# The Iranian petroleum crisis and United States national security

**Roger Stern***

Department of Geography and Environmental Engineering, The Johns Hopkins University, 3400 North Charles Street, Baltimore, MD 21218

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**The U.S. case against Iran is based on Iran's deceptions regarding nuclear weapons development. This case is buttressed by assertions that a state so petroleum-rich cannot need nuclear power to preserve exports, as Iran claims. The U.S. infers, therefore, that Iran's entire nuclear technology program must pertain to weapons development. However, some industry analysts project an Irani oil export decline [e.g., Clark JR (2005) *Oil Gas J* 103(18):34–39]. If such a decline is occurring, Iran's claim to need nuclear power could be genuine. Because Iran's government relies on monopoly proceeds from oil exports for most revenue, it could become politically vulnerable if exports decline. Here, we survey the political economy of Irani petroleum for evidence of this decline. We define Iran's export decline rate (*edr*) as its summed rates of depletion and domestic demand growth, which we find equals 10–12%. We estimate marginal cost per barrel for additions to Irani production capacity, from which we derive the "standstill" investment required to offset *edr*. We then compare the standstill investment to actual investment, which has been inadequate to offset *edr*. Even if a relatively optimistic schedule of future capacity addition is met, the ratio of 2011 to 2006 exports will be only 0.40–0.52. A more probable scenario is that, absent some change in Irani policy, this ratio will be 0.33–0.46 with exports declining to zero by 2014–2015. Energy subsidies, hostility to foreign investment, and inefficiencies of its state-planned economy underlie Iran's problem, which has no relation to "peak oil."**

market power | Middle East | oil | sanctions

The U.S. has projected military force in the Persian Gulf for two decades. The policy aims to preempt emergence of a regional superpower (1). However, preemption of Iraq has been accomplished only after two wars and an occupation. These costly exercises have not slowed Iran's procession toward regional superpower status but rather may have accelerated it (2).

Iran's rise illuminates a flaw in preemption policy. The flaw is that force projection is not a remedy for the underlying economic problem, market power. Oil cartel states exert market power to collect monopoly rents. In a lawless region such as the Gulf, each states' rents are a potential war prize to another. If rents could be aggregated by wars of seizure, a Gulf superpower would emerge, as was Iraq's aim in invading Iran and Kuwait. Yet, although U.S. force projection prevents wars of seizure, rents still flow.

Force projection thus keeps a peace in which cartel states can collect monopoly rents sufficient to attain near-superpower status, even without wars of seizure. Market power thereby perpetuates the need for force projection, whereas force projection protects the cartel states that exert market power. This paradox guarantees that the U.S. military will remain in the Gulf until some policy is adopted to reduce market power.

U.S. failure to confront market power is not an oversight, however. It is a policy whose premise is that cartel states must be appeased to secure their oil exports (3). This conception is based in turn on the perceived threat of an "oil weapon" (4), a fiction U.S. officials have believed for five decades. Whatever the shortcomings of past policy, the present concern is how to prevent a terror sponsor from attaining nuclear weapons or contain it if it does.

The U.S. case for action against Iran is based on its deceptions with respect to the Treaty on the Nonproliferation of Nuclear Weapons (NPT). However, this case is buttressed with assertions about Irani petroleum:

> Finally, there is Iran's claim that it is building massive and expensive nuclear fuel cycle facilities to meet future electricity needs, while preserving oil and gas for export. All of this strains credulity. Iran's gas reserves are the second largest in the world. [Yet] Iran flares enough gas annually to generate electricity equivalent to the output of four Bushehr reactors.[†]

Given the historic difficulties that U.S. policymakers have had with petroleum economics, it seems possible that these assertions are wrong. Iran is guilty of NPT deceptions, but it cannot be inferred from this that all Irani claims must be false. The regime's dependence on export revenue suggests that it could need nuclear power as badly as it claims. Recent analyses by former National Iranian Oil Company (NIOC) officials project that oil exports could go to zero within 12–19 years (5, 6). It therefore seems possible that Iran's claim to need nuclear power might be genuine, an indicator of distress from anticipated export revenue shortfalls. If so, the Irani regime may be more vulnerable than is presently understood. Here we survey Iran's petroleum economy for evidence of oil export decline that might suggest such vulnerability.[‡]

## Petroleum Sector Overview

Most Irani oil export revenues are monopoly rents, which comprised 63% of Irani state revenues in 2004 (4). Rents derive from the difference between market price and competitive price, which is the sum of marginal production cost plus return to capital. For states like Iran that subsidize domestic petroleum demand, such dependence can be problematic. If subsidies call forth demand growth in excess of production growth, the exportable fraction of production will decline.

