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## The Impacts of Oil Disturbances: Lessons From Experience

T. Randall Curlee

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**THE IMPACTS OF OIL DISTURBANCES:  
LESSONS FROM EXPERIENCE\***

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## **ABSTRACT**

An analysis of the impacts of previous oil disturbances can be used to suggest the impacts of future oil disturbances. This paper reviews how the 1973-74 Oil Crisis, the 1978-79 Iranian Revolution, and the 1980-81 Iran-Iraq War impacted the U.S. and world oil markets. Various measures of impacts are considered, such as impacts on physical flows of crude and products, crude and product price changes on the U.S. and world markets, impacts on stocks of crude and products, and impacts on refiners' inputs and outputs. Various macroeconomic indicators, such as gross national product, inflation rates, and unemployment, are also considered. Of particular interest in this study are the impacts that oil disturbances have had (and could have) on the availabilities of particular crude types and the abilities of U.S. refiners to process crudes of various types in the short run. In addition, this paper reviews how the actions of the consuming countries and the major oil companies affected the impacts of past disturbances. The paper briefly discusses the likely causes and impacts of future oil disturbances and summarizes the lessons to be learned from past reactions to oil disturbances.



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## I. INTRODUCTION

In recent years the question of oil vulnerability has attracted increasing attention. Despite all the attention, a great deal of controversy remains concerning various issues. Controversy exists not only over the optimal response of the public and private sectors to probabilistic future oil disruptions, but also exists over the impacts of previous disruptions.

The controversy exists because the oil vulnerability problem is inherently complex and because different individuals measure the impacts of previous disruption, as well as the expected costs and benefits of measures to respond to future disruptions, using different yardsticks. Obviously, because of the complexity of the problem, no one yardstick or measure can be used to adequately address the oil vulnerability problem. Rather, various measures must be considered simultaneously, and a comprehensive analysis of those measures must be undertaken before an accurate picture of the impacts of previous oil disruptions can be drawn. Likewise, the same comprehensive analysis must be done before any decisions can be made concerning how the private and public sectors should respond to the probabilities of future oil disruptions.

This paper does not claim to provide such a comprehensive analysis of these relevant measures. Rather, the impacts of previous oil disruptions are reviewed using the measures chosen by those who have specialized in this area. They include macroeconomic measures, such as gross national product (GNP), inflation rates, and unemployment, as well as disruption impacts on physical flows of crude and products. Impacts on stocks of crude and products are considered, in addition to the impacts on contract and spot market prices for crude and products. The positive and negative aspects of using these various measures to gauge the impacts of oil disruptions are discussed briefly.

The major emphasis of this paper is on the United States' markets for crude and products. Of course, since the marginal source of oil in the U.S. is imports, the U.S. impacts cannot be considered independently of world impacts. However, a complete analysis of the world impacts of previous disruptions is beyond the scope of this paper.

The three major world oil disruptions that have occurred within the past ten years are considered: (1) the so called 1973 Oil Crisis, (2) the 1978-79 Iranian Revolution, and (3) the current Iran-Iraq War. In addition to reviewing the micro and macro impacts of these disruptive events, this paper briefly examines the major causes of the disruptions, as well as the roles the international oil companies and consuming nations played in increasing or diminishing the impacts of the disruptions.

Beyond reviewing the above mentioned impacts, this paper pays particular attention to how the U.S. oil refiners responded. The available data are examined to estimate if (1) the mix of crudes available on the United States' market (defined according to sulfur content and specific gravity) changed significantly as a result of the disruptions and (2) whether domestic refineries changed their mix of final outputs as a result of an altered crude input slate.

Finally, this paper examines the likelihoods of future oil disruptions in the Middle East and estimates the changes in the available crude mix on the world market that would result from the most probable disruptions. Domestic refinery capacity data are examined to estimate if a significant change in the mix of input crude would cause refiners to alter significantly their output mix. It has been speculated that a large disruption of light-weight, low-sulfur crude could produce a severe change in the available mix of crude on the world market. If the mix of U.S. crude imports changed accordingly, our fixed refinery capacity might not be physically able to produce the current mix of light and heavy products. Light-weight-product markets, such as gasoline, might be particularly hard hit by a disruption, relative to heavy-weight-product markets.

The remainder of this paper is divided into four main sections. Section II reviews the causes and impacts of the 1973 Oil Crisis. Sect. III reviews the causes and impacts of the 1978-79 Iranian Revolution and the current Iran-Iraq War. Section IV examines likely future oil disruptions and speculates on whether the most likely disruptions would have a significant impact on our domestic refinery mix. In the final section several general conclusions are drawn concerning previous disruptions. The final section also discusses how these conclusions suggest the impacts of, and proper responses to, future disruptions.

## II. THE 1973-74 OIL CRISIS

### A. Major Factors Leading to the Crisis

In order to understand what has been commonly referred to as the 1973-74 Oil Crisis, one must first understand the events which led to the crisis. This section contains a brief description of how the world market for oil changed in the years previous to 1973 and the factors which actually precipitated the crisis. Major emphasis is given to the United States' changing role in the world market for oil.

U.S. oil imports have exceeded exports since 1946, and from 1946 to 1955 U.S. oil imports quadrupled. This resulted primarily from the development of low-cost-crude production in Venezuela and the Middle East. As imports became an increasing threat to the U.S. oil industry, President Eisenhower imposed a mandatory quota on oil imports in March 1959. The effect of the quota, which restricted imports to a fixed percentage of domestic production, was to create a domestic oil price that was higher than the world price.

Domestic-oil-demand increases, coupled with increasing domestic-crude-oil-production costs, put increased pressure on the quota policy in the late 1960s. These pressures led to the loosening of the import quota in 1970. Oil imports surged, especially from the Middle East, and for the first time Saudi Arabia became a major supplier to the United States. Domestic policies, such as interstate natural gas price ceilings and environmental regulations on the production and use of coal and nuclear power, increased the domestic demand for oil. With the supply of imports highly elastic relative to domestic supply, most of the increases flowed to imported oil. In addition, the domestic price controls, initiated in August 1971, reduced investment and output in the domestic crude oil industry. Imports increased in the early 1970s, and just prior to the disruptive events of 1973, the United States imported 37.6% of total U.S. oil consumption. Product imports were approximately 2.4 million barrels per day and crude imports approximately 3.3 million barrels per day. Domestic production was approximately 9.6 million barrels per day. Approximately 1.3 million barrels per day were imported from Arab countries.

