Oil and national security

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This paper estimates national security related expenditure in 1985 for oil imports at US$8.45 to US$9.05 per barrel. This estimate, in 1985 dollars, is divided between additions to defence spending (US$7.30 per imported barrel) and the cost of the strategic petroleum reserve (US$1.15 to US$1.75 per imported barrel). Based upon 1985 oil imports of about five million barrels per day, the estimate of the 1985 annual national security subsidy for oil imports totals US$18 billion, including US$2.1 to US$3.2 billion for the strategic petroleum reserve and US$14.8 billion for additional defence spending.

Keywords: Oil; National security; Gulf War

In February of 1992 Iraq lost the Gulf War and President Bush presented the National Energy Strategy (NES). The popular media reported that after considerable internal debate, leaders of the administration prevailed over the public record and proposals of the agencies within the executive branch, and based the NES on a philosophy of a free market.[1] The Bush administration excluded from the NES taxes on oil imports or gasoline, subsidies for energy conservation investments or alternative energy sources, and policies that mandate targets, such as gasoline mileage standards (corporate average fuel economy (CAFE)). Let consumers decide, based upon the market price of gasoline, whether to buy gas sippers or gas guzzlers. Let consumers decide, based upon the market price of energy, how much to invest on more energy efficient lighting, heating, air conditioning, electric motors, engines, and building designs. Let utilities and power producers decide, based upon market prices, how much power to produce from alternative energy sources. The Bush administration included in the NES policies that remove environmental restrictions on oil production, and safety restrictions on the construction of nuclear power. Meanwhile, military intervention dramatically altered the market price for oil, which to a considerable extent drives other energy prices. These are fair questions for adherents of the free market philosophy. 'What is the loss of economic efficiency because the price of oil excludes the military subsidies, and how different is the "market induced" combination of energy sources and investment in energy efficiency relative to the economically efficient combination?'

The paper is organized as follows. National security depends on oil imports, an argument developed in the first section. This section includes a definition of national security and a summary of the rationale for the Gulf War. An econometric model is presented in the second section. The model estimates increased defence spending attributable to oil imports. The cost of the strategic petroleum reserve is estimated in the third section, followed by a discussion of the empirical results and some concluding remarks.

GULF WAR AND OIL IMPORTS

In his letter transmitting the Energy Security report to the President, Energy Secretary John S. Herrington measured energy security by the size of US oil imports.[2] The reasons are these. Most of the oil remaining in the ground is in the Middle East, and the world is running out of this depletable resource. Oil price shocks, both up and down, are detrimental to the US economy. Oil prices can be controlled by those countries in the Persian Gulf that have major reserves and relatively low cost, productive capacity. Oil prices can be dramatically manipulated to deliberately harm US political and economic institutions and those of its allies.

Two-thirds of world crude oil reserves are in the Middle East (Table 1). Excepting the discovery in Alaska in the early 1970s, Figure 1 shows that US crude oil reserves, measured in billions of barrels, started to fall in the early 1960s. Were undiscovered oil plentiful in the USA, drilling would replenish the reserves. Figure 1 also shows footage drilled in million feet. In particular, drilling increased to

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Table 1. World oil reserves (billion barrels).

Continent	Reserves
North America	87.7
USA	26.8
Central and South America	68.0
Western Europe	18.5
Eastern Europe and former USSR	60.3
Middle East	654.0
Iran	92.9
Iraq	100.0
Kuwait	94.5
Saudi Arabia	255.0
United Arab Emirates	98.1
Africa	56.9
Far East and Oceania	45.1
World total	990.6

Source: Annual Energy Review 1989, Energy Information Administration, US Department of Energy, Table 107, p 247.

Table 2. Oil prices and recessions.

Oil price spikes	Recessions began
1947	1948
1953	1953
1957	1957
	1960
1969	1969
1970	
1973	1974
1979	1979
1980–1	1981

Source: James D. Hamilton, 'Oil and the macroeconomy since World War II', *The Journal of Political Economy*, Vol 91, No 2, 1983, pp 228–248; and James D. Hamilton, 'Historical causes of postwar oil shocks and recessions', *The Energy Journal*, Vol 6, No 1, 1985, pp 97–116.

historic highs from 1980 to 1986, while reserves continued to fall.

