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# IRAN AND THE NUCLEAR THRESHOLD

## Where is the Line?

Jacques E.C. Hymans and Matthew S. Gratias

*This article clarifies and evaluates the intellectual underpinnings of the respective military red lines that Western leaders have drawn against Iran's developing nuclear program: (1) the red line of "no Iranian nuclear weapon"—the stance that has been embraced by President Barack Obama—and (2) the red line of "no Iranian nuclear weapons capability"—the stance that has been embraced by Israeli Prime Minister Benjamin Netanyahu and many prominent American Iran hawks. We contend that the key intellectual divide between these stances is that the Netanyahu view implicitly assumes that a "significant quantity" (SQ) of highly enriched uranium is essentially equivalent to a bomb because an explosive nuclear test is technically unnecessary, whereas the Obama view implicitly assumes that if and when Iran gets to the point of being technically and psychologically ready to assemble a nuclear weapons arsenal, it will conduct a test. We show through theoretical and empirical analysis that the likelihood that Iran will choose an "Israeli-style" policy of creating an arsenal of untested but operational nuclear bombs is very low. Therefore, Obama's red line is more intellectually defensible than Netanyahu's.*

KEYWORDS: Iran; Israel; South Africa; India; Pakistan; North Korea; nuclear testing; nuclear weapons capability

There has been much discussion about where to draw the "red line"—the threshold for military action—against Iran's nuclear program. Despite the dubious strategic wisdom of launching preventive counterproliferation wars, many politicians have already drawn military red lines for Iran, including President Barack Obama and Israeli Prime Minister Benjamin Netanyahu. But their respective red lines are subtly different from each other. In this article, we examine the intellectual underpinnings of these different red lines. In other words, we ask, at what point must one conclude that the difficult Iranian nuclear *problem* has become an unacceptable Iranian nuclear *threat*? More precisely, at what specific stage in Iran's potential future nuclear development would it be prudent to begin assuming that the country had become, for all intents and purposes, a nuclear weapon state?

Our analysis proceeds in three steps. First, we detail the crucial difference between the red line of "no Iranian nuclear weapon," which has been embraced by Obama, among others, and the red line of "no Iranian nuclear weapons capability," which has been embraced by Netanyahu, among others. We contend that the key intellectual divide between these positions is that the Netanyahu stance implicitly assumes that a "significant

quantity" (SQ) of highly enriched uranium is essentially equivalent to a bomb since an explosive nuclear test is technically unnecessary, whereas the Obama stance implicitly assumes that if and when Iran becomes technically and psychologically ready to assemble a nuclear weapons arsenal, it will conduct a test.

Next, we contrast the general pros and cons of using the SQ/no SQ metric versus the test/no test metric as the key indicator of whether a state has "gone nuclear." We conduct this analysis both in terms of theory and in light of the global history of nuclear proliferation. We find that the test/no test metric—i.e., the metric on which Obama's Iran red line implicitly relies—is superior as a general rule to the SQ/no SQ metric—i.e., the metric on which Netanyahu's Iran red line implicitly relies. But this finding does not exclude the possibility of country-specific exceptions.

We then turn to the question of whether or not the Iranian case is likely to be one of those exceptions. We do this, first, by assessing the relevance of the historical nuclear behavior of Israel—the great exception to the test/no test rule—for Iran's likely future nuclear behavior. Although many analysts expect Iran to follow in Israel's footsteps, we find that the two countries' different external and internal situations provide little justification for this analogy. Therefore, the Israeli case does not undermine the applicability of the test/no test metric to the case of Iran. Second, because it is possible that Iran could choose opacity for reasons different than Israel's, we review Iran's empirical record of ballistic missile testing behavior as a potential precedent for its likely nuclear behavior. The missile test data, which is collected for the first time in this article, demonstrates that Iran is very "testy"—that is, the Iranians have a clear pattern of testing prior to induction of new strategic weapons systems. Iran's systematic practice of testing its technical advances in this closely related technology provides additional justification for applying the test/no test metric in the nuclear case.

In short, our analysis indicates that the test/no test metric for measuring a country's nuclear status is superior to the SQ/no SQ alternative, both in general and in the specific case of Iran. Iran's acquisition of one or more SQ would undoubtedly be a major event, but it should not be equated with the acquisition of a nuclear weapon. If we compare Iran to a team marching down a football field, acquiring enough fissile material for a bomb would mean it had entered the "red zone,"—the crucial, penultimate area of the field from which scoring is most likely—but not the "end zone," where scoring actually takes place. Therefore, the later military red line of "no Iranian nuclear weapon" is more intellectually defensible than the earlier red line of "no Iranian nuclear weapons capability."

This conclusion should not be taken as a simple endorsement of Obama's Iran policy. Many argue that setting any military red lines at all is a poor tactic for pulling Iran back from the nuclear brink. On the flip side, it is also possible that taking an extreme, hawkish position could be useful as a negotiating gambit, even if that position is illogical from an intellectual standpoint. This article does not seek to settle the broader policy issue of what should be done to rein in Iran.<sup>1</sup> Rather, we seek to clarify and evaluate the intellectual assumptions underlying the main contending Iran red lines, in the hope that this contribution may lead to a higher-quality policy debate.

## Lines in the Sand

President Obama has been vociferous in his opposition to Iran's acquisition of nuclear weapons. As he told a reporter in September 2012, "I've stated repeatedly, publicly that red line, and that is we're not going to accept Iran having a nuclear weapon."<sup>2</sup> Top Obama administration officials have used similar language, especially over the past two years.<sup>3</sup>

However, many in the United States and Israel have strongly objected to Obama's Iran red line, viewing it as a promise to close the barn door after the horses have already left. Foreign policy hawks such as John Bolton and Dan Senor convinced 2012 Republican presidential nominee Mitt Romney to draw his red line at Iran's development of a 'nuclear weapons *capability*.'<sup>4</sup> This phrase was widely interpreted to indicate that a Romney administration would support military action to stop Iran from acquiring what the International Atomic Energy Agency (IAEA) considers as one SQ of highly enriched uranium (HEU)—i.e., a stockpile of about 25 kilograms of weapon-grade uranium enriched to 90 percent—even if there was no evidence of Iranian intent and ability to rapidly weaponize that stockpile.<sup>5</sup> After Romney's defeat, many Republicans and not a few Democrats have continued to hold to this formulation, as indicated by a December 2012 letter to Obama that was signed by 74 senators.<sup>6</sup>

The Israeli government led by Prime Minister Netanyahu also strongly concurs with the view "that a nuclear-capable Iran—one with sufficient fissile material and weapons technology to be able to build a bomb in a few weeks—is as threatening to the international order as an Iran with an actual weapon."<sup>7</sup> Indeed, Netanyahu has gone even further than many American Iran hawks by putting forth an extreme interpretation of what he considers "sufficient fissile material" for "nuclear weapons capability."<sup>8</sup> After the prime minister literally drew a red line across a cartoon bomb during his September 2012 speech to the United Nations, Israeli officials let it be known that their red line is an Iranian stockpile of 240 kilograms of 20 percent enriched uranium—a threshold they believe Iran could reach as early as this spring.<sup>9</sup> Two hundred forty kilograms of 20 percent enriched uranium would place Iran within about one to two months of achieving a single SQ of weapon-grade, 90 percent enriched uranium, if it wanted to achieve that objective, and if all the technical steps went according to plan.<sup>10</sup> By defining "sufficient fissile material" at a level of enrichment far below what is needed for an actual nuclear device, the Israeli government apparently wants to give itself some extra cushion on top of the cushion that is already provided by setting the red line at "nuclear weapons capability."<sup>11</sup>

## Intellectual Justifications for the Obama and Netanyahu Positions

The intellectual justifications for these respective positions can be summarized as follows. Obama's red line of "no Iranian nuclear weapon" reflects the standard international norm against the emergence of new nuclear weapons arsenals. This norm is embodied in the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), which—as Iran often points out—permits fissile material production for peaceful purposes. From a strategic point of

view, Obama's red line reflects the hardly debatable proposition that the construction of actual Iranian nuclear weapons is the main problem to avoid here. And as the case of Japan demonstrates, there is no inevitability about fissile material stockpiles turning into bombs, even in the long run. Indeed, many analysts believe that Iran may not be intending to go any further toward the bomb than Japan has gone.<sup>12</sup>

The weakness in this traditionalist approach, however, is that it may be difficult for outsiders to *know* if Iran has converted its fissile material stockpile into a working bomb. In other words, Iran might be able to pass unnoticed from its current state of nuclear *ambiguity*—i.e., sending mixed signals about its ultimate nuclear intentions—to a state of nuclear *opacity*—i.e., secretly acquiring an untested, but operational nuclear arsenal.<sup>13</sup> This scenario would become more realistic if Iran, like Iraq and North Korea before it, were to expel the international inspectors who have been keeping watch over its evolving nuclear program. The Obama administration has expressed confidence that US and Israeli intelligence, with or without the help of the international inspectors, have ample means of detecting any sudden Iranian move toward the bomb.<sup>14</sup> But Iran hawks have been much more skeptical. Their view, as laid out in a *Wall Street Journal* editorial, is that "Tehran has a record of nuclear deceit. Intelligence analysts shouldn't assume that absence of evidence means evidence of absence."<sup>15</sup> Therefore, they counsel that the prudent stance is to bar Iran from obtaining a bomb's worth of fissile material, which they see as the last stage where the Iranian program's progress could be reliably tracked. In their view, after Iran had acquired its SQ, the uncertainty about what it had done with that material would require the world to consider it a *de facto* nuclear weapon state, whether it really was one or not.

