it remains competitive. Although a state's ability to eek additional performance out of old designs is finite, rebuilds and updates can prevent a state from rapidly losing its military edge once embargoed.

Questions must therefore be posed as to whether it is still supply security that drives states to produce armaments domestically and, if so, whether states pursue that objective by still seeking to develop self-sufficient defense industries or whether they today content themselves with industries capable of modernizing imported weaponry.

### **Technonationalism**

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<sup>10</sup> Paul Dowdall, 'Chains, Networks and Shifting Paradigms', *Defence and Peace Economics* 15/6 (2004), 535–50.

<sup>11</sup> Jocelyn Mawdsley, 'European Union Armaments Policy: Options for Small States?' *European Security*, 17?2 (2008), 367-85.

An alternative, yet complementary explanation for states' defense-industrial investments lies in the phenomenon that Richard Bitzinger terms the "technonationalist impulse."<sup>12</sup> Building on political economist Robert Reich's observations, technonationalism is a widespread belief that technology's indigenous development is central to states' growth and identities. Military technonationalism, as articulated by Richard Samuels, has at its core the related notion that states' rankings in the international system are largely determined by their ability to indigenously develop sophisticated weapons. Samuels, indeed, sums up the technonationalist worldview as the "embrace of technology for national security."<sup>13</sup>

Unlike arguments about supply security, which regard defense-industrial autonomy as a costly yet necessary goal, technonationalists champion defense industries as a positive good. Embracing variants of Japan's Meiji-era slogan of *kokusanka* or "Rich Nation, Strong Army," technonationalist governments regard defense industries as cultivating skills and infrastructure that can then be harnessed to develop cutting-edge civilian industries.<sup>14</sup> Developing defense-industrial capacities in aerospace and electronics, for example, can be used to bootstrap a state's civilian enterprises in those sectors. The ultimate goal is thus the creation of hi-tech dual-use economies wherein technologies "interdiffuse" between military and civilian applications.<sup>15</sup>

Besides economic benefits, technonationalists value defense industries for their symbolic significance. Externally, producing cutting-edge weaponry affirms a state's status. Domestically, meanwhile, regimes tangibly affirm their managerial powers to citizens by showcasing indigenously-developed weaponry at parades and demonstrations.

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<sup>12</sup> Richard Bitzinger, *Arming Asia: Technonationalism and its impact on local defense industries* (London: Routledge, 2017), 6-8.

<sup>13</sup> Richard Samuels, "*Rich Nation Strong Army*" *National Security and the Technological Transformation of Japan* (Ithaca: Cornell UP, 1994), 31.

<sup>14</sup> *Ibid*, 33-78.

<sup>15</sup> *Ibid*, 49.



Because of the desirability of this end-state—a hi-tech economy providing cutting-edge weaponry—technonationalists recognize the short-term need to compromise on their militaries' cost-effectiveness and autonomy.<sup>16</sup> Technonationalists argue, indeed, that governments need to initially import know-how through the licensed-production of foreign weapons in order to later indigenize, diffuse and nurture their underlying technologies.<sup>17</sup> This, in turn, requires invasive governments that foster the “one-way importation of advanced technology and knowledge.”<sup>18</sup> Technonationalists, moreover, pay a short-term premium because manufacturing weapons under license is invariably more costly than importing them.

A growing literature demonstrates technonationalism's role in shaping Asian states' policies. Samuels, for example, articulated our understanding of military technonationalism around the Japanese case. Tai Ming Cheung subsequently demonstrated that similar beliefs have driven Chinese policymaking since the Mao-era.<sup>19</sup> Bitzinger, finally, suggests that technonationalism holistically explains the defense policies of South Korea, Taiwan, Singapore, Indonesia and India, in addition to the Japanese and Chinese cases mentioned above. Although not explicitly framed in technonationalist terms, prior scholarship on South America highlights similar motivations for defense-industrial investments.<sup>20</sup>

Despite its demonstrated influence, reasons for scepticism abound as to technonationalism's applicability to a wide-range of cases. Most paradigmatic cases of military

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<sup>16</sup> Tai Ming Cheung, *Fortifying China: The Struggle to Build a Modern Defense Economy* (Ithaca: Cornell UP, 2009), 176-234.

<sup>17</sup> Samuels, 42-56.

<sup>18</sup> Tai Ming Cheung, 'Commentary on Asian arms industries and impact on military capabilities', *Defence Studies* 17/3 (2017), 312-13.

<sup>19</sup> Cheung, *Fortifying China*, 52-262.

<sup>20</sup> José Maldifassi and Pier Abetti, *Defense Industries in Latin American Countries* (Westport: Praeger, 1994), 107-26.

technonationalism involve states with large financial resources, which enjoyed long periods of peace. These states can, consequently, afford policies that provide relatively little value for the money spent. An increasing body of research on Japan—once considered an exemplar of successful technonationalism—suggests, for example, deep inefficiencies. Christopher Hughes chronicles corruption and a lack of competition, which have resulted in Japan producing weaponry that is far more expensive than foreign equivalents.<sup>21</sup> Bitzinger, meanwhile, argues that East Asian technonationalism has failed, after decades, to provide the desired levels of self-sufficiency and generates weapons that are rarely cost-effective.<sup>22</sup> Factors such as these have led certain states, such as Brazil, to scale-back governmental support for defense industries.

### **Military Adaptation**

Supply security's seeming unattainability and technonationalist policies' costliness raise questions as to why so many governments support defense industries. I argue that a hitherto neglected factor lies in domestic firms' contribution to armed forces' adaptation capacity. Warfare's unpredictability leads to states often encountering unforeseen challenges. Victories are consequentially won by whichever side adapts faster to unexpected battlefield realities. Even small defense industries can, within these circumstances, boost states' adaptation capacity thanks to their communities of technologists specialized at cooperating with militaries to solve tactical problems. Governments thus invest in defense firms because they enhance their capacity for military adaptation, which contributes to battlefield success.

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<sup>21</sup> Christopher Hughes, 'The Slow Death of Japanese Techno-Nationalism?' *Journal of Strategic Studies*, 34/3 (2011), 451-479.

<sup>22</sup> Bitzinger, *Arming Asia*, 135-38.

A long tradition of theorists, dating back to Carl von Clausewitz and Helmuth von Moltke, emphasize war's unpredictability.<sup>23</sup> A cacophony of variables—including weather, terrain, public opinion and enemy actions—ensure that wars unfold in unanticipated ways. Technology has, since the industrial revolution, also augmented war's uncertainty. Rapid technological change means that weapons' parameters evolve constantly and new types of equipment appear with increasing regularity. This pace of military-technical change provides opportunities for states to surprise their adversaries and detracts from armed forces' ability to evaluate opponents' innovations.<sup>24</sup>

Misperception and surprise are consequently ubiquitous in warfare. Recent conflicts all feature technological surprises, whether Iraqi improvised explosives devices surprising the US Army or Georgian UAVs catching Russian forces unawares. Non-technical surprises, such as mountain warfare in Afghanistan and urban combat in Chechnya, also unsettle armed forces. The ability of armed forces to respond to surprise is therefore arguably as important as their peacetime procurement decisions and military doctrines.<sup>25</sup>

Technological adaptation is an essential component of military adaptation considering technology's ever increasing role in warfare. Compared with the related topic of technological innovation, adaptation consists of “new uses of existing technologies, or indeed the introduction of a mature technology that is new to the organization, but itself hardly innovative.”<sup>26</sup>

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<sup>23</sup> Carl von Clausewitz, *On War* (Princeton: Princeton UP, 1976); and Helmuth von Moltke, *Moltke on the Art of War: Selected Writings* (London: Greenhill, 1993).

<sup>24</sup> Thomas Mahnken, *Uncovering Ways of War: U.S. Intelligence and Foreign Military Innovation, 1918-1941* (Ithaca: Cornell UP, 2002).

<sup>25</sup> Meir Finkel, *On Flexibility: Recovery from Technological and Doctrinal Surprise on the Battlefield* (Stanford: Stanford UP, 2011).

<sup>26</sup> Theo Farrell, ‘Improving in War: Military Adaptation and the British in Helmand Province’, *Journal of Strategic Studies*, 33/4 (2010), 570.

Adaptations, such as retro-fitting and modifying equipment, may appear less dramatic than wholly new innovations, such as the first nuclear submarines and tanks, but fast-paced adaptation can have equally significant battlefield effects.<sup>27</sup>

Four categories of actors can, within this context, hypothetically contribute to technological adaptation: warfighters, foreign defense industries, domestic civil industries and domestic defense industries. There are powerful reasons to anticipate, however, that domestic defense industries contribute most.

Prior technological adaptation studies focus on warfighters relying only on their organic resources. Cases ranging from Second World War hedgerow cutting devices to Vietnam gun trucks demonstrate, indeed, that mechanically-skilled soldiers can develop certain adaptations relying on materials available near the battlefield.<sup>28</sup> However, while these studies demonstrate military professionals' ability to improvise solutions to certain problems, they only capture a crude subset of technological adaptation. Adaptations involving processes more complex than welding armored plate and buttressing vehicles with sandbags require skills and resources that only industries can provide.

Foreign defense firms, in principle, possess the requisite scientific and engineering skills. Nevertheless, although foreign firms offer cost-effective weaponry, three factors oftentimes limit in practice the likelihood of their providing customized solutions to clients' adaptation needs. First, geographic distances and the absence of long-standing collaborative

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<sup>27</sup> James Russell, *Innovation, Transformation, and War: Counterinsurgency Operations in Anbar and Ninewa* (Stanford: Stanford UP, 2011), 8.