This is what happened to Iran. Since 1980, energy demand growth (6.4%) has exceeded supply growth (5.6%) (5, 7, 8), with exports stagnant since a 1996 peak (Fig. 1). A component of this imbalance is Iran's recent oil production decline and consequent failure to meet Organization of the Petroleum Exporting Countries

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Abbreviations: b/d, barrels per day; f-e, fuel efficiency; LDV, light-duty vehicle; LNG, liquefied natural gas; NIOC, National Iranian Oil Company; NPT, Treaty on the Nonproliferation of Nuclear Weapons; OPEC, Organization of Petroleum Exporting Countries.

*E-mail: rstern@jhu.edu.

[†]From a U.S. State Department transcript of remarks by Ambassador John Bolton to the Hudson Institute, August 17, 2004 (available at http://www.state.gov/t/us/rm/35281.htm1).

[‡]Our survey uses some data from the Irani press. Although this press is largely state-controlled, its energy reportage offers insights unavailable elsewhere. Quantitative data in Irani reportage usually correspond with trade press or agency reports when comparable.



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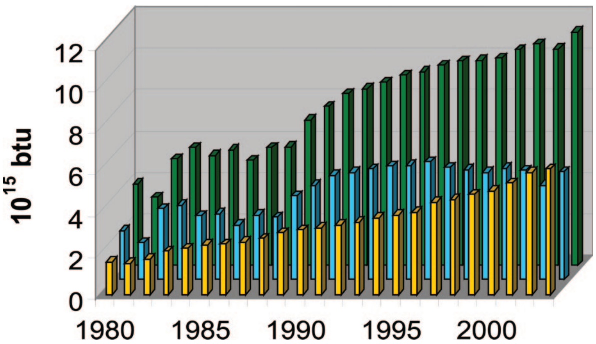


**Fig. 1.** Iran energy balance net of all trade, 1980–2003. The only nonpetroleum account in Fig. 1 is hydropower, 4.3% of total energy production; thus this energy balance gives an overview of Iran's petroleum economy. The graph is color-coded as follows: green, production plus imports; blue, exports; gold, domestic consumption.

(OPEC) quota (Fig. 2). Because Iran has failed to meet the quota in only 22% of all months since the Iran–Iraq War, the current 18-month shortfall is anomalous. Whereas two previous 12-month shortfalls during the Iran–Iraq War were the result of damage from Iraqi attacks, there appear to be no comparable exogenous variables to explain the current, longer shortfall. Apparently sensitive to this anomaly, Iran recently insisted production would reach quota by April 2006 (9) but failed to meet this goal (Fig. 2).

Could these developments indicate that the projected oil export decline (5, 6) has already begun? Given Iran's export revenue dependence, the question seems critical to U.S. Iran policy. We try to answer it by asking how much new production capacity Iran will need to maintain exports, how much this would cost, and whether Iran is attracting enough investment to meet the cost.

## Standstill Capacity Addition and Investment Requirements

Exports are the remainder of production minus domestic demand. Production also is diminished by depletion and, in Iran's case, by refinery leakage (10). Assuming constant leakage and depletion, the annual rate of oil production capacity addition required to sustain 2006 exports is equal to Iran's 8% depletion rate (6) plus its domestic demand growth rate (5%) (5) expressed as a percentage of total production (2%), i.e., 10%. Global depletion is lower, averaging 5–6% (11). Summed depletion and demand growth rates comprise Iran's "export decline rate" (*edr*) or interchangeably, its "standstill rate." A higher *edr* is suggested by a former oil minister who claims annual depletion is $0.4 \times 10^6$ barrels per day (b/d) (9), implying a 10% depletion rate and thus a 12% *edr*.

Both 10% and 12% *edr* estimates are conservative. These estimates ignore offshore production, where depletion is higher, and assume refinery leakage and depletion to be linear, whereas depletion recently increased (6). Refinery leakage presumably increased from zero to its present level, but at what rate we do not know. Multiplying our *edr* range by a present production capacity of $4.0 \times 10^6$ b/d (6) yields the standstill capacity addition range, $0.40 \times 10^6$ to $0.48 \times 10^6$ b/d.

Investment needed to build this capacity can be found by multiplying the standstill addition range times the marginal cost of additional production capacity ($MC_{\mathrm{Iran}}$). What is this cost? The *MC* of a new project is simply the quotient of project cost by anticipated capacity. For example, $\$0.92 \times 10^9$ invested in onshore light oil at Darkhovin will develop $0.16 \times 10^6$ b/d (12, 13); thus, $MC = \$0.92 \times 10^9/(0.16 \times 10^6 \text{ b/d}) = 5{,}750$ \$/b/d. Similarly, for onshore heavy oil development at Azadegan, $MC = \$7{,}692$ (14).[§]

$MC_{\mathrm{Iran}}$ is the weighted average of *MC* for all new projects. However, we lack data for all new projects. Because much 2006–2007 capacity will come from the projects just discussed, we take their average, 6,721 \$/b/d as an estimate of $MC_{\mathrm{Iran}}$. Our confidence in this estimate is bolstered by its resemblance to *MC* for nearby Iraq and Saudi Arabia (4). Multiplying 6,721 \$/b/d times the standstill addition range gives the standstill investment, $\$2.7 \times 10^9$ to $\$3.2 \times 10^9$ per year.

