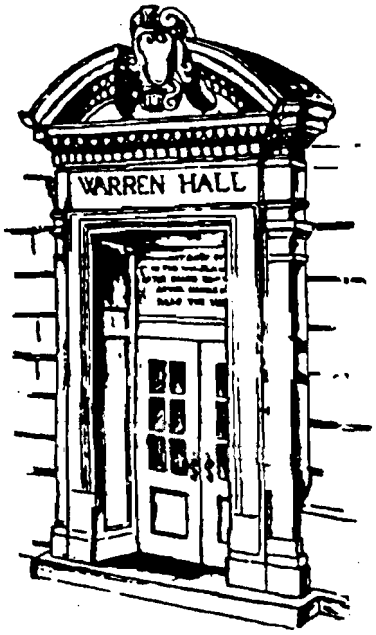


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## AN ECONOMIC ANALYSIS OF PETROLEUM AND MILITARY SECURITY IN THE PERSIAN GULF

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# An Economic Analysis of Petroleum and Military Security in the Persian Gulf

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# AN ECONOMIC ANALYSIS OF PETROLEUM AND MILITARY SECURITY IN THE PERSIAN GULF

DUANE CHAPMAN AND NEHA KHANNA

## ABSTRACT

*Geologic estimates of remaining global petroleum resources place about 50% in the Persian Gulf. Production costs are estimated at $5 per barrel there, and $15 per barrel in the North Sea and Alaska. Using mathematical methods derived from depletion theory, the present value of economic rent from oil is on the order of $20 trillion. Game theory is utilized to explain the $15-$20 per barrel price band that existed from 1986 to 1999; new economic forces may displace this stable pattern. International trade in petroleum and conventional weapons are analyzed with econometric methods; the occurrence of nuclear weapons capability is explored.*

## I. Introduction

In 1980, shortly after Saddam Hussein assumed the Presidency of Iraq, that country attacked Iran in the southwest Khuzistan region. Iraq sought control over two major geographic goals: the Shatt-al-Arab channel, a shipping route for export of Iraqi oil; and the petroleum production facilities in Khuzistan, where more than 75% of Iran's oil resources were located.[1]

In 1990, Iraq occupied Kuwait and threatened Saudi Arabia. If Iraq had been successful in these military actions, it would have controlled 40% of identified global reserves and 75% of Gulf reserves (see Table 1).

In 1991, U.S. President George Bush supported a U.S.-led U.N. military coalition which defeated Iraq, emphasizing that, "Our jobs, our way of life, our own freedom and the freedom of friendly countries around the world would all suffer if control of the world's great oil reserves fell into the hands of Saddam Hussein" (Yergin, 1991, p. 773). This military action eliminated Iraq's potential to raise crude oil prices and attain quasi-monopoly profits. Yet five years earlier, then Vice-President Bush had flown to the Persian Gulf, meeting with Saudi government ministers and the King. The purpose of this 1986 trip had been to raise crude oil prices, which at the time were below $10 per barrel.

The purpose of our analysis is to illuminate part of the economic rationale for these superficially contradictory U.S. policies. We shall show the magnitude of the economic incentives for control of Persian Gulf oil, and also the logic which leads the U.S. and some other OECD nations to work against crude oil prices below $15 per barrel, and above $20 per barrel.

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[1] See Yergin (1991) and the *International Petroleum Encyclopedia* (1983).

**Table 1: Estimates of World Conventional Crude Oil Resources (billion barrels, 1993)**

| Region/Country | Identified Reserves | Undiscovered Resources[a] | Remaining Resources |
|---|---|---|---|
| **Persian Gulf[b]** | **592.4** | **113.7** | **702.1** |
| Saudi Arabia | 258.6 | 50 | 308.6 |
| Iraq | 90.8 | 35 | 125.8 |
| Kuwait + Neutral Zone | 99.4 | 4 | 103.4 |
| Iran | 69.2 | 19 | 88.2 |
| UAE | 61.1 | 4.2 | 65.3 |
| **Former Soviet Union** | **125.1** | **100** | **225.1** |
| **United States** | **51.1** | **40.6** | **91.7** |
| **N. Sea - W. Europe** | **37.3** | **12.3** | **48.9** |
| United Kingdom | 19.5 | 5.6 | 25.1 |
| Norway | 17.1 | 6.7 | 23.8 |
| Netherlands | 0.7 | na | 49 |
| **World[c]** | **1094.5** | **427.7** | **1513.3** |

[a]: modal value.