<sup>28</sup> Nina Kollars, 'War's Horizon: Soldier-Led Adaptation in Iraq and Vietnam', *Journal of Strategic Studies*, 38/4 (2015), 529-553.

routines means that foreign firms are rarely attuned to warfighters' needs.<sup>29</sup> Secondly, even if they were aware, most states' markets are too small to incentivize foreign firms to shift priorities in order to meet their urgent requirements. International organizations, such as the European Union and United Nations, thirdly, often urge members to refrain from exporting weapons to conflict zones, which further restricts governments' ability to rely on foreign firms.

As an ensemble, these factors render it hazardous for many states to rely on foreign firms for their military adaptation needs. There are nonetheless exceptions. Such is particularly the case when smaller states enjoy privileged alliance relationships with great powers. Canada and Britain, within this context, largely eschewed developing specialized counterinsurgency vehicles for use in Afghanistan and relied instead on the United States, which intervened with its own defense firms to ensure that these allies swiftly and preferentially received mine resistant ambush protected (MRAP) vehicles.<sup>30</sup> Recognition that circumstances such as these are rare, however, drove military diffusion scholars to argue that domestic defense industries are frequently a prerequisite for states to efficiently assimilate foreign weaponry.<sup>31</sup>

Domestic civilian firms likewise contribute little to adaptation despite their possessing the requisite technological expertise. The reason for this lies, according to Peter Dombrowski and Eugene Gholz, in institutional factors that prevent them from efficiently applying their

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<sup>29</sup> Warren Chin, *British Weapons Acquisition Policy and the Futility of Reform* (Aldershot: Ashgate, 2004), 105-44.

<sup>30</sup> Claire Taylor, *Afghanistan: Equipment Issues* (London: House of Commons Library, 2009), 4-12; and Kenneth Holland and Christopher Kirkey, 'Introduction: Canada's Commitment to Afghanistan', *American Review of Canadian Studies*, 40/2 (2010), 167-170.

<sup>31</sup> Michael Horowitz, *The Diffusion of Military Power: Causes and Consequences for International Politics* (Princeton: Princeton UP, 2010), 1-64.

engineering capabilities to defense.<sup>32</sup> Whereas defense firms focus on armed forces' specific requirements, civil firms develop products for large numbers of undifferentiated consumers. Civil firms, consequently, focus on market research, rather than cultivating relationships with warfighters, and therefore lack the expertise to navigate defense acquisition procedures.<sup>33</sup>

Domestic defense firms are better equipped than these other actors to cultivate the close cooperation between warfighters and technologists so essential to adaptation. Cooperation with their states' militaries are one of these firms' core competences.<sup>34</sup> Domestic defense firms therefore nurture extensive interpersonal ties with commanders, often through retired officers on their payrolls, and develop expertise at navigating acquisition procedures. Domestic defense firms also routinely attach corporate personnel to military units when new equipment is deployed. Such interactions between armament engineers and military professionals foster organizational habits of jointly adapting to new challenges. The industrial capabilities needed for adaptations of this variety are broadly similar to those required to upgrade and rebuild imported weaponry in pursuit of a minimal degree of supply security.

The need to adapt militarily to unforeseen circumstances, in sum, incentivizes states to support defense industries. Defense firms augment states' power since military adaptation is critical to battlefield success and domestic defense industries enable armed forces' to better leverage technology for adaptation. Domestic defense industries, in principle, need not even approach self-sufficiency to provide significant adaptation advantages. Their industries can,

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<sup>32</sup>Peter Dombrowski and Eugene Gholz, *Buying military transformation: Technological innovation and the defense industry* (New York: Columbia UP, 2006).

<sup>33</sup> Office of Technology Assessment, *Assessing the Potential for Civil-Military Integration* (Washington DC: USGPO, 1994), 105-59.

<sup>34</sup> Dombrowski and Gholz.

rather, focus on niches provided that they also cultivate the collaborative relationships with warfighters needed to solve battlefield problems.

### Case Selection

Any strategy for selecting cases will inevitably possess advantages and limitations.<sup>35</sup> The paradigmatic cases—Japan, China and South Korea—around which the technonationalist hypothesis was built, for example, are larger and wealthier than the average arms producing state and have also enjoyed exceptional periods of peace. The two factors that must, however, be present to assess the relative influence of supply security, technonationalism and military adaptation on states' decisions to foster defense industries are their having recently experienced military conflict and their possessing domestic defense industries.

In principle, however, broadly representative cases can tell us the most about states' motivations.<sup>36</sup> Reportedly, over 60 states possess some form of defense industry.<sup>37</sup> Many of these states' industries, however, are miniscule and produce only a narrow range of products, such as light weapons or patrol boats. At the opposite end of the spectrum, the top arms exporters—the United States, Russia, China, Germany, France and the United Kingdom—occupy a privileged position. Those states' defense-industrial bases employ upwards of 100,000

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<sup>35</sup> Barbara Geddes, *Paradigms and Sand Castles: Theory Building and Research Design in Comparative Politics* (Ann Arbor: Michigan UP, 2006).

<sup>36</sup> Alexander George and Andrew Bennett, *Case Studies and Theory Development in the Social Sciences* (Cambridge: MIT, 2004), 83-84.

<sup>37</sup> Eric Berman and Jonah Leff, 'Light Weapons: Products, Producers, and Proliferation', in *Small Arms Survey 2008* (Cambridge: Cambridge UP, 2008), 7-41.

workers apiece and house 19 of the world's 20 largest defense firms.<sup>38</sup> These states' industries' exceptional size and dominance render findings derived from examining them doubtfully applicable to other producers.

Excluding those states with diminutive defense industries as well as the largest arms producers, one is left with 30 non-great power producers with defense-industrial labor forces in the thousands and which each produce a range of weaponry.<sup>39</sup> Statistically, these states average 43,960 defense-industrial employees and spend \$12.6 billion annually on defense. Selecting states that are representative of these non-great power producers will consequently provide the best cases for assessing states' motivations for investing in defense industries.

Israel's 50,000 defense-industrial employees and \$16 billion defense budget statistically render it one of the most representative non-great power producers when judged according to these criteria.<sup>40</sup> Although Israel is less average according to other criteria, it is not an outlier by any relevant measure. Israel's GDP lies within the second tier of non-great power arms producers, its population is towards the bottom of the third quartile and its per capita GDP (incorporating purchasing power parity) is close to the mean. Israel is, in sum, statistically exceptionally representative of states that invest in domestic defense industries.

Other factors—particularly Israel's fraught diplomatic relations and frequent military operations—render it a particularly good test for supply security and military adaptation hypotheses. Israel's experience being embargoed by its primary arms suppliers following the

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<sup>38</sup> Aude Fleurant et al., *The SIPRI Top 100 Arms-Producing and Military Services Companies* (Stockholm: SIPRI, 2014); and Aude Fleurant et al., *Trends In International Arms Transfers* (Stockholm: SIPRI, 2015).

<sup>39</sup> I compiled original data on non-great power producers, which will be made available as an online appendix.

<sup>40</sup> The statistically most average cases are (in declining order): Iran, Israel, Poland, Taiwan and Turkey.



1967 Arab-Israeli War provides, for example, an archetypical example of the type of trauma that scholars argue drive states to pursue supply security.<sup>41</sup> References to this embargo and fears of a recurrence suffuse Israeli debates, even today.<sup>42</sup> Meanwhile, Israel's recurrent military operations and the Israeli public's sensitivity to casualties creates a continuing imperative for military adaptation in response to new threats.

Israel's special relationship with the United States should, however, help it in principle respond to both its supply security and adaptation needs. Successive American governments have transferred weaponry to Israel since 1965 and have annually provided significant assistance since 1979.<sup>43</sup> The regularity with which the United States provides Israel cutting-edge weaponry and America's political consensus concerning supplying that aid provides Israel with a greater degree of supply security today than that state enjoyed during its first two decades or than many other conflict-prone states enjoy.

At the same time as reliably providing armaments, America also rushes new weaponry to Israel to compensate for battlefield setbacks. During the 1973 Arab-Israeli War the United States airlifted 30,500 tons of weaponry to Israel, including cutting-edge TOW anti-tank missiles and electronic jamming pods, in response to the unanticipated challenges Israel faced.<sup>44</sup> Later, American policymakers dispatched their latest Patriot missiles to protect Israel from Iraqi missiles in 1991 and expedited laser-guided bombs to help during Israel's 2006 Lebanon War.<sup>45</sup>

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<sup>41</sup> Sampson; and Gupta.

<sup>42</sup> David Rodman, *Arms Transfers to Israel* (Brighton: Sussex UP 2007), 94-97.

<sup>43</sup> Uzi Rubin, 'Israel's defence industries—an overview', *Defence Studies* 17/3 (2017), 235-36.

<sup>44</sup> Pierre Razoux, *La guerre du Kippour* (Paris: Economica, 1999), 274-81.

<sup>45</sup> "US Speeds Up Bomb Delivery for the Israelis," *New York Times* (22 July 2006).

These emergency shipments from a superpower's arsenal logically reduced Israel's need for domestic firms' help in overcoming unexpected battlefield conditions.

Israel, in sum, provides a powerful case for assessing why states support defense firms. I will, for this reason, examine the degree to which supply security, technonationalism and military adaptation account for Israel's investments in the domestic land armaments sector. French documents from *Documents Diplomatiques Français* (DDF) and American documents from the *Foreign Relations of the United States* (FRUS) enable me to assess Israel's relationships with its most historically important arms suppliers. Since the insights provided by any case are limited, I will scrutinize two medium-sized, middle-income states—South Africa and Iraq—that waged lengthy wars, yet possessed different arms acquisition capacities, to ascertain whether lessons drawn from the Israeli case are generalizable to others.<sup>46</sup>

### **Israel's Search for Supply Security**

Israel's defense-industrial base is a product of the country's history. The inability of Zionist paramilitary groups, such as the Palmach and Haganah, to legally import weaponry drove them to establish clandestine workshops in the 1920s. These expanded into a centrally-planned enterprise, TAAS, in 1933 that produced firearms, munitions and explosives.<sup>47</sup> Political leaders, including David Ben-Gurion, favored TAAS because they felt only indigenous production

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<sup>46</sup> Geddes, 89-129.

