

**THE OIL PRICE COLLAPSE AND
GROWING AMERICAN VULNERABILITY**

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The World Oil Supply Will Reconcentrate in the Persian Gulf - With Potentially Grave Consequences

The Saudi decision at the end of 1985 to end its policy of propping up the world price of oil, a policy which required it progressively to reduce its oil production on a path towards zero production, has caused the price to plunge by more than one-half since 1985. This price collapse - if it persists - will produce three direct and inevitable effects:

1. Over time, there will be a substantial increase in the world demand for oil.
2. There will be a reduction in the supply of oil in the high cost regions of the world, especially North America.
3. These two trends will increasingly shift the supply of oil back to the world's lowest cost supply area, that of the Persian Gulf.

This reconcentration of supply in the Gulf area will bring about two further major consequences:

1. At some point, the growth in the world oil market share of the Persian Gulf producers will give them (or rather return to them) enough market power to raise prices substantially.
2. As long as the price remains low (around \$15 a barrel in 1985 dollars), growth in the Gulf producers' share of the world oil market will steadily increase the exposure of the oil importing nations to supply disruptions in this politically destabilized region. The result could be another major economic shock for the West, on the scale of those of the 1970s or worse. This increased market share would also heighten the danger to Western security if these huge reserves, or any appreciable part of them, were to come under the influence or direct control of the Soviet Union. If Soviet influence grows, there could be not only another great economic shock but a security disaster for the West.

In short, the sharp fall in price, which is costly to oil and gas producing areas and has resulted in a sharp cut in oil sector investments, is, overall, clearly beneficial to the oil importing countries. But this decline is creating the conditions for future serious economic and security problems. The more evident prospect is the reconstitution sooner or later of an effective producers' cartel; the less obvious - and potentially more serious

one - is the growing cost to the importers if another disruption occurs. It is important to recognize that these two categories of cost/risks are opposed phenomena: the longer the price stays low (to the current benefit of the oil importers), the higher their loss from any future disruption that occurs and vice versa.

Recalling Past Traumas

In the mid-1960s, the non-Communist world's dependence on Persian Gulf oil was modest: around 30%. This meant that small supply disruptions there (and there were many small ones before 1973), hardly disturbed the oil market. But there was a rapid growth in the world demand for oil in the late 60s and early 70s and this demand was met by rapidly increased supply from the low cost supply region, the Persian Gulf - and at a gradually lower real price. This growth in Persian Gulf supply set up the economic conditions for the highly disruptive shocks of the 1970s.

Moreover, while the West's economic dependence on the region was growing, its political and military influence there was declining. In particular, the British decision in 1968 to withdraw its forces from East of Suez - at a time when the United States was burdened with Vietnam and unwilling to take Britain's place in the Gulf - set up the political conditions for later disruptions, or at least

removed an important obstacle to them. The U.S. hoped that the "twin pillars" of strength in the Gulf, Iran and Saudi Arabia, could maintain stability there. At the time, this seemed a doubtful proposition and it turned out to be disastrously wrong.

It is important to remember that the damage done by the oil shocks in the 1970s was the direct result of high dependence on Persian Gulf supplies. During this period there were three abrupt supply cuts which sharply boosted the price of oil and caused economic dislocation in much of the world:

- 1973/1974 During and after the Arab-Israeli war when most of the Arab producers reduced production;
- 1979/1980 When Iranian production collapsed after the fall of the Shah, and Iraqi exports were largely blocked after the outbreak of the Iran-Iraq war.

These supply cuts produced the following estimated losses to U.S. GNP:

1973/74	5.0%
1979/80	3.0%

There were also comparable economic losses in other oil importing nations.

It was the sharpness of the price increases that caused most of the damage. Industrial economies are always

experiencing changes in commodity prices and can adjust easily to sharp price changes in commodities whose weight in those economies is small. But oil makes up too large a part of the world's economies for sharp price changes to occur without major economic dislocations. Not only were great losses suffered in the immediate aftermath of these oil price shocks, but an important cause of the prolonged economic slowdown in the West since 1973 can plausibly be attributed to the shifts in the factors of production made necessary by the large increase in the price of oil and to the frictions in adjusting to large and rapid relative price changes.

The high oil price caused by events in the Gulf, with a lag, produced a large market response. The period from the late 1970s to 1985 saw a major reduction in the non-Communist world's oil consumption and a large increase in non-Persian Gulf - and non-OPEC - supplies. Combined, these market forces greatly reduced the ratio of oil use to economic output throughout the world, reduced the share of world oil from the Persian Gulf area and therefore enormously reduced the potential price rise - and damage potential - from any further supply disruptions.

During this period, the U.S. also reduced its oil use substantially (from 18 million BD in 1977 to 15 million BD in 1985) while U.S. domestic supplies held relatively steady. As a result, there was a one-third fall in U.S. net oil imports. We also built up the Strategic Petroleum

Reserve. These developments further reduced the potential loss to the U.S. economy from external oil market dislocations.

During the 1970s, the U.S. had no major military presence in the area. Most of our defense activity there was centered on supplying arms to Iran and Saudi Arabia. However, at the end of the 1970s, we became much more directly engaged as a result of further oil supply disruptions and, especially, Soviet actions. It became evident that we had a strong interest in protecting the oil supply of the West and a need to do so. Saudi Arabia, Oman, and others, especially after the Islamic Revolutionary Party came to power in Iran in 1979, had a desire to be protected (although the Arabs have wanted protection without an American presence on the scene). We also had an even stronger interest in keeping the Soviet Union from dominating the area. This latter interest was threatened by the Soviet Union's move into Afghanistan and our response was the Carter Doctrine. Jimmy Carter, in his State of the Union address in January 1980, said:

"Any attempt by an outside force to gain control of the Persian Gulf region will be regarded as an assault on the vital interests of the United States of America. And such an assault will be repelled by the use of any means necessary including military force."