[b]: includes Oman, Brunei, Qatar, and Bahrain, in addition to the 5 countries mentioned.

[c]: includes other regions and countries.

na: not available

*Source:* Masters et al. (1994). Table 1.

The first section identifies the magnitude of economic rent (defined below) which partially motivates foreign policies of the Gulf countries and the U.S.. It uses game theory logic to explain the $15-$20 per barrel range in which crude oil prices usually move. The second part analyzes global military trade in the context of petroleum imports and exports. This is followed by a brief summary of the growth in nuclear weapons capability in the region. Then we summarize the pre-1980 history of Gulf production and international relations. We conclude with a discussion of future implications.

## II. Petroleum Price, Rent, and Game Theory

In the petroleum economics trade literature, $5 per barrel is widely used as the likely equilibrium price in a theoretically competitive world oil market working without production quota agreements (Adelman, 1986 and 1993; The Economist, 1999; Yergin, 1991).

Table 2 illustrates the production cost in a low-cost area in the Persian Gulf, and also for the North Sea. "Production cost" here means exploration, development, lifting, and shipping costs to an OECD consumer. It includes a normal return on investment ("profit"), and allowances for depletion and risk factors. However, for purposes of discussion, assume average Persian Gulf cost is $5 per barrel, and North Sea (and Alaskan) cost is $15 per barrel.

In other words, if the market price is $15 per barrel, a Persian Gulf producer earns "rent" of $10 per barrel above the $5 per barrel production cost. With Gulf production typically 6 or 7 billion barrels per year, total economic rent above production cost was on the order of $100 billion annually in the late 1990s.

**Table 2: Illustrative Production Cost**

| | **Possible Low Persian Gulf Cost** | **Possible North Sea Cost** |
|---|---|---|
| Investment in Development, amortized (including profit) | 55¢ | $10 |
| Operations, lifting | 25¢ | $5 |
| Shipping | $1.50 | included in operations |
| **Total** (rounded) | $2.50 | $15 |

*Source*: Chapman and Khanna (2000) and Chapman (1993).

Mathematical techniques can be used in economic modeling to analyze the potential surplus or rent associated with use of the world's remaining oil resources. (Remaining resources are the sum of (a) identified reserves, and (b) geological estimates of undeveloped or unexplored petroleum resources). Equation (1) shows the basic objective of a hypothetical monopolistic world oil industry:

$$\text{Maximize with respect to } q_t \text{ and } T \qquad NPV = \sum_{t=1}^{T} \left( \frac{P_t(q_t,t)q_t - C_t(q_t,t)}{(1+r)^t} \right)$$
$$\text{subject to} \qquad \sum_{t=1}^{T} q_t \leq S. \qquad (1)$$

The logic is straightforward. NPV is the net present value of rent, the excess of revenue above cost. (Revenue is P*q, and cost is C). In the denominator, r represents the interest rate in calculating net present value. Remaining resources are S. The second line in the equation notes that future cumulative oil use cannot exceed remaining resources.

The goal, then, is to maximize NPV for producers by finding T, the optimal length of time for remaining production, and the best annual production levels $q_t$. (For a full explanation of this mathematical technique applied to world oil, see Chapman and Khanna, 2000, and Chapman, 1993[2].) Of course the same method can be applied to an assumption of a competitive market. The results are summarized in Table 3. In Table 3, the magnitude of the present value of producers' rent is generally \$15 to \$20 trillion. (The exception, Case 4, has a lower NPV of \$5.5 trillion).

[2] In these analyses, the problem is addressed with continuous rather than discrete functions. With conventional industry assumptions, the solutions show (a) a long period of accelerating use, followed by decline, and (b) prices stable or declining slightly, followed by continuous increases.