Oil price shocks, or equivalent supply disruptions, cause recessions. Hudson and Jorgenson, and Mork and Hall estimate that part of the recession and inflation following the 1973 OPEC oil embargo was caused by the increase in oil prices.[3] Gisser and Goodwin regress a set of reduced form equations of macro variables (GNP, prices, unemployment, and investment) on money supply, a measure of federal expenditures, and the price of oil.[4] They consider various lag structures. With Granger causality tests, they find that oil price shocks have a significant effect on macro variables. Burbidge and Harrison use vector autoregressions and find that oil price shocks lower output, raise prices and lower real wages, more so following the 1973–74 price shock than the 1979–80 price shock.[5]

Table 2 includes all the recessions and oil price spikes from World War 2 to 1981. Every recession except one was immediately preceded by an oil price spike. Every oil price spike except one was immediately followed by a recession. Hamilton's analysis of the period of 1948 to 1981 includes 8 spikes in oil prices and recessions since the end of World War 2.[6] He rejects the hypothesis of pure coincidence with a non-parametric method (the hypergeometric test) at the 0.03 level of significance. He rejects the hypothesis that macroeconomic indicators explain oil price changes, with a Granger causality test. He presents a detailed historical and institutional analysis of oil price shocks, consistent with the conclusion that upward oil price shocks cause recessions.

From 1981 to 1986 the deflated price of oil fell from US$5.83 per million Btus (MBtu) to US$1.89/MBtu in 1982 dollars.[7] During this period, the

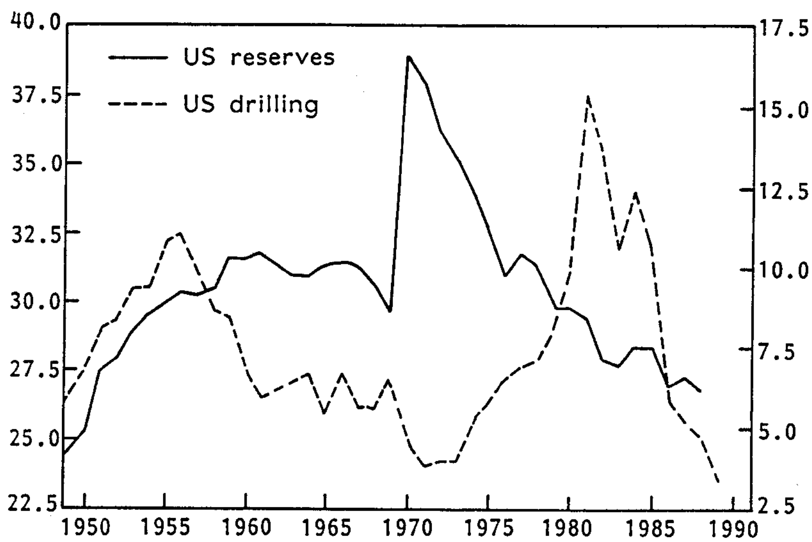

Figure 1. US crude oil reserves and oil drilling (billion barrels).

Reagan miracle occurred, with the second longest economic expansion since World War 2. Two quarters after the invasion of Kuwait by Iraq and the concomitant increase in oil prices, the USA experienced another recession.

One benefit of market incentives is that the price rises as depletable resource reserves fall, signalling increased scarcity. A rising price provides the incentive for the production of substitutes. Oil prices have, however, fallen as suddenly as they have risen, but not for the reasons related to scarcity. The second oil price shock of 1979, during the Iranian Revolution, was followed by a third price shock when the Iraq–Iran war began in September of 1980. By 1981 the nominal spot market price briefly topped US$41 per barrel. Even a cooperative cartel, however, is disciplined by demand. The recessions that followed the 1979 and 1980–81 price spikes reduced demand.[9] Gasoline mileage standards for automobiles, fuel switching by electric utilities, investment in building insulation, and numerous other substitutions reduced the quantity demanded. Between 1979 and 1986 petroleum consumption fell 15% in the USA and 7% worldwide.[9]

In this period (1979–86) of a reduction in oil consumption, the pressure on the OPEC cartel increased. As Adelman describes OPEC, the