The assertion of this Doctrine was followed by the creation of the Rapid Deployment Force (which evolved into the Central Command), facility access agreements with

Kenya, Oman, and Somalia, the expansion of facilities and materials stockpiling at Diego Garcia, various cooperative measures with Saudi Arabia, the stationing of carrier strike forces in the Arabian Sea, and other preparatory actions.

In short, our exposure to disruptive losses had grown - and was not noticed at the time - from the mid-1960s. Several oil supply disruptions together with the Soviet move into Afghanistan finally made us acutely aware that we had a vital stake in the region that needed to be defended.

Two conditions are necessary for the U.S. to be dangerously exposed to oil market disruptions:

1. Without a high concentration of world production in a comparatively small and vulnerable region, a supply disruption there would not have a major impact; i.e., cause the world oil price to rise greatly.
2. Without a high U.S. import share, a surge in the oil price would not cause a wealth transfer to the oil exporters. However, even if the U.S. import share were zero, the U.S. would still be damaged by the domestic economic dislocations caused by a sharply higher world oil price and by reduced exports to our economically impacted trading partners.

In addition, any major extension of Soviet

influence over the Gulf area would seriously hurt Western security interests.

Because several producers of this area, Saudi Arabia especially, have been able and willing to adjust production to promote their economic (and non-economic) goals, they have been the residual or swing suppliers to the world; that is, they have not often behaved as competitive producers. This role has caused their production share to fluctuate widely over time.

Persian Gulf Producers' Share of Non-Communist
World Oil Production

1965	31%
1970	35%
1975	44%
1980	39%
1985	22%

This pattern parallels and is largely responsible for the rise and decline in OPEC's market share over the same period, but has a somewhat different significance. The Persian Gulf share of world oil production is both an index of the potential power of the producers of this region over the price of oil and also of the potential loss to oil importing nations from political disruptions in this area.

U.S. imports have also "swung" along with the Persian Gulf share of world oil production.

Share of U.S. Oil Imports to Total Oil Use

1965	18%
1970	22%
1975	37%
1980	38%
1985	31%

Both the Gulf producers' share of world production and the share of imports in U.S. consumption have been positively correlated in the past because they have been responsive to the same market forces. As the rest of the world became more - or less - dependent on Persian Gulf oil, so also the U.S. became more - or less - dependent on oil imports.

These two "shares" are indicators of the U.S. exposure to economic losses given a sharp run-up in the oil price. The first, the Persian Gulf share of the world total, is an indicator of the macroeconomic loss from a given disruption in oil supply caused by rigidities in the U.S. and other economies. Such a sharp price run-up requires real wages to fall and the substitution of capital and labor for energy. History has shown that these shifts are not made smoothly. The second series, the U.S. import share, is an indicator of the transfer of wealth to foreign suppliers from a given price increase. Both effects are important: the former, economic dislocation, is responsible

for about two-thirds of estimated GNP losses and the latter, the transfer to foreign producers, for about one-third of the estimated losses.

The swing in our potential losses in GNP from these several factors is shown in Figure 1 for the period 1965 to 1985. Two levels of disruption are shown as indicators of our exposure: 1) one-half of Gulf oil supply being denied to the world market, and 2) all Gulf supply being denied, both for one year. The estimated loss in U.S. GNP from the resulting price run-up is comprised of the loss of economic output and the wealth transfer to oil exporters from the higher price. Figure 1 also shows losses suffered from the actual 1973/74 and 1979/80 disruptions.

Our potential losses were low in the mid-1960s and grew rapidly through the mid-1970s. They then fell sharply in the early 1980s. By 1985, exposure to this set of dangers had receded to a low level: the share of Persian Gulf oil in the world market was back down to about its 1965 level, there was excess production capacity outside of the Gulf, U.S. imports had receded substantially from their peak (but were still well above the mid-1960s level), and the Soviet Union was having trouble pacifying Afghanistan. The American perception that there was a fundamental underlying problem had also receded.

Looking Ahead

The late 1980s is now seeing these favorable processes of the early 1980s go into reverse. In terms of Persian Gulf dependence and exposure to potential losses, the latter half of the 1980s is shaping up as a re-play of the experiences of the latter half of the 1960s and early 1970s.

The basic energy fact is that the world's cheap oil is mostly in the Gulf region: 57% of the world's proven oil reserves and 64% of the non-Communist world's oil reserves are there and an even higher proportion of its low cost ones. Estimates of probable but unproven reserves reinforce the continuing crucial importance of this region for the world's supply of oil.

Although the trend towards greater Gulf dependence is clear, there are several major uncertainties, both on the demand and the supply sides in looking to 1990 and beyond:

1. OPEC's behavior is one major source of uncertainty. It has never demonstrated much cartel cohesiveness; instead, the key influence on the market has been Saudi Arabia. But, as the recent price collapse has shown, Saudi Arabia cannot control the market on its own indefinitely. However, while the oil price

stays low, excess capacity will be squeezed out of the system, especially in the non-Persian Gulf OPEC countries. As excess capacity shrinks, the ability of Saudi Arabia together with several other producers, to manipulate the price will grow. Nonetheless, experience suggests that OPEC will continue to have great difficulty in regulating its production over any extended time period.

2. The long-term price elasticities of demand and supply for oil have been demonstrated over the past 15 years to be high. But will the responses of demand and supply to a sharp fall in prices be symmetric with the responses to the sharp rise in price of the 1970s? To put it differently, will the time lags of response on the demand and or the supply side be similar to those in the past 15 years?