<sup>47</sup> D. Dvir and A. Tishler, 'The Changing Role of the Defense Industry in Israel's Industrial and Technological Development', *Defense Analysis* 16/1 (2000), 33-51.

guaranteed reliable arms supplies. Clandestine imports, nevertheless, proved a more cost-effective means of arming Zionist paramilitaries in 1947-48.<sup>48</sup>

Statehood, following Israel's May 1948 independence declaration, did not swiftly improve Israel's access to armaments. The United Nations (UN) imposed an embargo on Jewish and Palestinian groups in late-1947. Israeli agents and sympathizers adroitly evaded this embargo, clandestinely purchasing material ranging from Sherman tanks to B-17 bombers, and smuggling them to Israel. Only one state—Czechoslovakia—agreed however to officially sign contracts with the Jewish Agency, which formed the nucleus of Israel's post-independence government.<sup>49</sup> This Czechoslovak connection proved crucial, furnishing 60% of Israeli armaments during the 1947-49 Palestine War and 25% during the following three years.<sup>50</sup>

Israel's ability to purchase weaponry remained fraught, however, following the 1949 Arab-Israeli armistices. Although the UN General Assembly lifted its embargo, Britain, France and the United States unveiled a joint policy designed to prevent Middle Eastern arms races in May 1950. As part and parcel to their tripartite declaration, these states committed themselves to supplying only minimal quantities of weaponry to Middle Eastern states.<sup>51</sup> Czechoslovakia, meanwhile, curtailed exports to Israel in 1951, in retaliation for Israel's diplomatic support of the United States during the Korean War.<sup>52</sup>

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<sup>48</sup> Amitzur Ilan, *The Origin of the Arab-Israeli Arms Race* (Basingstoke: Macmillan, 1996).

<sup>49</sup> Uri Bialer, 'The Czech-Israeli Arms Deal Revisited', *Journal of Strategic Studies* 8/3 (1985), 307.

<sup>50</sup> *Ibid*, 308-10.

<sup>51</sup> Schuman aux ambassades, 22 mai 1950. in *DDF*, 1950-1, Document 132.

<sup>52</sup> Bialer, 311.

Israeli leaders struggled over subsequent years to negotiate contracts with Britain and France after Sweden and the United States rebuffed Israeli requests.<sup>53</sup> Although Britain and France both sold Israel a trickle of arms, they frequently suspended deliveries when Israel became embroiled in fighting. France, for example, began selling Israel light tanks and artillery in 1954, but froze deliveries in December 1955 in retaliation for Israeli attacks on Syrian troops near the Sea of Galilee.<sup>54</sup> Similarly, after agreeing to sell Israel tanks in February 1955, Britain cancelled the order after Israeli forces raided Gaza.<sup>55</sup>

Israel's chronic difficulty importing weapons drove leaders to invest in domestic defense industries. Israel's government reorganized its hitherto clandestine munitions factories as Israel Military Industries (IMI) following independence. Bedek Aviation, later to become Israel Aerospace Industries (IAI), was then established in 1953 to overhaul military aircraft. Israel's Defense Ministry then created a laboratory—Rafael—to develop missiles in 1958.<sup>56</sup> These industries' functions would remain contested for decades thereafter.

Initially these firms reconditioned the obsolescent weapons that Israel could purchase. One of their most significant early accomplishments, for example, was the upgrading of Sherman tanks with high-velocity French guns and new American diesel engines.<sup>57</sup> Certain policymakers,

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<sup>53</sup> Shimon Peres, *David's Sling* (London: Weidenfeld, 1970), 37-108.

<sup>54</sup> Pinay à Gilbert. *DDF*, 1955-2, Document 420.

<sup>55</sup> Zach Levey, 'Israeli Foreign Policy and the Arms Race in the Middle East, 1950-1960', *Journal of Strategic Studies* 24/1 (2001), 33.

<sup>56</sup> Rubin, 229-30.

<sup>57</sup> Robert Manasherob, *Lioness and Lion of the Line: Guide to Sherman Tanks in Israeli Service* (Beer-Sheva: SabingaMartin, 2007), 2-7.

led by Shimon Peres<sup>58</sup> and Zvi Zur,<sup>59</sup> argued however that Israel should aspire to a fully-autonomous defense-industrial base, capable of satisfying all their armaments needs.<sup>60</sup> Other decision-makers, including Yitzhak Rabin, contended that Israel could arm itself more effectively from international markets.

Successive Israeli governments weighed the merits of supply security against the cost-effectiveness of imports. Imported weapons prevailed from 1956 until 1967; a period during which France sold Israel a range of sophisticated weaponry and Britain exported modern tanks. Israel's elite consensus, however, shifted in favor of supply security following Israel's 1967 victory over its neighbors. Having launched the war with surprise air attacks, Israel suffered diplomatic condemnations and an arms embargo by its principle suppliers—France and Britain—after the war.

The rapidity with which these states severed relationships with Israel—withholding arms that had already been paid for—stunned Israelis and convinced them that they could rely only on domestic industries.<sup>61</sup> The United States' growing willingness to export arms to Israel throughout the 1960s did little to mitigate Israeli leaders' supply security concerns. America's State Department, indeed, opposed successive arms transfers to Israel because of their deleterious impact on American relations with Arab states.<sup>62</sup> Moreover, even when American

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<sup>58</sup> Peres was the Defense Ministry's Deputy Director-General in 1952, Director-General in 1953-59, Deputy Defense Minister in 1959-65, and Defense Minister in 1974-77.

<sup>59</sup> Zur was Israel's Defense Forces' Deputy Chief of Staff in 1958-60, Chief of Staff in 1961-63 and the Defense Minister's advisor in 1967-74.

<sup>60</sup> Sharon Sadeh, 'Israel's Beleaguered Defense Industry', *Middle East Review of International Affairs* 5/1 (2001), 65.

<sup>61</sup> Saul Bronfeld, 'The 'Chieftain Tank Affair'', *Contemporary British History* 29/3 (2015), 380-400.

<sup>62</sup> FRUS: 1961-1963: XVII-290 Memorandum from the Assistant Secretary, 7 June 1962.

governments supplied arms, they sought to leverage their deliveries to compel Israel into policy shifts.<sup>63</sup> Israel's government consequently launched ambitious tank, aircraft and warship projects in the 1967 Arab-Israeli War's aftermath with autonomy as the aim.

Israel thereafter developed its defense-industrial base with phenomenal speed thanks to its preexisting capacity to build certain French-designed weapons and American technology transfers. The base expanded five-fold between 1967 and 1973, and another four-fold between 1974 and 1984.<sup>64</sup> Throughout this period, the share of Israel's procurement budget devoted to domestic firms rose from 20% to 40% and the defense-industrial labor force grew from 14,000 to 80,000.<sup>65</sup> Buoyed by this expansion, Israeli firms soon played a visible role in mitigating the British and French embargoes' impact.

They achieved their greatest success, within this context, when they upgraded existing weaponry to prolong its battlefield utility. Israel's rebuilding of over 700 Second World War-vintage Centurion tanks between 1968 and 1973 is a case in point. Although other Centurion users, such as Britain, Canada and the Netherlands, were replacing this tank with newer models, the Israelis extended the Centurion's viability by installing a better gun, fire control system and engine.<sup>66</sup> Israeli industry achieved similar results upgrading captured Soviet-built T-55 tanks to Western standards and modernizing the aging electronics of Israel's French-designed fighters.<sup>67</sup>

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<sup>63</sup> Abraham Ben-Zvi, *Lyndon B. Johnson and the Politics of Arms Sales to Israel* (London: Frank Cass, 2004), 111-21.

<sup>64</sup> Hoyt, 83-93.

<sup>65</sup> Barnett, 198.

<sup>66</sup> Robert Manasherob, *Centurion Tanks of the IDF, Vol. 3* (Beer-Sheva: SabingaMartin, 2009), 1-22.

<sup>67</sup> Michael Mass and Adam O'Brien, *Tiran Wrecks: Tiran 4/5/6 in the IDF* (Tel Aviv: Desert Eagle, 2017), 3-11.

Soon Israeli industry was fulfilling 44% of the state's weapons needs and moved on to design sophisticated items as fighters (the Kfir), tanks (the Merkava) and warships (the Sa'ar).<sup>68</sup>

Although Israel's prioritization of domestic defense industries was driven by anxieties over military supplies, their drive for defense-industrial autonomy gave rise to the technonationalist aspiration of spinning off technologies into the civilian sector. Defense industries, particularly IAI, launched ambitious civilian projects to capitalize on their expanding capabilities. IAI's Jet Commander business jet and Arava lightweight transport consequently spearheaded this Israeli effort to build a hi-tech dual-use economy.<sup>69</sup> Capturing this spirit, an Israeli publication triumphantly referred to IAI as "the largest, most sophisticated aircraft establishment between Rome and Japan, the biggest employer in Israel."<sup>70</sup>

Defense-industrial autonomy and the technonationalist vision of defense-led development both proved beyond the means of a small state, such as Israel. Israel's second-generation fighter project—the Lavi—rendered these realities apparent. Escalating technological challenges over the course of the Lavi's development over-whelmed Israel's stagnant defense budget. The Lavi project consumed 15% of Israel's defense budget and occupied a quarter of its defense-industrial workforce by the early 1980s, yet seemed destined for failure, despite \$550 million of American financial assistance, because inadequate scale-economies would render the aircraft overpriced.<sup>71</sup>

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<sup>68</sup> Hoyt, 83.