**Table 3: Economic Rent and Oil Use**

| Case | T: optimal production period until depletion (years) | NPV: net present value of economic rent above cost (trillions) |
|---|---|---|
| 1. Competitive market | 69 | $ 16.7 |
| 2. Monopolistic market | 92 | $ 21.5 |
| 3. Competitive market until 2030, then monopolistic | 81 | $ 16.2 |
| 4. Competitive, but substitute biomass or coal liquid fuels available at $50 per barrel | 48 | $ 5.5 |
| 5. Monopoly with substitute fuels available at $50 per barrel | 55 | $ 14.9 |

*Source*: Chapman and Khanna (2000)

Gross World Economic Product is now on the order of $35 trillion. The magnitude of economic rent above cost for world oil producers is comparable but smaller. The incentive for Iraqi-type military actions is clear, as is the incentive for OECD and other nations to oppose monopolistic or single-nation influence in the Persian Gulf.

Notwithstanding the magnitude of economic surplus potentially available to a monopoly, crude oil prices have usually been in the $15 to $20 per barrel range. A competitive market would have lower prices (e.g. $5), and a monopolistic market would have higher prices (e.g. $30). Yet, since the Bush trip to Saudi Arabia in 1986, world oil prices were in the $15 to $20 range for 10 of the 13 years (MER, various issues).

We believe that economic, political, and military factors have lead both OECD consumers and OPEC producers to prefer this $15-20 per barrel range, as summarized in Table 4. Consider U.S. net imports of petroleum, which have risen slowly and have passed the 50% level for total consumption. The U.S. production is costly; production cost in the Persian Gulf is not. Consequently, low crude oil prices increase U.S. dependence on imports in two ways. High cost U.S. production has to be shut down when crude prices are near or below $10 per barrel on a long term basis. Second, U.S. consumption of oil increases with lower prices. The end result is that crude prices in the $15 to $20 per barrel range avoid financial loss for American oil producers, slow the decline in U.S. production levels, and encourage U.S. political support for Persian Gulf governments threatened by Iraq or other forces seeking monopoly power over Persian Gulf oil.[3]

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[3] This discussion of Table 4 is based upon the game theory analysis in Chapman and Khanna (2000).

**Table 4: General Economic Impact of Crude Oil Price Decision in a Game Theory Framework**

| Price per barrel | OECD Countries | Persian Gulf Oil Producers |
|---|---|---|
| $10 or less | • higher GNP growth<br>• shut domestic production<br>• greatly increased oil consumption<br>• much more imports<br>• more pollution, climate change<br>• end Persian Gulf political support | • loss of OECD political support<br>• lower revenue, greater volume<br>• higher market share<br>• faster depletion |
| $15 - $ 20 | • stable GNP growth<br>• stable near-term oil production<br>• slow growth in oil consumption<br>• slow growth in import share<br>• stable prices<br>• continued Persian Gulf support | • continued OECD political support<br>• stable revenue, profit, rent |
| $30 | • decline in GNP growth<br>• rapid near-term growth in production<br>• stable or declining consumption<br>• end Persian Gulf support | • loss of OECD political support<br>• less market share<br>• less production, more profit, rent<br>• greater payoff to successful Iraq-type action |

Consider Japan's position in supporting the military defense of Kuwait by the U.S.-led operation. Japan imports essentially all of its petroleum. Three-fourths of its crude oil has originated in the Persian Gulf region (USEIA, 1994, p. 52). In the short run, it would benefit from a $5 to $10 per barrel world price. But, if Persian Gulf oil drives out U.S. and North Sea producers, the resulting monopoly-influenced price would eventually exceed the current $15 to $20 per barrel range. With a long run perspective, Japan can depend upon stable prices and political stability for its supply, both supported by the U.S. (Yergin, 1991, pp. 759-760).

Table 4 lays out these and related points in a game theory framework. Both Persian Gulf and OECD governments have been accustomed to the $15 to $20 per barrel price range. Either group, acting alone, could for a short period force prices in either direction. However, at least for the near term, both groups have incentives to keep prices in this range. This is similar to the game theory concept of *Nash Equilibrium*: a status quo where neither side can improve its overall situation by changing its strategy. A game theory approach is intended to represent the previously noted interaction of politics, military defense, and economics in world oil markets.