U.S. consumption fell only with a lag of years after the 1970s price increases. Now, if consumers and businessmen expect the current period of low prices to be short-lived, they will continue to buy energy-efficient equipment. On the other hand, consumers with an ability to switch fuels will consume more oil now and still be in a position to switch back quickly to non-oil fuels if the price rises.

Evidence so far in 1986 shows a significant increase in U.S. demand, up about 3% cumulatively through July, 1986, by comparison with the year earlier period. This implies an end to the pattern of decline in oil use per dollar of the GNP.

Early indications also suggest an early major impact of the price fall on non-OPEC supply. There has been a record low usage of drilling rigs since World War II, a sharp fall in oil company exploration and development investments and the beginnings of a shut-in of high cost production. On the other hand, a substantial part of the revenue loss has been in the form of government taxes, there are likely to be some further efficiency improvements in the oil producing sector from the price squeeze, and the development projects now being squeezed out presumably are the high cost, marginal ones. Nonetheless, the evidence points to a marked fall-off in supply in the next several years if the price stays near or below \$15 a barrel.

These uncertainties suggest that both demand and supply could respond relatively rapidly to the price fall.

But demand or supply or both might respond

slowly for the reasons described. Also, governments might intervene to slow the rise in demand, to raise revenues, or to stimulate supply, or for all three reasons. Such actions would slow the response of the market to a low price regime, that is, they would extend the period of a low world oil price.

3. Future world economic growth is also uncertain. The cumulative effect of a 1% per year difference (say 3% vs. 2%) in annual world GNP growth, other things being equal, would produce about a 10% difference in the world demand for oil by 1995. Given the fact that the Persian Gulf area is the main swing oil supplier to the world, that area would experience a much larger response in its oil production.
4. Other uncertainties that affect both the steady state price of oil and the impact of possible disruptions include the willingness of the Persian Gulf producers to expand output, the size of oil shipments from Communist countries, and the amount of spare capacity in the world outside of the Gulf at the time of any disruption there.

The Key Parameter Is the Long-Term Average Price of Oil

In the short term (several years), because of low price elasticities of demand and supply, the oil price will be determined largely by decisions of Saudi Arabia and other major oil producers to adjust their production levels. Over the longer term, the price will also be strongly affected by world economic growth, the response of consumers, the response of higher cost suppliers, and the actions of governments. Within wide bounds, we do not know - nor does anyone - what the price path for oil will be over the next 10 to 15 years. The simplest way to summarize the behavior of these several uncertain parameters is to assume two price paths from now to 2000, a high path and a low one.

The Low Price Path

We have chosen a price of \$15 a barrel in 1986 dollars for the low price, as one that is highly likely to be below the expected price but can't be ruled out as a possibility (especially for the rest of the 1980s and the early 1990s). We show in the Appendix the values of key parameters which would be broadly consistent with such a price path. In this case, we have chosen assumptions that minimize the resulting dependence of the oil importers on

Persian Gulf oil: i.e., we assume that demand will grow more slowly, that non-OPEC supply will hold up better, that spare production capacity will be larger, etc., than seems likely at this price. Even so, 31% of world's oil supply would come from the Persian Gulf area in 1990 (up from 22% in 1985) and 46% in the year 2000. By then, the United States would be importing 58% (10.6 million BD) of its oil.

The High Price Path

The high price path assumes a rapid ramping up of the price from today's level of around \$12-\$15 per barrel to \$35 per barrel (in 1986 dollars) by 1990, and then staying at that level to 2000. Again, in this case we make assumptions which minimize the Gulf concentration problem. Still, 26% of non-Communist world oil supplies would come from the Gulf in 1990 and 30% (15 million BD) in 2000. In that year, the United States would depend on oil imports for 43% (6.8 million BD) of its oil -- much less than in the low price case, but a significantly higher proportion than today.

Estimated Losses From Future Shocks

Based on these assumptions, we have calculated the potential loss to U.S. GNP from a major disruption of supplies, year by year over time into the future. Figure 2