> cartel swings between two models. (a) The largest firm(s) bear the burden of restriction, making up the difference between total demanded and production of the smaller firms. Or (b) all firms together set total output, then divide it. Variant (a) is easier to manage, (b) is more rewarding. *Both are unstable* [emphasis added]; in (a) the dominant firm will push toward (b), to make others share the burden; in (b), cheating may force the dominant firm willy-nilly into (a). In 1975–1982, the Saudis maintained model (b).[10]

Adelman goes on to assert that by 1982, cheating on production quotas pushed the Saudis to model (a).[11]

Yergin chronicles the weakening of OPEC.[12] In 1979, OPEC produced 31 million barrels a day (mbbl/d). By 1982, OPEC established a quota of 18 mbbl/d. In March of 1983, OPEC reduced by 15% their quota to 17.5 mbbl/d. The swing producer Saudi Arabia's revenue fell from $119 billion in 1981 to $36 billion in 1984 to $26 billion in 1985. At the OPEC meetings in Geneva during the period from 1982 to 1985, Sheikh Yamani (the oil minister of Saudi Arabia at the time) repeatedly threatened to expand output unless Iran and Iraq stopped cheating on their agreed quotas. 'Cheating' is the dominant strategy for smaller producers, while 'not cheating' is the dominant strategy for Saudi Arabia for a game that is not repeated.[13] In this case, the game was repeated and Sheikh Yamani's threats were repeatedly ignored. To make the threat credible – a strategy Yergin calls 'the good sweating' – in 1986 Saudi Arabia finally expanded output and the nominal spot market price fell below US$10/bbl.[14] A recession occurred in oil producing regions in the USA. Companies that had invested in alternative energy sources without price guarantees failed. Downward oil price shocks clearly have adverse effects on oil production and investments in alternative energy sources.

Many argue that national security risks include both recessions following oil price spikes and detrimental impacts on the domestic energy industry following oil price slumps. For example, in April 1986, Vice-President Bush flew to Saudi Arabia where he threatened an oil import tax unless the Saudis raised oil prices from around US$10/bbl to around US$18/bbl.[16] While there, he promised AWACs and stinger missiles. As quoted by Yergin, Vice-President Bush said, 'There is some point at which the national security interest of the United States says, "Hey, we must have a strong, viable domestic industry." I've felt that way all my political life and I'm not going to start changing.'[16] On the contrary, fluctuating oil prices and concomitant adverse economic impacts do not inherently constitute a threat to national security. Were that the case, countries like Japan, with international trade a substantial portion of gross domestic product, would view fluctuating terms of trade as a national security risk. It is better to define national security as the absence of an external political threat, force or pressure to political and economic institutions. This definition has two litmus tests. First, the threat must be to institutions, not GNP. Second, the threat must come from deliberate political action, not from market forces that represent the decisions of many buyers and sellers.

Iraq was a threat to US national security in two ways. First, substantial oil revenues could be used to finance the development of weapons of mass destruction, including biological, nuclear and chemical weapons, and the means to attack the USA and allies with those weapons. A potential credible threat was averted by the war.

Second, the reserves and productive capacity of a combined Iraq and Kuwait equalled those of Saudi Arabia. Saddam Hussein would have had the ability to influence the internal politics of the USA. President Carter was unable to win reelection. His inability to respond to the Iranian hostage crisis, the failed military attempt to free the hostages, and the recession that followed the oil price shock of 1978–79 were major factors. When oil prices fell below US$10/bbl in 1986, Vice-President Bush went to Saudi Arabia and asked for a stable price at around US$18/bbl in exchange for AWACs and stinger missiles. Six months after his visit, the oil minister (Sheikh Yamani) was placed under house arrest, replaced, and oil prices subsequently rose to about US$17.50/bbl where they remained until after the presidential election in 1988. Were Kuwait not re-established as an independent state and the Iraqi military capability substantially reduced, a fate similar to Carter's could befall incumbent presidents in future elections.