The series of events that led to the crisis of 1973 began in 1970. Although the Organization of Petroleum Exporting Countries (OPEC) was formed in 1960, its members did not begin to effectively use their international power until around 1970. In January 1970, the new radical Libyan government forced the oil companies operating within Libya to renegotiate their oil prices. Substantial increases in both prices and royalties were achieved. Perhaps the more important consequence of the Libyan renegotiations, however, was the strong support that Libya received from OPEC, and Algeria and Iraq in particular. Later in 1970, both Algeria and Iraq won concessions from the oil companies over prices and reinvestment plans in those producing countries. These events seemed to set off a series of successful price and benefit demands made by the producing countries.<sup>1</sup>

It has often been argued that one reason the Libyan demands were so easily won was the lack of a coordinated response by the oil companies operating in the Middle East. Libya put nationalization pressures on Occidental, an American independent, first. Since the independents had the most to lose from nationalization, they were the most vulnerable targets. An effective and coordinated stand by the majors against Libyan demands was not made partly because of antitrust fears in the U.S. and a lack of support for such a coordinated effort by the United States government.<sup>2</sup> Whatever the reasons, the major oil companies gave in to demands of Libya, Algeria, and Iraq and set a precedent of future concessions on prices and benefits.

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<sup>1</sup>See Penrose (1976) for a more detailed analysis of the events in the world market for oil that led to the Crisis of 1973-74.

<sup>2</sup>See Wilkins (1976) for more details.

## B. Sources of the 1973-74 Crisis

What must first be understood about the 1973-74 Oil Crisis is that it consisted of three interrelated but separate events: (1) an embargo on oil sales to the United States by the Organization of Arab Petroleum Exporting Nations (OAPEC), (2) a production cutback by most of the OAPEC nations, and (3) sudden, severe oil price increases by OPEC that occurred both previous to and during the embargo.

For the most part, experts believe the OPEC price increases resulted from economic conditions rather than an objective to impose economic costs on the consuming countries. Negotiations over oil prices had begun in September 1973 and on October 16, 1973 the six major crude oil producers in the Persian Gulf region — Abu Dhabi, Iran, Iraq, Kuwait, Qatar, and Saudi Arabia — agreed to raise the posted price of Saudi "marker crude" from \$3.011 to \$5.119 per barrel. [Marker crude (Arabian light 34°API) is the Saudi Arabian crude that serves as a base for the OPEC price structure.] Then on January 1, 1974 the OAPEC producers further raised the posted price of Saudi marker crude to \$11.651 per barrel. This represented over a 380% increase in posted prices over the pre-October price.

Of course, the most publicly recognized source of the 1973-74 Crisis was the Arab oil embargo against oil sales to the United States and the Netherlands because of their support of Israel in the 1973 Arab-Israeli War. The embargo against the United States began on October 17, 1973 and continued until March 17, 1974.

It is generally agreed among the experts that the embargo itself did little economic damage to the United States. Although approximately 98% of the 1.3 million barrels per day of imports from the OAPEC producers was halted, increased imports from other world producers helped to mitigate the impacts of the embargo. One factor that prevented the embargo from being as severe as it might have been was that the oil companies had fairly good control over the flow of oil from non-OAPEC producing countries to the consuming countries. The oil companies could not direct OAPEC crude to the U.S. market because of fears that oil company properties might be seized in those OAPEC countries.

The more effective aspect of the OAPEC actions in response to the Arab-Israeli War was the production cutback that accompanied the embargo. Without such a cutback the embargo would have had few impacts because the oil companies could have simply redirected the flow of oil to meet the expected demands in the different world regions.

## C. Impacts on World Production and Prices

The levels of production cutbacks by the OAPEC countries in response to the oil embargo varied according to the country. In October 1973 Saudi Arabia, Kuwait, Dubai, and Algeria cut production by over 5%. These same countries cut production by a minimum of 25% in November 1973. Both Abu Dhabi and Qatar came very close to these targets during the same time period. Production cutbacks began to diminish in December, and in January 1974 production cutbacks for these countries were approximately 10%.

According to an analysis by Landis and Klass (1980), several of the OAPEC producers behaved erratically during the embargo. For example, Libya, Bahrain, and Oman actually increased their levels of production in October 1973 even though they were actively engaged in the embargo. Libya met the OAPEC mandated reduction in production of 25% only in the month of November.

Other OPEC producers actually increased their production during this same time period. Production increases of approximately 4% occurred in Iran, Indonesia, and Nigeria. The levels of production in the producing countries for the time period September 1973 to March 1974 are given in Table 1.

As can be seen from Table 1, there was virtually no increase in production in the oil producing countries of the Western Hemisphere in response to the higher world prices. Production in the Western Hemisphere remained at approximately 16 million barrels per day throughout the period

Table 1. Worldwide crude production, 1973-74

Daily average in thousands of bbl

	September 1973	October 1973	November 1973	December 1973	January 1974	February 1974	March 1974
<b>Western Hemisphere</b>							
Argentina	410.0	415.0	415.0	420.0	430.0	430.0	430.0
Bolivia	45.0	47.0	47.0	47.0	50.0	50.0	50.0
Brazil	168.0	169.0	170.0	170.0	170.0	170.0	170.0
Canada	1,745.0	1,812.0	1,831.0	1,835.0	1,840.0	1,844.0	1,881.0
Chili	31.0	31.0	31.0	31.0	31.0	30.0	30.0
Columbia	190.0	200.0	200.0	200.0	200.0	176.0	175.0
Ecuador	210.0	210.0	210.0	230.0	230.0	228.0	230.0
Mexico	470.0	480.0	480.0	480.0	485.0	580.0	580.0
Peru	67.0	73.4	74.0	74.0	75.0	75.0	75.0
Trinidad	165.0	160.0	165.0	165.0	165.0	171.0	170.0
U.S.	9,149.0	9,123.0	9,110.0	9,092.0	9,061.0	9,047.0	9,023.0
Venezuela	3,395.0	3,371.0	3,384.0	3,330.0	3,274.0	3,233.0	3,150.0
<b>Total</b>	<b>16,045</b>	<b>16,091.4</b>	<b>16,117.0</b>	<b>16,054.0</b>	<b>16,011.0</b>	<b>16,034.0</b>	<b>15,964.0</b>
<b>Western Europe</b>							
Europe	395.0	374.4	374.2	338.5	349.0	363.0	353.0
<b>Middle East</b>							
Abu Dhabi	1,381.0	1,340.0	1,155.0	1,016.4	1,210.0	1,273.0	1,489.0
Bahrain	68.0	68.1	68.7	68.6	70.0	69.0	68.0
Dubai	273.0	214.0	140.0	141.0	180.0	250.0	250.0
Iran	5,793.0	5,978.0	6,009.0	6,070.5	6,092.0	6,167.0	6,125.0
Iraq	2,167.0	1,797.0	1,923.0	2,135.5	1,794.0	1,802.0	1,812.0
Israel	110.0	20.0		50.0	100.0	100.0	100.0
Kuwait	3,479.5	3,058.4	2,625.0	2,555.8	2,837.0	2,849.0	2,841.0
Oman	302.1	304.0	300.0	302.0	299.0	295.0	292.0
Qatar	608.3	598.0	505.0	460.4	518.0	515.0	518.0
Saudi Arabia	8,533.5	7,797.9	6,269.4	6,615.8	7,520.0	7,795.0	8,135.0
Syria	120.0	20.0		50.0	50.0	50.0	100.0
Turkey	65.0	70.0	70.0	70.0	70.0	70.0	70.0
<b>Total</b>	<b>22,900.4</b>	<b>21,265.4</b>	<b>19,055.1</b>	<b>19,537.0</b>	<b>20,740.0</b>	<b>21,235.0</b>	<b>21,800.0</b>
<b>Asia Pacific</b>							
Australia	427.0	414.0	433.0	422.0	464.0	490.0	376.0
Malaysia	330.0	330.0	340.0	340.0	350.0	350.0	350.0
Indonesia	1,350.0	1,406.0	1,391.0	1,400.0	1,450.0	1,435.0	1,440.0
Other	196.2	188.2	198.2	197.8	195.7	195.7	195.7
<b>Total</b>	<b>2,303.2</b>	<b>2,338.2</b>	<b>2,362.2</b>	<b>2,359.8</b>	<b>2,459.7</b>	<b>2,470.7<sup>a</sup></b>	<b>2,361.7</b>
<b>Africa</b>							
Algeria	1,100.0	1,020.0	880.0	860.0	960.0	980.0	980.0
Libya	2,286.0	2,383.7	1,766.0	1,769.0	2,032.0	1,945.0	1,882.0
Nigeria	2,101.9	2,190.4	2,200.0	2,255.0	2,185.0	2,260.0	2,290.0
Other	675.3	518.3	488.0	488.0	567.3	566.0	566.0
<b>Total</b>	<b>6,163.2</b>	<b>6,112.4</b>	<b>5,334.0</b>	<b>5,372.2</b>	<b>5,744.3</b>	<b>5,751.0</b>	<b>5,718.0</b>
Communist	9,678.0	9,774.0	9,845.0	10,050.0	10,198.0	10,088.0	10,198.0
<b>WORLD TOTAL</b>							
<b>TOTAL</b>	<b>57,484.8</b>	<b>55,955.8</b>	<b>53,087.0</b>	<b>53,706.5</b>	<b>55,502.0</b>	<b>55,941.7<sup>a</sup></b>	<b>56,394.7</b>

