ABSTRACT:

This paper argues that nuclear transparency and disarmament are in Israel's strategic interest. Israel should lead efforts to achieve a Middle East Nuclear-Weapons-Free Zone (NWFZ) and accede to the Nonproliferation Treaty (NPT) as a Non-Nuclear-Weapon State (NNWS) by 2030. Such a policy would reduce the risk of Iran developing nuclear weapons after the 2031 expiration of restrictions on uranium enrichment and plutonium reprocessing under the Joint Comprehensive Plan of Action (JCPOA). In lieu of opaque nuclear deterrence, Israeli advantages in intelligence and missile defense will provide increasing assurance, while maintenance of Israel's qualitative military edge and an increase in its conventional power projection capabilities will provide deterrence against regional threats.

TRENDS IN PROLIFERATION & NON-PROLIFERATION:

The global nuclear nonproliferation regime is at a critical juncture. Fifty years after the adoption of the Nuclear Nonproliferation Treaty (NPT), global norms and regulations against the acquisition of nuclear weapons could either stagnate and erode or take a significant step forward. Indications of erosion and even potential collapse are several. North Korea has brazenly developed nuclear weapons and delivery systems. While this remains the only instance of a state withdrawing from the NPT to develop nuclear weapons, it could plausibly prompt a regional domino effect in which South Korea and Japan withdraw in order to acquire their own nuclear weapons.[1] India and Pakistan, neither of which signed the NPT, have acquired nuclear arsenals. Pakistan's doctrine suggests that tactical nuclear weapons may be used as battlefield weapons.[2] Both countries, moreover, impede a Fissile Material Cutoff Treaty that would reduce and regulate the global

supply of uranium and plutonium useful for nuclear and radiological weapons. The intensification of geopolitical competition among established nuclear powers stymies the good-faith negotiations toward nuclear disarmament called for by Article VI of the NPT. A majority of the world's states voted in July 2017 to adopt the Treaty on the Prohibition of Nuclear Weapons (TPNW) in an attempt to shore up the NPT, put pressure on the Nuclear Weapons States to fulfill Article VI, and achieve Global Zero – the term for a world without nuclear weapons. No state with nuclear weapons signed the TPNW. The new treaty's fate is uncertain. While it appears unlikely to actually achieve Global Zero anytime soon, it may nonetheless reinforce norms against nuclear proliferation. On the other hand, the dismissal of the treaty by both official and *de facto* nuclear weapons states could undermine nonproliferation norms and even trigger defection from the NPT by signaling a permanent double standard. NPT defection would be most consequential in regions that are not Nuclear-Weapons-Free Zones (NWFZs) – namely Europe, Northeast Asia, and the Middle East. The most consequential proliferation threat for Israel is Iran, which is widely believed to seek a nuclear-weapons capability. Moreover, though currently lacking in nuclear infrastructure, Sunni Arab rivals of Tehran could plausibly pursue their own nuclear weapons options if the NPT and JCPOA fail to adequately contain the Islamic Republic.

THE FADING BASIS OF ISRAELI EXCEPTIONALISM:

Israel has a large stake in the fate of nonproliferation treaties and norms. Because of hostility toward its existence, because it lacks territorial depth, and because it enjoys advantages in intelligence and conventional military capabilities, Israel would benefit from a world free of nuclear weapons. Simply put, nuclear weapons are the most efficient means by which one could annihilate the Jewish State. While Global Zero remains more an aspiration than an imminent

reality, Israel has a realizable interest in shoring up the NPT and achieving a NWFZ in the Middle East.

Israel is simultaneously central to and peripheral to nonproliferation. It is central because any Middle East NWFZ would require its inclusion. It is also central insofar as Iran's nuclear dissembling and hedging within the NPT may be, in part, a reaction to Israel's nuclear posture.[3] Iran appears interested in acquiring at least a breakout capability – or the ability to quickly re-direct ostensibly peaceful nuclear resources to the development of a weapon on short notice. This would constitute Iran's own version of opacity. While superficially preserving the NPT, it would fundamentally undermine the treaty and increase the risk of a nuclear conflict between Iran and Israel.

Israel, however, has long been a peripheral and exceptional player in nonproliferation. It is not a member of the NPT and is widely believed to have possessed nuclear weapons since the late 1960s. Israel neither confirms nor denies its possession of nuclear weapons. This policy – often referred to as opacity or ambiguity, and known in Hebrew as *amimut* – grants Israel the benefit of nuclear deterrence while sparing it the consequences of overtly flaunting global nonproliferation norms. Israel posits that it will not be the first to introduce nuclear weapons into the Middle East. In this formulation, "introduce…into" is quietly understood by the world to mean *use* – not *possess*. This exceptional posture has been made possible by the unique circumstances of the Jewish people and their state. A people targeted for annihilation in the Holocaust established a new state with minimal territorial depth, and subsequently fought a series of wars against other regional states opposed to its existence and seeking its erasure. It is a compelling case for a nuclear exception. Remarkably, even Israel's enemies have made little public fuss about *amimut*. The lack

of any declared opposition, however, should not be construed as a guarantee of the arrangement's durability, especially as Iran adopts its own ambiguous and threatening posture.