DEFENCE SPENDING AND OIL IMPORTS

There are reasons other than oil that motivate US defence spending in the Middle East. For example, Soviet hegemony was perceived as a threat by both the USA and Iran, and was the stated political basis for secret negotiations in early 1986 that ultimately led to the sale of arms from the USA to Iran.[17] Another example is the shift in US policy toward Iraq during the later stages of the Iran–Iraq war, based upon the perceived threat of an Iranian victory spawning an upsurge of Islamic fundamentalism throughout the Islamic world.[18]

It is imported oil, not just imports from the Middle East, that Secretary Herrington used to measure US energy security.[19] From 1980 to 1987, the percentage of oil imported from the Middle East relative to total imports varied as follows: 29%, 28%, 20%, 17%, 13%, 8%, 19% and 21%.[20] There is some evidence of regional and partially fragmented oil markets, so that an increase in prices or a supply disruption among Middle East suppliers and buyers does not instantaneously translate into an identically sized jump in oil prices among all sellers and buyers throughout the world.[21] There are significant transport costs and some long-term contracts without evergreen clauses. Yet Middle Eastern supply disruptions and price shocks of 1973 , 1979, 1981, 1986 and 1990 reverberated throughout the world oil market. This is why total imports, not just imports from the Middle East, are the relevant measure of energy security.

Broadman and Hogan estimate three parts of an optimal oil import tariff.[22] They distinguish between the adverse impacts of high oil prices and the impact of oil price shocks. One part corresponds to monopsony power, another to the adverse macroeconomic impact of higher oil prices on terms of trade, and the third to the adverse impact of oil price shocks. They refer to the third part of an optimal tariff, due to impact of oil price shocks, as the 'security tariff'. The security tariff can be interpreted as the value of additional oil security or the 'willing(ness) to pay for military protection of oil supplies'.[23] Conditioned on the price of oil at US$15/bbl in 1985$, they estimate the security tariff at US$7.07/bbl.

Broadman and Hogan's model is an optimizing model that estimates how much the USA should be willing to subsidize oil importation through expenditures on national defence and the strategic petroleum reserve. The questions raised at the beginning of this paper, however, require estimates of how much the USA actually spends to subsidize oil imports. In effect, Broadman and Hogan estimate the demand for national security relevant to oil imports, while what is needed is an estimate of the cost of national security actually supplied. This author could only find one such estimate of the cost of defending the Persian Gulf.

Ravenal estimates that US$47 billion (1985 dollars) was spent by the USA to defend the Persian Gulf in 1985.[24] His procedure is to allocate defence expenditures by region, determine the remainder available for the rapid deployment forces (RDF), and allocate a portion of the funding for the RDF for defending the Persian Gulf. That year US total imports of crude oil and petroleum products equalled 5 million barrels per day, including 3.2 million barrels of crude per day.[25] Ravenal's estimate can be calculated as equivalent to US$25.41/bbl of imported crude and products. National security is a joint product, provided jointly by the RDF and other components of defence. To the extent that the RDF enhances national security in other regions jointly, Ravenal's estimate is too large.

The question of interest is this. What portion of US defence spending can be attributed to oil imports? Certainly, not all defence spending in the Middle East is due to oil imports. Some portion of spending on the rapid deployment force should be attributed to oil imports, whether or not the force is deployed to the Middle East. A model will now be developed to answer this question.

In order to answer questions of interest regarding defence policy, it would be necessary to specify all of the factors that determine defence spending. An empirical model of defence spending would require measures of explanatory variables that are impossible to measure. The number of such explanatory variables would be larger than the sample size, rendering any estimation procedure impossible. The focus of this paper, however, is energy policy, and

Table 3. Autocorrelation and partial autocorrelation functions.[a]

Autocorrelations	Partial correlations		Autocorrelations	Partial correlations
. *******	. ******	1	0.524	0.524
. ****.	. .	2	0.280	0.007
. * .	. * .	3	0.070	−0.109
. .	. .	4	0.019	0.031
. * .	. * .	5	−0.082	−0.108
.*** .	. ** .	6	−0.213	−0.185
.*** .	. * .	7	−0.260	−0.075
. ** .	. * .	8	−0.171	0.058
. ** .	. * .	9	−0.146	−0.081
. ** .	. * .	10	−0.122	−0.047
.*** .	.*** .	11	−0.225	−0.203
. ** .	. * .	12	−0.181	−0.042
. * .	. .	13	−0.107	−0.007
. * .	. ** .	14	−0.097	−0.117
. * .	. .	15	−0.054	0.004
. * .	. * .	16	−0.051	−0.071
. * .	. * .	17	0.090	0.087
. ** .	. * .	18	0.188	0.055
. ** .	. * .	19	0.153	−0.067
. .	.*** .	20	−0.032	−0.252
. * .	. * .	21	−0.083	−0.051

Note: [a] Sample range 1968–89; 22 observations; Q-statistc (21 lags) 16.015; SE of correlations 0.213.

has a much more narrow focus relative to defence spending.