<sup>69</sup> Arnold Sherman, *Lightning in the Skies: The Story of Israel Aircraft Industries* (London: Stone, 1973), 149-91.

<sup>70</sup> *Ibid*, 13.

<sup>71</sup> John Golan, *Lavi: The United States, Israel and a Controversial Fighter Jet* (Lincoln: Nebraska UP, 2016), 166-82.

Although the Lavi was particularly burdensome, other programs suffered similar problems.<sup>72</sup> Israeli firms' technonationalist efforts to spin-off technologies into civilian product lines meanwhile failed. The Arava transport lost money, despite state subsidies, until IAI executives closed its assembly line in 1988.<sup>73</sup> IAI's business jets, likewise, long struggled to achieve profitability, competing with market leaders like Learjet and Dassault, until finally exiting that market.

Defense Minister Rabin responded to Israel's existing defense industrial program's failure by replacing three costly endeavors (the Lavi fighter, Sholef artillery system and next-generation warship) with cheaper imports.<sup>74</sup> Rabin's abolition of these programs, which constituted Israel's defense-industrial strategy's core, repudiated Israel's post-1967 self-sufficiency policy in a single stroke.<sup>75</sup>

Policymakers, however, salvaged Israel's defense-industrial base from this policy's wreckage and reshaped it to changing realities. They recognized that Israel would never achieve self-sufficiency and accepted their dependence on foreign weapons. They calculated, however, that defense industries nevertheless contributed to military effectiveness.<sup>76</sup> Israeli governments consequently supported domestic defense firms' reorganization to compete for export markets with subsidies and training programs.<sup>77</sup> These policies thoroughly transformed Israel's defense-industrial base. Israel fulfilled 80% of its military needs with imported products from the late

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<sup>72</sup> Hoyt, 104.

<sup>73</sup> Coby Ben-Simhon, 'It Won't Fly', *Haaretz* (31 July 2008).

<sup>74</sup> Hoyt, 99-104.

<sup>75</sup> Naaz, 2082-2084.

<sup>76</sup> Uzi Eilam, *Eilam's Arc: How Israel became a Military Technology Powerhouse* (Brighton: Sussex AP, 2011), 207-19.

<sup>77</sup>D. Breznitz, *The Military as a Public Space—The Role of the IDF in the Israeli Software Innovation System*. (Cambridge: MIT IPC, 2002).



1980s onwards and began exporting approximately 75% of the arms they produced, compared to 30% previously.<sup>78</sup>

This shift from a broadly-based defense-industrial base catering to the domestic market to one specializing in export niches was accompanied by the state's closure of uncompetitive assembly lines. For example, artillery manufacturer—Soltam—downsized from 2,400 employees to 400 in 1987-90, while vehicle producer—Israel Military Industries—shed 65% of its labor force.<sup>79</sup> Overall Israeli defense-industrial employment shrank from 80,000 until it stabilized at 49,000 in the 1990s.<sup>80</sup>

Israeli planners initially hoped to preserve a modicum of supply security despite this retrenchment. Surge capacity was their rationale, meaning that they believed exports would “ensure (surplus) industrial capacity” they could mobilize for domestic needs if Israel was embargoed.<sup>81</sup> However appealing in principle, Israeli firms' globalizing supply chains rendered surge capacity illusory. Israeli industries, indeed, imported ever more sub-systems to enhance their products' international competitiveness, which meant that most Israeli weapons could not be produced without imports.

This reality became apparent when Britain, France and Germany restricted defense exports to protest Israel's 2002 reoccupation of the West Bank. This so-called “soft embargo” brought Israeli assembly lines to a halt even though European states exported no major weapons to Israel and accounted for under 17% of its defense imports.<sup>82</sup> European components were,

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<sup>78</sup> Robin Hughes, ‘Israeli Defence Industry: In the Lion's Den’, *Jane's Defence Weekly* (26 February 2003).

<sup>79</sup> Dvir and Tishler, 33-51.

<sup>80</sup> Naaz, 2083.

<sup>81</sup> Alex Mintz, ‘The Military-Industrial Complex: American Concepts and Israeli Realities’, *Journal of Conflict Resolution*, 29/4 (1985), 635.

<sup>82</sup> SIPRI Arms Transfers Database at: {[www.sipri.org/databases/armstransfers/](http://www.sipri.org/databases/armstransfers/)}.

however, integral to Israeli weapons. Merkava tank production, for example, ground to a halt when Germany withheld 120 components.<sup>83</sup> Israeli UAV production was likewise stymied without British motors.<sup>84</sup> Deliveries of artillery ammunition, electronic warfare equipment and missiles also suffered. Israeli planners learned from Europe's soft embargo that they could not count on supplies of even Israeli-produced weapons in the event of an embargo.

Supply security, in sum, motivated Israeli leaders' development of a defense-industrial base from 1948 until the mid-1980s. Achieving this became a major priority following the 1967 Arab-Israeli War and Israel eventually attained 44% self-sufficiency. This apparent accomplishment in terms of supply security, however, conceals a more bifurcated reality. Israeli firms effectively buttressed the armed forces through their ability to upgrade and thereby prolong existing weaponry's utility, but largely failed when they sought to build original Israeli-designed weapon systems. Technological changes in the 1980s thereafter drove Israeli leaders to abandon this latter endeavor and accept their dependence on imports for 80% of their needs. As they abandoned self-sufficiency, Israeli leaders also foreswore technonationalist efforts to use defense projects to boost the civilian economy's competitiveness.

Israeli leaders nevertheless preserved Israel's defense-industrial base both because of its ability to upgrade existing weaponry stocks and because they had discovered another powerful mechanism—military adaptation—whereby defense industries contribute to national security.

### **Arab Armies and ATGMs**

Domestic defense industries enabled Israel to counter the technological “surprises” encountered during the 1973 Arab-Israeli War. One surprise, in particular, man-portable anti-

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<sup>83</sup> ‘Secret UK ban on weapons for Israel’, *The Guardian* (13 April 2002).

<sup>84</sup> ‘‘Soft embargo’ on Israel?’ *Jane's Defence Weekly* (26 February 2003).

tank weapons, inflicted substantial casualties and threatened Israel's ability to conduct large armored operations. Israeli firms cooperated therefore closely with the armed forces to first develop simple expedients, such as adding machine guns and mortars to tanks, and then more complex armor augmentation packages as well. These adaptations mitigated the anti-tank threat before Israel's 1982 invasion of Lebanon, safeguarding Israeli tanks against Syria's increasingly sophisticated anti-tank systems.

Few technological developments threatened Israel's military doctrine, predicated as it is on large-scale armored offensives, more than man-portable anti-tank weapons. Anti-tank guided missile (ATGM) technology improved from the 1950s onwards and gave infantry the potential to destroy tanks at ranges of 3 km.<sup>85</sup> Combined with shorter-range rocket-propelled grenades' (RPG) increased availability, ATGM developments gave infantry an unprecedented ability to destroy armored vehicles by the 1970s.

Israeli commanders downplayed the anti-tank threat even though Israel had acquired first-generation French ATGMs and been offered sophisticated American TOW missiles.<sup>86</sup> The Egyptian Army and its Soviet advisors, however, considered man-portable anti-tank weapons key to thwarting Israel's armored forces. They equipped front-line Egyptian units with copious numbers of these weapons—72 Soviet-designed AT-3 ATGMs and 450 RPGs per infantry division—and devoted their best personnel to anti-tank tasks.<sup>87</sup> These anti-tank forces stunned Israeli tanks when the latter attacked Egyptian units that had crossed the Suez Canal in October 1973. On the War's first day one Israeli brigade lost all but 14 of 100 tanks, while a division

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<sup>85</sup> John Stone, *The Tank Debate: Armour and the Anglo-American Military Tradition* (Amsterdam: Harwood, 2000), 76-78.

<sup>86</sup> Finkel, 150-63.

<sup>87</sup> Dani Asher, *The Egyptian Strategy for the Yom Kippur War* (Jefferson: McFarland, 2009), 126-43.

lost 200 of 300 tanks in two days.<sup>88</sup> Arab infantry destroyed 70% of these tanks with ATGMs and RPGs, single-handedly defeating Israeli armor for the first time.<sup>89</sup>

Commanders scrambled to solve the ATGM and RPG problems and urged Israeli firms to develop countermeasures. Front line units collected debris from AT-3 missiles and transmitted them to two defense firms, IMI and Rafael, which frenetically sought technical counters to the threat. Efforts to jam these wire-guided missiles, however, failed and neither IMI nor Rafael fielded solutions during the 20-day war.<sup>90</sup>

Absent technological solutions, warfighters improvised new tactics. They tasked, for example, one tank in three with watching for missile launches and warning the other tanks by radio should one be spotted.<sup>91</sup> They, likewise, discovered that machine gun fire could “shake up” anti-tank missile operators and cause them to miss. Finally, they learned to rely on infantry equipped with mortars to eliminate anti-tank teams. Egyptian defenses, however, thwarted Israeli tanks, despite these expedients, until ill-conceived Egyptian offensives disrupted Egyptian anti-tank forces eight days into the war.<sup>92</sup> By war’s end nearly 28% of Israeli casualties consisted of tank crewmen, more than in any prior Arab-Israeli War.<sup>93</sup>

Egyptian successes encouraged Israel’s other adversaries to emulate its practices. Syria’s President Hafez al-Asad embraced man-portable anti-tank systems most enthusiastically. The

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<sup>88</sup> Kenneth Pollack, *Arabs at War: Military Effectiveness* (Lincoln: Nebraska UP, 2002), 112-13.

<sup>89</sup> T.N. Dupuy, ‘The ’73 Arab-Israeli Conflict—A Military Analysis’, *Strategy & Tactics*, 90 (1982).

<sup>90</sup> Eilam, 148.