One may be inclined to view Israel's absence from nonproliferation regimes as evidence of its opposition to arms control. This would be wrong, however. Israel was not willing to forego the option of a nuclear weapon at NPT adoption in 1968 because of its precarious strategic circumstances. It did not have support to sign onto the treaty as a Nuclear-Weapon State; doing so, in fact, may have sabotaged the treaty by forcing Israel's enemies to publicly enshrine the Jewish State's nuclear superiority. This, by the logic of nuclear deterrence, would have effectively validated the continued existence of the State of Israel. Non-membership in the NPT, combined with *amimut,* allowed enemies of the Jewish State to commit to nuclear nonproliferation while saving face, and allowed Israel the freedom to quietly cultivate a nuclear deterrence option.[4]

Amimut was a smart policy when its impact was to bolster nonproliferation and keep nuclear weapons out of enemy hands. Fifty years on, *amimut* may be more of an impediment to regional nonproliferation. It normalizes opaque proliferation and feeds the argument of an enduring double standard, which undermines the NPT. Avner Cohen, the most prolific writer on the history of *amimut*, observes that "although *amimut* has served Israel well in many respects, not acknowledging its possession of nuclear weapons may now limit [Israel's] ability to address the Iranian problem in a straightforward, internationally supported way."[5] *Amimut* also contributes to uncertainty, which is recognized by realist international relations theory as a primary cause of war.

One might anticipate a number of counterarguments to Israeli disarmament. Some might consider calls for Israeli disarmament and leadership on nonproliferation tantamount to surrender. Disarming in response to Iranian behavior would reward the Islamic Republic for blackmail. Yet

Iran is not publicly linking its nuclear decisions to Israel, and Israel would not disarm in a manner that would surrender any strategic advantage. Israel would lock Iran (and others) into a nonproliferation regime while preserving advantages in intelligence (important for monitoring compliance) and conventional weapons. Nuclear proliferation – even if opaque and only to the threshold of a breakout capability – would strategically disadvantage Israel insofar as even a threshold nuclear threat could be a "great equalizer" for Israel's conventionally-inferior foes. Israel recognizes this, and it is one reason why Jerusalem deems an Iranian breakout capability unacceptable and has so vigorously lobbied the international community to hold Tehran accountable under the NPT.

Another argument against disarmament is that Israel remains a state under existential threat and a nuclear deterrent is the only guarantee against an enemy destroying the Jewish State. Israel indeed remains under threat; it has made peace with only two of its Arab enemies since 1948. Yet for several reasons, nuclear deterrence is a flawed foundation upon which to build Israel's current and future national security policy. First, nuclear deterrence could fail, with catastrophic results for the Jewish State. Secondly, Israel has the capacity to defend itself and to defeat enemies through conventional means. Finally, in the event that nuclear disarmament replaces nuclear deterrence in Israel's national security policy, trends in intelligence suggest that Israel and the international community will be increasingly able to detect cheating in time to pre-empt a nuclear threat.

THE GAMBLE OF NUCLEAR DETERRENCE:

As noted above, realist international relations theory holds that uncertainty is a driver of war. According to the logic of nuclear deterrence, nuclear weapons actually contribute to peace because they make *certain* that war would be unacceptably costly. Avner Cohen chillingly states:

"Distinguished by the scientific predictability of their effects, nuclear weapons are the most demonic weapons ever devised. They make possible the obliteration of entire communities, states, and in some scenarios, civilizations."[6] The prospect of Israeli retaliation with such weapons is understood by Israel's national security elites, its citizens, and by many foreign analysts and advisers as a valuable tool to ensure the Jewish State's survival. *Amimut* is periodically reviewed but enjoys widespread support in both Israel and in allied capitals.[7]

Louis Rene Beres is a prominent advocate of an Israeli nuclear deterrent, if not *amimut*. In a nod to the role of certainty in deterring enemies and avoiding war, Beres advocates a calibrated disclosure of Israel's nuclear arsenal in order to "heighten enemy perceptions" of Jerusalem's capabilities and intentions.[8] In other words, Jerusalem should more clearly and openly signal its nuclear firepower in order to boost the credibility of its deterrence. Beres has made his argument in several articles, including a piece that reviews the work of a joint Israeli-American advisory panel known as Project Daniel, which he chaired.[9] Project Daniel issued a set of recommendations about Israel's nuclear posture in 2003; one key point of its report was that a well-communicated deterrent is essential to Israeli national security.[10] Beres maintains this viewpoint years later. Moreover, he does little to critically evaluate the benefits of disarmament; instead, he implies that disarmament is a lost cause. His work proceeds on the assumptions that Iran (or another Israeli enemy) will acquire nuclear weapons, and that Israel's lack of strategic depth is "irremediable."[11]

The desire to increase certainty about the cost of threatening Israel is superficially sensible but ultimately flawed if based on a nuclear deterrence posture. Unconscionable devastation is a certainty if nuclear weapons are used, but the success of nuclear deterrence *cannot be a certainty*. The risk of nuclear war can be considered along two dimensions: probability and impact. Certainty

applies only to impact; nuclear war would *certainly* be devastating. Depending on the number of nuclear weapons used, their targeting, and their yield, Israel could cease to exist. However, the probability that nuclear deterrence will succeed or fail – especially in perpetuity – cannot be guaranteed as one-hundred percent.