The above discussion reveals that answering the apparently *technical* question of how close Iran may be to the nuclear weapon threshold actually depends on a *political* analysis of how Iran may prefer to enter the nuclear weapon state club—silently or with a bang. If Iran is likely to sneak a nuclear weapon into existence unbeknownst to US and Israeli intelligence, then the "no nuclear weapons capability" red line is more prudent. As former Secretary of Defense Robert Gates has put it, "If their policy is to go to the threshold but not assemble a nuclear weapon, how do you tell that they have not assembled? I don't actually know how you would verify that."<sup>16</sup> On the other hand, if Iran is likely to test a nuclear device prior to induction of nuclear weapons into its arsenal, then the "no nuclear weapon" red line is more prudent. As Gates and others have noted, there can be little doubt that with all of the resources that the US intelligence community has focused on this target, full-scale Iranian test preparations would be clearly discernible.<sup>17</sup> Note also that the utility of the test/no test metric is particularly great now that a superlative global network of nuclear test sensors has been built by the Preparatory Commission of the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO). That network essentially rules out the possibility that a state could verify its new nuclear status with a secret nuclear test, as sometimes occurred in the past.<sup>18</sup>

In short, to resolve this debate, a careful political analysis of Iran's testing tendencies is required.

## Iran's Testing Tendencies

The expectation that Iran may take the Israeli route of nuclear opacity—of building bombs without prior testing—is widespread. Indeed, it is almost an article of faith in Israel and among right-leaning US voices, and it has intermittently taken hold in the US intelligence community as well.<sup>19</sup> As argued above, this expectation provides the key intellectual justification for setting the red line for Iran at one SQ. The expectation that Iran is headed for nuclear opacity is founded on three intellectual pillars.

The first pillar is the general impression that, in the post-Cold War era, opaque proliferation has become the new normal. Recent nuclear history, however, contradicts this impression. Indeed, it is surprising that many analysts continue to believe that the world is undergoing a wave of opaque proliferation even after the threshold states Pakistan, India, and North Korea all tested bombs in the recent past, while others such as South Africa, Libya, and Myanmar clearly abandoned their nuclear weapons efforts.<sup>20</sup> As these examples show, if there is an international trend at this time, it is toward unambiguous demonstrations of one's nuclear status—the very opposite of what analysts so often suppose.

The second pillar is the Iranian regime's general reputation for being particularly wily and secretive. This image has persisted even though Iran has given international inspectors far more access to its nuclear activities than, for instance, Iraq did under Saddam Hussein, or Israel did under David Ben Gurion.<sup>21</sup> But even if Iran is successfully hiding something big from the inspectors today, we should not forget that almost all nuclear weapons projects have been carried out in secret—until the moment came to test. So, Iran's unwillingness to fess up to the full extent of its nuclear work over the years should not be taken as an indication of some extraordinary penchant for nuclear secrecy that will persist even after the country has achieved its putative nuclear ambitions.

The third pillar is the idea that Israel's stance of opacity has paid off handsomely for it—and that Iran has noticed. This is the strongest and most often-made point in the conventional litany on the question. Micah Zenko of the Council on Foreign Relations writes, "In a twist of historical irony, Iran's contemporary playbook mirrors the one used by Israel to acquire a nuclear weapon in the 1950s and 1960s."<sup>22</sup> Former US Special Representative for Nuclear Nonproliferation Christopher Ford writes, "I fear that the Iranians will choose to try to do—and from inside the NPT—what most observers claim Israel has done since the late 1960s."<sup>23</sup> Iran expert Shahram Chubin of the Carnegie Endowment for International Peace concurs: "I don't think there's going to be a day, and then a 'day after.' It's going to be as blurry as it has been."<sup>24</sup> Yaakov Katz reports in the *Jerusalem Post* that, according to senior Israeli officials, "Israel fears Iran will copy its policy of nuclear ambiguity."<sup>25</sup> And Representative Roscoe Bartlett—until recently, the Republican chairman of the Air and Land Forces Subcommittee of the House Armed Services Committee—and former CIA officer and congressional staffer Peter Vincent Pry go so far as to argue, "... there are good reasons for questioning this premise, so fundamental to our policy, that Iran is still a nonnuclear-weapons state. That Iran has not conducted a nuclear test is no guarantee that it does not have the bomb."<sup>26</sup> Bartlett and Pry continue, "Israel is credited with clandestinely developing a large and highly sophisticated nuclear

arsenal, all without nuclear testing . . . Why do we suppose that Iran, with resources vastly superior to Israel's, and helped by Russia, China and North Korea, cannot match or surpass Israel's nuclear weapons feat?"<sup>27</sup>

The notion of Iran wanting to sneak a bomb into existence may feel intuitively plausible. But in this article, we move beyond the reliance on gut feelings and instead offer a theoretically and empirically well-grounded forecast of Iran's potential nuclear testing behavior. We find that, assuming Iran decided to acquire nuclear weapons, there is no strong reason to believe that it would seek an opaque nuclear arsenal. Instead, it would most likely follow the traditional path of exploding a nuclear device prior to the induction of operational nuclear weapons into its arsenal. Therefore, as long as Iran does not conduct a nuclear weapon test, this absence of evidence should indeed be taken as evidence of absence of an Iranian nuclear bomb. We base this conclusion both on a general consideration of the pros and cons of the SQ/no SQ and test/no test metrics, and on Iran's specific political context and strategic weapons testing behavior to date.

Needless to say, political forecasting is an art, not a science. We do not have a crystal ball. Therefore, we cannot rule out the idea that Iran might try to pursue the Israeli pathway of opaque proliferation. Yet it is nonetheless significant that we find no theoretical or empirical reason to consider the hypothesis of a future Iranian opaque nuclear arsenal as anything more than fanciful. This finding has very important implications for the Iran red lines debate.

### Comparing Metrics

We begin our analysis with a discussion of the general arguments for and against using the test or SQ metrics for assessing a state's nuclear weapon status.<sup>28</sup>

#### *Advantages of the test/no test metric*

Measuring nuclear weapon state status with the test/no test criterion has at least six major advantages:

1. *Accordance with conventional conceptualization.* The test/no test distinction fits the conventional concept of the achievement of nuclear weapons as a sudden, qualitative, undeniable shift in the balance of power and threat. The SQ/no SQ distinction does not.
2. *Satisfaction of deterrence requirements.* Nuclear weapons are widely viewed as mainly being valuable for deterrence. Deterrence theory strongly emphasizes the importance of credibility; by testing, a state establishes that credibility. Therefore, most states that build a nuclear weapon can be expected to test it. The movie character Dr. Strangelove put this point best when he exclaimed, "The whole point of the doomsday machine . . . is lost . . . if you keep it a secret!"<sup>29</sup>
3. *Accordance with conventional praxis.* The test/no test distinction as the operational measure of a state's nuclear weapon status is embedded in

international institutions and even in the very wording of the NPT. Since the test/no test distinction is conventional in international legal, intersubjective understandings of what makes a nuclear weapon state, it should not be abandoned lightly.

4. *Minimization of subjective speculation.* A successful nuclear test provides a clear and relatively unambiguous signal that the state is, from a technical standpoint, very close to attaining operational nuclear weapons capability. It is important to note that even after conducting a successful nuclear test, most states have to put in still more work to create a real nuclear weapons system. For instance, the Indian nuclear tests of 1998—which, unlike the earlier test of 1974, were undertaken with a clear intent to weaponize—were followed by several more months of intense engineering work and an additional missile test. Only then did the Indians become confident that they had arrived at their destination.<sup>30</sup> The bottom line here is that India's tests provided the world with a great deal of hard data, thus minimizing the chances for assessment errors. By contrast, given the secrecy that envelops most nuclear weapons projects, whether a state has attained one or more SQ of fissile material is often a matter of subjective conjecture, and US and Western intelligence agencies have historically proven to be quite poor at these conjectures. The extreme overestimation of Iraq's nuclear status in the run-up to the 2003 Iraq war is just one of many examples of the recent US tendency to overestimate developing states' nuclear weapons project accomplishments. It is dangerous to rely on a metric that requires so much guesswork, let alone one that is also so vulnerable to politically motivated manipulation. Moreover, US reliance on the SQ/no SQ metric could encourage a state that actually did not yet have the bomb to try to achieve gains by bluffing. For instance, North Korea successfully bluffed the SQ-focused Bill Clinton and George W. Bush administrations for years until finally blowing its cover with its botched nuclear test of 2006, as explained in more detail below.
5. *Recognition of the technical and political challenges of moving from a fissile material stockpile to operational weapons.* It is often suggested that states that have achieved one SQ of fissile material can quickly and easily convert that material into operational weapons. But this is an oversimplification for two main reasons. First, even after the SQ is in hand, nuclear weaponization is not necessarily easy from a purely technical standpoint. The assumption that it is easy to weaponize fissile material led both the Clinton and George W. Bush administrations to believe that North Korea already had built one or two nuclear "weapons" in the early 1990s, due to its estimated plutonium stockpile. But North Korea's 2006 nuclear test fizzle proved that these assumptions had been incorrect.<sup>31</sup> In 2009, it tried again, and it got a somewhat bigger blast. But even on its second try, it "failed to get a simple plutonium bomb to detonate correctly," in the words of Yale geologist Jeffrey Park. This failure led Park to conclude that "one should be mindful of the technical challenges North Korea still faces in carrying out the threats implied by its deliberate pairing of its explosive test with test missile launches."<sup>32</sup>



Second, even in cases where a state's technical competence is less of a question mark, domestic and international politics can make the shift from SQ to bomb extremely difficult to carry out. This point can be seen in the case of Japan, which has created thousands of SQs of fissile material through reprocessing spent nuclear fuel, but remains quite securely a non-nuclear weapon state, because its domestic political environment features many institutional obstacles to a quick, top-down decision to weaponize that material.<sup>33</sup> The NPT system of inspections and safeguards presents a further institutional obstacle to rapid or secret weaponization. Proliferant states also have to worry about the US and other countries' intelligence services.