<sup>91</sup> *TRADOC Bulletin 2: Soviet ATGMs* (Leavenworth: US Army, 1975), 23-24.

<sup>92</sup> Asher, 150-53.

<sup>93</sup> M. S. Owen-Smith, ‘Armoured Fighting Vehicle Casualties’, *J.R. Army Med Corps*, 123 (1977), 65-76.

Soviet Union prior to 1973 supplied Syria with the same AT-3s and RPGs as it had Egypt, but Syrian forces employed them ineffectively. Asad rectified this after the war, concentrating Syria's best soldiers into 33 anti-tank commando battalions and equipping them with cutting-edge Soviet AT-4s and Franco-German Milan ATGMs.<sup>94</sup> Other potential enemies—Egypt and Iraq—also acquired new ATGMs, including TOWs, Milans and AT-4s. Palestinian groups, meanwhile, amassed RPGs, recoilless rifles and AT-3s.<sup>95</sup> Israeli forces would therefore face anti-tank threats regardless of whom they fought in future wars.

Israel's Defense Ministry urgently sought technological counters to this challenge. The international market, however, offered no adequate solutions. Britain's government refused to sell Israel the most promising technology, "Chobham" armor incorporating ceramic plates and elastic layers.<sup>96</sup> Chobham, however, would not have solved Israel's problem even if the British had sold it because Israel could not afford to replace its tank fleet wholesale with models equipped with the new armor.<sup>97</sup>

Israeli industry, however, offered simple expedients within two years. Close cooperation between IMI and Israel's tank corps inspired IMI to improve upon the wartime tactic of using machine gun fire to "shake up" missile operators by adding machine guns to armored vehicles. IMI installed one to two additional machine guns on tanks and two on M113 armored personnel carriers.<sup>98</sup> They also installed 60mm mortars on tanks so that tank commanders themselves could

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<sup>94</sup> Tom Cooper and Yaser al-Abed, "Syrian Tank Hunters in Lebanon," *ACIG* available at { [www.acig.org](http://www.acig.org) } accessed June 2016.

<sup>95</sup> Samuel Katz, *Israeli Tank Battles* (London: Arms and Armour, 1988), 103-16.

<sup>96</sup> Marsh Gelbart, *The Merkava Project* (Erlangen: Jochen Vollert, 2005), 10.

<sup>97</sup> Soeren Suenkler and Marsh Gelbart, *IDF Armoured Vehicles: Tracked Armour of the Modern Israeli Defense Forces* (Erlangen: Jochen Vollert, 2006), 8-9.

<sup>98</sup> Samuel Katz, *Israel's Armor Might* (Hong Kong: Concord, 1989).

engage concealed anti-tank teams.<sup>99</sup> These machine guns and mortars improved tanks' ability to suppress anti-tank teams by inundating them with bullets and mortar bombs.<sup>100</sup>

These expedients, however, offered only a partial solution. Such was particularly the case as newer ATGMs did not require the AT-3's arduous joystick guidance and missile operators were less likely to be distracted by incoming fire. Israeli industry therefore needed to develop countermeasures that could actually defeat anti-tank warheads.

Rafael's engineers identified a solution in a 1970 patent filed by a West German researcher, Manfred Held.<sup>101</sup> Held postulated that so-called explosive reactive armor (ERA) could defeat ATGM and RPG hollow-charge warheads. ERA consists of blocks of explosives sandwiched between metal plates. When ATGMs or RPGs penetrate ERA they detonate the explosives, driving the metal plates into warheads, disrupting their thermodynamic penetration of tanks. ERA had the added advantage for Israel that it could be added to existing tanks and was comparatively affordable.

By 1979 Rafael's collaboration with Held paid off and Israel began secretly stockpiling ERA. Israel revealed ERA's existence when ERA-equipped tanks spearheaded Israel's 1982 invasion of Lebanon. Lebanon's topography obliged Israeli tanks to advance through terrain suited to anti-tank ambushes, including cities dominating Lebanon's coast road and highlands further inland.<sup>102</sup> Elite Syrian tank hunters and Palestinian fighters with RPGs and AT-3s endeavored to thwart Israeli armored forces blitzing across this terrain.<sup>103</sup>

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<sup>99</sup> Michael Mass, *Magach 68 Gal (M60A1), Part 1* (Tel Aviv: Desert Eagle, 2006), 4.

<sup>100</sup> *TRADOC Bulletin* 2, 22.

<sup>101</sup> Rolf Hilmes, *Kampfpanzer: heute und morgen* (Stuttgart: Motorbuch, 2007), 360.

<sup>102</sup> George Solley, *The Israeli Experience in Lebanon* (Quantico: USMC, 1987).

<sup>103</sup> Cooper and al-Abed.

ERA and Israel's other post-1973 modifications repeatedly saved Israeli tanks from well-laid ambushes during the 1982 Lebanon War. Palestinian RPG teams surprised an Israeli armored brigade in the urban sprawl of the Ein el-Hilweh refugee camp and fought a five day battle against Israeli tanks.<sup>104</sup> Fifty Syrian anti-tank commando teams, supported by 650 tanks, then repeatedly caught Israeli tanks unprepared amidst Southern Lebanon's highlands. Over four days, 8-11 June, the Syrian army's so-called "finest hour," Syrian forces lured Israeli units into textbook anti-tank ambushes at Jezzine, Ein Zehalta and Sultan Yakoub.<sup>105</sup> In each case, concealed Syrian tanks barred an Israeli column's progress while anti-tank commandos closed in to destroy Israeli tanks.<sup>106</sup>

Israeli industries' technological adaptations preserved Israeli units from heavy casualties during these engagements. The machine guns and mortars IMI added to tanks enabled them to pour fire into surrounding hills and buildings, hampering Syrian commandos' efforts to close in for the kill. This suppressive firepower saved the 363<sup>rd</sup> Israeli tank battalion from destruction at Sultan Yakoub on 10 June and enabled other units to quickly recover when surprised at Ein el-Hilweh, Jezzine and Ein Zehalta.<sup>107</sup>

Syrian tank hunters and Palestinian guerrillas nevertheless hit substantial numbers of tanks. Syria's well-trained commandos hit 60 tanks, some multiple times, over four days.<sup>108</sup> Israel's enemies altogether hit 203 tanks with anti-tank weapons; a respectable 22% of the 1,025

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<sup>104</sup> Katz, *Israeli Tank Battles*, 103-05.

<sup>105</sup> Patrick Seale, *Asad: The Struggle for the Middle East* (Berkeley: California UP, 1989), 382.

<sup>106</sup> Katz, *Israeli Tank Battles*, 106-16.

<sup>107</sup> *Ibid*, 103-16.

<sup>108</sup> Cooper and Yaser al-Abed.

tanks Israel employed between 6 and 25 June 1982.<sup>109</sup> ERA, however, thwarted most attacks. ERA saved all but two of the 60 tanks Syrian commandos hit from complete destruction and allowed many to continue operating after repeated hits.<sup>110</sup> The likelihood that anti-tank weapons would penetrate the Israeli tanks they hit was a quarter lower in 1982 than 1973, and the casualties inflicted per penetration were 50% lower.<sup>111</sup> Anti-tank weapons thus penetrated only 108 of the 203 tanks they hit, destroying 52.<sup>112</sup>

Israel's adaptations, thus, preserved armored forces from heavy losses and tactical setbacks in Lebanon. Confidence in tanks' improved survivability inspired Israeli commanders to use them to spearhead attacks in otherwise perilous terrain, such as the Beka'a Valley's wooded hills.<sup>113</sup> This risk taking was amply justified. Tank crew casualties, as a proportion of total Israeli casualties, consequently dropped by 50%, from 28% in 1973 to 14%.<sup>114</sup> Israeli tanks, meanwhile, decimated Syria's anti-tank commandos, killing 85% of them, while the latter's ATGMs inflicted few losses despite achieving many hits.<sup>115</sup>

Induäry, in short, adapted Israeli tanks, through added weapons and ERA, within five years of the 1973 War. General Israel Tal, onetime commander of Israeli armored forces, argued

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<sup>109</sup> Suenkler and Gelbart, 10.

<sup>110</sup> David Eshel, 'Trends in Israeli Tank Development', *Armor* (January-February 1996), 44-46.

<sup>111</sup> Hanan Greenberg, 'Why did Armored Corps fail in Lebanon?' *YNetNews* available at {[www.ynetnews.com/articles/0,7340,L-3297431,00.html#n](http://www.ynetnews.com/articles/0,7340,L-3297431,00.html#n)} accessed July 2016.

<sup>112</sup> Suenkler and Gelbart.

<sup>113</sup> James Leaf, 'MOUT and the 1982 Lebanon Campaign', *Armor*, (July-August 2000), 8-11.

<sup>114</sup> R.A. Leitch et al., *Analysis of Casualty Rates & Patterns Likely to Result from Military Operations in Urban Environments* (Quantico: USMC Warfighting Laboratory, 1997), 360-62.

<sup>115</sup> М. Борятинакий, "Меркава" и другие танки Израиля (Moscow: Яуза, 2011), 96-106.



based on Israeli firms' role in defeating Syria's commandos that defense firms' new primary role is to, "to develop and manufacture weapons and military equipment based on original Israeli ideas... to add an element of technological surprise in war."<sup>116</sup>

### **Guerrilla Anti-Armor Threats**

Israeli industry's post-1973 adaptations mitigated, but did not end the anti-tank menace. Swift victories over Syrian and Palestinian units in 1982 inaugurated an era of insurgent warfare against Israeli tanks. Traditional design practices, such as concentrating armor on tanks' frontal quarters, are optimal for high-intensity warfare, but generate weaknesses insurgents can exploit.<sup>117</sup> Anti-Israeli insurgents—Hezbollah, Fateh and Hamas—now invested in weapons and tactics to capitalize on such vulnerabilities. Domestic industries spearheaded Israel's effort to counter each insurgent innovation, swiftly negating breakthroughs in 1982, 1996-97 and 2006.