A model where defence spending depends on the level of oil imports permits an empirical estimate only of that portion of defence spending attributable to imports. Of course, such a model omits other variables on which defence spending depends, such as political factors not related to oil generally or to oil imports specifically, such as the perceived Soviet threat. The objective of modelling is not, however, to show that we can specify complicated relationships, but to answer the energy policy question of interest. Let us use Occam's razor when specifying the model. As long as the omitted explanatory variables, such as the perceived Soviet threat, are not correlated with oil imports, a model with a single explanatory variable could result in an unbiased statistical estimate of the portion of defence spending due to imports. An important caveat is that the model accounts for statistical complexities associated with time series data so that the level of oil imports is not correlated with the error term. The empirical model, then, leads to an unbiased estimate of the question of interest as long as the omitted variables do not rise or fall in value inversely or directly with oil imports.

A single variate autoregressive moving average (SARMA) model explains the amount of defence spending as a function of oil imports. This model specifies that defence spending in year t depends on oil imports in year $t-2$. The lag is introduced to account for institutional lags. The budget process takes most of a year and determines the following year's budget. Events that affect the size of the budget therefore occur before the debate in Congress, two years prior to changes in the budget.

The time frame for analysis was chosen to cover the period since deflated oil prices began to rise, which was 1970.[26] Accounting for the budgetary lag, the data for the analysis covers the period 1968 to 1989, the last available year of data.

Defence spending for the calendar year was deflated using the implicit price deflator for GNP. Since there is a secular trend for defence spending, the series is non-stationary. The model assumes that the first difference of defence spending conditioned on lagged oil imports is first order homogeneous stationary. To check this assumption, the first difference of defence spending was regressed on oil imports, lagged two periods, and the autocorrelation function (Table 3) of the error term was examined. The correlation falls off rapidly and approaches zero, a pattern consistent with stationarity. The Q-statistic of the autocorrelation function equalled 16.015, substantially lower than 28.41, the value of the chi-squared distribution for 20 degrees of freedom at the 90th percentile. The decision is to reject the hypothesis that the distribution of the error term is non-stationary.

The model is specified as:

$$D_t - D_{t-1} = a + bM_{t-2} + e_t \qquad (1)$$

Table 4. Single autoregressive model.

Variable	Coefficient	SE	T-statistic	Two-tail significance
C	−14.992743	9.5788624	−1.5651904	0.134
$OILMPTS(-2)$	2.6767464	1.5225299	1.7580911	0.095
$AR(1)$	0.4800626	0.1513172	3.1725579	0.005

Dependent variable: $CWARDEF$		Observations: 22	
R^2:	0.542883	Mean of dependent variable:	1.604082
Adjusted R^2:	0.494765	SD of dependent variable:	9.806669
SE of regression:	6.970568	Sum of squared residual:	923.1876
Durbin–Watson:	1.428612	F-statistic:	11.28242
Log likelihood:	−72.32134	Sample range: 1968–89	
Convergence achieved after 6 iterations			

where D is defence spending, M is oil imports and e is stationary.