<sup>a</sup>Indicates that OGJ data has been altered to reflect an addition error.Source: *Oil and Gas Journal*, various issues.

September 1973 to March 1974. Production in Western Europe actually decreased slightly, while Asia Pacific production remained constant at about 2.3 million barrels per day. African production fell about 7.3% from September 1973 to November-December 1973 due to the reductions in production in Libya and Algeria. Nigerian production increased slightly over the same time period. Of course, production decreased most in the Middle East where the level of production decreased by 16.8% from September to November 1973.

Total non-communist production fell 4.56 million barrels per day from September to November 1973, or a 9.5% reduction in production. Therefore, while the production cutback was significant, it was not critical per se. The price increases that accompanied the embargo and production reduction were, however, more severe.

As stated in the previous section, drastic posted price increases occurred during this time period. The posted price of Saudi Arabian light (the marker crude) increased from \$3.011 per barrel in October 1973 to \$11.651 per barrel in January 1974. The OAPEC production reductions helped to maintain the higher posted prices. Table 2 gives the contract selling prices of selected crude oils from selected countries over the 1973-74 time period. Note that the contract selling prices were generally lower than the posted prices during this time period.

Spot market prices for crude were not significantly higher than posted and long-term contract prices. Although the available data on spot prices are not good for this time period, Birdsall (1980) estimates that long-term contract prices decreased when the drastic crude price increases occurred in 1973-74. By March 1974 spot market prices reached a fairly stable price at about \$1 per barrel below the contract price for crude.

#### D. Impacts on the U.S. Economy

In this section the impacts of the 1973-74 Oil Crisis on the United States economy are examined. Various types of impacts are considered, including the impacts on (1) the flows of imported crude and product, (2) crude and end-product stocks, (3) refinery outputs, (4) product prices, and (5) levels of domestic crude production. The available studies that have estimated the macro impacts of the 1973-74 disturbance are reviewed. In addition, the various government regulations and controls that influenced the impacts of the 1973-74 disturbance are discussed briefly.

**Table 2. Contract prices for selected crude oils**

Crude type	January 1973	December 1973	January 1974	July 1974	January 1975
Arab light-34	2.10	3.60	9.60	10.40	10.46
Arab heavy-27	1.86	3.26	9.40	10.18	10.27
Iran light-34	2.11	3.75	10.63	10.56	10.67
Kuwait-31	1.97	3.44	9.80	10.17	10.37
Abu Dhabi	2.36	4.25	11.80	11.43	11.21
Murban-39					
Iraq Basrah-35	2.03	3.56	9.55	10.48	10.48
Libya-37	3.10	6.45	14.30	12.43	11.98
Algeria-44	3.21	7.54	14.23	12.36	12.00
Nigeria-37	3.10	5.84	12.60	11.85	11.80
Venezuela-26	2.60	5.50	9.30	10.00	11.00
Indonesia-34	2.96	6.00	10.80	12.60	12.60

Note: The number beside the crude type indicates American Petroleum Institute (API) degrees gravity. The lower the number, the heavier the crude, and thus the more difficult the crude is to refine into lightweight products.

Source: *Petroleum Intelligence Weekly*, September 1, 1980.

## 1. Impacts of government measures

There is little doubt that the actions of the U.S. government leading up to, and during, the Oil Crisis of 1973-74 affected the impacts of that disturbance on the U.S. market for oil and the U.S. economy in general. The impacts of these government programs and regulations have been the subject of several papers and books.<sup>3</sup> It is not the purpose of this section to rehash those various arguments. Rather, this section reviews the major governmental responses to the 1973-74 disturbance and summarizes the consensus opinions about the impacts of those responses.

In Sect. I of this paper the government regulations that preceded the 1973-74 disturbance were discussed. Price controls on domestic crude oil and oil products are generally believed to have reduced domestic quantity supplied and increased domestic quantity demanded in comparison to the no-price-control case. The net result was to increase oil imports above what they would have been without price controls; and, to the extent that our increased level of imports put upward pressure on the world oil price, those price controls were detrimental to the U.S. economy.

There were two major programs implemented by the federal government once the disturbance began — the Mandatory Petroleum Allocation Program, which was established by the Emergency Petroleum Allocation Act of 1973 (EPAA), and federal energy conservation guidelines imposed by the Federal Energy Office, which later became the Federal Energy Administration. The allocation system under the EPAA was complex. The intent of the system was to provide for (1) protection of public health, (2) maintenance of all public services, (3) maintenance of agricultural operations, (4) preservation of an economically sound and competitive petroleum industry, (5) the allocation of suitable types, grades, and quality of crude oil to refiners to permit those refiners to operate at full capacity, (6) equitable distribution of crude oil, residual fuel oil, and refined petroleum products at equitable prices among all regions, and (7) the allocation of petroleum products to promote economic efficiency and minimize unnecessary interference with the market mechanism. The allocation system was more effective in meeting some goals than others. For the most part, priority users were provided all the fuel they demanded at the depressed market prices. The fuel users not designated as priority users were forced to bear the brunt of the disturbance. Certainly, efficiency goals were in some cases sacrificed for equity goals. Efficiency was also sacrificed in the name of promoting competition in the oil industry.