Scott Sagan and Kenneth Waltz offer the most well-known framework for debate about the reliability of nuclear deterrence.[12] Waltz is an unequivocal defender of nuclear deterrence; he suggests that nuclear proliferation increases stability through the certain effects of nuclear weapons. He grounds his argument in his systems theory of international relations, in which all actors are rational like-units that wish to survive. Waltz goes so far as to argue in the influential pages of *Foreign Affairs* that Iran should be allowed to acquire a nuclear deterrent because it would contribute to regional stability.[13] Sagan counters Waltz's general proliferation optimism with perspectives from organizational theory, suggesting that deterrence could fail not only due to miscommunication between adversary states, but due to dynamics *within* supposedly-unitary and rational states. A nuclear strike could occur as a function of any number of flaws in the management of nuclear arsenals, ranging from deliberate insubordination to poor analysis or pure accident wrought by human error or systems failure.[14]

The ways in which nuclear deterrence might fail are well-chronicled in the academic literature; it is neither within the scope nor is it the intention of this article to describe the universe of arguments about potential deterrence failure. A couple of recent contributions on the topic, however, do deserve mention.

Israelis view nuclear weapons as their "sacred insurance policy," in the words of Avner Cohen.[15] Harald Muller's application of insurance economics to deterrence logic is thus highly

relevant. Muller first notes that historically-based inferences about deterrence's reliability can only be probabilistic and not absolute.[16] He then identifies five instances both during and after the Cold War in which nuclear deterrence nearly failed. Deterrence advocates who cite the Cold War as evidence that deterrence works may, in fact, be wildly off the mark in their reading of history. The superpowers, it turns out, may just have been lucky. Carl Lundgren, for example, applies a Bayesian measure to conclude that the probability of a nuclear exchange during the Cold War actually exceeded fifty percent.[17] In turn, Muller draws upon his experience analyzing accidents and risk in the field of civilian nuclear insurance to argue that "with enough proliferation and time, deterrence degenerating into nuclear war will happen with a probability close to one."[18] But even if proliferation were to remain relatively constrained and the probability of nuclear war were not as high as fifty or one hundred percent, insurance math does not support nuclear deterrence. This is because insurance companies are not concerned only with probability, but with impact. Insurance liability limits exist because even low-likelihood propositions that carry an extremely high negative impact constitute a foolish investment. Viewed from this standpoint, a nuclear deterrence posture is not an insurance policy so much as it is an *uninsurable* policy. Says Muller:

> Rather than pronouncing the belief that "it will not happen," it is more useful to submit the question of nuclear war to an insurance thought experiment: if there were a global agreement that nuclear weapons could be held by states that would insure themselves against liability for the damages their weapons would cause in the case of nuclear war, would there be companies offering affordable policies without an imposed limit on liability? … Insurance companies would not volunteer to offer full liability protection. Since it is not within the range of the prudential policy of security-seekers to incur risks that are so high that they cannot be insured, Waltz's proposition and recommendation is inconsistent with his theory's rationalist foundations.[19]

Advocates of an Israeli nuclear deterrent may argue that this critique is off the mark on the basis that Israel does not seek a stable, mutual nuclear deterrence relationship; it wants to prevent Iran and others from acquiring nuclear weapons while maintaining its exclusive "Samson Option."

The biblical Samson faced certain, imminent death at the hands of the Philistines, but had such great asymmetrical power that he was able to wreak destruction taking several Philistine lives with him. Taking the Samson metaphor literally, an Israel that engages in any nuclear conflict will already be condemned to death, so nothing will be lost that would not have already been lost. An Israeli nuclear strike will hold nothing back. This very prospect ought to deter any modern Philistine.

There are a number of problems with this. It discounts that the very cultivation of a Samson Option could normalize and incentivize a symmetrical response, which would ironically and counterproductively increase the risk to Israel that use of the nuclear Samson Option would be necessary. The Philistines could not engineer their own Samson, but Israel's enemies could acquire nuclear arsenals to neutralize Jerusalem's. Under such a proliferation scenario, the admonitions of Sagan, Muller, Lundgren, and many others about the risks of deterrence failure become more relevant. The need to have and use a nuclear Samson Option could be a self-fulfilling prophecy.

A second problem with the Samson Option, and deterrence logic writ large, is that it makes dubious assumptions about rationality. Two realist assumptions undergird nuclear deterrence: states are rational actors and states seek to survive. These two assumptions are often conflated, since the will to survive is assumed to be rational. Indeed, discourse about rationality is often confounded by the failure of its participants to adequately operationalize the term *rationality*. Ambiguity as to what constitutes rationality is especially problematic and consequential for discourse about Israel's nuclear posture.

It is too vague to describe an actor as simply rational or irrational. Scholars from various social science disciplines have operationalized variants of rationality such as substantive

rationality, procedural rationality, and bounded rationality.[20] The realist assumption that states seek to survive is a judgment about *substantive* rationality. Substantive rationality does not measure the procedural relationship between means and ends; it measures the legitimacy of the end itself. Procedural rationality, by contrast, measures how an actor applies means to achieve his or her end. For example, a serial killer may tally a high number of victims and evade capture for several years because of procedural rationality; the murderer knows exactly how to identify targets, kill them, and cover his tracks. Though rational in matching means and ends, this person would be considered by society to be substantively irrational. Why would anyone value hunting and killing innocent people? Even if psychologists could assemble a coherent motive, this perpetrator would likely be considered crazy or irrational – if not clinically, then at least colloquially.

Deterrence theory is fundamentally grounded in the belief that states uniformly view survival as substantively rational. Deterrence theory, moreover, relies on procedural rationality. States are assumed to be capable of controlling escalation such that it does not result in the substantively-irrational outcome of one's own destruction. States not only wish to survive, but know *how to*.