An ordinary least squares regression results in a low Durbin–Watson statistic of 0.79, indicating first order autocorrelation of the error term. Consequently, it is important to consider alternative specifications of the error term. With a single explanatory variable, Equation (1) is a single autoregressive moving average [SARMA (p,q)] model with, in general, a p-order autocorrelation process and a q-order moving average process:

$$e_t = p_1e_{t-1} + p_2e_{t-2} \ldots + p_pe_{t-p} + u_t - r_1u_{t-1} - r_2u_{t-2} - \ldots - r_qu_{t-q} \quad (2)$$

The autocorrelation function of the error term in Figure 2 follows the typical pattern of first order autocorrelation, exponentially diminishing in size. The order of the autocorrelation function is selected using the partial autocorrelation function (PAF) in Table 3. When the PAF is close to zero for all order greater than k, then use k as the order of the autocorrelation.[27]

The partial correlation function confirms the specification of first order autocorrelation for the error term. The autocorrelation function drops off rapidly and then slightly increases in the 6th period and 11th period, so a moving average term may also be appropriate. Consequently, some alternative specifications for the error term may be in order. Four alternative specifications are considered, all with first order autocorrelation. One specification has no moving average term, the second has a moving average for one period, the third has a moving average for one and two periods, and the fourth has a moving average for the second period only.

The model with a moving average process of order two has a statistically insignificant autoregressive term, and the model with a first order moving average process has a statistically insignificant moving average term. Results for the two models that perform best are presented in Tables 4 and 5. In both tables the error term is first degree autoregressive. In Table 4 there is no moving average. In Table 5, there is a moving average term for the second period only.

There are two important results from all of the models considered. First, the point estimate of the impact of oil imports on defence spending does not depend on the specification of the error term. Second, the estimate of the coefficient is statistically significant at the 10% level of significance for all models, including ordinary least squares.

The results show that, in 1982 dollars, for every million barrels of daily oil imports, annual defence spending increased by US$2.67 billion, the estimate of b found in Tables 4 and 5. In 1985 dollars this must be increased by 11% to US$2.96 billion. To convert annual defence spending (in billions per year) and daily oil imports (in millions of barrels per day), divide 2670 by 365 days; the estimate of the defence subsidy for importing oil equals US$7.32 per barrel in 1985 dollars. The estimated annual defence subsidy for importing oil, using the five million barrels per day in 1985, equals US$14.8 billion in 1985 dollars.

STRATEGIC PETROLEUM RESERVE

The strategic petroleum reserve (SPR) is another source of subsidy. The SPR is an oil stockpile to mitigate the impact of an oil supply disruption and associated price shock. The annual cost of the SPR has two parts. First is interest on an amount of money equivalent to a fund that could have been accumulated instead of spending the money to pay for the oil stockpile. Second is the annual cost of increasing the size of the reserve. Each year the oil for the reserve has been purchased in part from domestic sources and the remainder from foreign sources. Let $Cd(t)$ and $Cf(t)$ be the average cost of

Table 5. Single autoregressive moving average model:

Variable	Coefficient	SE	T-statistic	Two-tail significance
C	−14.863231	7.7953097	−1.9066890	0.073
OILMPTS(−2)	2.6694207	1.2623084	2.1147136	0.049
MA(2)	0.5059013	0.2868454	1.7636722	0.095
AR(1)	0.3896790	0.1544915	2.5223320	0.021

Dependent variable: *CWARDEF*

R^2:	0.617294	Mean of dependent variable:	1.604082
Adjusted R^2:	0.553510	SD of dependent variable:	9.806669
SE of regression:	6.552809	Sum of squared residual:	772.9075
Durbin–Watson:	1.386693	F-statistic:	9.677836
Log likelihood:	−70.36693	Sample range: 1968–89	
Observations: 22		Convergence achieved after 4 iterations	

domestic and foreign crude in year t, and the amounts of domestic and foreign oil purchased for the reserve be denoted by $Ad(t)$ and $Af(t)$. Then the annual cost of additions to the reserve can be estimated by:

$$A(t) = Cd(t) \cdot Ad(t) + Cf(t) \cdot Af(t) \quad (3)$$

The cost of the reserve in 1985 can be estimated by calculating the cost of additions, $A85$, to the reserve in 1985 plus lost interest on a fund, $F(t)$, equal to the money spent on the reserve and accumulate interest. The fund in year t is given by:

$$F(t) = F(t-1) \cdot [1 + i(t)] + A(t) \quad (4)$$

where $A(t)$ is defined above and $i(t)$ is the long-term interest rate on government securities. The values for Cd, Cf, Ad and Af are from DOE. [28] The values for $i(t)$ are from CEA.[29]