## Is Actual Investment Enough?

Most investment in Irani capacity is made via "buyback" agreements in which foreign exploration and development firms provide ≈60% of the funding and Iran provides the remainder. Assuming foreign investment is 60% of the total, the standstill investment is $0.6(\$2.7 \times 10^9$ to $\$3.2 \times 10^9$ per year$) = \$1.6 \times 10^9$ to $\$1.9 \times 10^9$ per year. This standstill investment compares to an actual foreign investment for 1998–2004 of 0.027, 0.86, 1.4, 2.5, 2.0, and 2.5 billion dollars (nominal values) (17), respectively. Because a 3- to 6-year lag exists between investment and production, we infer that capacity now coming on stream was underwritten by investments since 2000, which average $\$2.1 \times 10^9$ per year. This average exceeds our standstill investment estimate of $\$1.6 \times 10^9$ to $\$1.9 \times 10^9$ per year; hence we would expect recent capacity additions to offset *edr*. However, Iran's post-2004 production decline (Fig. 2) is inconsistent with this expectation.

The discrepancy may be explained by overconservative assumptions, a difference between present versus lagging $MC_{\mathrm{Iran}}$, or both. With respect to present versus lagging $MC_{\mathrm{Iran}}$, recent new capacity has come mainly from difficult redevelopments of old, offshore facilities damaged in the Iran–Iraq War. Incremental cost for such projects is higher than for $MC_{\mathrm{Iran}}$, which we estimated from the larger, less-difficult onshore developments scheduled to provide the next increments of new capacity. These onshore projects seem to have been reserved for less experienced Asian firms now negotiating for Azadegan and Yadavaran. As an example of higher lagging costs, $\$1.6 \times 10^9$ was invested to develop $0.14 \times 10^6$ b/d at Norouz–Souroush, an incremental cost of 13,571 \$/b/d. If lagging $MC_{\mathrm{Iran}}$ is closer to this cost, lagged average investment has been insufficient to offset *edr*, consistent with the post-2004 production decline.

Unfortunately, Iran has frustrated our desire to extrapolate further into the future from lagged investment. Oil data previously routinely reported toward compliance with an annual International Monetary Fund certification (e.g., ref. 18) were withheld in 2006

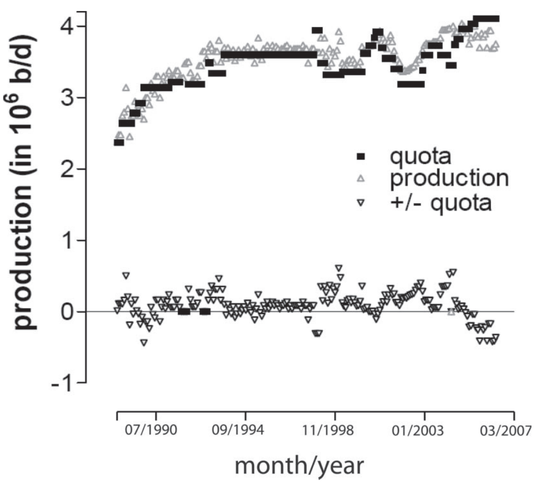


**Fig. 2.** Iran oil production versus OPEC quota, 1989–2006.

§Most reports give Azadegan cost as $\$2.0 \times 10^9$ for $0.26 \times 10^6$ b/d (= 7,692 \$/b/d). A conflicting report gives cost as $\$3.0 \times 10^9$ and capacity as $0.235 \times 10^6$ b/d (15). The conflicting cost seems an error in which an oil purchase of $\$3.0 \times 10^9$ secured Japan's option to invest in Azadegan (16). The $\$3.0 \times 10^9$ sum appears to have been mistaken for total project cost, which all other reports give as $\$2.0 \times 10^9$.

(17). Fortuitously, new forecasts of anticipated global capacity additions have appeared. Two new schedules anticipate the same seven new projects coming on stream between 2006 and 2010 and give similar cumulative capacity additions ($0.985 \times 10^6$ versus $0.99 \times 10^6$ b/d) (15, 19). A third forecast provides a closely similar volumetric estimate, a $1.0 \times 10^6$-b/d addition to 2010 (11). The three forecasts thus appear to judge identical projects as likely to proceed. The most optimistic forecast equates to an annual addition of $0.25 \times 10^6$ b/d to 2010, well below the standstill range of $0.40 \times 10^6$ to $0.48 \times 10^6$ b/d.