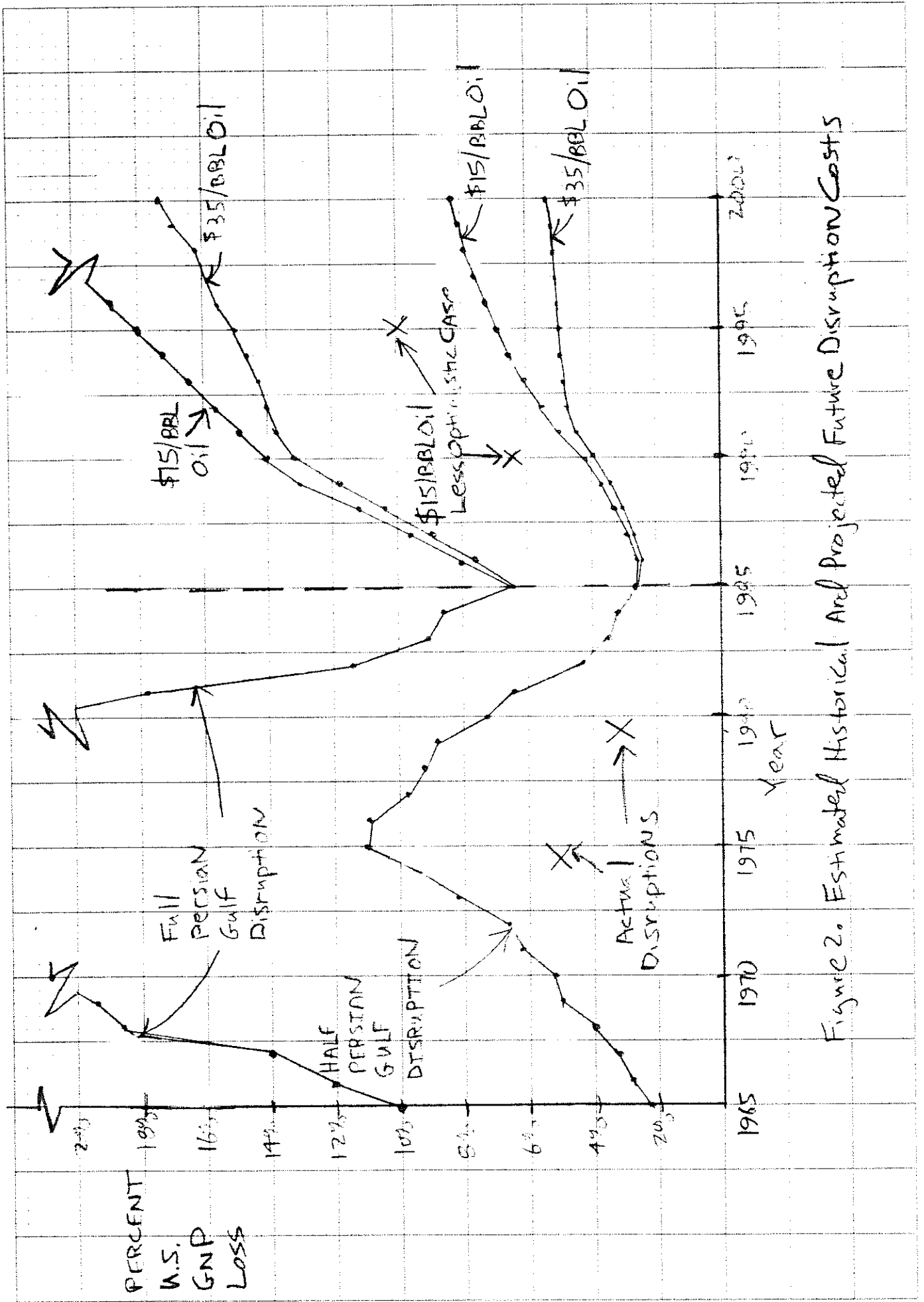


Figure 2. Estimated Historical And Projected Future Disruption Costs

continues the story of Figure 1. It shows the estimated losses to the U.S. economy from a year-long disruption of Persian Gulf supplies, from now to the year 2000 on the same assumptions as Figure 1: a loss of one-half of the area's supply for a year, and the loss of all of its supply.

Figure 2 shows that the low point in potential loss was in 1985. Looking ahead, the loss potential grows steadily: it grows slowly if the oil price follows a high path and grows rapidly if the price stays low through the 1990s. In the low price case, the estimated GNP loss to disruption of one-half of the Persian Gulf supply for a year doubles between 1985 and 1990 (from 2% to 4% of GNP - the latter level being approximately the level of GNP loss suffered in 1973/74 and in 1979/80) and doubles again to 8% by 2000. Even along the high price path, the estimated GNP loss doubles between the 1985 low and the late 1990s.

Although Figure 2 shows a broadly symmetrical pattern centering on 1985, the future estimated disruption exposure is somewhat lower than in the past because:

1. In the near term there remains some spare oil producing capacity outside of the Gulf;
2. And oil has become less important in the economies of the oil importing countries over the past 15 years. For the U.S., the ratio of oil use to GNP has fallen by about 35% since 1973.

Looking ahead, both of these "cushioning" factors erode, especially on the low price path, although even by 2000 the oil to GNP ratio is unlikely to reach its high 1973 level.

We reiterate that these loss estimates are based on optimistic assumptions: the potential for losses might well grow more rapidly. Figure 2 also shows the estimated GNP loss from disruptions in 1990 and 1995 using less optimistic assumptions. (These less optimistic estimates correspond more closely to projections in several recent studies by the Energy Information Administration, the Congressional Budget Office, the DOE Policy Office, Chevron, the American Petroleum Institute and DRI.) The exposure to loss grows markedly more rapidly than in the optimistic case. By 1990, the potential loss on this less optimistic case is almost three times the 1985 level.

The steepness of the gradient of our exposure to loss is an important parameter because of the long lead times that would be entailed if we decide to take additional steps to limit this exposure or damage resulting from it. This is true of significant additions to strategic petroleum stocks, measures to limit oil consumption, or to increase non-Persian Gulf supplies. All of these measures take years to have an appreciable effect. If prospective exposure around 1990 looks dangerously high, the time to face this danger is now.