The possibility of error and miscalculation is accounted for by the concept of bounded rationality. Bounded rationality is central to arguments that deterrence can be intolerably risky, even between adversaries that are substantively and procedurally rational in the realist sense. Catastrophic mistakes can occur because otherwise "rational" actors make procedural decisions based on incomplete or flawed information. Data that should lead one to a make a procedurally rational decision may be misinterpreted, leading to a procedurally irrational decision. Human beings are human, after all.

Beres's proposal for Israel to retain and to more clearly signal its nuclear deterrent addresses potential lapses in procedural and bounded rationality. Increased certainty about Israel's capabilities and intentions would support any adversary's substantively rational goal of self-preservation. They would know that threatening Israel's existence would be counterproductive to self-preservation. But what if a state did not consider self-preservation its primary value? Moreover, what if it were willing to absorb more pain and damage than Western thinkers might consider substantively rational?

Discourse on the Iranian threat is littered with references to rationality and irrationality. To be constructive, any such discussion requires clear operationalization of the concept. The most breathless alarmists view Iran as a messianic, suicidal actor that ultimately does not care about its survival as much as it cares about the destruction of the Jewish State. There are actually two judgments about Iran's substantive rationality embedded in this viewpoint. The first judgment is that Iran is substantively irrational insofar as it seeks the destruction of Israel. There is little controversy on this point in Israel or the West. Iran is clear in word and deed that it would prefer the Jewish State cease to exist, and this position is unconscionable within the Israeli and Western worldviews. More debatable, however, is whether Iran would sacrifice itself to annihilate Israel. Those most frightened by the prospect of a nuclear Iran argue that the Islamic Republic is substantively irrational in a second sense insofar as it does not view survival as its primary end; it would destroy Israel even if doing so meant absorbing Israel's Samson Option. Even if Iran does wish to survive, it may have a higher pain threshold than an Israeli or Westerner might consider substantively rational. Cohen notes that a scenario in which both Tehran and Jerusalem have nuclear weapons "could be exceptionally unstable due to the asymmetry in size and population between Iran and Israel."[21] Nuclear scientist Israel Dostrovsky fears that Iran may be willing to

sacrifice a few million lives to eliminate Israel.[22] Indeed, even the ostensibly moderate Iranian statesman Hashemi Rafsanjani once remarked that "the use of a nuclear bomb against Israel will leave nothing on the ground, whereas it will only damage the world of Islam."[23]

A more mainstream view among defense and security professionals is that while Iran has the substantively irrational desire to destroy Israel, it also shares the standard, substantively *rational* desires to survive and to achieve its goals at the lowest cost. From this perspective, some form of nuclear deterrent (even a mere breakout capability) combined with an asymmetric proxy war of attrition is the most procedurally rational way for Iran to achieve its substantively irrational goal of eliminating Israel. In the spirit of Herbert Simon, Iran could be said to possess a *bounded fanaticism*. It is fanatical, but that fanaticism has its limits. This is the preferred analytical viewpoint of this author. Iran's history of cautious provocation does not suggest a suicidal actor. The assumption that Iran is like other states insofar as it seeks survival is compelling in terms of both realist theory and actual evidence. Moreover, there are infrequently-discussed reasons that Iran (or any other regional or Muslim foe) would refrain from attacking Israel with nuclear weapons. Israel is valued real estate. To destroy Israeli governing institutions in Jerusalem via a nuclear weapon would require the destruction of the third-holiest city in Islam. It would be both substantively and procedurally irrational from a Muslim standpoint. Despite Rafsanjani's claim that the Muslim world would leave nothing on the ground, any Muslim foe has a deep interest in finding a non-nuclear means to reclaim Palestine and al-Quds. Moreover, the nuclear fallout would not necessarily be geographically contained. Prevailing winds would carry radiation eastward to Iran and to other Muslim countries.

However unlikely a nuclear attack against Israel might be, it cannot be ruled out if the nonproliferation regimes and norms that constrain its adversaries stagnate or erode – even if Israel maintains its own nuclear arsenal. Deterrence could fail due to breakdowns in procedural rationality, the limits of bounded rationality, or deviation from realist conceptions of substantive rationality. It is possible that all of the above could contribute to a nuclear exchange involving Israel. Remarkably, Beres and his Project Daniel colleagues acknowledge this. As early as 1997, Beres notes that "Jerusalem's possession of nuclear weapons – even if it were fully disclosed – can never bestow real safety" because a rational cost-benefit analysis by an enemy might convince it to absorb any Israeli nuclear counterstrike.[24] In a 2009 review of Project Daniel, he writes that "whether for reasons of miscalculation, accident, unauthorized capacity to fire, outright irrationality, or the presumed imperatives of jihad…a state could opt to launch a nuclear first strike against Israel in spite of the latter's nuclear posture."[25] Moreover, according to the Project Daniel final report presented to the Israeli government, Israel's enemies may be both rational and irrational: "From an intelligence perspective, the rational versus irrational inclinations of Israel's enemies must always be regarded as a dynamic rather than static condition."[26]

If Israel's enemies could be irrational, and if deterrence might fail even on the basis of a *rational* calculation, then why is there such a consensus on the need for a nuclear deterrent? The justification for maintenance of a nuclear deterrent requires a clearer explication of rationality and irrationality on the part of Beres and other members of the Israeli elite for whom he speaks. Beres writes in 2017:

> It is time for one final observation, one already familiar to Israeli strategic planners. All nuclear deterrence is contingent upon an assumption of enemy rationality. This means that in calculating deterrence, an enemy must always be assumed to value its continued physical survival more highly than any other preference, or combination of preferences. Where this assumption might be unwarranted, all deterrence bets could be off.[27]