This forecast recognizes its optimism (11). An obvious example is the $0.125 \times 10^6$-b/d Azadegan project scheduled to produce by 2009. Reports from the trade press and Irani and Japanese sources agree that no Azadegan contract exists. Therefore, the project cannot produce by 2009 or even 2010 unless a contract is agreed almost immediately, which seems unlikely. Problems of a long negotiation (20) have been compounded by Japan's displeasure with Iran's NPT violations (21). Scratching Azadegan reduces annual additions to $0.22 \times 10^6$ b/d to 2010.

Equally questionable is the $0.255 \times 10^6$-b/d Ahvaz expansion scheduled for 2009. NIOC is building this expansion alone. However, NIOC has led no major project since the 1978 Revolution. We would expect that if a project of Ahvaz's great size were proceeding without foreign help, it would be a cause for national pride and, therefore, well reported. We find no reports, however. Of course, Ahvaz could be proceeding with reportage only in Farsi, which we do not read. This would be atypical, however, given that English, French, or Italian reporting exists for all other Irani projects. Hence, we believe that neither Ahvaz nor Azadegan will be built on schedule. If so, annual additions to 2010 will be $0.155 \times 10^6$ b/d, compared with the standstill range of $0.40 \times 10^6$ to $0.48 \times 10^6$ b/d.

## Could Investment Shrink Further?

Iran's unique buyback investment vehicle embodies its petroleum finance problems. In most exporting countries, foreign exploration and development firms offer capital, technology, and management in exchange for some share of the resource to be extracted. Iran's constitution considers such arrangements as foreign ownership, which it prohibits. This prohibition has affected disinvestment and deterioration in Iran's petroleum infrastructure, most of which was built before the Iranian Revolution. Compounding the problem is NIOC's inability to lead major project construction.

Iran's 5-year plan of 1995 implicitly recognized this problem by devising the buyback, a scheme to attract foreign capital while avoiding foreign ownership. Foreign investments in buyback deals become sovereign debt Iran "buys back" at a 15–17% rate of return. The scheme is unpopular. Iranis resent the high rate of return (22). Exploration and development investors chafe at both practical and political constraints. Worst is a chaotic process in which tenders are inexplicably withdrawn, redrawn, or repeated. For example,

> President Ahmadinejad has directed the ministry to repeat tenders for 12 of 16 exploration projects. [The oil] minister did not say why the tenders have to be repeated, but said the chief executive has expressed 'concerns' about these projects (23).

For a buyback project that survives the tender process, Irani subcontractors must be hired. Subcontractors may cause problems, as in a recent $\$0.31 \times 10^9$ write-down by Norway's Statoil (24). Furthermore, anti-Western sentiment among the ruling elite has become so great that normal development delays can be interpreted as intentional acts to harm Iran. For example, saltwater contamination occurred soon after Shell's Norouz–Soroush project began production, probably a complication of war damage. Yet an opinion piece emanates threat on this account:

> Soroush and Norouz offshore oilfields are examples of the damaging impact of noneconomic decisions on the economy. The project has suffered delays and no legal action has been taken against the company yet despite the huge losses. Shell continues to get away with the delays (25).

Buybacks have become so unattractive that negotiations now take years. A Japanese consortium has negotiated for the Azadegan buyback for 7 years with no result. By 2005, few firms wanted the business (6). A frank report in the state-run *Iran Daily*, "Buybacks Not Attractive," recognized that ". . . foreign companies are not interested in buyback deals. The buyback deals must be reformed to attract foreign investors" (26).

Yet even after Iran attempted to mollify investors, India was compelled to renegotiate gas price in a liquefied natural gas (LNG) deal bundled with an oil buyback. Trouble over this $\$20 \times 10^9$ deal began after India failed to vote with Iran at a meeting of the International Atomic Energy Agency (27). Iran's Oil Ministry has therefore come to seem almost incapable of closing a deal, because there may always be some more conservative element in Tehran prepared to block a project if it believes the Ministry's terms are too generous. A recent *Iran Daily* article, "Western Oil Firms Active," tries to reassure investors but lists only four projects actually under contract (28). Of course, Iran could elect to improve its investment climate but to date has been unwilling or unable to do so.

Investor apprehension rose further following Irani resistance to diplomatic pressure over the NPT. Of prospects for $\$15 \times 10^9$ in urgently needed refinery investment, a trade journal reported

> Foreign financing will prove almost impossible to secure, and in an environment of higher government spending on social needs and the public sector wage bill, refining projects must compete for state cash. Foreign bankers in Tehran say all project finance has stopped because of the tense political environment. Political pressure is also making it difficult to complete the international procurement packages of a project, with major engineering and plant manufacturers coming under pressure from the U.S. to stop trading with Iran (29).

Postponements of gas buyback decisions by Shell and Total soon followed (30). These setbacks may explain the unusual award of a gas development contract to the Revolutionary Guards, which have no petroleum development experience, which in turn may explain why the Oil Minister

> . . . fell short of revealing the financial details and the time schedule of the [Guards'] contract. He said the major challenge facing the oil and gas industry is the lack of funds, expressing hope that the Ahmadinejad administration and the parliamentarians manage to overcome this very obstacle (29).