Israeli forces first experienced insurgent anti-tank warfare when they barreled towards Beirut after breaking through Syrian and Palestinian conventional units in June 1982. Israeli commanders felt victory within their grasp as they motored into Khalde, 14km from Beirut, with no organized forces in their way. Swarms of Shiite and Fateh irregular fighters disrupted this illusion on 9 June, sallying from Khalde's alleyways and deluging Israeli Merkava tanks with RPG fire at point-blank ranges.<sup>118</sup> Insurgents destroyed two tanks, hitting a poorly protected

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<sup>116</sup> Israel Tal, *National Security: The Israeli Experience* (Westport: Praeger, 2000), 63.

<sup>117</sup> Marc Chassillan, *Encyclopédie des chars de combat modernes, tome 2* (Paris: H&C, 2011), 55.

<sup>118</sup> C. Abu Attayib, *Flash Back: Beirut 1982* (Nicosia: Sabah, 1985), 74-96.

point behind their turret bustles, thereby stalling Israel's advance.<sup>119</sup> Insurgents, flush with success, repeated this tactic, destroying four more Merkavas in subsequent days.<sup>120</sup>

Israel's defense research director recognized that Israel was getting mired in a counterinsurgency and pushed firms to "change Israel's paradigm of weapons development" and provide swift responses to insurgent tactics.<sup>121</sup> IMI's engineers, in turn, scrambled to offset the weaknesses revealed in Lebanon. They improvised one countermeasure—a curtain of steel chains weighed down by balls—to detonate RPG warheads prematurely, preventing them from penetrating turret bustles.<sup>122</sup> IMI's experts, meanwhile, developed anti-insurgent cannon rounds, known as Anti-Personnel/Anti-Materiel (APAM).<sup>123</sup> APAM rounds, compatible with Israel's tanks, containing sub-munitions that explode mid-air, killing insurgents over broad territories.<sup>124</sup>

IMI's rushed debut of this ball-and-chain armor in 1983 and APAM rounds in the 1990s shifted the tactical balance back in Israel's favor and secured 13 years without tank losses. Tanks' new-found invulnerability emboldened commanders to employ them aggressively in anti-guerrilla sweeps, escorting convoys and ambushing infiltrators. Israel's reliance on tanks grew when its forces consolidated their Lebanon presence into an 850km<sup>2</sup> security zone adjoining Israel's northern frontier in 1985.<sup>125</sup> Israel deployed 50 tanks with its 1,500 man occupation

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<sup>119</sup> Chassillan, 38.

<sup>120</sup> Борятинакий, 105-06.

<sup>121</sup> Eilam, 204-07.

<sup>122</sup> Сергей Суворов, *Меркава* (Moskow: Стратегия КМ, 2007), 66-69.

<sup>123</sup> Gelbart, *The Merkava Project*, 78-79.

<sup>124</sup> Danny Schirding, *The Modified Tank Ammunition IMI M152/6* available at {[www.dtic.mil/ndia/2005garm/wednesday/schirding.pdf](http://www.dtic.mil/ndia/2005garm/wednesday/schirding.pdf)} accessed December 2016.

<sup>125</sup> Joel Chasnoff, *The 188<sup>th</sup> Crybaby Brigade* (New York: Free Press, 2010), 211-35.

force and donated 55 tanks to its allied militia, the South Lebanon Army (SLA).<sup>126</sup> Israel's massing 100 tanks in a territory comprising only 8% of Lebanon represented an exceptional armor concentration for counterinsurgency operations.

Hezbollah leaders concluded, however, that inflicting significant tank losses would eventually force Israel from the security zone.<sup>127</sup> Hezbollah amassed an RPG arsenal, acquired AT-3 ATGMs in 1992 and targeted Israeli tanks beginning in 1993. They struck 13 Israeli and SLA tanks in 1993, an identical number in 1994, and 18 tanks in 1995.<sup>128</sup> Israel's upgraded tanks—M60 tanks with ERA and Merkava's with the ball-and-chain armor—resisted every attack.<sup>129</sup> When guerrillas then climbed escarpments to fire on tanks' thinner roof armor, Israeli industry countered by immediately installing extra armor on tank roofs.<sup>130</sup>

Repeated failure spurred Hezbollah's tank hunters to withdraw from the field in late-1995 to intensively retrain in new tactics and with a more accurate ATGM, the AT-4.<sup>131</sup> Hezbollah then struck in November 1996, after an 11 month hiatus, finally penetrating two ERA-equipped M60 tanks and wounding six of the tanks' eight crewmen. Their new technique relied on volley

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<sup>126</sup> Anthony Cordesman, *After The Storm: The Changing Military Balance in the Middle East* (Bloomsbury: London, 1993), 216.

<sup>127</sup> On Hezbollah's effectiveness and relationship with Iran, see: Marc DeVore and Armin Stähli, 'Explaining Hezbollah's Effectiveness: Internal and External Determinants of the Rise of Violent Non-State Actors', *Terrorism and Political Violence*, 27/2 (2015), 331-357; and Marc DeVore, 'Exploring the Iran-Hezbollah Relationship: A Case Study of How State Sponsorship affects Terrorist Group Decision-Making', *Perspectives on Terrorism* 6/4-5 (2012), 85-107.

<sup>128</sup> "Diary of Resistance Operations 1993-2000," *Alahednews* available at {[www.english.alahednews.com.lb/](http://www.english.alahednews.com.lb/)} accessed November 2016.

<sup>129</sup> David Eshel, "Armored Anti-Guerrilla Combat In South Lebanon," *Armor*, (July-August 1997), 29.

<sup>130</sup> Mass, 6.

<sup>131</sup> Nicholas Blanford, *Warriors of God: Inside Hezbollah's Thirty-Year Struggle Against Israel* (New York: Random House, 2011), 196-99.

fire: repeatedly hitting a single point, first stripping ERA away and then penetrating the underlying armor.<sup>132</sup> Shock at ERA-equipped M60s' vulnerability forced Israel to withdraw this model from Lebanon. Hezbollah ATGM teams surprised the Israelis again, however, by penetrating three Merkavas in late-1997, striking a weak point above the driver's position with pin-point accuracy.<sup>133</sup>

Hezbollah's successes in 1996-97 sent Israeli tank crews' morale plummeting and boosted Hezbollah's prestige.<sup>134</sup> IMI urgently developed bolt-on ceramic armor packages to protect the weak points Hezbollah was striking at the government's instigation. By reassigning engineers and cancelling vacations, IMI developed add-on armor for Merkavas in under 14 weeks.<sup>135</sup> IMI's up-armored Merkavas so impressed commanders that they requested a similar package for the M60s. IMI, in this case, responded even more rapidly, developing so-called BATASH armor packages in 11 weeks.<sup>136</sup>

Add-on armor, once deployed, thwarted every attack for the next eight years. One meticulously planned 2005 ambush, in particular, demonstrated Israeli tanks' renewed invulnerability. Although Hezbollah fighters hit multiple Merkavas, including one seven times, they failed to penetrate a single tank.<sup>137</sup> Hezbollah, indeed, killed only one tank crewman from

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<sup>132</sup> Eshel, 'Armored Anti-Guerrilla Combat In South Lebanon', 28.

<sup>133</sup> М. Никольский, "Меркава," *Техника и вооружение*, 1 (2000), 38-39.

<sup>134</sup> Na'im Qâsseem, *Hezbollah: La voie, l'expérience, l'avenir* (Paris: Albouraq, 2008), 96-97 ; and Chasnoff, 128-32.

<sup>135</sup> Marsh Gelbart, *Modern Israeli Tanks and Infantry Carriers, 1985-2004* (London: Osprey, 2004), 32.

<sup>136</sup> Ibid, 24.

<sup>137</sup> David Eshel, 'Lebanon 2006: Did Merkava Challenge its Match?' *Armor*, (January-February 2007), 12.

1998 to 2005, when an ATGM killed a driver riding with his hatch open in 2001.<sup>138</sup> Israeli tank commanders' renewed confidence emboldened them during the five year Second Intifada, wherein Palestinian weapons failed to penetrate a single tank.<sup>139</sup>

Tanks' impenetrability discomfited Israel's adversaries and drove Hezbollah and Iranian experts to study videos of Hezbollah's unsuccessful attacks to ascertain why they failed.<sup>140</sup> They identified Israel's add-on armor and determined that Hezbollah needed more powerful weapons. Hezbollah and Iran therefore connived, with Syrian assistance, to purchase Russia's latest anti-tank weapons. These weapons—the AT-13, AT-14 and RPG-29—feature tandem warheads designed to burn through successive armor layers.

Hezbollah benefitted from its improved anti-tank capabilities when it renewed cross-border attacks in July 2006, provoking the 33 day Second Lebanon War. Hezbollah's 600 anti-tank specialists were exceptionally well prepared when overconfident Israeli crews maneuvered 250 tanks into Lebanon.<sup>141</sup> They swiftly struck 50 tanks, penetrating 22 and destroying three.<sup>142</sup> Although the proportion of tanks penetrated was lower in 2006 than 1982 (44% versus 47%) and the proportion destroyed lower still (6% versus 23%), Israel's 2006 tank losses eclipsed anything experienced in two decades and revealed that well-equipped insurgents could destroy even Israel's up-armored tanks.<sup>143</sup>

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<sup>138</sup> Adam Geibel, 'Recent Merkava Attacks Highlight Growing Command Detonated Mine Threat', *Armor*, (May-June 2002), 47.

<sup>139</sup> IEDs destroyed two Merkavas. *Ibid*, 46-47.

<sup>140</sup> Eshel, 'Lebanon 2006', 12-13.

<sup>141</sup> Blanford, 406-07.