This foundational assumption about substantive rationality carries with it many sanguine assumptions about procedural and bounded rationality that are noted in the literature on deterrence skepticism. It also suggests a limited explication of the concept of rationality among Israeli elites, at least in the open sources. What I call *bounded fanaticism* is the only way to make sense of an otherwise incoherent but common claim: that Iran cannot be allowed to get the Bomb because it is irrational, but an Israeli nuclear deterrent is essential to keeping Iran at bay. If Israel assesses that Iran and other foes are *boundedly-fanatical* insofar as they wish death and destruction upon Israel but prefer their own survival, then nuclear deterrence may be of value. Yet the risks of accident and miscalculation remain. Moreover, if nonproliferation norms and regulations stagnate or erode, terrorists may more easily acquire nuclear materials to use against Israel, and rival states could more readily acquire opaque or overt nuclear deterrents that would neutralize Israel's conventional advantage.

Ultimately, the consensus behind Israel's nuclear deterrent seems to be that, while risky, it is the least-bad option. *Risky but least-bad* is a flimsy foundation upon which to maintain a consensus. While nuclear opacity may have made the most sense in 1968, linear thinking and groupthink on the nuclear issue may cause Israel to discount both the risks of *amimut* as well as the alternative means by which it can now deter enemies and reassure itself of its long-term survival.

A NON-NUCLEAR 'IRON WALL':

Writing in the pages of *Survival*, Isaac Ben Israel and Deganit Paikowsky address the logic of Israel's space program in terms of the "Iron Wall" concept. [28] This concept, which originated with Zev Jabotinsky, suggests that deterrence is "accumulated" by the possession of several capabilities (none of which are necessarily nuclear). Deterrence, dissuasion, and reassurance are rooted in a breadth of capabilities that work together to convey the message that Israel cannot be defeated. The Israeli space program is one element of Israel's Iron Wall, even by mere virtue of its prestige. The authors make only vague reference to the "tangible and concrete capabilities" of the space program that are relevant to intelligence collection.[29] Their caution in discussing intelligence capabilities is understandable, especially since Ben Israel is the chair of the Israel Space Agency. Though the most important details are surely classified, this paper assumes that Israel enjoys major advantages over its regional adversaries in intelligence collection – especially technical collection. The argument proceeds on this basis, and also adopts the Iron Wall concept to make the case that Israel can more safely ensure its future by actively working to eradicate nuclear weapons and unregulated fissile material from the region, by developing and maintaining superior intelligence capabilities, by developing and maintaining superior missile defense systems, and by maintaining a qualitative edge in conventional warfighting capabilities. Superior conventional attack capabilities, superior missile defense, superior Intelligence, and a Nuclear-Weapons-Free Zone constitute four pillars in a proposed Iron Wall.

Conventional Power to Dissuade, Deter, and Defeat

An Israeli F-16 was shot down for the first time since 1982 on February 17, 2018. A Syria-based, Russian-made anti-aircraft system brought down the jet. Iranian foreign minister Javad

Zarif celebrated the event as shattering Israel's "myth of invincibility."[30] The emplacement of Russian S-300 and S-400 air defense systems in Iran and Syria is certainly problematic for Israel, and the loss of the F-16 may not be the last. Yet it would be a leap too far to interpret this development as support for the nuclear Samson Option. Israel re-established air supremacy after the event and retaliated against the Syrian air defense position. Israel also continues to employ superior intelligence in striking Iranian forces there, notes Amos Yadlin of the Institute for National Security Studies in Tel Aviv.[31] Moreover, wrote Yadlin after the incident: "There are uncertainties, surprises, and mistakes in every battle that come with a cost."[32] War is not sterile, and there is no indication that Israel is on the cusp of losing its long-cultivated qualitative military edge.

Yaakov Katz and Amir Bohbot broadly illustrate the extent to which Israel exceeds its rivals in military technology.[33] Israel's advantage, importantly, is not a mere function of foreign aid, nor is it a passing moment in the ebb and flow of arms races. According to their thesis, Israel's advantage has deep institutional roots. It is rooted in Israel's overall culture of self-reliance and existential fear, and in a military culture that values the merit of an idea over the hierarchical rank of the idea's source. Mandatory military service requirements build professional networks and enhance communication between the private sector and the armed forces; an Israeli engineer developing tank armor probably knows what it is like to serve on a mission inside of a tank. Several domestic institutions channel this culture and energy into education, research, development, and production of systems that provide an enduring qualitative edge. These institutions include the Israel Institute of Technology, more commonly referred to as Technion and known as Israel's version of MIT; Israel Aerospace Industries (IAI); Israel Military Industries (IMI); Israel Space Agency (ISA); Rafael Advanced Defense Systems; and Elbit Systems – among

others. Israel invests about 4.5 percent of its GDP in research and development – more than any other country – and is a global leader in the export of drone and cybersecurity products.[34]

Katz and Bohbot identify their own three pillars of Israeli deterrence: an opaque nuclear weapons capability, a strategic alliance with the United States, and conventional military capabilities. Their work focuses on the third pillar of conventional military capabilities and technology, much of which applies to both intelligence collection and the use of force. They note 21st century Israeli advances in drones, submarines, stealth aircraft, missile accuracy, and tank survivability. Israel is also a leader in developing missile defenses and satellites.[35] Katz and Bohbot do not argue that Israel should embrace nuclear disarmament; in fact, their pillars suggests that they support a nuclear deterrent. However, the many non-nuclear advantages that they describe *can* be viewed as a solid foundation upon which to build a security doctrine completely free of nuclear weapons.