The cost in any year has two parts. First is the interest on the forgone capital account. The second part depends on whether there are, or should be, continuing additions (or withdrawals) to the reserve. If the size of the reserve was at an optimal steady state in 1985, then the interest in that year would be the correct estimate. If the optimal size of the reserve is growing at a steady rate over time, and the size of the reserve was optimal in 1985, then the correct estimate of cost is given by:

$$F(85) = F(84) \cdot [1 + i(85)] + A(85) \quad (5)$$

which equals US$3.2 billion. Of this amount, US$2.1 billion is interest and US$1.2 billion is additional purchases. Of the two estimates, the

Table 6. Defence spending price deflator, deflated defence spending, change in defence spending, oil imports.

	Defence	*IPDGNP*	*WARDEF*	*CWARDEF*	*OILMPTS*
1968	79.10000	37.70000	209.8143	5.357498	2.840000
1969	78.90000	39.80000	198.2412	−11.57310	3.170000
1970	76.80000	42.00000	182.8572	−15.38400	3.420000
1971	74.10000	44.40000	166.8919	−15.96529	3.930000
1972	77.40000	46.50000	166.4516	−0.440308	4.740000
1973	77.50000	49.50000	156.5657	−9.885895	6.260000
1974	82.60000	54.00000	152.9630	−3.602707	6.110000
1975	89.60000	59.30000	151.0961	−1.866898	6.060000
1976	93.40000	63.10000	148.0190	−3.077103	7.310000
1977	100.9000	67.30000	149.9257	1.906708	8.810000
1978	108.9000	72.20000	150.8311	0.905396	8.360000
1979	121.9000	78.60000	155.0891	4.257996	8.460000
1980	142.7000	85.70000	166.5111	11.42200	6.910000
1981	167.5000	94.00000	178.1915	11.68040	6.000000
1982	193.8000	100.0000	193.8000	15.60851	5.110000
1983	214.4000	103.9000	206.3522	12.55220	5.050000
1984	234.3000	107.7000	217.5488	11.19659	5.440000
1985	259.1000	110.9000	233.6339	16.08510	5.070000
1986	277.8000	113.8000	244.1125	10.47861	6.220000
1987	294.8000	117.4000	251.1073	6.994797	6.680000
1988	298.0000	121.3000	245.6719	−5.435394	7.400000
1989	302.8000	126.3000	239.7466	−5.925308	7.980000

choice depends on assumptions regarding the optimal size and growth of the reserve. Per barrel of imported crude oil and petroleum products, the two estimates of the subsidy from the strategic petroleum reserve equal US$1.15/bbl and US$1.75/bbl.

CONCLUDING REMARKS

The 1991–92 budget proposed by President Bush contains less than US$1 billion for research in alternative energy technologies, compared to the 1985 estimates of US$14.8 billion per year for additional defence spending attributable to oil imports prior to the Gulf War and US$2.1 to US$3.2 billion per year for the strategic petroleum reserve. The above estimates depend on the level of oil imports, which equalled five million barrels per day in 1985 and rose to eight million barrels per day by 1989. These estimates do not include the time period spanning the recent Gulf War.

The combined estimates of increased defence spending and the strategic petroleum reserve equal US$8.47 to US$9.07 per barrel of imported oil in 1985. Were the price of oil 50% higher than the market price, and were the price stable, investment in solar, wind, geothermal and energy efficiency would be substantially greater than today.

Two final points are these. Investment in energy equals 20% of all investment in the economy. Many of these investments (power plants, building design, pipelines) last for 50 years or more. There is a large divergence between the social cost of energy and the price because of environmental externalities associated with conventional energy sources, as well as the security subsidies developed here.[30]

The philosophy of the administration is to rely on market prices to determine 20% of the investment in the economy. Misplaced investments based on such a policy carry over for more than half a century. The policies of the administration reflected in the NES will result in gross economic inefficiency.

This paper is a revision of a paper, presented before the Gulf War, in July 1990 at the 65th Annual Conference of the Western Economic Association. I am grateful for comments from Alejandra Edwards, and an anonymous referee.

[1]For example, see Ian Anderson, ' "Black Gold" obscures green vision in US', *New Scientist*, Vol 129, No 1756, 16 February 1991, p 14.
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