EPAA also provided for the control of the price of so called "old oil" — defined as the quantity of oil produced previous to the bill — at \$5.25 per barrel.<sup>4</sup> Since the contract price of Saudi marker crude was around \$9.60 per barrel in January 1974, old domestic oil was priced less than the marginal source of domestically used oil. The reason for the price controls was to prevent the domestic owners of old oil from reaping windfall profits given the large world price increase. The controls, however, provided a disincentive to the owners of old oil wells to produce from those wells at a higher rate. Thus, the domestic quantity supplied of crude was less than what it might have been without the controls, which resulted in larger oil imports. It has been argued that the domestic price controls not only discouraged domestic production and encouraged consumption, but also, through the entitlements program that accompanied the controls, subsidized imports.<sup>5</sup>

There is argument over whether the crude price controls and the entitlement program that accompanied those controls caused the domestic price for refined products to be lower.<sup>6</sup> Phelps and

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<sup>3</sup>See for example Landis and Klass (1980), Krapels (1980), Klass, Burrows, and Beggs (1980), Deese and Nye (1981), Vernon (1976), Bohi and Russell (1978), Bohi and Russell (1975), Cox and Wright (1978), Curlee (1981a), Curlee (1981c), and Mancke (1974).

<sup>4</sup>Actually, the crude oil price controls distinguished between "old oil," "new oil," "released oil," and "stripper oil." The ceiling price on "old oil" was set at the May 1973 posted prices plus \$1.35 per barrel. The Federal Energy Administration estimated that the average price of "old oil" was about \$5.25 per barrel.

<sup>5</sup>See Cox and Wright (1978) and Landis and Klass (1980).

<sup>6</sup>The entitlements program was established to ensure that all refiners could obtain crude at the same cost. Without such controls, it would have been possible for refiners with access to "old," controlled domestic oil to have an advantage over refiners that had access only to higher priced, imported oil.

Smith (1977) concluded that the domestic prices of refined products were determined by the price of imported crude because the marginal source of crude in the U.S. is imports. Therefore, the domestic program did not decrease refined product prices. However, Cox and Wright (1978) concluded that the price controls and entitlements program did result in a significant decrease in prices of refined products.

The general consensus concerning EPAA is that, while the program was effective in meeting various equity goals, the costs that the EPAA imposed in terms of efficiency were large. Most who have studied the issue have concluded that the EPAA made the 1973-74 disturbance more, rather than less, severe.

The other major response to the 1973-74 disturbance was the imposition of a federal energy conservation program which required that the government sector adopt various conservation measures. Among those measures were reductions in vehicle mileage and a reduction in heating, cooling, and lighting. While there were no formal means of enforcing the rules, the compliance percentages seem to have been high.<sup>7</sup> However, the impacts of the government's own conservation program are agreed to be minuscule compared to the impacts of the price controls and forced allocations under the EPAA.

## 2. Impacts on U.S. imports

Prior to the Arab oil embargo of October 1973, the United States imported approximately 1.3 million barrels per day of crude oil and oil products from the Arab countries. As a result of the embargo, the U.S. lost approximately 98% of all Arab imports. This was an amount equal to about 8% of our total oil consumption and about 20% of our total imports. Prior to the embargo, Saudi Arabia was by far the largest Arab supplier of crude to the U.S., providing 56% of all Arab imports. Table 3 shows how imports of crude oil from selected countries changed from August-September 1973 to January-February 1974. Note that while imports from the Arab countries all but stopped, there were substantial import increases from Iran and Indonesia. There were substantial import decreases from several non-OAPEC countries — Canada, Nigeria, and Venezuela. Non-OAPEC imports decreased approximately 0.9%.

While the imports of crude decreased during the embargo, total imports of products actually increased, helping to dissipate the impacts of the crude embargo. Table 4 shows how imports changed from month to month from September 1973 to May 1974. Total crude imports decreased by 1.444 million barrels per day from September 1973 to January 1974 — 40% — while total product imports increased by 0.236 million barrels per day — 9.1%. Total imports of crude and

<sup>7</sup>See Landis and Klass (1980) page 61.

**Table 3. Crude imports from selected countries, 1973-74**

	Thousands of barrels per day		
	August-September 1973	January-February 1974	Percentage difference
Total Arab	1,203	19	-98
Venezuela	633	493	-22
Canada	1,082	960	-11
Nigeria	524	462	-12
Iran	229	430	88
Indonesia	237	275	16

Source: Stobaugh (1976).

**Table 4. Total product and crude imports, 1973-74**

Thousands of barrels per day

	September 1973	October 1973	November 1973	December 1973	January 1974	February 1974	March 1974	April 1974	May 1974
Gasoline	150	129	152	120	116	162	168	146	324
Distilate	160	333	417	301	368	194	261	138	256
#4 Fuel oil	31	28	76	110	75	104	135	96	59
Residual	1,660	1,701	1,965	1,895	1,685	1,533	1,496	1,507	1,701
Jet Naph.	10	5	6	12	18	6	17	13	
Jet Kero	158	136	171	124	170	102	156	144	109
Asphalt	30	31	10	27	28	21	22	37	106
LP Gas	97	76	101	108	110	133	152	153	196
Petroleum feedstock	39	5				10	16	8	20
Unfinished plant	123	73	138	127	134	151	105	263	183
Condensate	117	96	98	112	102	105	104	95	65
Total products	2,575	2,617	3,162	2,938	2,811	2,521	2,664	2,574	3,019
Total crude	3,615	3,254	3,477	3,005	2,171	2,412	2,617	2,855	3,339
Total imports	6,190	5,868	6,639	5,943	4,982	4,933	5,281	5,429	6,358

Source: *The Oil and Gas Journal*, various issues.

products decreased by 1.208 million barrels per day — 19.5%. Increases in distillate imports accounted for most of the product-import increases.

Of course, looking simply at the changes in absolute imports may be misleading because such an analysis does not consider that the level of imports was growing over time prior to the embargo. Robert Stoubaugh in his 1976 paper examined the difference between the actual level of imports and the forecasted level of imports had the embargo and world price increases not occurred. Stoubaugh's work indicates that actual imports decreased by 27% compared to the forecasted imports. The forecast was done by taking the compounded growth rate for all petroleum products between 1968 and 1973 and assuming that rate would have remained constant after 1973.<sup>8</sup>

Therefore, it appears that the events of late 1973-early 1974 had a significant impact on the flow of crude oil into the United States. It must be recognized, however, that the import reduction was short lived. The months of January and February 1974 were most severe. Recovery started in March 1974, and by May 1974 the level of imports actually exceeded the pre-embargo level.

### 3. Impacts on domestic stocks of crude and products

The drawdown of stocks of crude and products can partially or totally replace disrupted oil. Table 5 shows how U.S. crude and product stocks varied over the time period October 1972 to October 1974.