6. *Historical relevance.* Of the ten states that are generally recognized as having achieved de facto nuclear weapon state status, the large majority of these tested a bomb prior to induction. More specifically, there is only one country that almost certainly chose to induct operational weapons into its arsenal without a prior nuclear test: Israel. But that is only one case, which can be labeled as "*sui generis*."<sup>34</sup> Therefore, the historical record does not provide much basis for the increasingly widespread contemporary fear that proliferant states are likely to skip over the nuclear test step and move directly from the attainment of the SQ to induction of operational nuclear weapons.<sup>35</sup>

The literature often points to two other possible cases of nuclear opacity in addition to Israel: 1980s South Africa and 1990s Pakistan.<sup>36</sup> The best scholarship on the South African case, however, provides considerable circumstantial evidence that, in 1979, Pretoria did carry out a secret nuclear test prior to constructing its small stockpile of weapons.<sup>37</sup> (Recall that the CTBTO network of sensors essentially precludes a state from choosing the "secret test" route today.)<sup>38</sup> As for Pakistan, while the literature generally takes 1990 as that country's date of entry into the nuclear weapon state club, this coding seems to be based on the SQ/no SQ criterion. The balance of evidence suggests that Pakistan did not consider itself to have a nuclear weapon in 1990. Notably, former Pakistani President Pervez Musharraf has clearly stated that Pakistan did not have operational nuclear weapons in its arsenal until about a year after its 1998 nuclear tests.<sup>39</sup> Furthermore, in his recent history of the Pakistani bomb program, retired General Feroz Hassan Khan reveals that Pakistan's nuclear status was a big question mark for its own scientific and political leaders until the 1998 tests. If the Pakistanis had been confident in what they had, as the top Pakistani physicist Samar Mubarakmand recalled, then even after the provocation of India's May 1998 nuclear tests, Pakistan's "position on nuclear testing and CTBT would have been like the Israelis."<sup>40</sup> But since they were not confident, "It was important for us to get an opportunity to test to validate our design and that is why May 1998 was such a great opportunity for which we should thank the Indians."<sup>41</sup> In short, it appears that historically, only Israel has been a case of nuclear opacity as we have defined it.

Since no metric in social science is 100 percent infallible, the test/no test criterion's failure in the single case of Israel does not invalidate the use of the measure in general. The general superiority of the test/no test metric would be less clear if, contrary to the evidence provided above, one were to conclude that South Africa and Pakistan historically

also secretly inducted untested but militarily operational bombs into their arsenals. Later in this article, we demonstrate that even if all three states are judged to have inducted nuclear weapons without prior testing, their experiences are a poor guide for what to expect in the case of Iran.

### *Advantages of the SQ/no SQ metric*

In contrast to this long list of major advantages of the test/no test metric, the SQ/no SQ metric has only two major advantages: it accounts for the case of Israel, and it recognizes the technical possibility that a state could build working nuclear weapons without testing, thereby giving itself the potential for strategic surprise.

First, the fact that the SQ/no SQ metric accounts for the case of Israel is certainly important. But as argued above, this single exceptional case does not represent a telling blow against the general application of the test/no test metric.

Second, the fact that adopting the SQ/no SQ metric essentially rules out the possibility of a nuclear strategic surprise is an important advantage for it. But a state that launched a surprise attack with a technically uncertain nuclear arsenal in this day and age would have to be extraordinarily—even insanely—risk-acceptant. Moreover, it is certainly possible for outsiders to discover the existence of an untested arsenal and thus negate the chances for strategic surprise. The existence of the Israeli nuclear arsenal has long been well-recognized, for instance.

In sum, given the many advantages of the test/no test metric, we strongly endorse it as a first-cut approach to assessing a state's nuclear weapon status. However, as former State Department official Jacqueline Shire has argued, despite the value of the test/no test metric in general, it is still possible to imagine that Iran could choose the road less traveled.<sup>42</sup> Therefore, it is insufficient to rest our case for applying the test/no test metric to Iran solely on the general advantages of that metric. Instead, we now turn to a detailed theoretical and empirical analysis of the Iranian case in particular. Although no one can predict the future with certainty, we find that Iran's political situation and weapons testing behavior to date offer strong evidence for maintaining the test/no test metric in this case, unless and until future Iranian behavior requires a reassessment.

### **The Israel Model and the Iran Case**

Is Iran—if it were to decide to build a nuclear weapons arsenal—likely to become the second exception to the general rule of testing prior to induction of operational weapons? Many proliferation observers believe that it is, and as noted above, a major reason is because they think the posture has worked for Israel.

Is the Israel analogy useful to apply to the case of Iran? Surprisingly, this question has hardly ever previously been considered in a systematic manner.<sup>43</sup> It is not sufficient to enumerate the potential advantages and disadvantages of opacity from a strategic and/or technical standpoint, as many authors do, because to take such an approach is to ignore the primacy of politics in determining nuclear postures. Instead, we need to assess

whether Iran's leaders are facing geopolitical, strategic, domestic, and technical conditions similar to those that led Israel toward the opacity policy. If the two states' situations are similar, then it would be reasonable to expect that their nuclear postures would also be similar. But if their situations are different, then the Israel analogy would seem much less apt, and the standard case for using the SQ/no SQ metric to judge Iran's nuclear status would lose its most important supporting pillar.

This is not to deny that Iran could conceivably adopt the "Israeli" stance of nuclear opacity for very different reasons than Israel's. We will consider this knotty problem of equifinality later in the article. But since the current literature has largely pointed to the Israeli case as a justification for its expectations about Iran, it is important to first assess the relevance of that analogy.

### *Why Israel Opted for Opacity*

A preeminent scholar of Israeli nuclear history, Avner Cohen, has identified four main historical drivers of Israel's policy of nuclear opacity: "domestic, international, regional, and conceptual-technical."<sup>44</sup> Other scholars of the Israeli program have also identified these same drivers, to different degrees.<sup>45</sup> The emergence of Israeli opacity—which, it must be stressed, was more of a political *outcome* than a strategic *choice*—required the convergence of all four of these drivers.<sup>46</sup> The requirement of having this "perfect storm" of causal variables helps to explain why Israel's posture, despite being arguably quite successful, has remained so unusual to this day.

*Domestic politics.* First, Israel's nuclear opacity developed as a way to defer a heated domestic political debate about Israel's security posture. The Holocaust trauma made it difficult for Israel's political culture to "deal with the bomb in a straightforward way," in Cohen's words.<sup>47</sup> Many Israelis viewed nuclear weapons as embodying the best defense against another Holocaust, and, simultaneously, as the primary harbinger of another such tragedy. Given this deep ambivalence, Israeli politicians and ordinary people alike found it psychologically easier to simply bury the question. Even within the Israeli security establishment, nuclear ambivalence was quite common. This was not only because of the moral issue, but also the pragmatic consideration that building a nuclear weapons arsenal could be a serious misallocation of scarce resources.<sup>48</sup>

Politicians often prefer to delay hard choices, but a posture of nuclear opacity requires more than mere indecision. The historical literature strongly indicates that, even more than the ambivalence of Israeli politicians' preferences, it was the strength of Israel's state institutions that gave the country sufficient capacity to develop the opacity policy, and to make it stick. Israel's strong state institutions were a crucial background condition that allowed opacity to become a depoliticized, administrative matter that could easily be ignored by the parliamentarians in the Knesset. Those strong state institutions were also crucial for enforcing the impressive, longstanding silence by the many high- and low-level officials who knew about Israel's nuclear status. This strong code of silence partially survived even the dramatic 1986 revelations by the nuclear whistleblower Mordechai Vanunu.<sup>49</sup>

*Role of the United States.* Second, important as domestic drivers were in Israel's case, it is hard to imagine that Israeli opacity would have emerged if not for the tension between Israel's security interest in nuclear weapons and its main ally's global nonproliferation agenda. By the late 1960s, the United States was perhaps no longer in a position to stop Israel's program, but it certainly could have decided to openly tell the world what it knew. In short, without US complicity, Israeli nuclear opacity could never have been sustained. But the United States did become complicit. Indeed, Cohen describes the United States playing the role of a "real partner" in the Israeli policy of opacity.<sup>50</sup> In particular, the understandings between President Richard M. Nixon and Prime Minister Golda Meir in 1969 "introduced nuclear opacity as a political modus vivendi under which the Israeli bomb would be tolerated by the United States as long as Israel did not acknowledge it in public."<sup>51</sup> The arrangement permitted the continued flow of US economic aid and advanced weaponry, even as US nonproliferation legislation grew tougher over subsequent years.

*Regional situation.* Third, the regional security situation in the Middle East also facilitated Israel's policy of nuclear opacity. Israel's position as the first and, so far, only nuclear weapon state in the region means that it has not needed to formally establish nuclear deterrence against a nuclear rival. And it wants to maintain the status quo. Therefore, Israel has not only had a *posture* of opacity; it has also pursued a *strategy* of what Hebrew University's Shlomo Aronson calls "opaque nuclear monopoly."<sup>52</sup> Indeed, it is plausible to suggest that Israel's reticence to come clean about its nuclear status helped it to avoid facing a regional nuclear rival, particularly during the crucial formative years of the opacity policy from 1967 to 1973. During that time period, Egypt—Israel's main military foe—largely accepted Israel's feigned nuclear posture as if it were its actual posture.<sup>53</sup> Most other Arab leaders also appeared at that time to have taken the Israeli nuclear fig leaf as a kind of olive branch, even often dismissing the issue "as nonexistent or as something Egypt would be able to deal with."<sup>54</sup> Thus, as Cohen writes, "In a peculiar way, the Arabs were also a partner, albeit a junior one, in the making of opacity."<sup>55</sup> After the 1973 war, various regional states including Egypt, Iraq, and Libya would openly accuse Israel of having violated its non-introduction pledge and obtained the bomb, but by then the opacity policy was already firmly in place.