Iran's petroleum investment climate therefore appears to have greatly deteriorated since 1998–2004, a period when investment was insufficient to offset the recent production decline (Fig. 2). Zero future foreign investment thus appears plausible.

## Other Petroleum Sector Problems

Turning from Iran's prospects for new capacity to that which it has already built, we can infer from its lengthy quota shortfall that production from existing capacity cannot be increased. Since January 2005 production has averaged $\approx 0.25 \times 10^6$ b/d below quota, an annual forfeit of $\$5.47 \times 10^9$ at the present price. The shortfall is related not only to investment problems but also to a shortage of natural gas for reinjection.

Reinjection is an important maintenance technique in older fields. Insufficient reinjection at one Irani field led to its decline from $0.25 \times 10^6$ to $0.16 \times 10^6$ b/d. If gas were available for

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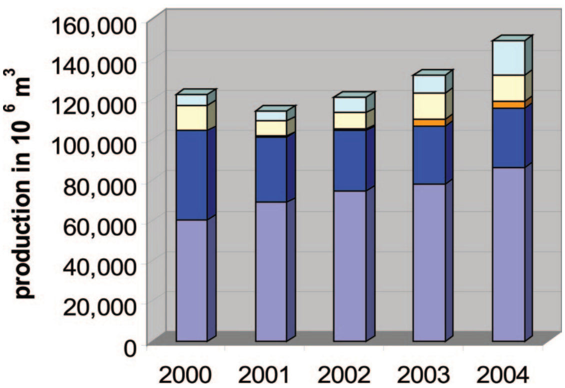


**Fig. 3.** Iran natural gas disposition 2000–2004. The graph is color-coded as follows: purple, domestic consumption; dark blue, reinjection; yellow, flaring; orange, exports; light blue, shrinkage.

reinjection, production could be increased to $0.22 \times 10^6$ b/d (6). Reinjection shortages may underlie the collapse of Iran's oil recovery rate to 24–27% compared with a 35% world average. NIOC estimates that recovery could approach 30% with adequate reinjection. Declining recovery rates also contribute to oil depletion, which recently increased from 7% to 8% (31).

It seems enigmatic that a state with such large gas reserves cannot lift enough to sustain production of its most valuable export, oil. In a state-planned economy such as Iran's, one might expect that maximization of oil export revenue would be a priority. Accordingly, Iran's current 5-year plan consigns some gas to domestic electric power generation to substitute for oil (6).

Simultaneously, however, NIOC has sought to expand gas export, which allows it to turn a profit. In contrast, selling to the subsidized domestic market generates a loss. Gas was therefore committed to export in what is also a geopolitical strategy to cultivate allies in Asia. However, this strategy takes no account of reinjection shortfalls or exploding domestic gas demand, which already conflict with oil export. In response, an anti-gas-export faction has arisen in the Majlis (32), casting doubt on Iran's ability to perform on gas export contracts.

Gas demand growth of 9.2% per year has far outpaced growth of the economically useful fraction of production, i.e., 4.5% per year from 2000 to 2004 (Fig. 3). Growth minus shrinkage and flaring is still lower, 3% per year. Fig. 3 also reveals that domestic gas demand increased at the expense of reinjection. The reinjection shortage must also accelerate oil depletion, but by how much we cannot know. If further starved of reinjection, oil recovery rates could be depressed still further and thus could accelerate export decline.

Iran has also struggled to develop an LNG export business (33). This effort seems a disaster in waiting, because any success will reduce gas available for reinjection. Fortunately for Iran, importers have been reluctant to accept LNG on the terms offered. Apparently desperate to enter the market, Iran has offered some unusual incentives. China's Sinopec was offered a buyback contract to develop the Yadaravan oilfield in exchange for taking LNG. This deal appeared near consummation when the new Ahmadinejad government announced that the buyback needed "correction" (33). The stalled Indian deal discussed above is of this same type, an oil buyback bundled with an LNG import contract.

Remarkably, India is proceeding with an agreement for an Iran–Pakistan–India gas pipeline, apparently oblivious to what is common knowledge from the Majlis to the trade press; Irani gas is overcommitted, which will continue to be the case even when new South Pars gas comes on stream (6, 33). It therefore seems open to question whether Iran will continue gas exports should oil exports decline precipitously for lack of reinjection.

Iran's gasoline import problem reprises familiar themes. A rich subsidy prices gasoline at \$0.08 per liter (\$0.34 per gallon), which has called forth 11–12% demand growth. However, because refining gasoline for domestic consumption is unprofitable because of the subsidized price, imports are favored over refinery expansion. A NIOC official explains:

> Given the fact that our refineries are outdated and that NIOC does not have the necessary funds to build new refineries and that the private sector does not engage in the business of construction of refineries due to the low profits involved, import of gasoline is more economically feasible than building refineries (34).