This $15 to $20 per barrel level is far below a true monopoly price. It is also far above a truly competitive world price. The outcome in one narrow facet resembles a competitive market: world price is about the level where its equals the marginal cost of high cost producers.

In 1998, cash prices for Persian Gulf oil ranged from $10 to $15 per barrel. The primary cause may have been a cessation of accelerated growth in petroleum consumption in Asia. Throughout most of that year, futures prices remained within the $15-$20 per barrel range. With the downward pressure on 1998 cash prices, the 1999 response could be anticipated which would raise crude oil prices.

## III. Arms Trade and the Oil Economy

The economic incentive underlying military activity in the Persian Gulf has been established in the previous section. Here we examine the global arms trade in the context of the oil economy and determine the empirical significance of a few key nations in this context.

Based on a comprehensive global data set, Table 5 determines a fairly close empirical relationship between world trade in conventional weapons and the trade in crude oil and refined petroleum products: arms exports (imports) are highly correlated with oil imports (exports).

Exploring this relationship are a pair of regression models based on a cross section of 121 countries for 1995.[4] The regression coefficients have the expected sign given the results in Table 5. These coefficients should be interpreted carefully since the arms variables are measured in million dollars whereas the oil variables are in billion dollars. Thus, according to these regression results, a $1 billion increase in total oil imports yields a $0.16 billion increase in the exports of conventional weapons, on average. Similarly, a $1 billion increase in the total volume of oil exports results, on average, in a $0.11 billion increase in the value of arms imports. It is interesting that in both models variables measuring the size and overall economic health of the economy, namely GNP and GNP per capita, were found to be insignificant explanatory variables.

[4] The sources for these data are the same as those in Table 5. The figures in parenthesis are the heteroscedasticity consistent t-ratios based on White's heteroscedasticity consistent standard error estimates. See Greene (1997) for details. As expected, no evidence of autocorrelation was found. The regression slope coefficients are significant at the 5% level in both models.

**Table 5: Correlation Coefficients**

| Correlation of | | | Pearson's Correlation Coefficient |
|---|---|---|---|
| Arms exports | with | Oil imports | 0.74 |
| Arms imports | with | Oil exports | 0.70 |
| Total arms trade | with | Total trade | 0.69 |
| Total arms trade | with | Total oil trade | 0.80 |
| Total trade | with | Total oil trade | 0.81 |

Variable definitions: All data are for 1995

*Arms exports (imports)*: value of conventional weapons exports (imports)

*Arms trade*: sum of arms exports and arms imports

*Oil imports (exports)*: total volume of crude oil and refined petroleum products imports (exports)

*Total trade:* total value of merchandise imports and exports

*Data sources*: ACDA 1997 and 1998, WTO 1999, USEIA 1996.

Model 1

Arms Exports = -294.56 + 159.95 Total oil imports + error $R^2 = 0.52$
(-1.11) (2.16)

Model 2

Arms Imports = -2.65 + 108.24 Total oil exports + error $R^2 = 0.51$
(-0.03) (2.32)

To identify the key countries in this context, consider Table 6 which provides details on the value of arms transfers between the major supplier and recipient countries. It is clear from this table that more than 50% of the global exports of conventional arms between 1994 and 1996 originated in the United States, followed by the United Kingdom at a distant second. Saudi Arabia was the single largest recipient of these weapons, receiving almost three as times as high a value of arms imports as the next highest recipient, Egypt. Other countries in the Persian Gulf region, particularly Kuwait and the United Arab Emirates, are also significant importers of conventional weapons, each receiving approximately $800-$1000 million per year.[5]

Drawing together the statistics on arms trade presented above, the crude oil reserves data in Table 1, and country specific details on the imports and exports of crude oil and refined petroleum products (USEIA 1998), we can identify the key countries in the international oil-conventional weapons economy. It is clear that, in general, the worlds largest arms exporters are also the largest oil importers, whereas the countries with the largest remaining and identified crude oil resources are the largest recipients of these arms.

[5] For detailed country specific arms imports and exports data see various issues of the World Military Expenditure and Arms Trade reports published annually by the United States Arms Control and Disarmament Agency.