<sup>142</sup> Chassillan, 48-49.

<sup>143</sup> Greenberg; and Suenkler and Gelbart, 10.

Hezbollah's successes inspired Syria to re-organize 10,000 commandos to imitate Hezbollah's anti-tank forces and Hamas to seek weapons and advice from Hezbollah. Israeli forces would, thus, face Hezbollah-style anti-tank threats in future wars.<sup>144</sup> Israeli firms moved swiftly to preempt this challenge. Careful analysis of Israel's tank losses in 2006 revealed that reducing the amount of ammunition carried by each tank would enhance their survivability should they be hit. Heeding this advice, Israel's high command insisted that tanks fight with only half their normal ammunition allocations when they next attacked Hamas, during Operation Cast Lead in 2018.<sup>145</sup>

Reducing ammunition loads, however, was never more than a stop-gap measure. Worried by tandem-warhead ATGMs since their apparition during the 1990s, Rafael's engineers identified active protection systems (APS) as the most plausible solution. An untried Soviet concept from the 1970s, APS protects tanks by detecting incoming ATGMs via radar and destroying them with shot-gun like blasts.<sup>146</sup> Rafael began developing an APS, Trophy, in 1995. Israel's government then rushed the nearly-mature Trophy into production after the 2006 war and deployed its first Trophy-equipped battalion in 2010, just after Hamas penetrated a Merkava with its first AT-14 attack.<sup>147</sup>

Trophy's arrival thwarted Hamas' next tandem-warhead attack, in 2011.<sup>148</sup> Trophy's successful debut heartened Israeli commanders and encouraged them to advocate using ground

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<sup>144</sup> Anthony Cordesman, *Israel and Syria: The Military Balance and Prospects of War* (Westport: Praeger 2008), 2-8, 172-73.

<sup>145</sup> Ehud Eilam, *Israel's Future Wars* (Washington D.C.: Westphalia, 2016), 46-47.

<sup>146</sup> Hilmes, 344-50.

<sup>147</sup> Yaakov Katz, 'IDF predicts violence to subside despite Gaza pounding', *Jerusalem Post*, (21 December 2010).

<sup>148</sup> 'IDF Merkava Mk4 with Rafael's trophy', *Israel High-Tech & Investment Report*, (April 2011).

forces to destroy Hamas' infrastructure. Trophy-equipped Merkavas of Israel's 401<sup>st</sup> Armored Brigade led Israel's 2014 offensive into Gaza and Israeli APS intercepted the dozens of weapons that Hamas launched.<sup>149</sup>

Trophy's triumph over tandem-warhead weapons guaranteed Israel against a single tank loss during the 50-day war and concluded the latest competition between insurgent anti-tank specialists and Israel's defense industries. Israeli industry prevailed, overall, by rapidly developing countermeasures each time insurgents unveiled new anti-tank weapons and tactics. IMI's chief engineer described Israeli firms' accomplishment in the following terms,

We have the shortest development use cycle in the world; sometimes it takes us only a few days to adapt to operational needs. So basically we have an immediate response to changing operational requirements.<sup>150</sup>

General Tal, the architect of Israel's armored doctrine and founder of its Merkava project, likewise, declared late in life that domestic defense industries' greatest contribution to Israel's security lies in battlefield adaptation.<sup>151</sup> These industries, indeed, enabled Israel's army to staunch losses swiftly on the three occasions—1982, 1996-97 and 2006—that insurgents destroyed tanks. Israeli crews consequently enjoyed long periods, 13 and eight years respectively, during which their tanks remained functionally impenetrable.

### **Generalizability**

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<sup>149</sup> Barbara Opall-Rome, 'Israel To Equip Troop Carriers with Trophy APS', *DefenseNews* available at: {[www.defensenews.com/story/defense/land/vehicles/2016/01/28/israel-trophy-active-protection-system-aps/79460018/](http://www.defensenews.com/story/defense/land/vehicles/2016/01/28/israel-trophy-active-protection-system-aps/79460018/)} accessed June 2016.

<sup>150</sup> Robin Hughes, 'Shield of David: Israel—Protection and Survivability', *Jane's Defense Weekly* (24 May 2006), 24.

<sup>151</sup> Yaakov Katz and Amir Bohbot, *The Weapons Wizards: How Israel Became a High-Tech Military Superpower* (New York: St. Martin's, 2017), 105-11.

Supply security's, technonationalism's and military adaptation's relative impacts on one state's defense-industrial decisions can be seen in the Israeli case. Supply security concerns first drove decision-makers to support domestic industries and embargos then convinced them to pursue full-fledged autonomy. Israeli policymakers only later embraced technonationalist goals as their defense-industrial build-up reached its apogee in the 1970s. It was domestic industries' contribution to military adaptation, however, that convinced governments to sustain them even after these self-sufficiency and technonationalist policies failed. I now assess two further cases to ascertain whether similar motivations drove other states' defense-industrial investments. These cases, South Africa and Iraq, are medium-sized, middle income states that waged lengthy wars, yet possessed different levels of access to international arms markets.

South Africa's military relied on British doctrine and weapons until Namibian guerrillas began fighting for independence and the international community started condemning South Africa for the 1960 Sharpeville massacre of anti-apartheid protestors.<sup>152</sup> UN debates in Sharpeville's aftermath worried South African leaders lest they be subjected to an arms embargo, spurring them to create the Defense Research Council (DRC) to promote domestic defense manufacturing.<sup>153</sup> Although the UN enacted an arms embargo in 1963, this embargo's voluntary character enabled the DRC to frenetically purchase licenses to build foreign-designed weapons until the UN strengthened its embargo in 1977.

The 1960s consequently witnessed the rapid expansion of South Africa's defense manufacturing, with the country manufacturing French armored cars, Italian jet trainers and

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<sup>152</sup> Willim Steenkamp, *The Black Beret: The History of South Africa's Armoured Forces, Vol.2* (Solihul: Helion, 2017), 306-56.

<sup>153</sup> Dan Henk, *South Africa's Armaments Industry* (Lanham: UPA, 2006), 11-12.



French helicopters.<sup>154</sup> Government studies, meanwhile, led decision-makers to deliberately model their defense-industrial base on France's, forming the state-owned Armscor conglomerate in 1968 to oversee this process.<sup>155</sup> These policies catalysed the domestic defense-industrial labor force's expansion, which surged from 1,000 in 1961 to 130,000 in 1989.<sup>156</sup> This success at producing foreign-designed weaponry, however, lulled South African leaders into a false sense of security, believing that they had achieved "self-sufficiency" and could henceforth design new weaponry "at the forefront of technology."<sup>157</sup>

Escalating threats in the mid-1970s demonstrated that foreign-designed weaponry was ill-suited to the challenges South Africa faced. Vast unpaved roads, firstly, offered insurgents ideal opportunities for laying anti-vehicle mines and ambushing communications arteries. Cuba's military intervention and the Soviet Union's support for Angola's *Movimento Popular de Libertação de Angola* (MPLA), secondly, meant that South African forces soon found themselves fighting opponents whose tanks and artillery outgunned their own. South African industries, however, swiftly embraced the new mission of modifying existing platforms to resolve these challenges.

They designed wheeled armored vehicles—the Buffel and Casspir—around imported Unimog and Ford chassis to overcome the mine threat.<sup>158</sup> For greater counterinsurgency firepower, they developed wheeled Ratel fighting vehicles combining German (MAN) truck

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<sup>154</sup> James McWilliams, *Armscor: South Africa's Arms Merchant* (London: Brassey's, 1989), 14-22.

<sup>155</sup> Henk, 11.

<sup>156</sup> Peter Batchelor and Susan Willett, *Disarmament and Defence Industrial Adjustment in South Africa* (Oxford: Oxford UP, 1998), 40-41.

<sup>157</sup> McWilliams, 2.

<sup>158</sup> Steve Camp and Helmoed-Römer Heitman, *Surviving the Ride* (Pinetown: 30° South, 2014), 19-96.

chassis with French (Panhard) turrets.<sup>159</sup> Munitions makers, working with Rhodesian engineers, meanwhile, developed simple, yet specialized anti-guerrilla bombs, which maximized the dispersion of shrapnel at ground level.<sup>160</sup> To counter Cuban and Angolan tanks, Armscor, finally, rebuilt aging Centurion tanks into heavily-modified vehicles, re-baptised Oliphants.<sup>161</sup>

Armscor's ability to modify platforms and develop munitions enabled over-stretched South African forces to fight insurgents in Namibia and wage conventional warfare in Angola. Mine-resistant vehicles minimized losses in the former while Ratels and Oliphants repeatedly bested their MPLA opponents in the latter.<sup>162</sup> South Africa's strategic situation, however, deteriorated in the late-1980s because its defense industries could not provide self-sufficiency, in the form of new major weapons systems, while the embargo prevented it from importing them. South Africa, indeed, developed only one wholly indigenous platform, its G5 and G6 artillery systems, during these conflicts. All other projects involved retrofitting foreign-built equipment, developing specialized munitions or building vehicles with substantial foreign inputs. As the conflict continued, South Africa's highly-modified weapons, such as Oliphant tanks and Cheetah fighters, found themselves increasingly outmatched by the newer Soviet weapons their opponents received.<sup>163</sup>

Domestic firms' military adaptation accomplishments, nonetheless, convinced South Africa's post-apartheid governments to preserve them. Policymakers, indeed, emphasized two

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<sup>159</sup> Ibid, 166-72.

<sup>160</sup> J.R.T. Wood, *Counter-Strike from the Sky* (Johannesburg: 30° South, 2009), 67-74.

<sup>161</sup> Peter Victor, 'Development of the Elephant Tank', *V.E.G. Vertically Elevated Generation*, No. 6 (2006), 16-22.