This policy is remarkable. Former OPEC Secretary General Parra estimates that if the oil market were competitive, Persian Gulf producers could supply the market at \$5 per barrel (35). Another study estimated a competitive price to be \$4–10 (4). Assuming that cost should approach price under competition, when Irani oil costing \$10 per barrel at most can fetch \$64 per barrel (assuming Brent price as of this writing, \$69 per barrel, and that Irani oil fetches \$5 less than Brent), NIOC lacks "the necessary funds" only because an Islamist welfare state strips it of the \$54 monopoly rent it extracts on each export barrel.

Thus shorn of cash, NIOC must import gasoline at market price. These imports have become the focus of a showdown between NIOC and Majlis conservatives. To assert more control over petroleum, the Majlis cut the gasoline import budget. By fall 2006 import funding will be exhausted. As past attempts to raise price or ration fuel have been politically impossible, the $\$2 \times 10^9$ to $\$3 \times 10^9$ import funding shortfall will probably be found in a raid on the Oil Stabilization Fund (OSF), as happened in 2005. However, the OSF pool is not inexhaustible. Amuzegar notes the depletion of OSF rainy-day funds for pet projects "at a time when the sunshine [of high price] has never been brighter" (36).

Yet the cost of importing gasoline is small compared with losses from deferred refinery maintenance. Aggregate refinery leakage is $0.25 \times 10^6$ b/d (10), 6% of total oil production. The implied 2006 loss if price is \$60 per barrel will be $\$5.47 \times 10^9$. As elsewhere in Iran's petroleum economy, because no profit comes from repairing refineries that produce only to sell below cost, leaks are ignored. Oil and money simply seep back into the ground.

## Export Decline Forecast

To forecast oil exports, we take 2006 Irani capacity = $4.0 \times 10^6$ b/d and domestic demand = $1.6 \times 10^6$ b/d and subtract to find that 2006 exports = $2.4 \times 10^6$ b/d. We then solve for ranges of export extinction year ($y_0$) and the ratio of 2011 to 2006 exports ($r_{2011}$) by using 12% and 10% *edr* estimates in four investment scenarios:

1. No new investment or capacity addition after 2006 ($y_0$ = 2012–2013; $r_{2011}$ = 0.10–0.25).
2. No new investment but lagging investment is sufficient to complete all projects scheduled to begin by 2008. Projects such as Azadegan, Ahvaz, and Yadavaran that are not under contract and not scheduled before 2008 are excluded. These criteria give $0.155 \times 10^6$ b/d annual additions to 2010 but no new additions from 2011 ($y_0$ = 2014–2015; $r_{2011}$ = 0.33–0.46).
3. New investment sufficient to add $0.155 \times 10^6$ b/d indefinitely ($y_0$ = 2016–2018; $r_{2011}$ = 0.40–0.52).
4. New investment sufficient to add the most optimistic scheduled rate, $0.25 \times 10^6$ b/d, indefinitely ($y_0$ = 2019–2022; $r_{2011}$ = 0.56–0.69).

We believe scenario 2 is most probable. In this case, export extinction in 2014–2015 is preceded by a decline to 33–46% of 2006 exports by 2011. Notice, however, that export declines are substantial, even in the least likely, most optimistic scenario. Because government revenue could be sustained only by rising price in all scenarios, absent such a price rise political challenges might overwhelm the regime long before exports go to zero.

## House of Cards

Our survey suggests that Iran's petroleum sector is unlikely to attract investment sufficient to maintain oil exports. Maintaining exports would require foreign investment to increase when it appears to be declining. Other factors contributing to export decline are also intensifying. Demand growth for subsidized petroleum compounds from an ever-larger base. Growth rates for gasoline (11–12%), gas (9%), and electric power (7–8%) are especially problematic. Oil recovery rates have declined, and, with no remedy in sight for the gas reinjection shortage, this decline may accelerate. Depletion rates have increased, and, if investment does not increase, depletion will accelerate. If the regime actually proceeds with LNG exports, oil export decline will accelerate for lack of reinjection gas. In summary, the regime has been incapable of maximizing profit, minimizing cost, or constraining explosive demand for subsidized petroleum products. These failures have very substantial economic consequences. At $60 per barrel, 2006 income foregone from quota shortfall and refinery leakage will approach $\$11 \times 10^9$.

Despite mismanagement, the Islamic Republic's real oil revenues are nearly their highest ever as rising price compensates for stagnant energy production and declining oil exports. Despite high price, however, population growth has resulted in a 44% decline of real oil revenue per capita since the 1980 price peak. Moreover, virtually all revenue growth has been applied to pet projects, loss-making industries, etc. If price were to decline, political power sustained by the quadrupling of government spending since 1999 (derived from ref. 18) may not be sustainable. Yet we found no evidence that Iran plans fiscal retrenchment or any scheme to sustain oil investment.