**Table 6: Value of Arms Transfer Deliveries by Major Supplier and Recipient Country**
(Cumulative 1994-1996, millions of current dollars)

| Supplier / Recipient | Total | US | UK | Russia | France | Germany | China | Other NATO | Middle East | Other East Europe | Other West Europe | Other East Asia | All Others |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **World** | **119,565** | **67,210** | **16,405** | **8,490** | **6,675** | **4,045** | **1,970** | **4,610** | **3,070** | **2,130** | **2,485** | **595** | **1,880** |
| **Developed** | **52,070** | **38,760** | **1,355** | **845** | **2,160** | **3,025** | **40** | **1,990** | **1,310** | **180** | **1,370** | **200** | **835** |
| US | 3,330 | - | 950 | 40 | 160 | 320 | 40 | 950 | 330 | 30 | 140 | 200 | 170 |
| Israel | 2,865 | 2,600 | 0 | 0 | 0 | 150 | 0 | 5 | 0 | 10 | 0 | 0 | 80 |
| Russia | 50 | 30 | 0 | - | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 |
| France | 695 | 550 | 0 | 0 | - | 0 | 0 | 40 | 5 | 0 | 0 | 0 | 80 |
| Germany | 2,710 | 2,600 | 0 | 0 | 0 | - | 0 | 60 | 10 | 0 | 0 | 0 | 0 |
| Japan | 6,020 | 6,000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Developing** | **67,495** | **28,450** | **15,050** | **7,645** | **4,515** | **1,020** | **1,930** | **2,620** | **1,760** | **1,950** | **1,115** | **395** | **1,045** |
| China | 2,565 | 120 | 0 | 2,000 | 0 | 0 | - | 0 | 320 | 30 | 0 | 0 | 80 |
| Taiwan | 4,090 | 3,300 | 0 | 0 | 775 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **OPEC** | **36,080** | **15,150** | **12,915** | **1,625** | **3,040** | **190** | **525** | **940** | **85** | **310** | **860** | **150** | **290** |
| Iran | 1,025 | 0 | 0 | 320 | 0 | 0 | 500 | 10 | 10 | 80 | 10 | 50 | 5 |
| Kuwait | 3,405 | 1,900 | 675 | 750 | 60 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 |
| Saudi Arabia | 26,585 | 11,700 | 11,200 | 0 | 2,000 | 60 | 0 | 775 | 0 | 0 | 850 | 0 | 0 |
| UAE | 2,270 | 800 | 260 | 200 | 750 | 0 | 0 | 0 | 0 | 20 | 0 | 40 | 200 |
| **NATO** | **25,525** | **18,150** | **1,195** | **230** | **1,300** | **1,470** | **40** | **1,785** | **580** | **45** | **275** | **200** | **255** |

*Source*: ACDA, 1998. Table III.

## IV. Instability, Local Conflict, and Nuclear Weapons

The Middle East, the Persian Gulf, and South Asia are usually considered distinct regions. However, a broader network of national tensions overlays the Persian Gulf region. Five of the world's nuclear-capable countries have borders within 1600 miles of the Straits of Hormuz.[6] In all cases, the missile range is long enough to make a nuclear aggression in the Persian Gulf region a technically feasible option (see Table 7). The other two nuclear capable regions, the United States and the European Community, are both major importers of Persian Gulf oil.

Figure 2 shows countries with nuclear warheads and their oil production. The apparent association is spurious, in the sense that crude oil production does not cause nuclear capability. There are at least seven sets of national rivalries that have involved nuclear-capable countries.[7] The simplest interpretation of the Figure is that most of the conflicts associated with nuclear-capable countries have the potential of affecting the Persian Gulf.

Pakistan, though not a major oil producer, borders the Gulf of Oman and the Indian Ocean. A nuclear conflict involving India and Pakistan would probably impact Gulf shipping and perhaps production.

Petroleum revenues received from the OECD by Gulf producers probably do not directly finance conflict in what, for lack of an established term, we call the "Straits of Hormuz global sector". But individuals and organizations in the Gulf countries finance military operations in

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[6] From West to East: Israel, Russia, Pakistan, India, China. See map (Figure 1).

[7] Since World War II: Israel-Arab countries; Pakistan-India; India-China; Russia-U.S.; France and U.K.-Russia; Russia-China; China-U.S.