Figure 1 illustrates the trend in product and crude stocks over the same time period. As can be seen from the table and figure, both product and crude stocks decreased during the 1973-74 embargo. Crude stocks were at their lowest point in January 1974. This coincides with the low point in crude oil imports (see Table 4). Product stocks reached a low point in April 1974. Product imports reached a low point over the period February-April 1974. On first inspection it may appear that stocks were being drawn down to replace lost imports. However, on closer inspection we find that these stock drawdowns simply reflect seasonal adjustments. In fact, the level of product stocks was significantly higher in March-April 1974 than it was during the same period of 1973. The crude oil stock drawdown was approximately the same as in 1973. When compared to the stocks held in January 1972, we find that crude stocks were slightly higher at 236,776 thousand barrels. Product stocks in April 1972—about 535,553 thousand barrels—were lower than they were in April 1973.

This analysis suggests that domestic holders of crude and product stocks did not draw down those stocks significantly during the embargo. The tendency was to increase, rather than decrease, stocks.

The same general conclusion is drawn if one examines the ratio of stocks to average daily refinery throughput. Table 6 shows how this ratio changed in 1972, 1973, and 1974. The ratio for both crude and products remained fairly stable over this time period.

### 4. Embargo impacts on the availability of crude oil types in the U.S.

Of particular interest in this paper is the question of whether a disruption of crude oil production in a particular part of the world can result in a significant change in the mix of crude oil [defined according to American Petroleum Institute (API) degrees gravity and sulfur content] available on the world market. If the mix of crude oil on the world oil market changes significantly, it may imply that the type of crude available for import also changes. Given that it is more difficult to produce certain light-weight products, such as gasoline, from crudes of heavier weights and higher sulfur contents, and given that refinery capacity is effectively fixed during a short-term disturbance, a significant change in the mix of crude going into domestic refineries could imply that light-weight product markets could be impacted more severely than heavy-weight product markets. This may be particularly true if the disrupted crude is light weight and low sulfur.

<sup>8</sup>According to Stoubaugh's analysis, the United States was impacted (in terms of reduced import quantities) more than any other major Western economy. The impact in Japan was 11%; France, 3%; and West Germany, 18%. The Netherlands—a major target of the embargo—was impacted 41%. The United Kingdom was virtually unchanged.

**Table 5. U.S. stocks of crude and products, 1972-73-74**

Thousands of barrels

	Motor gasoline	Aviation gas	Jet fuel		Kero	Dist.	Resid.	Unfinished oils	Total product stocks	Crude stocks
			Naph.	Kero						
October 1972	204,624	3,733	6,481	23,825	21,890	197,096	64,600	103,996	626,245	239,949
November 1972	205,752	3,988	6,097	21,162	21,771	192,628	57,204	99,600	608,202	237,519
December 1972	209,536	4,092	6,207	20,272	19,711	171,403	54,939	97,781	583,941	232,803
January 1973	215,186	4,181	6,035	20,147	17,478	149,541	55,044	90,604	558,216	224,056
February 1973	221,373	3,708	5,630	20,018	15,574	118,868	45,937	87,218	518,326	221,893
March 1973	215,298	3,671	5,225	20,788	16,196	114,585	45,700	91,342	512,805	230,696
April 1973	204,373	3,398	5,575	22,238	17,768	108,472	42,027	103,014	506,865	235,383
May 1973	201,425	3,210	4,890	22,072	19,562	114,013	46,569	106,209	517,950	244,777
June 1973	202,926	3,215	5,102	21,588	19,774	127,842	50,735	104,723	535,905	235,846
July 1973	203,339	3,142	4,715	20,392	19,955	152,143	50,530	103,972	558,188	230,750
August 1973	201,234	3,104	4,335	21,381	19,791	170,753	52,221	103,166	575,985	235,660
September 1973	206,575	3,555	4,113	19,286	22,707	190,475	55,430	98,658	600,799	228,280
October 1973	202,619	3,593	4,993	20,291	22,461	201,107	56,898	101,739	613,701	233,520
November 1973	203,791	3,721	4,568	22,422	23,252	204,193	55,193	101,533	618,673	237,001
December 1973	203,173	3,606	5,645	23,208	22,868	203,041	52,104	96,900	610,545	229,504
January 1974	208,116	2,826	5,336	22,588	20,928	188,652	49,056	93,307	590,809	220,261
February 1974	218,637	3,712	6,077	23,343	18,189	171,811	46,380	91,479	579,628	228,004
March 1974	221,782	3,589	6,388	24,400	15,771	142,573	43,928	98,828	557,259	231,705
April 1974	225,580	3,452	6,747	24,806	15,413	128,855	47,874	101,000	553,727	243,687
May 1974	225,840	3,419	6,447	26,016	15,533	138,508	52,276	113,800	581,839	256,736
June 1974	222,793	3,148	6,559	21,105	16,442	155,443	55,044	116,745	597,278	255,762
July 1974	221,728	3,191	6,326	24,939	16,495	172,957	58,789	117,700	622,125	255,936
August 1974	226,092	3,216	6,081	26,168	17,192	189,420	59,306	115,524	643,000	251,905
September 1974	223,074	3,624	5,433	24,598	16,980	199,406	61,065	113,264	647,444	253,623
October 1974	225,653	3,572	6,017	24,984	16,298	206,058	59,885	112,156	654,623	256,430

Sources: *Oil and Gas Journal*, various issues. *Monthly Energy Review*, various issues.