Israel faces no foreseeable, plausible ground-invasion scenario that could threaten its existence. Currently, the major concern is that Iran could exploit its influence in Iraq and Syria to build bases close to Israel and project power over the 1,000 kilometers separating the countries. This would be a tall order for Tehran. Israel enjoys major advantages in tank power and air power. Iran's ground and air forces are dated; the country's acquisition of modern equipment is hindered by sanctions, and its domestic defense industry cannot match Israel's.[36] Despite claims that is has produced a new cutting-edge "Karrar" battle bank and wishes to purchase T-90 tanks from Russia, Iran remains reliant on the 1970s-era T-72 as its main battle tank.[37] No matter what tank Iran (or any other regional adversary) might deploy, Israel remains well-positioned to prevail in a conventional ground war. Its domestically-designed and produced Merkava tank anchors the

armored corps. Jerusalem continues to invest heavily in the Merkava program, and its capabilities are among the most highly-classified military secrets in Israel precisely because Jerusalem views it as a major asset in any "doomsday" scenario, note Katz and Bohbot.[38] Among the Merkava's known capabilities is the Trophy active protection system, which can intercept anti-tank missiles and rocket-propelled grenades. The Merkava can operate in traditional battlefield or asymmetric urban environments.[39]

Iran's air forces are also inferior; its F-14s and MIG-29s are no match for the Israeli Air Force (IAF).[40] Tehran's old-model Su-24 long-range attack aircraft could reach Israel but would require refueling.[41] Israel, for its part, also lacks the conventional air power to destroy Iran, but it could threaten its nuclear facilities as well as its oil and gas industry. Most of Iran's oil infrastructure is in the country's west and within striking range of Israeli F-15s and F-16s.[42] Amos Yadlin noted in 2013 that Israel might target Iran's oil facilities.[43] It could do this not only with aircraft, but with ballistic and cruise missiles. The loss of revenue from oil and gas could strain the regime in Tehran, and the overt prospect of a disruption to the global energy supply could help promote international vigilance regarding Iran's provocative behavior. Moreover, other energy-producing states could increase production to compensate for supply shortages. The ability to drive a dagger through the heart of Iran's economy is a credible deterrent that Israel should embrace, cultivate, and communicate.

Advanced anti-aircraft systems are the most likely enemy asset to threaten Israeli air superiority. Iran acquired a variant of the Russian S-300 air defense system in 2016. It can simultaneously detect up to one-hundred aerial targets at a 300 kilometer range, and engage six of them with surface-to-air missiles (SAMs) that can travel 150 kilometers.[44] Syria has deployed the

S-400 air defense system, which can target aircraft operating in Israeli airspace as far west as Tel Aviv.[45] These are concerning developments, but should not be exaggerated. Israel retains the ability to project airpower, and will remain able to do so. Israel can repress air defenses with air bombardments as well as cyber and electronic attacks. In the 2007 operation against Syria's nuclear reactor, Israel employed a combined cyber and electronic attack to fool Syrian air defense radars.[46] Even if advanced enemy SAM systems make manned missions more dangerous for the IAF, drones provide an attractive alternative, and constitute another technological realm in which Israel enjoys advantages.

Israel invented the military drone in 1968 when it attached a camera to a toy airplane and flew it over the Suez Canal to collect intelligence on Egyptian positions.[47] In 1982, Israel flew its drones over the Bekaa Valley to identify Syrian SAM batteries and to collect their radar and communications frequency data, thereby assisting the IAF in its repression of Syrian air defense and the conduct of the war in Lebanon.[48] Israel became the world's leading exporter of drone technology in 1985.[49] The United States purchased its first drone from Israel in 1986, and Israeli engineers would eventually assist the US in developing the armed Predator drone.[50] During Operation Cast Lead in 2009, Israel used a drone as far afield as Sudan to neutralize a smuggling route for Hamas weapons. [51] By 2015, drones conducted a majority of IAF flights, and by 2030, the IAF plans to phase out current manned systems and to employ an air force composed of drones and manned stealth aircraft.[52] This would negate many of the gains made by Israel's enemies in air defense. Drones are cheaper and more difficult to detect than conventional manned aircraft, and any successful air defense engagement with a drone would not cost Israel a human life. The development of stealth drones would further minimize the financial cost to Israel by requiring fewer drones to overcome any enemy defenses. Meanwhile, missions that require a human pilot

would employ stealth to protect both the mission and the life of the pilot. By 2030, it is plausible – if not likely – that Israel will be able to command air superiority at even less risk than has been the case for the first two decades of the 21st century.

The most likely war that Israel will face is one involving missiles and rockets. Hezbollah possesses an estimated 100,000 missiles and rockets, and Hamas an estimated 10,000.[53] Iran can strike Israel with ballistic missiles and continues to advance its missile programs. Missile defense is thus critical to dissuade enemies and to reassure Israel. Fortunately, Israel possesses a layered missile defense capability. The Iron Dome is a one-of-a-kind system to shoot down short-range rockets, including the most rudimentary systems launched by Hamas from Gaza. Iron Dome deployed in 2011. It achieved an 85 percent success rate in Operation Pillar of Defense in 2012 and a 90 percent success rate in Operation Protective Edge in 2014.[54] Its command system can detect where a rocket will land, allowing Israel to judiciously employ its interceptors against only those rockets that threaten a valuable target. Meanwhile, the Arrow 3 missile defense system can protect against long-range ballistic missiles, such as those that Iran might launch against the Jewish State. The Arrow 3 has an extended range and can engage missiles close to their point of launch, meaning that Israel could conceivably destroy an Iranian ballistic missile while it was still over Iran.[55] Finally, David's Sling offers a middle layer of defense against short- and medium-range ballistic missiles. It is a replacement for Israel's older American Hawk and Patriot missile defense systems. Iron Dome has proven itself in combat, and David's Sling and Arrow have tested successfully, though they have not yet been used in combat. Continued investment in reliable and superior missile defense systems would reassure Israel and dissuade enemies. It would reduce the risk of an adversary cheating on a nuclear arms control agreement, as well as the likelihood that Israel would find itself in a Samson-like situation. Meanwhile, Israel can threaten Iran with its