Figure 3 shows the same, base-case, contingencies

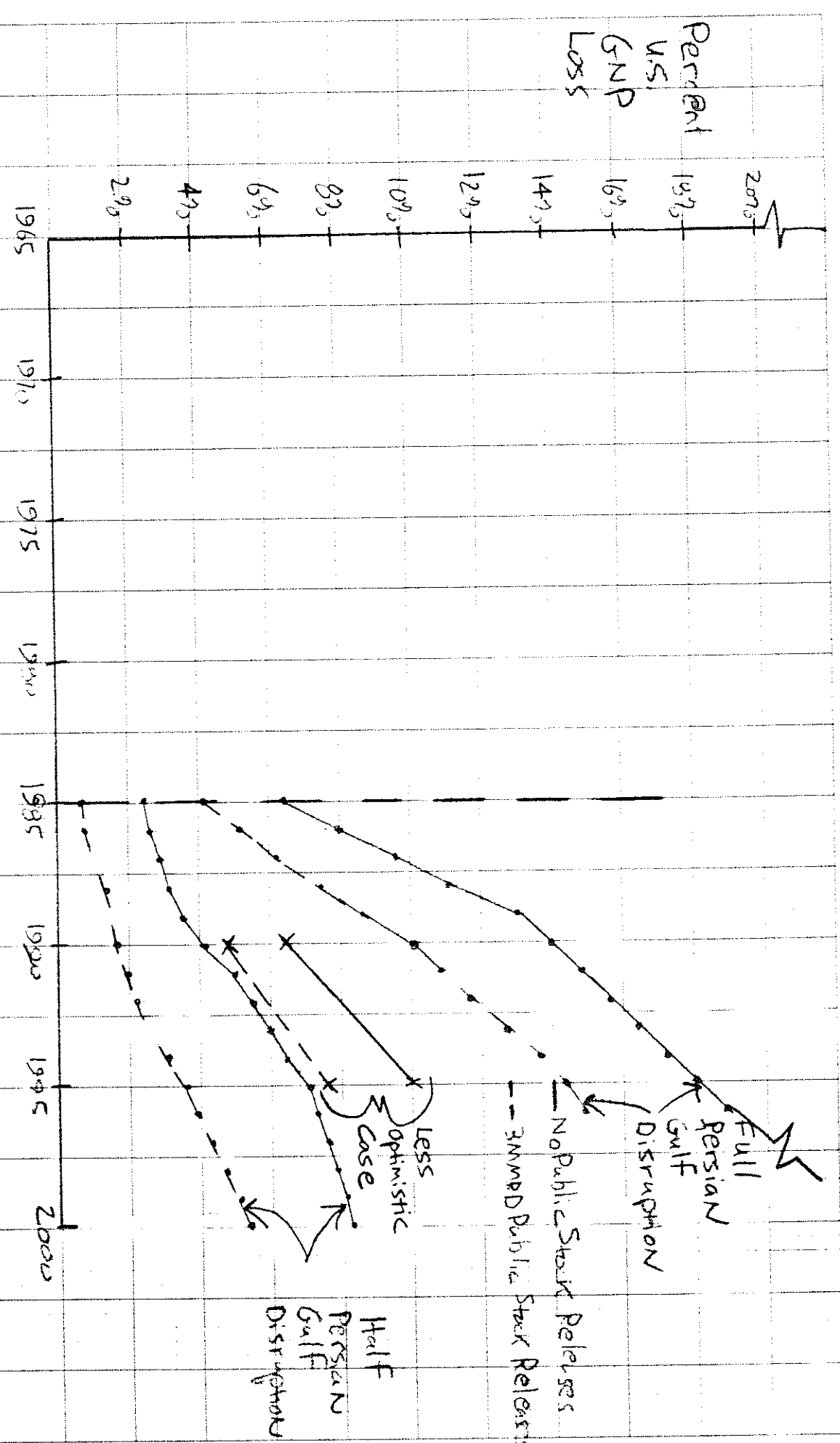


Figure 3. Impact of 3MMPD worksheet Releases on Low Price Path Disruption Costs

of supply disruption over time, but allows for the effect of the use of the world's strategic petroleum stockpiles. Assuming that these are released at the rate of 3 million BD during the disruption (an assumption which is consistent with the estimate that world government-owned and mandated stocks are now over 1 billion barrels), the predicted GNP loss is reduced by about one-third, but the resulting damage is still very large.

The Political-Military Prospects

Several possible sources of further trouble within the Persian Gulf area can be identified including:

- A widening of the Iran-Iraq war;
- Victory by Iran followed by radical political changes in Iraq and perhaps throughout the Arab side of the Gulf;
- Overthrow of the regime in Saudi Arabia;
- Renewal of severe factional fighting within a post-Khomeini Iran.

The domestic stresses resulting from the sharp reduction in income in the area, and in the Middle East generally, may increase the likelihood of political troubles. This is most worrisome with regard to Egypt with its very large, poor population. Although Egypt is outside of the Gulf area, a political upheaval there could have spill-over effects in the Gulf.

Internal disruptions would not necessarily be as deep or have as long-lasting effect on the supply of oil as we assumed in the estimates presented in the Figures, but the repetition of the kind that the West has suffered would be damaging enough. As to the duration of a possible supply restriction, Iranian production has been far below its level of the 1970s for 8 years and the Iran-Iraq war has gone on for 7 years.

Most serious among the contingencies would be increased Soviet influence in the region, a possibility which is widely under-estimated. Soviet military forces are only 600 miles from the head of the Gulf and 400 miles from the Strait of Hormuz. The Soviet ability to airlift troops over the comparatively short distances involved is much greater than our capacity to airlift troops the far greater distance from the United States. Soviet forces can roll into the region on wheels and tank treads; we have to load and unload ships and aircraft - and then roll on wheels. It also has a military presence in South Yemen. It is pressing Pakistan with increasing vigor. It is a major arms supplier to Iraq - and a minor one to Iran and it would doubtless try to increase its influence in a post-Khomeini Iran. The possibility that a combination of local developments and Soviet action will produce a significant increase in Soviet influence over the next 10-15 years should not be seen as remote. Two contingencies seem especially important:

-- The Soviets are increasing cross-border military operations into Pakistan, are supporting internal opposition to President Zia, and are adopting a more threatening diplomatic stance. The destabilization of Pakistan could result in a pro-Soviet regime there (analogous to the outcome of the 1978 coup in Afghanistan), the consolidation of Soviet power in Afghanistan, and intensified pressure on Iran - not only directly from the Soviet Union but via Afghanistan and Pakistan.

-- The Soviets can be expected to try to influence the character of the government of a post-Khomeini Iran. Especially if there are sharp internal divisions, the Soviets might intervene with their own military forces in Iran (for the third time in this century.)

One or the other of these two contingencies (or perhaps others) could bring Soviet military power to the shores of the Persian Gulf or the Arabian Sea. A marked increase in the Soviet military presence, or less direct influence, would put it in a position to affect, if not directly control, the flow of oil from the Gulf. Even with the reduced share of oil in the world energy economy over the last decade and even with today's relatively low dependency on the Gulf (about 25% of non-Communist world supply as of summer, 1986), such influence would give the Soviets great political leverage over the rest of the

world. This leverage would be much the higher if Western oil dependence on the region grows as we show over the next decade.