Rather, the government promises "to put oil revenues on every table" (37), as if monopoly rents were not already the entrée. Backing this promise is a welfare state built on the Soviet model widely understood as a formula for long-run economic suicide. This includes the 5-year plans, misallocation of resources, loss-making state enterprises, subsidized consumption, corruption, and oil export dependence that doomed the Soviet experiment. Therefore, the regime's ability to contend with the export decline we project seems limited.

The allure of nuclear power to a regime in such straits is obvious. First, Russians are financing the new capacity, something foreigners are increasingly unwilling to do for oil and gas. Second, Russian reactors will substitute for power now generated by petroleum, freeing petroleum for export. Although the prospective nuclear power capacity is insignificant to Iran's total energy budget, it is part of a larger if ill managed plan to preserve exports.

For example, ambitious goals have been set for power generation capacity additions from coal (38), hydro (39), solar, and thermal (40) resources. Just as with petroleum, however, foreign investment in power generation has been inadequate (38). The power generation problem has become so acute has that the unprecedented step was recently taken to partially privatize it. This major policy change required reinterpretation of the constitution by the Supreme Leader. The hope is that domestic firms can somehow "overcome the challenges and revive the loss-making power sector" (39). This seems unlikely, however, because losses owe to politically untouchable demand subsidies, not management.

To summarize, Iran's claim that its nuclear technology is entirely peaceful appears to be false (insofar as we can judge from the statements of arms control officials). However, the oil export decline we project implies that Iran's claim to need nuclear power to preserve exports is genuine. U.S. insistence that Iran's nuclear technology program has no economic purpose has obscured the regime's petroleum crisis, of which the nuclear power need is one symptom. If export decline proceeds as we project, Iran might try to optimize revenue by threatening to cut supply unless some unreasonable concession were met. Iran could ostensibly make good such a threat by disguising export decline as a voluntary cut. The persistence of the "oil weapon" belief in importer states makes this gambit likely to work. A fear premium would attach to price, buffering Irani revenue from export decline.

## Security Opportunity

Iran's petroleum crisis is a strategic opportunity. Unless price increases, export erosion seems likely to reduce the regime's monopoly rent stream. Such a dynamic seems propitious for some policy to compound the regime's self-inflicted problems. A nonviolent, economic attack on monopoly price is such a policy.

A price attack implies measures that would erode market power and hence reduce price. Market power exerted through OPEC investment restraint is responsible for most of the difference between the $4- to $10-per-barrel competitive price and market price, which has been much higher for most of the past 33 years. This difference underwrites the Islamic Republic, the need for U.S. force projection in the Gulf, and many other security problems (4). An analogous target in a military campaign would be an adversary's industrial capacity. Market power should be understood in this way, as inseparable from the threats it underwrites but also more vulnerable.

A price attack implies forced adoption of fuel-efficient technology by importing states. The resulting fuel efficiency (f-e) improvement would have to reduce demand by enough to force cartel producers to defend price, which they would do by reducing supply. Equitable sharing of supply cuts is an inherent problem for any cartel that lacks an enforcement mechanism for market sharing agreements.

A price attack would exploit this weakness by forcing OPEC states that do not cheat against declining quotas to absorb most of the supply reduction necessitated by importer f-e improvement. This is what happened to Saudi Arabia between 1981 and 1985 as price fell. Other cartel states declined to match Saudi cuts, choosing instead to get as much revenue as they could while they could. Saudi net oil revenue fell almost to zero as it cut production ever further in defense of price. Finally nearly broke, the Saudis initiated a dramatic production increase. This recaptured lost market share but drove down price further, to $10 (2005$). A collapse like this is the goal of a price attack. If Saudi Arabia were forced to reprise its 1980s behavior, Iran's revenues would collapse. Unlike Saudi Arabia, Iran cannot increase production to compensate for falling price.

The most efficient policies to force f-e would be fuel taxation, cap and trade mechanisms (for horsepower, emissions, or miles traveled), or fleet f-e standards. Given what appears to be a decreasing price elasticity of gasoline demand in the U.S., some combination of standards and taxation might be most successful. The burden of new taxation could be partially offset by reductions to payroll or other taxes. Although the optimal price attack policy cannot be known, present U.S. energy policy is nonoptimal in that it ignores price. Energy policy has been adopted in response to the imaginary problem of oil dependence (4), which has reduced it to a quest for tax preferences by domestic producers.

Whatever policy might be adopted to mount a price attack, light-duty vehicles (LDVs) would be the source of most demand reductions because they are the least efficient among all oil-demand technologies. Unfortunately, Americans are not savers, new car consumers least of all. Indeed, car consumers may discount f-e savings almost to zero. Yet, although f-e may be unattractive to consumers, a policy to force adoption would be akin to a mandatory savings plan like social security but with higher returns.