Jericho ballistic missiles, against which Tehran has no comparable missile defense capability. Israel can also deter threat actors in Lebanon, Syria, and the Palestinian Territories with conventional force. Despite the conventional wisdom that the 2006 Lebanon War was a political victory for Hezbollah, the group's leader Hassan Nasrallah remarked that he would "absolutely not" have provoked Israel into that war had he known the damage that it would inflict on his constituents.[56]

Trends in Intelligence and Verification

Intelligence capabilities are a core component of any Iron Wall and any arms control regime. On both counts, Israel has reason to be optimistic. Its domestic intelligence capabilities are superior to those of its adversaries, especially in the technical realm. Moreover, global trends in nuclear monitoring technology suggest that a NWFZ will become increasingly verifiable.

Israel's drones can perform sophisticated surveillance operations. The Heron drone, which Katz and Bohbot describe as Israel's "main workhorse," can remain airborne for fifty hours in order to conduct surveillance and strike a target with a laser-guided munition at the most appropriate time.[57] Israeli drones carry MASINT and GEOINT sensors capable of detecting WMD signatures and subtle changes in terrain that may suggest the presence of underground facilities.[58] Increasingly, drones will carry out missions that are too dangerous or too labor-intensive for humans, including border patrols, ongoing surveillance, and operations in areas contaminated by WMD.[59]

Israel's satellite program also gives it an intelligence edge. Israel Space Agency launched the Ofek-10 in 2014, giving Jerusalem seven spy satellites in orbit. Israel's space-based sensors include synthetic aperture radar (SAR) sensors capable of producing high-resolution images

through cloud cover and camouflage netting. These systems have been tasked to monitor Iran's nuclear program.[60] Israel is now making advances in miniature satellites that are significantly lighter than traditional satellites (300 kilograms versus 25 tons).[61] Satellite miniaturization will empower Israel to deploy more satellites more quickly and at lower cost, leading to more coverage and more detailed intelligence. For intelligence targets that are inaccessible to human agents or that evade aerial or space-based detection, Israel is working on small robots. For example, robotic snakes are under development that may be able to access suspicious or dangerous buildings.[62] One can imagine Israel using stealth drones to penetrate Iranian airspace and deploy small ground-based robots that would discretely access military facilities or survey terrain to transmit GEOINT or MASINT data. To preserve this advantage and prevent reverse-engineering, the systems could carry a self-destruct mechanism.

Superior drones, satellites, robots, and sensors will give Israel superior command of the conventional battlespace for the foreseeable future, and will increasingly enhance its ability to detect WMD-related activities in neighboring countries. Meanwhile, advances are being made internationally in nuclear monitoring that make a verifiable NWFZ more plausible. Katlyn Turner, writing in *Bulletin of the Atomic Scientists* in 2018, explains the significance of advances in fissile material detection technologies.[63] Current technology does not allow one to confidently detect illicit uranium or plutonium if it is shielded by metal or even some plastics. Radiation meters and X-ray scanners are both deficient in case of even moderate distance from the source or in case of an effort to conceal. A new method, however, exploits the high densities of uranium and plutonium for purposes of detection. A 2016 study by Pacific Northwest National Lab measured the interaction of X-rays and neutrons to detect fissile material. This measurement allowed the scientists to distinguish fissile materials from other metals even in the presence of camouflage and

without the benefit of detecting radioactive particles. The study's authors suggest that this technology could be used to enforce arms control agreements like the JCPOA.[64]

Studies in South Korea and Japan suggest additional means by which to detect fissile material. Researchers at the Ulsan National Institute of Science and Technology in South Korea have measured the presence and breakdown of plasma in order to detect radioactive materials. Their method allows detection at a distance of one kilometer from the source of radiation – a vast improvement over the few meters' reach of today's technology. Japanese researchers, meanwhile, have measured antineutrinos as an indicator of nuclear activity. Antineutrinos are particles produced during radioactive decay. An antineutrino detection array tested in 2014 was able to determine whether or not a nuclear reactor was operating. According to Turner, the ability to tell whether a reactor is switched on or off would be a boon to safeguards and assist with verification of the JCPOA.