## Trends in Crude and Product Stocks, 1972-73-74

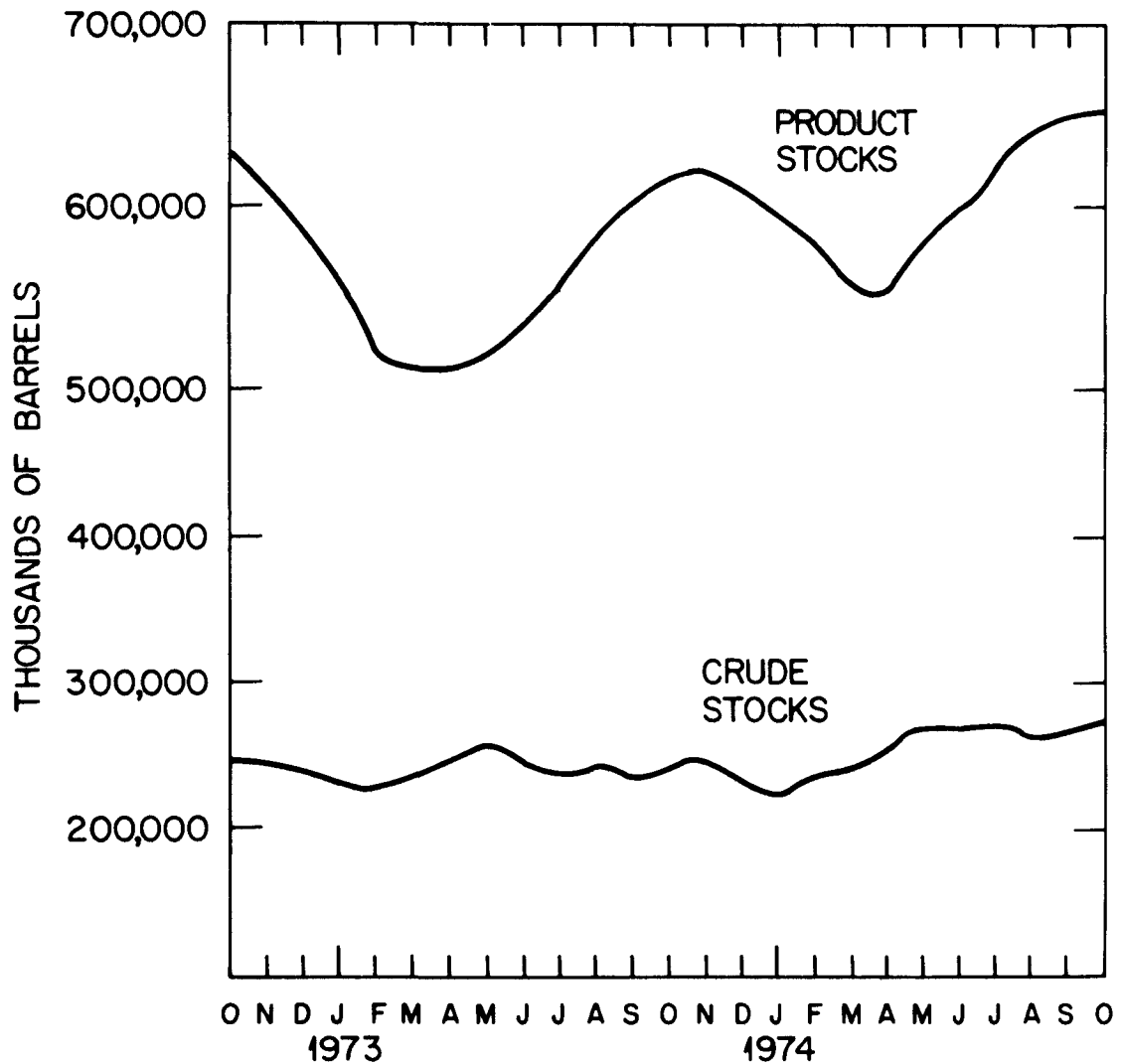


Figure 1

**Table 6. Ratio of crude and product stocks to average daily refinery runs, 1972-73-74**

	Crude stocks	Products stocks
January 1972	21.79	56.88
April 1972	23.57	47.9
January 1973	18.37	45.76
April 1973	19.63	42.28
January 1974	19.27	51.71
April 1974	20.75	47.14

Source: *Oil and Gas Journal*, various issues.

This section reports on how the mix of crudes available on the domestic oil market changed during the 1973-74 disturbance. First, crude oils are broken down into seven main categories according to API degrees gravity and sulfur content. Second, data on the types of crude that come from the various producing nations and the producing states in the United States are reviewed. Third, import and domestic-production changes that occurred during the 1973-74 disturbance are examined, and the change in the mix of crudes available on the U.S. market is estimated.

a. The crude oil classification scheme

A crude oil classification scheme has been adopted from DeNoya (1981). Crude oils are divided into seven different categories according to their sulfur contents and specific gravities — shown in Table 7.

Table 8 shows the crude oil characteristics of the producing states in the United States and of world crude producers.

Tables 9 and 10 show the mappings of U.S. and foreign crude productions, respectively, into the classification scheme given in Table 7.

b. Domestic production response to the 1973-74 disturbance

During the 1973-74 disturbance the domestic production of crude oil did not increase to mitigate the impacts of the embargo. In fact, the level of production actually decreased. This response, or the lack thereof, can be explained in two ways: (1) there was little excess production capacity at the time of the embargo, and the time of the embargo was too short to construct new capacity; and (2) there was little incentive for domestic crude producers to increase production given the government price controls on crude and product.

Table 11 shows how domestic production changed during 1972, 1973, and 1974. Note that domestic production reached a low point in January 1974 — the same month crude oil imports reached a low point.

**Table 7. Crude oil categories**

Category	API° range	Sulfur range
I "Sweet"	Greater than 28.5° Less than or equal to 35.6°	Less than or equal to 0.50%
II "Sweet"	Greater than 35.6°	Less than or equal to 0.50%
III "Heavy medium"	Less than or equal to 28.5°	Greater than 0.50% Less than or equal to 1.00%
IV "Light medium"	Greater than 28.5° Less than or equal to 35.6°	Greater than 0.50% Less than or equal to 1.00%
V "Light medium"	Greater than 35.6°	Greater than 0.50% Less than or equal to 1.00%
VI "Heavy high"	Less than or equal to 28.5°	Greater than 1.00%
VII "Light high"	Greater than 28.5° Less than or equal to 35.6°	Greater than 1.00%

Source: DeNoya (1981).

Table 8. Crude oil characteristics in the producing regions

Region	API°		Sulfur	
	Mean	Range	Mean	Range
<b>Domestic</b>				
Alabama	37.5	19.4-49.7	1.57	0.23-4.59
Alaska	33.0	27.0-42.8	0.25	0.02-0.82
Arizona	34.9	15.9-49.2	1.42	0.20-3.30
California	25.1	8.9-37.2	1.36	0.17-5.93
Colorado	39.7	34.8-48.1	0.22	0.07-0.56
Florida	40.7	21.6-50.6	1.41	0.02-3.95
Illinois	36.2	33.2-38.6	0.21	0.17-0.26
Indiana	35.2	N/A	0.20	N/A
Kansas	37.3	34.6-39.8	0.38	0.18-0.57
Kentucky	48.7	30.4-44.7	0.34	0.12-0.87
Louisiana	34.5	28.6-40.4	0.26	0.14-0.53
Michigan	39.4	32.7-44.5	0.53	0.08-1.06
Mississippi	28.2	17.1-39.2	1.97	1.22-2.71
Missouri	26.0	19.5-37.8	0.59	0.10-0.82
Montana	34.5	30.4-40.2	0.52	0.22-0.79
Nebraska	33.3	31.9-38.4	0.33	0.11-0.62
Nevada	20.9	18.4-23.3	1.45	0.79-2.10
New Mexico	37.8	28.8-46.0	0.72	0.17-1.41
New York	42.2	39.2-45.8	0.11	0.10-0.17
North Dakota	42.3	41.3-43.2	0.28	0.24-0.31
Ohio	41.9	34.2-53.0	0.33	0.10-10.30
Oklahoma	36.1	21.0-42.5	0.45	0.09-1.68
Pennsylvania	45.9	31.0-52.0	0.10	0.04-0.15
South Dakota	27.0	N/A	0.19	N/A
Tennessee	42.7	39.0-46.5	0.62	0.53-0.70
Texas	35.0	24.9-45.6	0.88	0.05-3.33
Utah	37.7	24.3-48.4	0.13	0.02-0.20
Virginia	No information			
West Virginia	46.7	30.2-66.4	0.12	0.07-0.84
Wyoming	29.2	19.8-41.3	1.69	0.12-3.18
<b>Foreign</b>				
Algeria	38.1	31.5-45.4	0.12	0.20-0.31
Canada	32.0	14.1-39.8	1.06	0.11-3.38
Ecuador	27.5	N/A	0.77	N/A
Indonesia	27.1	16.4-32.8	0.16	0.10-0.28
Iran	30.5	17.4-35.0	2.10	1.39-3.68
Iraq	36.1	35.6-36.6	1.95	1.93-1.97
Libya	35.9	23.8-47.6	0.52	0.09-1.57
Mexico	24.0	8.3-58.7	3.14	0.10-5.84
Nigeria	32.8	21.5-43.4	0.21	0.05-0.86
Norway	36.1	32.3-39.4	0.18	0.12-0.22
Oman	32.8	N/A	1.25	N/A
Qatar	35.5	32.8-38.2	1.74	1.48-1.99
Saudi Arabia	31.8	26.8-37.0	2.22	1.25-3.03
Syria	21.6	19.5-24.0	N/A	N/A
Trinidad	29.2	16.2-45.2	0.98	0.30-2.00
U Arab Em	39.2	37.8-40.9	0.71	0.62-0.77
U Kingdom	36.8	30.5-40.5	0.19	0.10-0.35
Venezuela	25.8	11.3-42.1	1.42	0.09-5.54