Short of any major geo-strategic change which would bring Soviet power to the shores of the Gulf, any disruption of supply there would benefit the Soviet Union. That country, as an oil exporter, was among the chief beneficiaries of the oil price run-up after 1973 and it is among the main victims of the recent fall. Soviet hard currency earnings have fallen by nearly one-half as the result of the oil price decline. Without postulating the means by which the Soviets might contribute to an early supply disruption in the Gulf - and there might be no viable ones - it is important to recognize that they have a financial interest in such a disruption.

Our oil security-of-supply problem is not to a significant extent that of having enough fuel for our military forces. They use only about 2% of our total consumption now; in a major crisis they might take five times or more as much. But military uses would be at the head of the queue and civilian uses would be cut. In short, the dominant function of our military forces, insofar as they are relevant to contingencies in this area, are, primarily, to help assure the continued production of oil at the source and to protect its transportation to oil importing nations.

We are in a strategically poor position to block a

Soviet move. Our friends in the area have been unwilling to provide us with the facilities needed to defend their and our interests against a Soviet move (nor have we been eager to put forces there). We have no forces on land stationed in the immediate area and even when significant naval ones are there, they have only a modest capacity to project power ashore - where it matters most. The Europeans and Japanese are unwilling to do very much. The Turks, whose location makes them potentially a key player, will not commit themselves to helping in Persian Gulf contingencies. In short, the Carter Doctrine commits the United States to an important but difficult task. This is not to suggest that it is beyond our capacity, but it is not assured.

Unlike the potential costs of disruption, we do not have a quantitative estimate of the security cost of implementing the Carter Doctrine. There are several reasons: the forces that would be involved are mobile and most if not all would exist to deal with contingencies elsewhere in the world even if the Persian Gulf didn't exist. Some of the relevant facilities and programs are also potentially dual-purpose. For instance, airfields in Eastern Turkey which would be crucial to the outcome of a Soviet military move into Iran were developed for NATO contingencies. Another joint-purpose example is our economic and military aid to Pakistan. This aid is motivated not only by a desire to preserve its internal stability and to help it to

resist Soviet (and Indian) pressure, it is an integral part of our effort to aid the resistance in Afghanistan. Finally, even if there were no oil in the Persian Gulf, we would have an interest in containing Soviet expansionism to South Asia and beyond.

Still, some part, if modest, of our defense budget is no doubt attributable to the security threat to Persian Gulf oil. Whatever that amount is, it should grow as our loss exposure to this region's oil climbs, as shown in Figure 2.

Some perspective on the relationship between the costs of protecting the area versus our potential losses is the fact that a disruption on about the scale of those we have suffered in the past, 3% - 5% of GNP, would cost us today \$120-\$200 billion over one year; and we show much higher potential losses than these in Figures 2 and 3. For contingencies involving the Soviet Union, the economic and security costs could be much greater, allowing for the costs of mobilization and even conflict. By comparison, presumably only a comparatively small proportion of the \$300 billion U.S. defense budget is now incrementally assignable to the defense of our Persian Gulf interests. We surmise that future potential economic losses and security risks far exceed today's relevant defense expenditures.

Conclusions

The U.S. and the rest of the oil importers are headed on a course similar to the one taken twenty years ago. Then, we all allowed our dependency on Persian Gulf oil to increase greatly while the main prop to regional stability was withdrawn. We are again allowing this dependency to grow while the general security situation there - both within the region and with respect to the Soviet Union's presence - is much more ominous than it appeared twenty years earlier. We paid heavily for these errors in the past. It is worth a great deal not to have them repeated and, even more, not to experience much worse ones. Although there is uncertainty on how long it will take for this dependency to grow to a dangerous level, our less optimistic projection suggests that this could occur by around 1990. Given the lead times involved in taking forestalling actions, now is the time to face up to this coming danger.

APPENDIX

It is impossible to predict the exact trajectory of oil prices over the balance of this century. Moreover, our main objective here is in examining the relationship between future oil prices and the oil import vulnerability of the United States. Consequently, we limit ourselves to two simple non-disrupted oil price paths that probably bound the range of plausible outcomes.

Low Oil Price Case

The low oil price case was constructed around a set of assumptions designed to be consistent with a constant \$15 per barrel (in 1986\$) price for world oil through 2000. In addition, to test our hypothesis that lower oil prices could lead to greater vulnerability to oil import disruptions, we picked assumptions that result in less dependence on Persian Gulf oil at the \$15 per barrel oil price than would our best estimates of oil consumption and non-OPEC production at that price level (a less optimistic set of assumptions is considered at the very end of this appendix; results for that case are also shown in Figure 2).

This is not a baseline forecast. Indeed, increasingly optimistic assumptions about Persian Gulf oil supplies have to be made in order to keep oil prices at the \$15 per barrel level. By 1990, the current excess capacity in the Gulf is assumed to be absorbed, so it is necessary to assume that the Iran-Iraq war has wound down to the point where those two countries can resume their pre-war levels of oil production. By 1995 this additional capacity has been absorbed as well, so it is assumed that total

OPEC production capacity is increased to 41.3 million barrels per day by 2000 (this to insure that it is only 85% utilized, pre-empting upward pressure on oil prices and explains the increase in spare capacity shown in this case), primarily through increases in Persian Gulf production capacities. These capacity additions are feasible at this price level, but there is no guarantee that the Gulf producers will find them in their own best self interest. The assumptions for this case are shown in the middle of Table A-1, with the corresponding historical data shown at the top of the table.