> "A portable antineutrino detector…could accurately determine whether the IR-40 reactor was shut down or operational, what the material inside the reactor core was, and how much plutonium was in the reactor…[This] type of detection scheme could be used at any reactor, anywhere, to verify and monitor nuclear activities."[65]

The timeframe for maturation of these technologies, according to Turner, corresponds to the timeframe for expiration of the JCPOA's restrictions on fissile material. She writes: "While we don't yet have a working solution, with a continued focus on the basic research that underpins these technologies, as well as sustained funding, we could have one in the coming decade."[66]

Meanwhile, the International Monitoring System (IMS) associated with the CTBTO provides another intelligence suite from which a non-nuclear Israel could take reassurance. The IMS is geared toward the detection of nuclear testing. It includes 337 stations worldwide that

perform seismic, hydro-acoustic, infrasound, and radionuclide monitoring. Ten stations and three auxiliary stations are operational in the Middle East.[67]

Finally, a Federation of American Scientists (FAS) task force report on nuclear monitoring and verification in the digital age suggests that artificial intelligence and citizen participation could boost arms control. The increasing availability of satellite imagery and commercial transaction data in the open sources will give citizens and the NGO community the ability to participate in monitoring through what Christopher Stubbs and Sidney Drell call "Public Technical Means.".[68]

TOWARD A MIDDLE EAST NWFZ:

Given the many trends discussed in this paper, Israel should actively promote and work for a Middle East Nuclear-Weapons-Free Zone and accede to the Nuclear Nonproliferation Treaty as a Non-Nuclear-Weapons State by 2030. Meanwhile, it should continue to enhance its conventional deterrence and power projection capabilities, its missile defense infrastructure, and its superior intelligence collection capabilities. Global nonproliferation regimes and norms are under strain. Their failure could ultimately prove fatal for Israel, which is small and has many enemies. Nuclear deterrence is of dubious reliability, and the risk of an adversary successfully cheating on a nuclear arms control agreement will decrease as technologies for intelligence collection and nuclear monitoring improve. In 2030 – one year before JCPOA restrictions on Iran's use of fissile material expire – Israel will have an extensive unmanned and stealth air force capable of projecting power and collecting intelligence at reduced risk to Israeli lives. With proper investment, new technologies that can detect illicit nuclear activity will be sufficiently advanced to be deployed for monitoring and enforcement of nuclear arms control treaties.

This vision is not excessively optimistic or unrealistic. Monitoring technologies will not be able to see everything happening everywhere at every time. But the probability of being caught cheating will increase as monitoring technologies mature. Where international assets, such as those of the IAEA and CTBTO, fall short, Israel is well-positioned (along with its allies) to collect intelligence in time to detect and forestall cheating.

The dissuasive and reassuring effects of monitoring technologies should be matched by dissuasive and reassuring norms. The normative prohibition on nuclear weapons needs a boost. The Treaty on the Prohibition of Nuclear Weapons is likely to sputter, and disillusionment over NPT Article VI is likely to grow as Great Power competition re-emerges among the recognized Nuclear Weapon States. Israeli accession to the NPT would inject much-needed life into the beleaguered regime, and a regional NWFZ would draw Iran and other Middle Eastern states into doubling down on their own nuclear nonproliferation commitments. Ideally, norms against nuclear proliferation and war in the Middle East would be internalized as substantively rational by all parties. But even if they were not, they could still affect cost-benefit calculations. Cheating on both NPT and NWFZ commitments would carry increased political costs and would increase the credibility of an Israeli threat of conventional strikes. Currently, Israel's threat to use force against a country violating the NPT lacks the legitimacy that it would carry if Israel and its neighbors were together more deeply embedded in an arms control regime. Though Israel often thumbs its nose at international opinion, even Katz and Bohbot acknowledge that international legitimacy is a force multiplier for a conventionally-superior Israel. In celebrating Israel's weapons wizardry, they write:

> All of this, though, is meaningless if Israel's operations lack the international stamp of legitimacy. The state can develop, manufacture, and even sell weapons around the world, but that won't mean much if the world refuses to support Israel's actions…For a country like Israel, legitimacy is not trivial.[69]

Beyond reinforcing norms, a Middle East NWFZ should improve upon the monitoring and verification mechanisms employed by the IAEA under the NPT. Safeguards agreements with the IAEA are the basis for monitoring and verifying compliance in most of the world's NWFZs. The Middle East, however, may benefit from a more aggressive model given the lack of trust among the region's actors. Any robust monitoring regime will surely test the member states' political and counterintelligence sensitivities. To address the specific concern of fissile material diversion, the region's actors should consider a fissile material consortium with only a few regional sites engaging in processing and enrichment. The concentration of fissile material would ease the task of monitoring and reduce the risk of diversion while also reducing the risk that terrorists could illicitly acquire significant quantities of fissile material. Several technical and political hurdles indeed remain before the realization of a Middle East NWFZ.[70] The details of these hurdles are beyond the scope of this paper, which makes the broader strategic case that a NWFZ is in Israel's interest. The presence of political and technical hurdles is why work should begin immediately. A starting point would be re-engagement with sponsoring state Finland, which last hosted a Middle East WMD-Free Zone conference in 2011.

No country in the Middle East is opposed in principle to a NWFZ. Even Israel supports one, but considers a comprehensive regional peace a prerequisite. This position not only ignores current trends, but turns the logic of arms control on its head. Arms control is not a luxurious byproduct of good relations. Its purpose is to reduce the risk inherent in the conflicts that inevitably plague the world. Conflict is likely to plague the Middle East into the foreseeable future. Critics may

contend that the political and technical path to a regional NWFZ is too difficult or unclear. However, it is much clearer than any foreseeable path to regional harmony. The world has changed since 1968. Proceeding down the path of nuclear transparency and disarmament is less risky now for Israel than it has been in the past. Technological trends in conventional military systems and intelligence should reassure Israel. Moreover, while caution and some skepticism are smart, Israel cannot thrive as a nation that has no faith in international norms and regimes. Prolonged cynicism may eventually produce a catastrophic self-fulfilling prophecy.

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