*Technical feasibility.* Fourth, many scholars have noted the importance of what Cohen calls the "conceptual-technical" dimension of Israel's nuclear opacity.<sup>56</sup> There were two main reasons why the opaque pathway was technically feasible for Israel. First, France allegedly provided Israel with considerable technical assistance, even to the extent of permitting Israeli scientists to witness France's own nuclear tests and then to use the data coming from those tests.<sup>57</sup> Second, and no less importantly, Israel had a highly competent and trustworthy elite group of scientists and engineers on whom it could rely. As nuclear policy expert Leonard Spector writes, "Israel may have learned enough from its involvement in the French program to feel confident that it could successfully design a nuclear weapon without the need for a test of its own."<sup>58</sup> Indeed, Israel's scientists and engineers were so capable that they were not only able to make the best

use of the French assistance, but they also actually helped the French overcome their own technical obstacles.<sup>59</sup>

### *Iran is Not Israel*

As noted above, the literature generally assumes that since opacity has worked for Israel, it is also a logical choice for Iran.<sup>60</sup> This argument, however, ignores fundamental differences between the two states' external and internal political contexts. A perfect storm of variables had to come together to produce nuclear opacity in the Israeli case, but none of these variables is equivalent in the Iranian case. Therefore, whether or not the posture of opacity has been good for Israel, it is unlikely to be mimicked by Iran. We consider the variables one by one.

*Domestic politics.* Iran's domestic political system is very different from Israel's, and these differences provide significant reasons to doubt that Iran either would or could follow in Israel's footsteps on this matter.

First, recall that Israel's move toward nuclear opacity was in no small measure due to the widespread sense of moral unease about acquiring a weapon of genocide in the wake of the Jewish people's Holocaust trauma. Some have suggested that in Iran, a theocratic state, Supreme Leader Ayatollah Ali Khamenei's religious *fatwa* against nuclear weapons also represents a strong moral barrier to building the bomb—or at least to parading it around for all to see.<sup>61</sup> We do not claim to know Khamenei's ultimate nuclear intentions, but we do know that Khamenei's *fatwa* is only as durable as he wishes it to be. Khamenei's *fatwas* are taken seriously in Iranian political culture, but only in the sense that they convey the leader's sentiments at the moment. Far from being eternal religious commandments, they can be altered or reversed in light of changed circumstances based on the principle of political expediency (*maslahat-e nezam*), and indeed this happens frequently.<sup>62</sup> If Iran's leadership decides to build the bomb, it will simply overturn the *fatwa*.

The difference between the politics of the nuclear option in contemporary Iran versus 1960s Israel is even more striking when we consider the views of a broader circle of Iranian elites. Unlike in Israel, in Iran the question of acquiring nuclear weapons appears to be fomenting a debate that seems rather normal in international comparison. Like many other states past and present, Iran has its nuclear doves and its nuclear hawks, some of whom speak very openly about their preferences for the bomb despite the intense international scrutiny. For instance, take the comments by Ayatollah Mohammad Taqi Mesbah Yazdi, a member of the Assembly of Experts who was once considered a spiritual advisor to President Mahmoud Ahmadinejad, and is still today a potential successor to the current Supreme Leader: "The most advanced weapons must be produced inside our country even if our enemies don't like it. There is no reason that they have the right to produce a special type of weapons, while other countries are deprived of it."<sup>63</sup> President Ahmadinejad has also expressed his views on nuclear issues quite openly, for instance stating on Iranian television, "If we want to make a bomb we are not afraid of anyone and we are not afraid to announce it."<sup>64</sup> It is worth mentioning that, for these men and for the conservative factions they represent, the advantages of

getting the bomb seemingly extend far beyond international security, to domestic legitimization and international prestige—motivations that militate for acquiring the bomb openly.<sup>65</sup> Our basic point here is not that these men could overturn the Supreme Leader's wishes on this very important policy question, or even that they are definitely pro-bomb. Rather, it is that senior Iranian officials' relative openness and seemingly clear conscience when discussing the nuclear option is a far cry from the sense of taboo that existed in 1960s Israel.

Second, a key condition for Israel's nuclear opacity was that it had a strong enough state to make that policy stick. By contrast, Iran has a highly fragmented—even incoherent—state structure. There is no single institution able to definitively maintain a hold over a given issue-area.<sup>66</sup> Instead, there is continuous and brutal competition among the various political factions, not just over policy direction, but also over control of pieces of the state, and even over the very configuration of the country's basic political institutions. Political scientist Mehran Kamrava writes of a "Balkanization of the state at the highest levels," leading to an "inability of the state to articulate and stick to a coherent set of policies."<sup>67</sup> The events following the 2009 presidential election have further eroded Khamenei's status as the ultimate decider, forcing him to engage fully in factional squabbles.<sup>68</sup> Despite Khamenei's support for Ahmadinejad at that moment of crisis, the past few years have been marked by a battle royal between the Supreme Leader and the president, whose very office Khamenei now hints he might abolish.<sup>69</sup>

Notwithstanding the Supreme Leader's tight grip on Iran's nuclear policy, even this issue has not been immune to the dynamics created by the country's incoherent institutions and rampant factionalism. The hyper-politicization of the nuclear issue following the rise of Ahmadinejad in 2005 can be seen as a consequence of the country's unsettled institutional situation. As Kamrava explains, "If Khamenei or his office were the sole decision maker in regard to the nuclear issue, Iran's relations with the IAEA and the EU-3 (the United Kingdom, France, and Germany) would not have changed from one of relative conciliation during the Khatami administration to one of intransigent belligerence so far during the Ahmadinejad presidency."<sup>70</sup> Moreover, Ahmadinejad and other conservative politicians have amply exploited the domestic popularity of the nuclear program, associating themselves with its progress—and trying to spark it further with pre-announcements of future technical triumphs. In short, in the Iranian environment of political fragmentation and intense rivalry among state institutions, the Israeli model of nuclear opacity as a depoliticized, administrative solution simply does not compute.

*Role of the United States.* Opacity requires the complicity of both allies and adversaries to operate—recall Egypt's relative silence on Israel's growing arsenal between 1967 and 1973, which may have been just as important for the implantation of the opacity policy as was Washington's. Yet it is nearly impossible to imagine that the United States could ever become a "partner" sustaining Iranian opacity. The United States has offered very loud opposition to the Iranian nuclear program at every turn, and it recently led the successful push for severe multilateral sanctions, which now even extend to oil exports.<sup>71</sup>

Washington may have been willing to humor its close ally Israel's preference for nuclear opacity, but it would not do the same for an enemy such as Iran.

Having raised the issue of sanctions, we might note here that although a policy of nuclear opacity could conceivably help a state to avoid new sanctions, it could not help the state to reverse sanctions that have already been imposed. By definition, a state pursuing nuclear opacity can neither confirm nor deny the possession of weapons, meaning that if Iran were to choose this path, it could never satisfy the international community that the conditions for lifting the sanctions had been met—as Saddam Hussein's Iraq found during the years leading up to the 2003 war. There are only two potential ways for Iran to get out from under the sanctions to which it is now subjected: either (a) verifiably end its nuclear weapons project, or (b) reshuffle the deck completely by testing a nuclear bomb and then hope to negotiate the end to sanctions from a position of strength, as India has successfully done, and as North Korea is attempting to do. Thus, one of the standard conventional arguments for why Iran is likely to opt for nuclear opacity—to avoid sanctions—is sorely misguided. Instead, the desire to get out from under sanctions should push Iran to opt for a nuclear test and an overt nuclear weapons arsenal, if and when it decides to “go nuclear.”

*Regional situation.* Third, Iran's regional security situation could hardly be more different than Israel's when the latter got the bomb. Then as now, Israel was the only nuclear-armed state in the region. By contrast, Iran's main regional enemy, Israel, already has the bomb, and of course the “Great Satan”—the United States—has the bomb as well. Iran also shares a border with nuclear-armed Pakistan, and its northwestern neighbor, Turkey, has hosted and maintained some control over a variety of NATO-allocated nuclear weapons since 1959.<sup>72</sup> In light of this vastly different strategic situation—not to mention Israel's regular threats to launch strikes against Tehran—it is very hard to imagine that Iran's leaders will be satisfied with the uncertain modicum of deterrence that is supposedly generated by a stance of nuclear opacity. Rather, basic deterrence theory teaches that Iran will test as soon as it is in a position to do so, in order to establish the credibility of its nuclear deterrent.

We can make this point in a different way as well. Many commentators assume that the emergence of even a virtual Iranian bomb will force Israel to finally reveal its own nuclear arsenal.<sup>73</sup> The logic is simple: Israel's nuclear deterrent could remain opaque as long as it had no nuclear adversary in the region; but once such an adversary does emerge, Israel will have no choice but to switch to a more traditional, credible deterrent posture. Why shouldn't this very same, straightforward deterrence logic also determine Iran's behavior in the face of Israel's much greater nuclear firepower?<sup>74</sup>

*Technical feasibility.* Fourth, Israel's pathway into nuclear opacity was made possible not least because it was technically feasible for that country. Commentators sometimes note that Iran's focus on HEU is compatible with an eventual choice for the simple gun-type bomb design, which is said to be reliable even without full-yield testing.<sup>75</sup> The literature is right to signal this technical possibility. But on the other hand, the November 2011 IAEA report presented evidence of Iranian interest in the implosion design, not the gun-type design, and implosion designs are generally viewed as requiring

testing.<sup>76</sup> It is hardly surprising that the Iranians appear to prefer the implosion design, because it requires far less fissile material than the gun-type design, but this means that testing becomes much less avoidable.

In addition, whatever Iran's preferred weapon design may be, the technical need for verification through testing is heightened by Iran's track record of poor implementation of the other elements of its nuclear program.<sup>77</sup> The contrast between Iranian technical mediocrity and the crack Israeli team of the 1950s and 1960s could hardly be starker, and Iran's leadership is surely far too cynical to take the potentially inflated claims of its scientific and technical workers at face value. It will want clear proof.