High Oil Price Case

The high oil price case was constructed around a set of assumptions designed to be a counter point to the low oil price case. OPEC is assumed to re-establish its role as a price setter by 1987, and to be able to increase the price of oil by \$5 per barrel (in 1986 dollars) in each year until 1990. The resulting \$35 per barrel 1990 oil price is assumed to be maintained throughout the 1990s. OPEC's sustainable capacity remains at 26-27 million barrels a day, which helps maintain the \$35 per barrel price at utilization rates that do not reach the 80 percent level until nearly 2000. No growth in non-OPEC supply and little in non-Persian Gulf OPEC supply help insure the success of this price maintenance strategy. Unlike the low price path which gets harder to justify as we move into the 1990s, given current market trends the high price case is hardest to envision during the late 1980s. The assumptions for this case are shown at the bottom of Table A-1.

Disruption Cost Estimates

The calculation of the costs of oil supply interruptions was done in three steps: (1) assume a size for the disruption based on the pre-disruption market balance, (2) calculate the world oil price during the disruption based on the pre-disruption world oil market balance and the size of the disruption, and (3) estimate the cost of the disruption based on the magnitude of the disruption price increase and the pre-disruption U.S. oil market balance.

Disruption Size. In the full Persian Gulf Disruption all Persian Gulf production and spare capacity is assumed to be unavailable for one year. In the Half Persian Gulf Disruption one half of all Persian Gulf production and spare capacity is assumed to be unavailable for one year.

Disruption World Oil Price. During the one year disruptions a total elasticity of oil demand of .25 is assumed. This figure includes oil demand (conservation, and fuel switching), oil supply and income level (feedback) effects. Under this assumption, a 52% price increase would be required to accommodate a 10% net short fall in oil supply, while a 144% increase would be required to accommodate a 20% shortfall.

Disruption Costs. According to the Energy Modeling Forum's study on macroeconomic impacts of energy shocks (EMF 7), a 50% increase in world oil price during 1983 would have resulted in about a 2.2% decrease in U.S. GNP. This was the median impact calculated with 14 models of the U.S. economy, including the widely-used DRI, Wharton, and Chase Econometrics quarterly macroeconomic forecasting systems. These models are fully articulated representations of the U.S. macroeconomy, including both product and financial market effects, and (for the EMF study) summary representations of the effects of an energy shock on non-energy trade

between the U.S. and its trading partners. The oil demand elasticities employed in the disruption price calculations (described above) are consistent with the inclusion of indirect effects on economic activity of the magnitude assumed here.

The 2.2% estimate is adjusted in two ways in the present study: (1) to take into account the changing role of oil in the U.S. economy, each 50% price increase is assumed to cause a GNP loss of 2.2% times the weighted average value share of oil in the economy during the 15 years preceding the disruption divided by its weighted average value share in the 15 years prior to 1983 (the averaging reflects the slow rate of turnover of energy using capital stock in our economy; for example, although the price of oil has fallen about 50% in the past year, most of our energy using capital stock was installed at a time when higher prices prevailed - thus in that equipment oil is currently worth more than its market price), and (2) the total GNP loss estimate for each disruption in each year is modified slightly to take into account terms of trade effects on the welfare of U.S. consumers that are not reflected in the conventional GNP estimates.

GNP loss estimates of greater than 20% calculated via this method are not reported in Figure 1-3. Such high losses would almost surely lead to significant government intervention or remarkable changes in consumer behavior, invalidating the assumptions upon which the original cost estimate was based.

Relation to Other Studies

This study can be related to other recent (i.e., post-price collapse studies) on three dimensions: (1) disruption cost estimates, (2) world oil price outlooks, and (3) oil supply and demand balances. Recent studies

by the Energy Information Administration, the Congressional Budget Office, the Department of Energy's Policy Analysis Office, Chevron Corporation, The American Petroleum Institute, and Data Resources, Inc. are referenced in Table A-2. These studies all express varying degrees of concern over the increasing level of U.S. oil imports that are projected at lower oil prices, but none includes any attempt to update the kind of disruption cost estimates that have been produced in the past.

In general, the low world oil price case considered here (constant \$15/BBL oil from now until 2000) is below that considered in the scenarios developed in these other studies, but the CBO, DRI, API, and DOE policy studies do include \$10/BBL scenarios which they agree are difficult to maintain for more than a year or two. Only the EIA study (which goes through 1995), and the DOE policy and Chevron studies (which go through 2000) go beyond 1991. Only the highest DOE Policy price scenario and the Chevron "High Trend" case reach the \$35/BBL oil price case (and not until about the year 2000) assumed for the entire 1990s in the high price case considered here; however, several of the EIA scenarios would likely reach that level if continued beyond 1995. Thus, our high price case generally considers higher world oil prices than anyone is currently projecting.

Since most of these studies consider a price scenario that is approximately \$15 until 1990 or 1995, it is possible to compare the assumed price responsiveness of oil supply and demand with that assumed here. This is done for U.S. oil supply and demand in Table A-2, where the 1990 and 1995 U.S. Oil supply and demand projections are differenced to the 1985 levels assumed in each study. In general, our supply and demand responses at the \$15/BBL oil price are on the optimistic side. This is as we had intended so as to avoid overstating the rate of increase in the oil import

vulnerability of the U.S.. To avoid understating the urgency with which this problem might re-emerge, we considered a less optimistic supply and demand case. The U.S. oil supply and demand assumptions for this case are shown in Table A-2, with the corresponding world oil balances compared with those for the optimistic case in Table A-3.