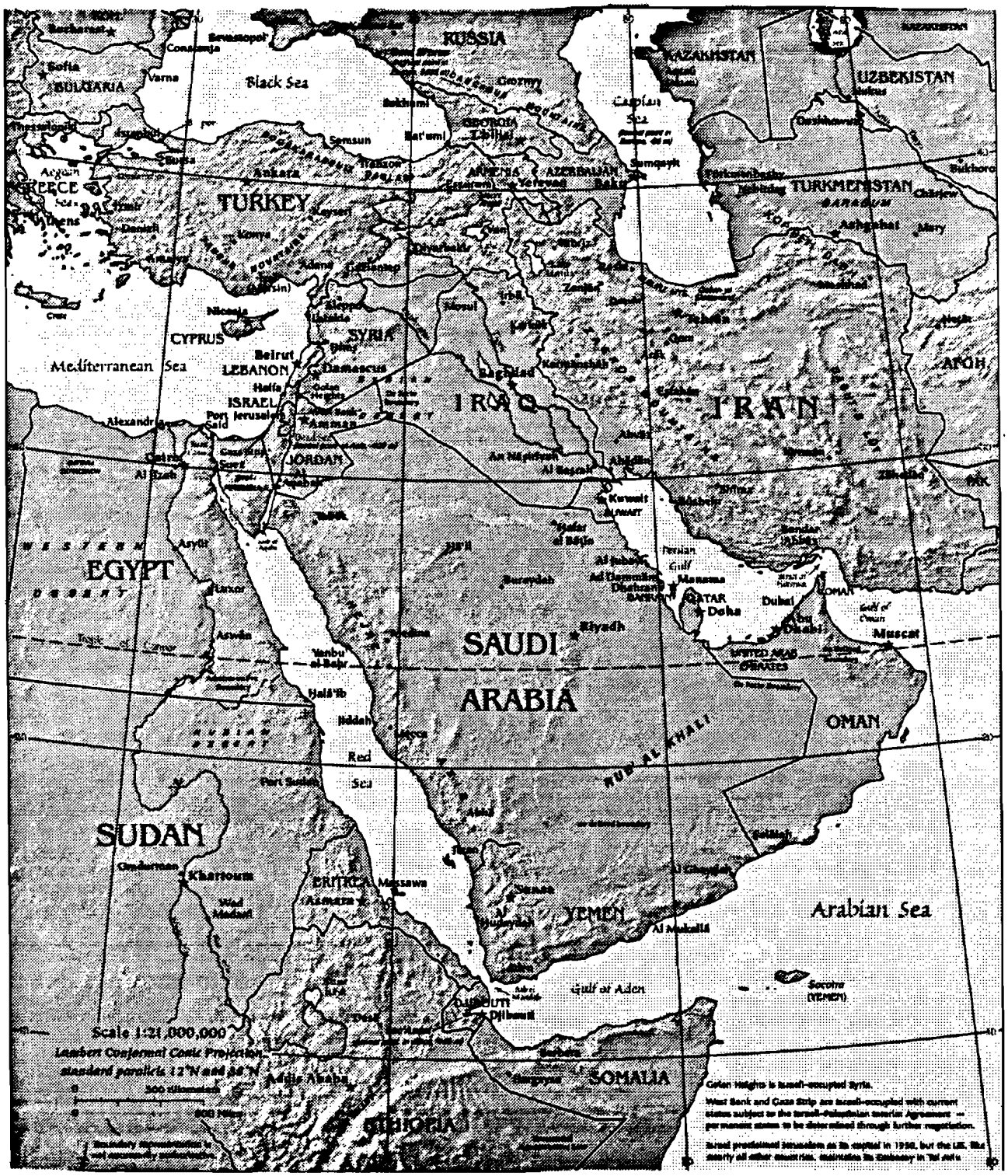
other countries in this sector.[8]

[8] It has been asserted that sources in Saudi Arabia and Iran support Muslim military operations in Kashmir (*National Geographic*, 1999).