In sum, the Israel analogy is not applicable to the case of Iran. In the Israeli case, all four dimensions of domestic politics, international politics, regional strategic environment, and technical competence came together to produce the policy of nuclear opacity. But Iran's situation does not resemble Israel's on any of the four dimensions. Therefore, although the apparent success of Israel's policy of nuclear opacity may make it superficially appealing to Iranian leaders, upon further examination, the Israel case actually provides us with much reason to expect that Iran—if it opts for getting the bomb—will choose overt nuclearization via an explosive nuclear test. As Cohen has recently written, "It would be difficult and politically dangerous for Iran to mimic Israel."<sup>78</sup>

Disproving the Israeli analogy seriously damages the case for SQ/no SQ as the proper metric by which to assess Iran's nuclear weapon state status, since Israel is the only clear-cut historical case of nuclear opacity. Earlier in the article, we noted the conventional view that South Africa and Pakistan also followed the Israel model of opacity for a time. We disputed that view. But even if one accepts it, it is important to note that both South Africa's and Pakistan's domestic and international political contexts were much more like Israel's than Iran's at the time they were in the realm of nuclear ambiguity. The South African apartheid state and the Pakistani army were strong institutional structures that were capable of enforcing a policy of nuclear opacity; both states were allies of the United States, which chose to turn a blind eye to their nuclear development until nearly the end of the Cold War; both states were allegedly the first to introduce nuclear weapons into their regions (since India's nuclear test of 1974 did not lead to any follow-through); and both states had extensive help from existing nuclear weapon states—Israel and China, respectively—thus permitting them some modicum of confidence in their technical workmanship even without carrying out a definitive test.<sup>79</sup> On all four dimensions, the cases of South Africa and Pakistan differ sharply from Iran. Thus, even when we expand the set of potential empirical cases where the SQ/no SQ metric might plausibly have been superior to the test/no test metric, we still find no indication that it is the appropriate metric for assessing the nuclear weapon status of Iran.

### **Iran's Propensity to Test: Empirical Analysis of the Case of Ballistic Missiles**

With the Israel analogy debunked, in order to justify applying the SQ/no SQ metric to the case of Iran, it would be necessary to fall back on the possibility of equifinality.



In other words, Iran might decide to pursue an opacity policy like Israel's, but for very different reasons.

The literature offers various plausible hypothetical reasons why Iran might benefit from a policy of opacity: Iran may want to avoid further sanctions, to avoid inviting a military attack, to maintain the option of strategic surprise, etc. There are, however, an infinite number of hypothetical arguments and counterarguments. As long as the debate focuses on them, it will keep spinning in circles.

Therefore, we prefer a strategy that is based in empirical analysis. In particular, we analyze Iran's pattern of ballistic missile testing as a *proxy* for its likely nuclear testing behavior.

Political scientist Vipin Narang has recently demonstrated the empirical connection between nuclear testing behavior and ballistic missile testing behavior. Narang's analysis reveals a great deal of continuity between the motivations for India's and Pakistan's ballistic missile flight tests over the years and the countries' nuclear tests of 1998.<sup>80</sup> Three main reasons justify studying ballistic missile flight-test behavior as a proxy for nuclear test behavior. First, ballistic missiles are the primary delivery vehicles for nuclear weapons. This is true not only for the major nuclear weapon states, but also for the more recent entrants to the club.<sup>81</sup> Second, the technical hurdles to building nuclear weapons and ballistic missiles are comparably high, so testing is important for technical verification purposes.<sup>82</sup> Third, given the connection between ballistic missiles and nuclear weapons, ballistic missile flight tests are evidently a key part of a state's overall strategic behavior, and states have often used such tests to send political signals.

Narang's insight about the utility of studying ballistic missile testing patterns as a proxy for nuclear weapons testing behavior gains special force from Israel's historical pattern of ballistic missile testing—or, rather, its pattern of *not* testing. For many years, Israel was not just an opaque nuclear weapon state; it was also an opaque ballistic missile state. In the 1960s, in parallel with its nuclear research, Israel secretly entered into a joint missile development project with the French company Marcel Dassault. The company built about twenty-five copies of what was dubbed the Jericho-1 missile, testing the two-stage, solid fuel, 500 kilometer-range missile approximately eighteen times in France from 1965-68, and then secretly shipping the remainder to Israel. The Central Intelligence Agency (CIA) wrote in a top secret 1969 report, "The Israelis will undoubtedly be obliged to flight test the missile before the system can be operationally deployed."<sup>83</sup> But the Israelis apparently did not do so.

As far as can be gathered from the open literature, the first ballistic missile test from Israeli territory occurred only in May 1987, nearly twenty years after the country had first deployed them. The test was apparently of a two-stage, solid fuel, 1500 kilometer-range Jericho-2 missile that Israel developed in collaboration with South Africa.<sup>84</sup> That first test date of May 1987 is very interesting, as it came soon after whistleblower Mordechai Vanunu "outed" the Israeli bomb in spectacular fashion in October 1986. We surmise that, in the wake of the Vanunu affair, Israel may have felt somewhat less bound by the strictures of its nuclear opacity policy, though even so, the 1987 missile test was officially secret. Having (partially) broken with its tradition, Israel then tested the Jericho-2 approximately five more times.<sup>85</sup> A variant of the missile was also apparently tested three times

in South Africa, and a somewhat different configuration meant for space flight was tested twice as well—for a grand total of eleven tests. That is a very low number in comparison to the normal missile testing programs of the formally acknowledged nuclear weapon states, and even to those of resource-poor Pakistan and India.<sup>86</sup>

Again, all of Israel's Jericho-2 tests were officially secret, and as journalist Michael Karpin wrote in 2006, "Israel has never admitted to having the Jericho-2 in its arsenal."<sup>87</sup> The first openly announced Israeli ballistic missile test—Israel did not specify if it was the Jericho-2 or Jericho-3—occurred only in 2008.<sup>88</sup> Israel has conducted just one more open test since then, apparently of a Jericho-3. That test took place in November 2011.<sup>89</sup>

The history of Israeli ballistic missile testing shows a strong correlation with its policy of nuclear opacity. This is what a posture of opacity looks like in the missile area. Is Iran's pattern of ballistic missile testing similar or different?

### *Iran is Very Testy*

To answer this question, we present results from our newly-collected data on Iranian missile tests. The data set includes detailed and triangulated information on all of Iran's publicly reported, nuclear-capable, medium-range ballistic missile (MRBM) flight tests as well as space launch vehicle (SLV) flight tests, a closely related technology.<sup>90</sup> We do not list the numerous tests of the short-range Shahab-1 and-2 and Qiam-1 missiles, even though they are also theoretically nuclear-capable. Creation of the data set involved very detailed consideration of a range of daily English and Farsi language news sources, as well as secondary literature. Our systematic data collection effort allows us to make a novel contribution to the Iran debate.

As of late 2012, there have been thirty-five Iranian MRBM and SLV tests since the first one in 1998. The full chronological list of flight tests is presented in Table 1. Note that there are indications of one additional (failed) test of an Ashura/Sejjil-1 on November 20, 2007, but the evidence is not quite strong enough to meet our coding criteria.

The first conclusion that can be drawn from Table 1 is that Iran shows a strong tendency to test the key components of its incipient strategic arsenal. It tests early, it tests often, its first tests of a new system have a strong chance of failure, it announces its tests if they did not fail, and it tests the same systems multiple times. This last point becomes even clearer when we recognize the Iranian tendency to give very similar technical systems new names—for instance, there is considerable technical overlap between its "missiles" and "SLVs."

Considering Iran in cross-national comparison, the frequency of its tests appears quite high for a developing country, and it is certainly much higher than Israel's. Moreover, the rate of Iranian tests is accelerating. Iran conducted ten ballistic missile tests in the seven years between 1998 and 2005, then twenty-five tests in the six years between 2006 and 2012.

Iran conducts ballistic missile flight tests for a variety of reasons. These include the standard purposes of testing for engineering design validation and reliability, verifying operational procedures, and improving military unit readiness. In addition, political motivations—such as signaling policy objectives and resolve, celebrating national

**TABLE 1**  
Iran's ballistic missile tests

Test No.	Test Date (Approximate)	Missile Type	Iran Confirmed	Test Outcome	Testing Organization	Test Reason
1	July 22, 1998	Shahab-3	Yes	Failure	Iran Revolutionary Guard Corps (IRGC)	Technical/operational
2	February 20, 2000 (alleged)	Shahab-3	No	Failure	IRGC	Technical/operational
3	July 15, 2000	Shahab-3	Yes	Success	IRGC	Technical/operational
4	September 21, 2000	Shahab-3	Yes	Failure	IRGC	Domestic politics
5	May 2002	Shahab-3	Yes	Success	IRGC	Technical/operational
6	June 2002 (alleged)	Shahab-3	No	Unclear	IRGC	Technical/operational
7	July 4, 2002	Shahab-3M	No	Failure	IRGC	Technical/operational
8	June 2003	Shahab-3	Yes	Success	IRGC	Technical/operational
9	August 11, 2004	Ghadr-1*	Yes	Success	IRGC	International signal
10	September 12-18, 2004	Ghadr-1	Yes	Success	IRGC	Technical/operational
11	October 20, 2004	Ghadr-1	Yes	Success	IRGC	International signal
12	January 17, 2006 (alleged)	Ghadr-1?	No	Success	IRGC	International signal
13	May 23, 2006	Ghadr-1?	No	Partial success	IRGC	International signal
14	November 2, 2006	Ghadr-1	Yes	Success	IRGC	International signal
15	February 25, 2007	Unnamed	Yes	Unclear	Iran Space Agency (ISA)	International signal
16	February 4, 2008	Kavoshgar-1	Yes	Success	ISA	Domestic politics
17	July 9, 2008	Shahab-3	Yes	Success	IRGC	International signal
18	August 17, 2008	Safir-1 SLV	Yes	Failure	ISA	Domestic politics
19	November 12, 2008	Sejjil-1	Yes	Success	IRGC	International signal
20	November 26, 2008	Kavoshgar-2	Yes	Success	ISA	Technical/operational
21	February 2, 2009	Safir-2 SLV	Yes	Success	ISA	Domestic politics
22	May 20, 2009	Sejjil-2	Yes	Success	IRGC	Domestic politics