Source DeNoya (1981)

N/A Not Available

**Table 9. Types of crude produced in oil producing states**  
(in percentages)

State	Type						
	I	II	III	IV	V	VI	VII
Alabama					100		
Alaska	100						
Arizona	100						
Arkansas							100
California			45	5	50		
Colorado		100					
Florida		100					
Illinois		100					
Indiana	100						
Kansas		100					
Kentucky		100					
Louisiana	63	17		20			
Michigan					100		
Mississippi						55	45
Missouri			100				
Montana	60			25	15		
Nebraska		100					
Nevada						100	
New Mexico		48		30	22		
New York		100					
North Dakota		100					
Ohio		100					
Oklahoma		47				53	
Pennsylvania		100					
South Dakota	100						
Tennessee					100		
Texas	15	39	3			4	39
Utah		100					
Virginia	No information						
West Virginia		100					
Wyoming	19					46	35

Source: DeNoya (1981).

c. Changes in available types of crude oil

Monthly, state production data were obtained from the *Oil and Gas Journal*. Data on imports of crude from the various countries were obtained from Stobaugh (1976). Using the crude oil classification scheme presented in Tables 9 and 10, domestic and imported crude was broken down into the seven crude types.

Table 12 shows how domestic production changed during 1972, 1973, and 1974 (when broken down into the seven crude types). Note that there was no significant change in the makeup of domestic production during this time period. Further, note that during the disturbance of 1973-74 all types of domestic crude production were down, indicating that there was not a significant shift in the mix of domestic crude types.

**Table 10. Types of crude produced in foreign countries**  
(in percentages)

Country	Type						
	I	II	III	IV	V	VI	VII
Algeria		100					
Canada		55				38	7
Ecuador			100				
Indonesia	69	31					
Iran							100
Iraq							100
Libya	34	66					
Mexico							100
Nigeria	66	34					
Norway		100					
Oman				60			40
Qatar							100
Saudi Arabia							100
Syria						100	
Trinidad			70	30			
U. Arab Em.				100			
U. Kingdom		100					
Venezuela						100	

Source: DeNoya (1981).

Table 13 shows how the mix of crude types changed on the domestic market during the 1973-74 disturbance when both domestic production and crude imports are considered. The table indicates that there was no significant change in the available domestic crude mix in percentage terms.

It can therefore be concluded that the disturbance of 1973-74 did not contribute to a significant change in the available mix of crude domestically. As a result, there should have been no problems concerning the abilities of U.S. refineries to physically process the available crudes into the same proportions of end products as produced in the pre-embargo period.

##### 5. Refinery output changes

Total refinery capacity in the United States was about 13.9 million barrels per day in 1973 and increased to about 14.9 million barrels per day in 1974. Prior to the 1973-74 embargo, daily refinery runs were approximately 12.3 million barrels per day. Daily average runs dropped approximately 1 million barrels per day during the duration of the embargo.<sup>9</sup> Given that the available mix of crudes did not shift significantly during the embargo, there appears to have been no significant refinery capacity constraint, at least on the national level.<sup>10</sup>

Table 14 shows how refinery inputs and outputs changed over the period October 1972 to October 1974. From October 1973 through February 1974, daily average crude inputs into refineries decreased 1656 thousand barrels per day (about 13%) from 12,758 to 11,102 thousand barrels per day. Historically, crude inputs do not vary significantly from month to month. In terms of the productions of particular products, no product seems to have been particularly affected by

<sup>9</sup>This information is from the *Oil and Gas Journal*, various issues.

<sup>10</sup>Addressing what occurred on a regional level is beyond the scope of this study.

**Table 11. Domestic crude oil production, 1972-73-74**

Thousands of barrels per day	
	Domestic production
1972	
January	9,114
February	9,336
March	9,462
April	9,513
May	9,614
June	9,522
July	9,496
August	9,483
September	9,508
October	9,482
November	9,426
December	9,335
1973	
January	9,179
February	9,395
March	9,272
April	9,292
May	9,262
June	9,214
July	9,217
August	9,169
September	9,065
October	9,224
November	9,161
December	9,063
1974	
January	8,907
February	9,156
March	8,950
April	8,952
May	8,903
June	8,777
July	8,754
August	8,682
September	8,432
October	8,616
November	8,569
December	8,514

Source: Bureau of Mines as reported in *The Monthly Energy Review*, various issues.

**Table 12. Domestic crude production by crude category, 1972-73-74**

Thousand barrels per day

	Type												Total		
	I	II	III	IV	V	VI	VII								
1972		%		%		%		%		%		%		%	
January	2,432	24.4	2,697	27.0	534	5.3	1,431	14.4	627	6.3	726	7.3	1,523	15.3	9,970
April	2,500	25.7	2,912	30.0	539	5.5	665	6.8	614	6.3	745	7.7	1,739	17.9	9,714
July	2,428	25.2	2,942	30.5	542	5.6	671	6.9	618	6.4	701	7.3	1,733	17.9	9,635
October	2,530	26.3	2,905	30.2	534	5.5	682	7.1	619	6.4	705	7.3	1,650	17.1	9,627
1973															
January	2,377	25.5	2,841	30.5	531	5.7	638	6.8	621	6.6	677	7.2	1,621	17.4	9,306
April	2,370	25.3	2,878	30.8	526	5.6	626	6.7	602	6.4	691	7.4	1,657	17.7	9,350
July	2,319	24.9	2,871	30.8	528	5.7	606	6.5	612	6.6	684	7.3	1,694	18.2	9,314
October	2,354	25.1	2,899	30.9	525	5.6	598	6.4	606	6.5	680	7.3	1,703	18.2	9,365
1974															
January	2,242	24.5	2,827	30.9	521	5.7	578	6.3	587	6.4	670	7.3	1,707	18.7	9,132
April	2,150	23.8	2,813	31.1	519	5.7	565	6.3	604	6.7	682	7.6	1,670	18.5	9,033
July	2,122	23.9	2,799	31.5	510	5.7	542	6.1	598	6.7	655	7.4	1,651	18.6	8,877
October	2,075	24.0	2,719	31.5	498	5.8	535	6.2	592	6.9	641	7.4	1,577	18.3	8,637

Source: *Oil and Gas Journal*, various issues.