<sup>162</sup> Stephen Weigert, *Angola: A Modern Military History* (New York: Palgrave, 2011), 69-104.

<sup>163</sup> Tom Cooper et al., *African MiGs, Vol. 1* (Houston: Harpia, 2010), 17-90.

specific rationales for preserving domestic defense firms: helping the military adapt in response to unanticipated threats and providing a modicum of supply security through the upgrading of existing weaponry.<sup>164</sup> It was, ironically, only at this late stage that certain stakeholders—trade unions and local authorities—began to unsuccessfully advocate for such technonationalist policies as spinning off defense technologies into the civil sector.<sup>165</sup> South African leaders rather prioritized a small, yet globally-integrated defense-industrial base capable of fulfilling their strategic needs. To this end, they inaugurated a policy of defense offsets and counter-trade arrangements to encourage foreign corporations to invest in South Africa’s defense firms.<sup>166</sup>

Iraq’s experience highlights both the disadvantages states without adequate defense industries face as well as the types of capabilities that such states seek to develop during prolonged wars. Iraqi leaders began developing a modest defense-industrial base around foreign-built turn-key factories in the mid-1970s.<sup>167</sup> Policymakers evoked technonationalist arguments to justify these investments, claiming that defense industries would feed the civil sector with outputs from military R&D and that they would invigorate dual-use sectors.<sup>168</sup> Iraqi President Saddam Hussein, however, counted on imported weapons and Iranian forces’ disarray when he invaded Iran in 1980.

Unanticipated battlefield challenges, however, soon blunted Iraq’s offensive. Iranian soldiers and *Basij* volunteers destroyed copious numbers of Iraqi tanks with RPGs and ATGMs,

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<sup>164</sup> *White Paper on the South African Defence Related Industries* (Pretoria: South African Government, 1999).

<sup>165</sup> Batchelor and Willett, 177-81.

<sup>166</sup> Henk, 65-89.

<sup>167</sup> Yezid Sayigh, *Arab Military Industry: Capability, Performance and Impact* (London: Brassey’s, 1992), 106-07.

<sup>168</sup> *Ibid*, 104.

and Iranian SAMs shot down droves of Iraqi aircraft.<sup>169</sup> Hussein initially exuded confidence that the international arms market would resolve these problems. He confided to advisors that his ability to import armaments from a wider range of exporters would soon give him the edge.<sup>170</sup>

International markets soon, however, disappointed Hussein. Iraq's principle supplier—the Soviet Union—embargoed Iraq during the war's first 18 months to show its displeasure at Iraqi expansionism. Iraq's leaders compensated by turning to other sources—France, China, Italy and Egypt—for their immediate needs, which convinced the Soviets to lift their embargo as well. Iraqi strategy subsequently leveraged the country's access to foreign credit to import \$43.5 billion worth of armaments, which amounted to four times more than Iran.<sup>171</sup> Foreign governments, however, continued to frustrate Hussein both by refusing to sell him the specific systems—long-range missiles and chemical weapons—he thought would win the war and by offering products ill-suited to the Iran-Iraq War.

Hussein consequently poured money into domestic defense industries from 1982 onwards.<sup>172</sup> Hussein prioritized chemical weapons from the outset and contracted with Germany's Karl Kolb GmbH to build a massive poison gas factory at Samarra.<sup>173</sup> He then expedited his missile program by contracting in 1984 with two further German firms, Gildmeister Projecta and Messerschmitt-Bölkow-Blohm, to build rocketry facilities and train

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<sup>169</sup> Anthony Cordesman and Abraham Wagner, *The Lessons of Modern War: The Iran-Iraq War* (Westview: Boulder, 1990), 423-529.

<sup>170</sup> Kevin Woods et al. (eds.), *The Saddam Tapes: The Inner Workings of a Tyrant's Regime* (Cambridge: Cambridge UP, 2011), 141-46.

<sup>171</sup> *Ibid*, 49-53.

<sup>172</sup> Hoyt, 140.

<sup>173</sup> Herbert Krosney, *Deadly Business: The Arming of Iran and Iraq* (New York: Four Walls, 1993), 41-73.

engineers.<sup>174</sup> These endeavors slowly developed what Hussein hoped would be miracle weapons. Iraq first used yperite gas in 1983 and then more effective nerve gasses in 1984. Iraq's efforts to extend imported Scud missiles' ranges, meanwhile, took longer and Iraqi missiles only began striking Tehran in February 1988.<sup>175</sup> Despite Hussein's faith in these weapons, they either proved less impactful, with chemical weapons inflicting only 5% of Iranian casualties, or arrived later than anticipated.

Battlefield outcomes consequently hinged on infantry's ability, supported by tanks and artillery, to seize and hold terrain. Imported weaponry, while quantitatively abundant, proved unsuited to this warfare. Denied cutting-edge Western tanks and offered limited numbers of their Soviet equivalents, Iraq imported large numbers of outmoded T-55 tanks from China, Romania and Egypt. These inadequately armed and protected vehicles suffered grievously at the hands of Iranian RPGs and ATGMs. Imported artillery, meanwhile, lacked the mobility to support Iraqi infantry. Iraq's defense industries responded by launching a crash program to improve this weaponry. They began by enhancing heavy 120mm and 160mm mortars' mobility by installing them on Soviet armored vehicles and East German trucks.<sup>176</sup> In 1986, Iraqi engineers began modifying T-55 tanks, equipping them with British 105mm cannons and better electronics.<sup>177</sup> They subsequently developed armor packages—comprised of layers of steel, polyurethane and aluminum—for augmenting T-55s' protection against anti-tank weapons.<sup>178</sup>

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<sup>174</sup> Kenneth Timmerman, *The Death Lobby: How the West Armed Iraq* (London: 4<sup>th</sup> Estate, 1992), 142-60.

<sup>175</sup> *Ibid*, 287-89.

<sup>176</sup> Hoyt, 135.

<sup>177</sup> *Ibid*, 131-36.

<sup>178</sup> Fernando Sanchez and Jesus Huelamo, *Iraqi Tank T-55 "Enigma"* (Alicante: Hobbyworld, n.d.).

Iraq's belated defense-industrial investments, however, failed to yield decisive results during the Iran-Iraq War. Few projects yielded timely results and those that did reached maturity only towards the war's end, such as Iraq's missiles hitting Tehran in 1988 and its first up-armored T-55s reaching units at that time.<sup>179</sup> Hussein's tardy recognition that defense firms boost military adaptation, however, drove him to commit \$20 billion to sustaining Iraqi defense industries after the war's end.<sup>180</sup>

The South African and Iraqi cases, in sum, support the finding that states derive significant adaptation advantages from their domestic defense industries. Neither government developed a defense-industrial base with adaptation as its objective. South Africa, indeed, did so for supply security, while Iraqi policymakers initially advanced technonationalist arguments. Nevertheless, adaptation imposed itself as firms' main task once fighting began and both states' governments acknowledged this reality in their subsequent defense-industrial policies.

### **Conclusion**

Israel demonstrates, and the South African and Iraqi cases confirm, that military adaptation provides a hitherto unappreciated motive for states' investments in domestic defense industries. Evidence from these states suggests that different objectives drive governments' defense industrial decisions at distinct periods of time. Supply security, within this context, shaped governments' initial defense-industrial investments and technonationalist ambitions subsequently impacted leaders' calculations about these investments' economic impact at diverse junctions. Neither supply security nor technonationalism, however, provided sufficient incentives for states to sustain their defense-industrial investment. It was, rather, defense

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<sup>179</sup> Sayigh, 114-21.

<sup>180</sup> Hoyt, 139.

industries' unanticipated contribution to military adaptation that led governments to support them even after their self-sufficiency and technonationalist policies had failed.

States' motivations for cultivating defense industries and the benefits they derive from them are more fluid than hitherto appreciated. Supply security played a major role in encouraging governments to initially develop defense industries. Armaments' complexity, however, meant that none of these states remotely approached self-sufficiency. Israel and South Africa, for example, conspicuously failed to develop major weapons systems, while Iraq never attempted to design such systems.

Nevertheless, domestic industries' capacity to upgrade states' existing weaponry insulated states from embargoes' full impact. This limited form of supply security proved more attainable and relevant for the states in question than the traditional vision of states autonomously producing their own major weapons systems. Technonationalism, meanwhile, intruded into decision-making processes at diverse points, yet rarely proved the primary consideration. Technonationalism, for example, influenced Iraq's defense industry's debut, shaped Israeli policy once the state had already committed to expanding its defense-industrial base, and became a factor in South Africa only when post-apartheid governments sought to both downsize, yet preserve defense firms.

Military adaptation, however, emerged as a key function of each state's defense-industrial base once states became embroiled in prolonged conflicts. Unexpected battlefield challenges, indeed, discomfited all three states' armed forces. Israelis repeatedly discovered their tanks' vulnerability to new weapons, South Africans faced the mine threat on Namibia's dirt roads, and Iraqis were shocked at their Soviet-produced weaponry's inadequacy for overcoming Iranian infantry. Although combat units modified their tactics in response to these threats, their high command identified a need for adapting technologically as well. Domestic defense industries fulfilled this essential function by liaising with armed forces and developing

simple, customized solutions for them. Executed in a timely manner, even such expedients as modifying existing platforms and developing munitions tailored to specific targets had an outsized impact on battlefield outcomes. States that already possessed defense-industrial bases, such as Israel and South Africa, enacted these adaptations more expeditiously than those that did not, such as Iraq, which nevertheless embarked on a crash program of defense-industrial development to fulfill this need.

A heightened capacity for military adaptation, in sum, constitutes a significant benefit conferred by domestic defense industries. Combined with the well-chronicled, yet frequently unattainable supply security and technonationalist goals that states also pursue, defense industries' contribution to military adaptation helps account for why so many states continue investing in them despite the costs involved.

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