23	September 28, 2009	Ghadr-1	Yes	Success	IRGC	International signal
24	September 28, 2009	Sejjil-2	Yes	Success	IRGC	International signal
25	December 16, 2009	Sejjil-2	Yes	Success	IRGC	International signal
26	February 3, 2010	Kavoshgar-3	Yes	Success	ISA	Domestic politics
27	October 2010	Sejjil-2	No	Unclear	IRGC	Technical/operational
28	February 2011	Shahab-3	Yes-delay	Success	IRGC	Technical/operational
29	February 2011	Sejjil-2	Yes-delay	Success	IRGC	Technical/operational
30	March 15, 2011	Kavoshgar-4	Yes	Success	ISA	Technical/operational
31	June 15, 2011	Safir-2B SLV	Yes	Success	ISA	Technical/operational
32	June 28, 2011	Ghadr-1	Yes	Success	IRGC	Technical/operational
33	August 23-September 22, 2011	Kavoshgar-5	Yes-delay	Failure	ISA	Technical/operational
34	February 3, 2012	Safir-2B SLV	Yes	Success	ISA	Domestic politics
35	July 3, 2012	Shahab-3	Yes	Success	IRGC	International signal

Source: Authors' database. \*We utilize the Ghadr-1 designation for all "enhanced" Shahab-3 variants from 2004.

commemorations, and demonstrating capabilities to foreign powers—also appear significant.<sup>91</sup>

Table 1 offers a rough coding of the likely reasons for each test, based on a reading of news reports and temporal correlations with other military and political events. Overall, we find the following breakdown:

- About half of the tests appear to have taken place for technical-operational reasons. This motivation to verify that the missiles are really working was especially prominent in the earlier period, when many of the tests failed.
- About a quarter of the tests have occurred on or around major Iranian religious festivals and national days, suggesting that the regime wants to use the tests to appeal to its domestic audience. This tendency has been particularly pronounced for space launches undertaken by the Iranian Space Agency (ISA), which is known to be under the influence of President Ahmadinejad.<sup>92</sup> Ahmadinejad has often personally attended many of the SLV launches, giving lengthy speeches, and has even conducted the countdown to launch on at least one occasion.<sup>93</sup> This is hardly surprising, since Ahmadinejad's position as an elected official clearly requires him to appeal to public opinion. (This motivation is strong despite the likelihood that his 2009 re-election was rigged.)
- Finally, about a quarter of the tests have occurred in the run-up to international nuclear negotiations, and this has been particularly common in advance of P5+1 (the United States, Russia, France, the United Kingdom, China, and Germany)

meetings. This suggests that Iran sees strategic weapons testing as a means of indicating its material power and moral resolve, allowing it to enter negotiations from a position of strength.

Iran's pattern of ballistic missile and SLV flight tests provides evidence of strategic behavior that is thoroughly inconsistent with the logic of opacity. Iran's record of missile testing shows that it perceives little value in holding anything back, and that it perceives multiple reasons to show what it has—unless, of course, the technology isn't fully developed.

We conclude this section by using Iran's ballistic missile testing patterns to rebut some common claims for why Tehran supposedly should have a preference for nuclear opacity.

*Fear of sanctions or international condemnation?* The threat and actual imposition of sanctions against its nuclear and ballistic missile programs over the past few years has not led to a decrease in Iran's strategic activity. Instead, it has produced an increase in flight tests. In particular, Iran has conducted five MRBM (and many SRBM) flight tests in contravention of the explicit ban on such activity included in Section 9 of UN Security Council Resolution 1929 of June 9, 2010.<sup>94</sup> Moreover, these tests have often been launched on the eve of critical international negotiations. Rightly or wrongly, Iran's current leadership clearly believes that the more tests it conducts, the stronger its negotiating position becomes.

*Fear of counterproliferation strikes or preventive war?* Iran has not moderated or ceased its ballistic missile flight tests as the threat of counterproliferation strikes against it increased. Instead, we have seen a greatly increased pace of Iran's test program both in quantitative and qualitative terms since the 2003 invasion of Iraq and subsequent belligerent rhetoric and saber-rattling against Iran by the US and Israel. Again, rightly or wrongly, Iran's current leadership clearly believes that strategic weapons testing is valuable for deterring counterproliferation strikes against it.

*A desire for strategic surprise?* Iran has also shown no inclination toward holding back its latest technologies to maintain the option of strategic surprise. Iran has consistently tested and usually publicly advertised its most recently developed weapons systems, whether they are brand new systems or incremental improvements in existing systems.<sup>95</sup>

*Strong confidence in the technology?* Iran tests both major and minor advances in its missile technology, including even the systems and components it acquires from foreign sources. These are not the actions of a regime that believes it could develop an untested weapon in secret and be able to count on it at the moment of truth. And it is right to be cautious, as many of its missile tests have failed.

In sum, Iran's pattern of missile testing behavior reveals a strong tendency to test its new weapons technologies. It has various reasons for doing so, ranging from deterrence to domestic politics. In light of this pattern, one would expect that an Iranian decision to "go nuclear" would lead it to carry out a nuclear test. Of course, we cannot guarantee this outcome, but we believe that our empirically-grounded analysis provides a much more

solid basis for US policy on Iran than the usual approach of offering a myriad of superficially plausible hypothetical scenarios for why Iran might or might not benefit from a stance of nuclear opacity.

## Conclusion

Those who equate an Iranian “nuclear weapons capability”—i.e., an SQ of fissile material—with possession of nuclear weapons implicitly (and, often, explicitly) assume that this equation can be made because nuclear testing is a luxury that Iran is likely to dispense with, just as Israel did. If Iran could be expected to sneak nuclear weapons into existence without prior testing, then the SQ/no SQ metric of nuclear weapon stateness would have strong intellectual justification in this case. Our analysis, however, has shown that this line of reasoning is theoretically and empirically weak. Iran’s external and international conditions are very different than Israel’s were, and its ballistic missile testing behavior reveals a strong tendency to show what it has—that is, once it has something to show. Since the chances of an Iranian decision to follow the exceptional Israeli path of nuclear opacity are very low, the traditional test/no test metric for nuclear weapon state status is the appropriate one to apply here. This means that many current estimates of Iran’s timeline to the bomb are too short; that a bomb’s worth of HEU in Iranian hands should not be seen as a definitive crossing of the Rubicon to nuclear weapon possession; that the chances of an Iranian surprise nuclear attack against Israel or America are essentially zero; and therefore, that the imposition of a military red line to stop Iran from getting a fissile material SQ would be intellectually flimsy.

Beyond the specific case of Iran, our analysis should also restore faith more generally in the test/no test metric as the basic line separating non-nuclear from nuclear weapon states the world over. In recent years, this traditional understanding of the location of the nuclear threshold has come under sustained attack from nonproliferation advocates of various political persuasions. But in fact, the authors of the NPT were basically right to identify non-nuclear weapon states and nuclear weapon states as two, qualitatively distinct categories of states, and to try to tell the difference between them by asking if they had conducted an explosive nuclear test. Sometimes—as Leonardo da Vinci once said—simplicity is the ultimate sophistication.

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11. Israel previously tried to give itself even more cushion by threatening to act if Iran reached the "zone of immunity," by which it meant the point after which Israeli air strikes could no longer knock out Iran's bomb-making capabilities in one clean blow. However, Israel did not follow through on these threats. Amos Harel, "Former Top IDF Officials Worry That Netanyahu Is Bent on Iran Strike," *Ha'aretz*, July 27, 2012, <[www.haaretz.com/weekend/week-s-end/former-top-idf-officials-worry-that-netanyahu-is-bent-on-an-iran-strike-1.454048](http://www.haaretz.com/weekend/week-s-end/former-top-idf-officials-worry-that-netanyahu-is-bent-on-an-iran-strike-1.454048)> .
12. See, for example, Yoel Guzansky and Jonathan Schachter, "Iran's Japanese Nuclear Option: Arms Within Arm's Reach," *Jerusalem Post*, August 22, 2011, <[www.jpost.com/Opinion/Op-Ed/Contributors/Article.aspx?id=234965](http://www.jpost.com/Opinion/Op-Ed/Contributors/Article.aspx?id=234965)> ; and Brian Murphy, "AP Analysis: Iran Nuclear Denial Has Japanese Ring," *Guardian*, September 1, 2012, <[www.guardian.co.uk/world/feedarticle/10418753](http://www.guardian.co.uk/world/feedarticle/10418753)> .
13. The original definition of "opaque proliferation" was more complicated than this, but we believe that our simple definition captures the essence of the concept. See Avner Cohen and Benjamin Frankel, "Opaque Nuclear Proliferation," in Benjamin Frankel, ed. *Opaque Nuclear Proliferation* (London: Frank Cass, 1991), pp. 14–44.
14. David E. Sanger, "On Iran, Questions of Detection and Response Divide U.S. and Israel," *New York Times*, March 6, 2012, <[www.nytimes.com/2012/03/07/world/middleeast/on-iran-2-central-questions-divide-us-and-israel.html](http://www.nytimes.com/2012/03/07/world/middleeast/on-iran-2-central-questions-divide-us-and-israel.html)> .
15. "Tick-Tock Tehran," *Wall Street Journal*, October 20, 2012, p. A12.
16. Sanger, "On Iran, Questions of Detection and Response Divide U.S. and Israel."
17. *Ibid.* See also the White House Press Briefing by Press Secretary Jay Carney, August 10, 2012, <[www.whitehouse.gov/the-press-office/2012/08/10/press-briefing-press-secretary-jay-carney-81012](http://www.whitehouse.gov/the-press-office/2012/08/10/press-briefing-press-secretary-jay-carney-81012)> .
18. See Preparatory Commission for the Comprehensive Nuclear-Test-Ban-Treaty Organization, *Annual Report 2011*, <[www.ctbto.org/publications/annual-reports](http://www.ctbto.org/publications/annual-reports)> .
19. For instance, around December 1999, the Central Intelligence Agency (CIA) informed President Bill Clinton that it could no longer rule out the possibility that Iran already had nuclear weapons. This "sharp departure from its previous assessment of Iran's nuclear capacity," in the words of *New York Times* reporters James Risen and Judith Miller, was not based on any new intelligence. Rather, it was based on a reconsideration of the importance of the CIA's inability to verify that Iran had not simply acquired a fissile material SQ by purchase in the former Soviet Union. James Risen and Judith Miller,