Table A-1
World Oil Market Assumptions for Disruption Calculations
(millions of barrels per day)

<u>Year</u>	<u>WOCA Demand</u>	<u>Non-OPEC Supply</u>	<u>CPE Exports</u>	<u>OPEC Supply</u>	<u>OPEC "Spare" Capacity</u>	<u>Non-Gulf OPEC Supply</u>	<u>Persian Gulf Supply</u>	<u>U.S. Demand</u>	<u>U.S. Supply</u>	<u>U.S. Imports</u>
<u>Historical</u>										
1973	47.6	16.3	-	31.3	2.7	10.0	21.3	14.5	11.3	5.9
1975	44.9	16.3	1.1	27.5	6.5	7.8	19.7	15.9	10.0	5.9
1980	48.6	19.8	1.3	27.5	3.5	8.7	18.8	16.5	10.2	6.3
1985	46.3	27.8	1.8	16.7	9.3	6.6	10.1	15.1	10.5	4.6
Growth Rate	(-0.2%)	(4.5%)	(5.0%)	(-5.1%)	(10.9%)	(-3.4%)	(-6.0%)	(-0.9%)	(-0.4%)	(-2.1%)
<u>Low Price Case</u>										
1990	50.6	26.4	1.5	22.7	4.0	7.0	15.7	16.1	9.5	6.6
1995	55.3	25.1	1.5	28.7	5.1	7.0	21.7	17.2	8.6	8.6
2000	60.7	23.9	1.5	35.1	6.2	7.0	28.1	18.3	7.7	10.6
Growth Rate	(1.8%)	(-1.0%)	(-)	(5.1%)	(-2.7%)	(.4%)	(7.1%)	(1.3%)	(-2.0%)	(5.7%)
<u>High Price Case</u>										
1990	47.4	26.5	1.5	19.4	7.6	7.0	12.4	15.3	9.7	5.6
1995	48.6	26.5	1.5	20.6	6.4	7.0	13.5	15.6	9.3	6.3
2000	49.9	26.5	1.5	21.9	5.1	7.0	14.9	15.8	9.0	6.8
Growth Rate	(0.5%)	(-)	(-)	(1.8%)	(-3.9%)	(.4%)	(2.6%)	(.3%)	(-1.0%)	(2.6%)

Table A-2

Changes in U.S. Oil Consumption and Production Relative to 1985
Resulting from 15\$/BBL Oil (in Real 1986\$s) According to Various Studies

Study	Approximate Change in U.S. Oil Consumption (MMBD)		Approximate Change in U.S. Oil Production (MMBD)	
	1990	1995	1990	1995
EIA ¹	+1.6	+3.6	-2.0	-5.4
CBO ²	+3.0	-	-0.8	-
DOE Policy ³	+1.0	+2.4	-1.9	-3.7
Chevron ⁴	+2.0	-	-2.8	-
API ⁵	+2.2	-	-2.2	-
DRI ⁶	+1.9	-	-0.8	-
<hr/>				
<u>This Study</u>				
Optimistic	+1.0	+2.1	-1.0	-1.9
Less Optimistic	+2.4	+5.2	-2.4	-4.2

¹Energy Information Administration, "The Impact of Lower World Oil Prices and Alternative Energy Tax Proposals on the U.S. Economy" U.S. Department of Energy, Washington, D.C, April 18, 1986.

²Congressional Budget Office, "The Budget and Economic Effects of Oil Taxes," Congress of the United States, Washington, D.C. April 1986.

³Office of Policy Planning and Analysis, "Low World Oil Price Scenarios," U.S. Department of Energy, Washington, D.C. May 1986.

⁴Chevron Corporation, "World Energy Outlook," Economics Department, San Francisco, June 1986.

⁵American Petroleum Institute, "Two Energy Futures: National Choices Today for the 1990s, Washington, D.C., July 1986.

⁶Data Resources Inc., "Costs and Benefits of Lower Oil Prices: Whose Gain, Whose Loss," Lexington, MA, July 1986.

Table A-3
 World Oil Market Assumptions for Disruption Calculations - Less Optimistic Low Oil Price Case
 (millions of barrels per day)

<u>Year</u>	<u>WOCA Demand</u>	<u>Non-OPEC Supply</u>	<u>CPE Exports</u>	<u>OPEC Supply</u>	<u>OPEC "Spare" Capacity</u>	<u>Non-Gulf OPEC Supply</u>	<u>Persian Gulf Supply</u>	<u>U.S. Demand</u>	<u>U.S. Supply</u>	<u>U.S. Imports</u>
<u>Historical</u>										
1973	47.6	16.3	-	31.3	2.7	10.0	21.3	14.5	11.3	5.9
1975	44.9	16.3	1.1	27.5	6.5	7.8	19.7	15.9	10.0	5.9
1980	48.6	19.8	1.3	27.5	3.5	8.7	18.8	16.5	10.2	6.3
1985	46.3	27.8	1.8	16.7	9.3	6.6	10.1	15.1	10.5	4.6
Growth Rate	(-.2%)	(4.5%)	(5.0%)	(-5.1%)	(10.9%)	(-3.4%)	(-6.0%)	(-0.9%)	(-0.4%)	(-2.1%)
<u>Low Price Case - Optimistic Case</u> (Less Optimistic Case)										
1990	50.6 (53.7)	26.4 (23.9)	1.5 (1.5)	22.7 (28.3)	4.0 (5.0)	7.0 (7.0)	15.7 (21.3)	16.1 (17.5)	9.5 (8.1)	6.6 (9.4)
1995	55.3 (62.2)	25.1 (20.5)	1.5 (1.5)	28.7 (40.2)	5.1 (7.1)	7.0 (7.0)	21.7 (33.2)	17.2 (20.3)	8.6 (6.3)	8.6 (14.0)
Growth Rates	1.8% (3.0%)	-1.0% (-3.0%)	-	5.6% (9.2%)	-5.8% (-2.7%)	.6% (.6%)	8.0% (12.6%)	1.3% (3.0%)	-2.0% (-5.0%)	6.5% (11.8%)