**Table 7: Nuclear Weapons**

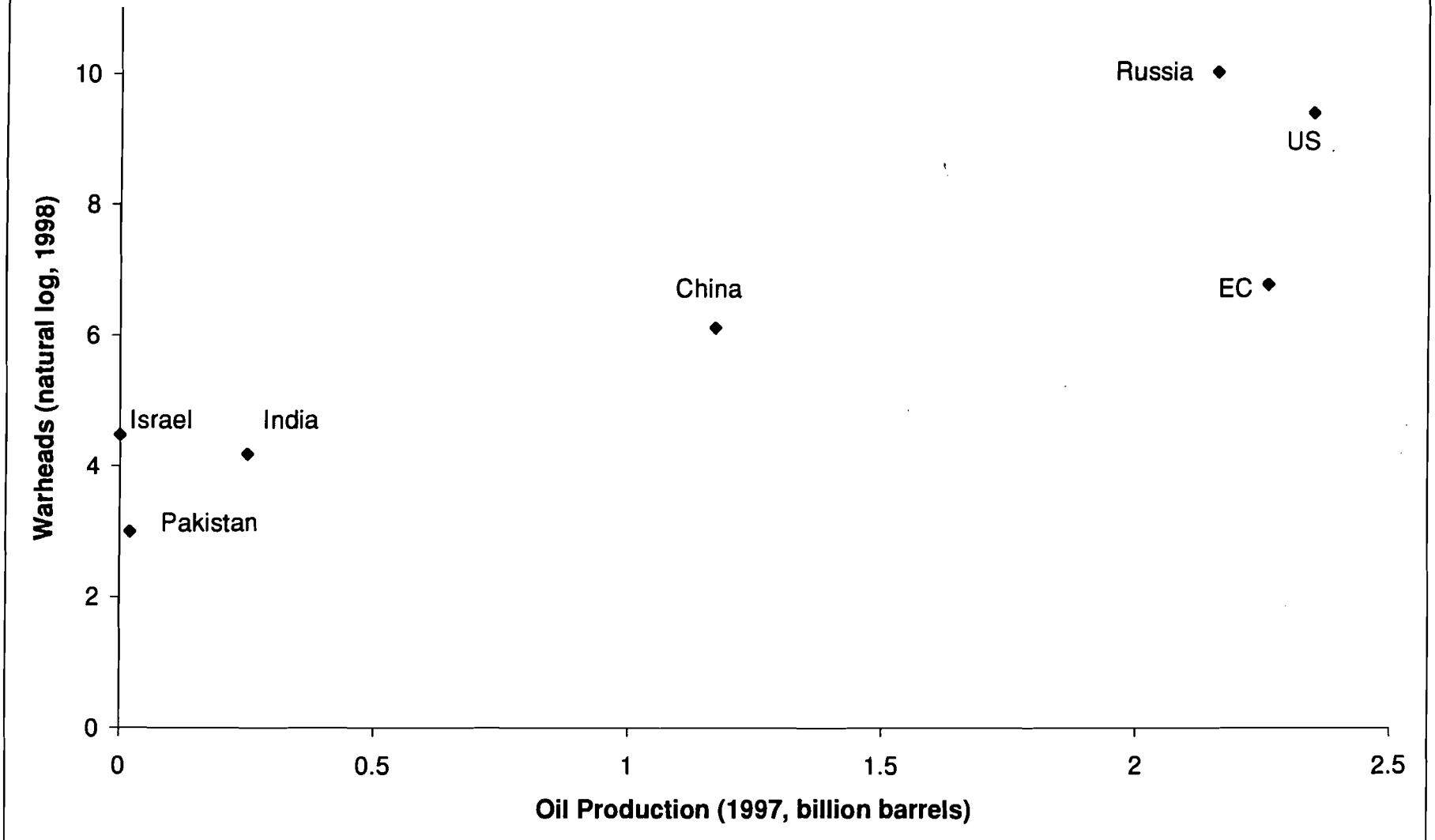
| Name and history | Arsenal (number of warheads) | Representative Missile Range (miles) |
|---|---|---|
| *1. Countries with declared nuclear weapons capabilities* | | |
| United States<br>First test: 1945<br>Total number of tests: 1,030 | 12,070 | 8,100 |
| United Kingdom<br>First test: 1952<br>Total number of tests: 45 | 380 | 7,500 |
| France<br>First test: 1961<br>Total number of tests: 210 | 500 | 3,300 |
| Russia<br>First test: between 1945-1952<br>Total number of tests: 715 | 22,500 | 6,800 |
| China<br>First test: 1964<br>Total number of tests: 45 | 450 | 6,800 |
| India<br>First test: 1974<br>Total number of tests: 6 | 65 | 1,500 |
| *2. Countries with undeclared nuclear weapons capabilities* | | |
| Israel<br>Known to have bomb | 64-112 | 930 |
| Pakistan<br>Began secret program in 1972 | 15-25 | 930 |
| *3. Countries that terminated nuclear weapons programs* | | |
| Algeria, Argentina, Brazil, Belarus, Kazakhstan, Ukraine, South Africa. | | |
| *Source*: *Time Magazine*, 1998. | | |