- "CIA Tells Clinton an Iranian A-Bomb Can't Be Ruled Out," *New York Times*, January 17, 2000, <[www.nytimes.com/2000/01/17/world/cia-tells-clinton-an-iranian-a-bomb-cant-be-ruled-out](http://www.nytimes.com/2000/01/17/world/cia-tells-clinton-an-iranian-a-bomb-cant-be-ruled-out)>.
20. On this point, see also S. Paul Kapur, *Dangerous Deterrent: Nuclear Weapons Proliferation and Conflict in South Asia* (Palo Alto, CA: Stanford University Press, 2007), p. 8.
  21. Of course, many observers are not assuaged by the presence of the IAEA in Iran, because they also have a low opinion of the abilities of international inspectors. But the value of the IAEA inspection system post-1991 was dramatically vindicated in the aftermath of the 2003 Iraq War. For the details of the IAEA's excellent performance in Iraq after 1991, see Gudrun Harrer, *Dismantling the Iraqi Nuclear Programme: The International Atomic Energy Agency, 1991–1998* (forthcoming, 2013).
  22. Micah Zenko, "Israel's Nuclear Weapons Program and Lessons for Iran," Council on Foreign Relations blog post, March 5, 2012, <<http://blogs.cfr.org/zenko/2012/03/05/israels-nuclear-weapons-program-and-lessons-for-iran/>>. See also Micah Zenko, "Iran's Secret Nuclear Development Looks a Lot Like Israel's," *Atlantic*, March 6, 2012, <[www.theatlantic.com/international/archive/2012/03/irans-secret-nuclear-development-looks-a-lot-like-israels/254037/](http://www.theatlantic.com/international/archive/2012/03/irans-secret-nuclear-development-looks-a-lot-like-israels/254037/)>.
  23. Christopher Ford, "Iran's Coming Nuclear 'Opacity,'" remarks at an event sponsored by the National Defense University Foundation, Washington, DC, June 22, 2010, <[www.newparadigmsforum.com/NPFtestsite/?p=326](http://www.newparadigmsforum.com/NPFtestsite/?p=326)>.
  24. Quoted in Scott Peterson, "What Would Happen If Iran Actually Had the Bomb?" *Business Insider*, February 16, 2012, <[http://articles.businessinsider.com/2012-02-16/news/31065974\\_1\\_nuclear-program-nuclear-weapons-nuclear-powers/2](http://articles.businessinsider.com/2012-02-16/news/31065974_1_nuclear-program-nuclear-weapons-nuclear-powers/2)>.
  25. Yaakov Katz, "Israel Fears Iran Will Copy Its Policy of Nuclear Ambiguity," *Jerusalem Post*, March 10, 2011, <[www.jpost.com/IranianThreat/News/Article.aspx?id=240286](http://www.jpost.com/IranianThreat/News/Article.aspx?id=240286)>.
  26. Rep. Roscoe G. Bartlett and Peter Vincent Pry, "What If Iran Already Has the Bomb? Better to be Prepared than Surprised," *Washington Times*, August 2, 2010, <[www.washingtontimes.com/news/2010/aug/2/what-if-iran-already-has-the-bomb/print/](http://www.washingtontimes.com/news/2010/aug/2/what-if-iran-already-has-the-bomb/print/)>.
  27. *Ibid.*
  28. Jacques E.C. Hymans, "When Does a State Become a 'Nuclear Weapon State'? An Exercise in Measurement Validation," *Nonproliferation Review* 17 (March 2010), pp. 161–80.
  29. See Dan Lindley, "What I Learned Since I Stopped Worrying and Studied the Movie: A Teaching Guide to Stanley Kubrick's *Dr. Strangelove*," *PS: Political Science & Politics* 34 (September 2001), p. 663.
  30. Ashley Tellis, *India's Emerging Nuclear Posture: Between Recessed Deterrent and Ready Arsenal* (Santa Monica, CA: RAND, 2001), pp. 198–99.
  31. On this, see Hymans, "Why Does a State Become a 'Nuclear Weapon State?'"
  32. Jeffrey Park, "The North Korean Nuclear Test: What the Seismic Data Says," *Bulletin of the Atomic Scientists* online, May 26, 2009, <<http://thebulletin.org/web-edition/features/the-north-korean-nuclear-test-what-the-seismic-data-says>>.
  33. Jacques E.C. Hymans, "Veto Players, Nuclear Energy, and Nonproliferation: Domestic Institutional Barriers to a Japanese Nuclear Bomb," *International Security* 36 (2011), pp. 154–89.
  34. Avner Cohen, "Israel: A *Sui Generis* Proliferator," in Muthiah Alagappa, ed., *The Long Shadow: Nuclear Weapons and Security in 21st Century Asia* (Palo Alto, CA: Stanford University Press, 2008), pp. 241–68. We view Cohen's recent work as somewhat backpedaling from his earlier assertions that Israel's experience may serve as a model for later proliferant states.
  35. This fear is expressed, for instance, in Leonard S. Spector, *The Undeclared Bomb: The Spread of Nuclear Weapons 1987–1988* (Cambridge, MA: Ballinger Publishing Company, 1988), pp. 4–5.
  36. The United States and the Soviet Union inducted their first nuclear weapons after secret tests. We consider that such tests fit the test/no test criterion.
  37. The South African test was apparently carried out in combination with Israel, and Israel's involvement would seem to explain the continuing mystery surrounding that event. If Israel can be said to have tested a bomb in 1979, then by the test/no test metric, its period of nuclear opacity ended then. Helen E. Purkitt and Stephen F. Burgess, *South Africa's Weapons of Mass Destruction* (Bloomington, IN: Indiana University Press, 2005), pp. 51–52.
  38. Some extremely low-yield tests or computer simulations could be kept secret, but such experiments are not comparable to full-yield tests, either in their technical validity or their political impact. In addition, they often require greater technological sophistication than today's proliferant states can muster. On this point, see Jonathan Medalia, "Comprehensive Nuclear-Test-Ban Treaty: Issues and



- Arguments," Congressional Research Service report RL34394 (updated March 12, 2008); Angela Charlton, "Computers Simulating Atomic Tests," *International Herald Tribune*, October 18, 2006, <[www.nytimes.com/2006/10/18/world/europe/18iht-tests.3201835.html](http://www.nytimes.com/2006/10/18/world/europe/18iht-tests.3201835.html)>.
39. Musharraf quoted in Mark Fitzpatrick, *Nuclear Black Markets: Pakistan, A.Q. Khan and the Rise of Proliferation Networks: A Net Assessment* (London: International Institute for Strategic Studies, 2007), p. 32.
  40. Feroz Hassan Khan, *Eating Grass: The Making of the Pakistani Bomb* (Palo Alto, CA: Stanford University Press, 2012), p. 278.
  41. Ibid.
  42. Jacqueline Shire, "A Nuanced Approach to Nuclear Weapons Analysis," *Nonproliferation Review* 17 (2010), pp. 213–14.
  43. But see the insightful discussion in Avner Cohen, *The Worst-Kept Secret: Israel's Bargain with the Bomb* (New York: Columbia University Press, 2010), pp. 227–29.
  44. Avner Cohen, *Israel and the Bomb* (New York: Columbia University Press, 1998), p. 3.
  45. Other important works on Israel's nuclear policy include Yair Evron, "Israel and the Atom: The Uses and Misuses of Ambiguity, 1957–1967," *Orbis* 17 (Winter 1974), pp. 1326–43; Shai Feldman, *Israeli Nuclear Deterrence: A Strategy for the 1980s* (New York: Columbia University Press, 1982); Alan Dowty, "Going Public with the Bomb: The Israeli Calculus," in Louis Rene Beres, ed., *Security or Armageddon: Israel's Nuclear Strategy* (Lexington, MA: Lexington Books, 1986), pp. 15–28; Gerald M. Steinberg, "Deliberate Ambiguity: Evolution and Evaluation," in Beres, ed., *Security or Armageddon*, pp. 29–44; Shlomo Aronson with Oded Bush, *The Politics and Strategy of Nuclear Weapons in the Middle East: Opacity, Theory, and Reality, 1960–1991—An Israeli Perspective* (Albany: State University of New York, 1992); Yair Evron, *Israel's Nuclear Dilemma* (Ithaca: Cornell University Press, 1994); Edwin S. Cochran, "Deliberate Ambiguity: An Analysis of Israel's Nuclear Strategy," *Journal of Strategic Studies* 19 (September 1996), pp. 321–42; Yoel Cohen, *The Whistleblower of Dimona: Israel, Vanunu, and the Bomb* (New York: Holmes and Meir Publishers, 2003); and Michael Karpin, *The Bomb in the Basement: How Israel Went Nuclear and What That Means for the World* (New York: Simon and Schuster, 2006).
  46. Evron, *Israel's Nuclear Dilemma*, pp. 61–62.
  47. Avner Cohen, "Israel: A *Sui Generis* Proliferator," p. 242. See also Aronson, *The Politics and Strategy of Nuclear Weapons*, p. 211.
  48. Yoel Cohen, *Whistleblower of Dimona*, p. 19; Evron, *Israel's Nuclear Dilemma*, pp. 5–10; Avner Cohen, *Israel and the Bomb*, pp. 290–91; Avner Cohen, "Nuclear Arms in Crisis under Secrecy: Israel and the Lessons of the 1967 and 1973 Wars," in Peter R. Lavoy, Scott D. Sagan, and James J. Wirtz, eds. *Planning the Unthinkable: How New Powers Will Use Nuclear, Biological, and Chemical Weapons* (Ithaca, NY: Cornell University Press, 2000), pp. 104–24.
  49. For details on the impressive institutional infrastructure of Israel's nuclear opacity, see Avner Cohen, *The Worst-Kept Secret*, pp. 88–120. On the Vanunu affair, see Yoel Cohen, *The Whistleblower of Dimona*.
  50. Avner Cohen, *The Worst-Kept Secret*, p. 48.
  51. Avner Cohen, "Israel: A *Sui Generis* Proliferator," p. 246.
  52. Aronson, *The Politics and Strategy of Nuclear Weapons*, pp. 167–84.
  53. Nasser was vocal in condemning—and threatening—Israel's nuclear program before it actually had the bomb, but his successors became quiet about it. It is unclear whether the key variable here was Nasser's demise or Israel's success. On the period to 1967, see Ariel E. Levite and Emily B. Landau, "Arab Perceptions of Israel's Nuclear Posture, 1960–1967," *Israeli Studies* 1 (Spring 1996), pp. 39–40. On the period since 1967, see Avner Cohen, *Israel and the Bomb*, pp. 243–58.
  54. Aronson, *The Politics and Strategy of Nuclear Weapons*, p. 156.
  55. Avner Cohen, *Israel and the Bomb*, p. 5.
  56. Ibid., pp. 5–6; Theodore B. Taylor, "Nuclear Tests and Nuclear Weapons," in Benjamin Frankel, ed., *Opaque Nuclear Proliferation: Methodological and Policy Implications* (London: Frank Cass, 1991), pp. 175–90; Evron, *Israel's Nuclear Dilemma*, p. 11; Cochran, "Deliberate Ambiguity: An Analysis of Israel's Nuclear Strategy," p. 323–37.
  57. Peter Pry, *Israel's Nuclear Arsenal* (Boulder, CO: Westview Press, 1984), p. 12; Yoel Cohen, *Whistleblower of Dimona*, p. 12. A less reliable source claims that French nuclear assistance also included bomb designs, testing data, and even hands-on assistance in constructing its first bombs. See Steve Weissman and Herbert Krosney, *The Islamic Bomb* (New York: Times Books, 1981), pp. 113–14.