We find that existing LDV f-e technology can deliver 30–50% demand reductions with monetary returns much greater than zero. For example, using existing f-e supply curves (derived from ref. 41), we determined lifetime new vehicle fuel savings net of f-e technology cost. We then solved for maximum net present value (*npv*) of

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lifetime savings at $3.00 per gallon. Under the highest cost assumptions, the maxima delivers a 30% demand reduction (compared to a base vehicle average of 28.5 miles per gallon), *npv* = $1,134 per new vehicle (assuming a 3% discount rate, 14.7-year vehicle life, first year miles traveled =15,220, and travel decline rate = .05 per year), a 63% *npv* return.

However, because fleet turnover is slow and U.S. LDV oil consumption is only 10% of global demand, adoption of the f-e maxima by the U.S. alone would reduce global demand only 3% (gasoline = 0.45 U.S. oil consumption; U.S. = 0.26 global oil consumption; demand reduction = $0.3 \times 0.45 \times 0.25 = 0.033$) in 15 years, which is the fleet vehicle turnover rate. A 50% U.S. f-e increase would result in $1,000 *npv* savings per new vehicle (assuming 16,106 annual new car sales for 15 years) and 5% global demand reduction in 15 years, or 2–3% in 5–7 years. Such a demand reduction might be sufficient to force a cartel price defense within 5–7 years, which might affect the Iran regime if its export extinction path ends closer to 2017 than to 2013.

If Organization for Economic Cooperation and Development (OECD) states, along with India and China, could be enlisted to join a price attack monopsony, cartel price defense would be forced much sooner. Given that OECD states produce most world vehicles, an f-e monopsony would affect most of the world new car fleet. LDVs account for ≈40% of global oil demand. Assuming that a monopsony of the top six LDV producer states could effect a 40% f-e increase in 80% of the new LDV fleet, the 15-year global demand reduction is ≈13%. This value is much greater than the 2–3% demand reduction that precipitated a $70-per-barrel price decline in 1981–1986. Whether such a monopsony could affect price in the short run is less certain. However, price attack seems capable of containing Iran in the long run. In contrast, it is not obvious how war or sanctions policies could do so.

## What's Wrong with Alternative Policies?

Neither war nor sanctions would reduce security threats underwritten by monopoly rents or the lure of rents as war prize. In this sense, these policies would perpetuate violence and instability, not reduce them. Further problems exist with both policies.

Some war advocates believe that U.S. military action would not generate support for the regime. They cite the example of Irani dissent against the Iran–Iraq War to assert that an attack would not unite Iran against the U.S.:

> Something so secular and adventitious as an American airstrike on a nuclear facility is *very* unlikely to bring back that magic, that love of God and man, that can send young boys across minefields on motorcycles (42).

This assertion ignores Iran's fierce resistance to Iraq's invasion of 1980. When Saddam Hussein attempted to seize Iran's oil province of Khuzestan, even Khuzestani Arabs rallied to Irani nationalism. Indeed, the invasion united all Iran behind a theocracy whose grasp on power had been far from secure. Dissent arose only many years later. After Iraqi forces were driven from Iran, Khomeini determined not to quit fighting until Saddam Hussein was deposed. Irani forces thus pursued Saddam's army deep into Iraq in an invasion that faltered only at the gates of Basra. This was when protest began, after most of the 750,000 Iranis who would perish in the war were already dead.

Protests decried any further slaughter in what had become an expeditionary war. Of the need to resist invasion in 1980 there had been no dissent, only volunteers for battle (43). A U.S. war or air campaign would seem the equivalent of Saddam Hussein's invasion. Furthermore, U.S. military action would allow the theocracy to escape culpability for the economic disaster looming before Iran. Perceived responsibility for economic problems would be transferred to the U.S., as happened in Iraq.

Advocates of sanctions seem equally ill schooled in the Islamic Republic's short history. Recall that in its 8-year war with Iraq, Iran suffered 750,000 combat deaths, destruction of more than half its oil production and stronger sanctions than those now under discussion, yet never conceded to a single Iraqi demand. Therefore, we do not think sanctions rise to the level of hardship the regime has shown it can endure. Our oil export decline projections suggest that Iran's self-imposed petroleum sector implosion will inflict far more harm on the regime than could sanctions. Even if sanctions could be agreed on, without enforcement they would simply distract from the real problem, which concerns how to reduce rents that fund Irani nuclear weapons development and terror efforts.

The price attack proposed here is a third-way policy: aggressive yet peaceful, less risky than war, more forceful than sanctions, and more likely than either to contain Iran. Unlike costly war, an f-e monopsony could yield monetary savings while simultaneously repatriating rents extracted from importer states, most of which are poor.

Of course, an Irani petroleum crisis might unfold so rapidly that threats it now projects would disappear before a price attack began to bite. Even so, without some importer state intervention to drive down price, threats that now emanate from Iran will simply migrate to some other locus of oil market power. If Middle East stability is really a U.S. security goal, the cartel must be broken.


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