**Figure 1: The Persian Gulf and Surrounding Regions**




*Source:* http://www.lib.utexas.edu/Libs/PCL/Map_collection/middle_east.html

**Figure 2: Countries with Nuclear Warheads and Oil Production**




Data for this figure were obtained from USEIA (1999) and *Time Magazine* (1998).

## V. A Historical Perspective on Persian Gulf Policy

Throughout the 20th century, the Gulf has been of considerable interest to the U.S., European, and Russian governments. The Anglo-Persian Oil Company preceded the British Petroleum Company. Both companies worked to provide a secure supply of petroleum for the United Kingdom during the earlier decades of the century. As was typical, British companies simply assumed the responsibilities of government in their concessions in Iran's oil regions: customs, police, taxation, telegraph, education, and banking (Upton, 1961; Chapman, 1983). Russia, on the other hand, sought, rather unsuccessfully, to promote Soviet republics in Northern Iran. From 1953 to 1978, Iran's policies were coordinated with U.S. interests, as is well known (e.g., Yergin, 1991; Roosevelt, 1979).

In Saudi Arabia, four U.S. oil companies established economic relations with the Saudi government. Originally formed in 1933 as the California Arabian Standard Oil Company, ARAMCO, (Arabian American Oil Company) managed Saudi oil after WWII (ARAMCO, 1960; Yergin, 1991). While the companies no longer exert such control, the relations between the Saudi and the U.S. government remain strong, as discussed above.

Each Persian Gulf country has an analogous individual history that fits into the larger mosaic of oil production and historical relations with European and U.S. companies and governments.

## VI. Summary: Implications for International Policy

Historically, Europe, the United States, and Russia have sought to secure access to Persian Gulf oil. Its low cost and high volume of remaining resources continue to place the Gulf

at the center of petroleum geopolitics. The magnitude of economic rent above cost is on the order of $15-20 trillion.

Military power has played a significant role in policy. Iraq, in its invasions of Iran and Kuwait and its threat to Saudi Arabia, has sought control over one-half of the world's remaining resources. The U.N. alliance, led by the United States, eliminated Iraq's military power, and continues to control Iraq's military capabilities as well as its oil sales.

In the late 1990s, weapons trade became closely associated with petroleum trade, as analyzed above. As nuclear weapons capabilities slowly spread, an unexpected byproduct of national rivalries has been the creation of a geographic pattern in which five of the nuclear powers are within 1600 miles of the Straits of Hormuz. The other nuclear powers are major consumers of Persian Gulf oil. Iraq would probably have nuclear warheads today if not for the U.N./U.S. control over its military resources.

Thus far, international policy in the Gulf is the result of diplomacy, military action, and economic relations, setting the $15-20 per barrel price range outlined above.

As production from Alaska and the North Sea continue to decline while world consumption grows, the stable picture of growing production in the context of mild price fluctuations may change. Mexico and Norway have initiated effective coordination with Saudi Arabia and OPEC (*New York Times*, 1999). If this effort is successful beyond the immediate short run, future crude oil prices may be move out of their recent $15-20 per barrel range. The impact of higher prices above this range will, as noted above, change the relations between the OECD consumers and the Gulf producers. In addition, the magnitude of the economic rent would increase above the values analyzed here.

We do not suppose that we can suggest or advocate practical new policies to stabilize politics, prices, and production. We hope this analysis lays out some of the motivation for more explicit international policies in this context.

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