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59. Karpin, *The Bomb in the Basement*, pp. 80, 170. The crucial importance of having a strong indigenous nuclear program as the basis for nuclear weapons project efficiency is underscored in Jacques E.C. Hymans, *Achieving Nuclear Ambitions: Scientists, Politicians, and Proliferation* (Cambridge, UK: Cambridge University Press, 2012).
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61. *Economist*, "Iran's Nuclear Theology: Bombs and Truth," May 19, 2012, <[www.economist.com/node/21555541](http://www.economist.com/node/21555541)>.
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64. Farhad Pouladi, "Ahmadinejad insists Iran not seeking nuclear bomb," Agence France-Presse, June 23, 2011.
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66. Arang Keshavarzian, "Contestation Without Democracy: Elite Fragmentation in Iran," in Marsha Pripstein Posusney and Michele Penner Angrist, eds., *Authoritarianism in the Middle East: Regimes and Resistance* (Boulder and London: Lynne Rienner Publishers, 2005), pp. 63–88; Houchang E. Chehabi, "The Political Regime of the Islamic Republic in Comparative Perspective," *Government and Opposition* 36 (Winter 2001), pp. 48–70; Mehdi Moslem, *Factional Politics in Post-Khomeini Iran* (Syracuse, NY: Syracuse University Press, 2002); Wilfried Buchta, *Who Rules Iran? The Structure of Power in the Islamic Republic* (Washington DC: The Washington Institute for Near East Policy, 2000).
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68. Mehran Kamrava, "The 2009 Elections and Iran's Changing Political Landscape," *Orbis* 54 (Summer 2010), pp. 400–12.
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70. Kamrava, "The 2009 Elections and Iran's Changing Political Landscape," p. 96.
71. Kenneth Katzman, "Iran Sanctions," Congressional Research Service report RS20871, October 15, 2012, <[www.fas.org/sgp/crs/mideast/RS20871.pdf](http://www.fas.org/sgp/crs/mideast/RS20871.pdf)>.
72. Alexandra Bell and Benjamin Loehrke, "The Status of U.S. Nuclear Weapons in Turkey," *Bulletin of the Atomic Scientists* online, November 23, 2009, <<http://thebulletin.org/web-edition/features/the-status-of-us-nuclear-weapons-turkey>>.
73. See, e.g., Dmitry Adamsky, "Why Israel Should Learn to Stop Worrying and Love the Bomb," *Foreign Affairs* online, March 31, 2012, <[www.foreignaffairs.com/articles/137374/dmitry-adamsky/why-israel-should-learn-to-stop-worrying-and-love-the-bomb?page=show](http://www.foreignaffairs.com/articles/137374/dmitry-adamsky/why-israel-should-learn-to-stop-worrying-and-love-the-bomb?page=show)>.
74. An anonymous reviewer of this article suggested that the answer to this question is that Iran would want the world to think that it has more nuclear firepower than it actually does. In other words, Iran might try to bluff that it had a serious deterrent before that was really the case. This idea is plausible, but such a bluff could only work if the international community was relying on the SQ/no SQ metric of nuclear weapon state status. This is, therefore, yet another reason why the SQ/no SQ metric tends to be misleading.
75. For a general discussion of the technical value of nuclear testing, see Taylor, "Nuclear Tests and Nuclear Weapons," in Frankel, ed., *Opaque Nuclear Proliferation: Methodological and Policy Implications*, pp. 175–90. For a specific discussion of implosion versus gun-type testing requirements in South Africa, the last country known to produce a gun-type device, see David Albright, "South Africa and the Affordable Bomb," *Bulletin of Atomic Scientists*, July/August 1994, p. 46.

76. "Implementation of the NPT Safeguards Agreement and Relevant Provisions of Security Council Resolutions in the Islamic Republic of Iran," IAEA Board Report, 18 November 2011, GOV/2011/65, Annex p. 4. <[www.iaea.org/newscenter/focus/iaeaairan/iaea\\_reports.shtml](http://www.iaea.org/newscenter/focus/iaeaairan/iaea_reports.shtml)>.
77. See Hymans, "Botching the Bomb."
78. Avner Cohen, *The Worst-Kept Secret*, p. 228.
79. For a description of Chinese technical support to Pakistan, including bomb designs, see Khan, *Eating Grass*, pp. 81, 109, 152, 157, 171–75, 188, 238–42. For the Israeli-South Africa nuclear connection, see Peter Liberman, "Israel and the South African Bomb," *Nonproliferation Review* 11 (Summer 2004), pp. 46–80.
80. Vipin Narang, "Pride and Prejudice and Prithvis: Strategic Weapons Behavior in South Asia," in Scott D. Sagan, ed., *Inside Nuclear South Asia* (Stanford: Stanford University Press, 2009), pp. 137–83.
81. *Ibid.*, p. 146. See also Feroz Hassan Khan, "Nuclear Signaling, Missiles, and Escalation Control in South Asia," in Michael Krepon, Rodney Jones, and Ziad Haider, eds., *Escalation Control and the Nuclear Option in South Asia* (Washington, DC: Henry Stimson Center, 2004), pp. 75–100. On missile proliferation generally, see Dinshaw Mistry, *Containing Missile Proliferation: Strategic Technology, Security Regimes, and International Cooperation in Arms Control* (Seattle, WA: University of Washington Press, 2003).
82. Narang, "Pride and Prejudice and Prithvis," p. 146. See also Aaron Karp, *Ballistic Missile Proliferation: The Politics and the Technics* (New York: Oxford University Press, 1996), p. 176.
83. Central Intelligence Agency, Directorate of Science and Technology, "Scientific and Technical Intelligence Report: Foreign Ballistic Missile and Space Developments in 1968," September 1969, marked "Secret" (approved for release December 2003), CIA-FMSAC-STIR/SC/69-13, p. 14. <[www.foia.cia.gov/docs/DOC\\_0001028025/DOC\\_0001028025.pdf](http://www.foia.cia.gov/docs/DOC_0001028025/DOC_0001028025.pdf)>.
84. Karp, *Ballistic Missile Proliferation*, p. 141, refers to an Israeli test in 1986, but this appears to be a typo, as the report Karp cites actually places the test in 1987: "Israel's Jericho IRBM Completes Long Range Test," *International Defense Review* 7 (July 1987), pp. 857.
85. See Karp, *Ballistic Missile Proliferation*, p. 141.
86. *Ibid.*, pp. 140–41.
87. Karpin, *The Bomb in the Basement*, p. 214.
88. Youval Azoulay, "Missile Test 'Will Improve Deterrence,'" *Ha'aretz*, January 18, 2008, <[www.haaretz.com/print-edition/news/missile-test-will-improve-deterrence-1.237555](http://www.haaretz.com/print-edition/news/missile-test-will-improve-deterrence-1.237555)>.
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90. Iran's early SLVs were based on its ballistic missile designs with scientific instrumentation packages replacing the warhead, and the US government has been very concerned about the potential military applications of Iran's space program. For a discussion of the historic connection between ballistic missiles and civilian space programs, see W. Seth Carus, *Ballistic Missile Proliferation in the Third World: Threat and Response* (New York: Praeger, 1990), p. 24.
91. *Ibid.*, pp. 96, 119.
92. See official website of the Iranian Space Agency, <[www.isa.ir/index.php](http://www.isa.ir/index.php)>.
93. William J. Broad, "Iran Reports Test of Craft Able to Carry Satellite," *New York Times*, August 18, 2008, <[www.nytimes.com/2008/08/18/world/middleeast/18iran.html](http://www.nytimes.com/2008/08/18/world/middleeast/18iran.html)>.
94. For the text of the resolution, see <[www.iaea.org/newscenter/focus/iaeaairan/uncsc\\_res1929-2010.pdf](http://www.iaea.org/newscenter/focus/iaeaairan/uncsc_res1929-2010.pdf)>.
95. IISS, *Iran's Ballistic Missile Capabilities*, pp. 45, 49.