Note: Total production figures in this table do not match the figures in Table 11 because of the different data sources.

**Table 13. Available crude domestically by crude type, 1973-74**

Crude type	January 1973		July 1973		January 1974	
	Total crude available	%	Total crude available	%	Total crude available	%
I	2,736	22.0	2,881	22.2	2,737	23.2
II	3,709	29.7	3,818	29.4	3,597	30.5
III	564	4.5	561	4.3	554	4.7
IV	721	5.8	694	5.4	578	4.8
V	621	4.9	612	4.7	587	5.0
VI	1,617	13.0	1,728	13.3	1,527	12.9
VII	2,497	20.0	2,664	20.6	2,229	18.9
Total	12,465	100 <sup>a</sup>	12,958	100 <sup>a</sup>	11,809	100

<sup>a</sup>Do not sum to 100 because of rounding error.

Sources: *Oil and Gas Journal*, various issues. Stobaugh (1976).  
*Monthly Energy Review*, various issues.

the embargo. In absolute terms, the production of motor gasoline was impacted most. However, on closer inspection we find that, historically, gasoline production is down in the months of January and February.

Only about two-thirds of the refinery input reductions are explained by crude import reductions. The remainder of the refinery input reductions can be attributed to decreases in domestic crude production and additions to domestic crude storage.

#### 6. Domestic refined product price changes

The domestic price controls that were in effect during 1973-74 prevented the prices of refined products from reaching their equilibrium level. Thus, the available price data must not be confused with short run equilibrium prices. Noting these problems with the data, Table 15 shows how the wholesale price index for the major petroleum products changed domestically during the 1973-74 disturbance. Table 16 shows the nominal price changes for three selected refined products.

Light distillate, middle distillate, and residual fuel prices were impacted most severely. The wholesale price index for light distillate rose from 153.1 in September 1973 to 347.5 in December 1973; middle distillate rose from 154.1 to 326.2; and residual fuel rose from 196.0 to 294.3 over the same time period. In January 1973 the index for all refined products came down drastically from its level in December 1973 — 230.3 to 151.2. All product prices decreased with the exceptions of residual fuel and lubricating oil. There were major real price decreases in light distillate and middle distillate from December 1973 to January 1974.

#### 7. Macro impacts

Determining the macroeconomic impacts of an oil disruption is an enormously complex task. Sudden and severe oil price increases, such as those that occurred during the 1973-74 disturbance, produce "ripple" effects throughout the economy, and quantifying those effects is difficult both theoretically and empirically. Higher oil prices alter the prices of all goods that require oil in their production processes and for goods that are either complements of, or substitutes for, oil. Further, oil price increases indirectly alter the demands for, and prices of, all goods by producing shifts in income. There is an increasing belief that these indirect macro impacts are the most severe impacts

**Table 14. Refinery inputs and outputs, 1972-73,74**

	Average daily runs	Motor gasoline	Aviation gas	Jet fuel		Kero.	Dist.	Resid.	Average daily crude inputs	Percentage change in average crude inputs
				Naph.	Kero.					
1972										
October	11,705	6,418	76	216	628	176	2,678	738	11,871	
November	11,419	6,400	45	186	594	189	2,559	822	11,851	-.16
December	11,892	6,298	32	194	605	252	2,834	967	12,113	2.21
1973										
January	12,198	6,283	25	158	701	322	2,946	1,040	12,190	.64
February	12,223	6,004	35	172	673	310	2,924	933	12,187	-.02
March	12,314	6,148	31	208	711	256	2,720	956	12,201	.11
April	11,987	6,206	44	183	662	207	2,470	853	12,208	.06
May	12,217	6,570	51	163	705	224	2,509	841	12,281	.60
June	12,890	6,992	63	199	763	146	2,736	889	12,862	4.73
July	12,807	6,884	45	166	688	198	2,697	862	12,750	-.87
August	12,790	6,840	65	152	704	224	2,664	806	12,635	-.90
September	12,533	6,568	50	150	713	238	2,678	819	12,560	-.59
October	12,715	6,524	55	177	783	185	2,899	923	12,758	1.58
November	12,318	6,268	58	169	722	222	2,850	896	12,374	-3.01
December	12,038	6,023	38	278	647	204	3,102	1,134	12,150	-1.81
1974										
January	11,425	5,907	37	183	536	209	2,986	962	11,491	-5.42
February	10,960	5,987	29	220	577	195	2,377	1,019	11,102	-3.39
March	11,037	5,911	26	207	597	139	2,265	759	11,355	2.28
April	11,746	6,275	30	178	605	101	2,588	875	11,823	4.21
May	12,302	6,437	55	192	630	91	2,672	1,015	12,333	4.31
June	12,397	6,670	61	177	588	123	2,739	946	12,697	2.95
July	12,700	6,813	42	140	637	53	2,807	1,118	12,811	.90
August	12,537	6,817	60	143	703	74	2,647	1,100	12,644	-1.30
September	11,717	6,411	74	217	602	99	2,370	946	12,124	-4.11
October	12,086	6,256	35	181	712	117	2,552	1,057	12,286	1.34

Sources: *Oil and Gas Journal*, several issues. *Monthly Energy Review*, several issues.

Notes: Crude inputs and outputs do not always equal because of technical characteristics of crude refining.

**Table 15. Wholesale index for refined products, 1973-74**

	Gasoline	Light distillate	Middle distillate	Residual fuel	Lubricating oil	All refined products	All commodities index
1973							
September	143.5	153.1	154.1	196.0	110.8	143.5	140.2
October	148.4	177.4	176.7	220.4	114.9	148.4	139.5
November	196.4	269.2	256.2	287.8	122.6	196.4	141.8
December	230.3	347.5	326.2	294.3	132.2	230.3	145.3
1974							
January	151.2	154.3	194.8	319.4	171.6	151.2	146.6
February	162.0	184.8	238.1	417.2	174.8	162.0	149.5
March	177.5	198.7	251.8	505.9	174.8	177.5	151.4
April	188.7	209.4	257.9	522.0	182.2	188.7	152.7
May	194.1	217.6	215.8	505.9	252.0	194.1	155.5
June	205.9	233.2	279.7	497.6	252.0	205.9	155.7
July	214.1	241.7	288.9	476.2	275.7	214.1	161.7
August	214.6	250.2	294.9	533.8	275.7	214.6	167.4

Source: *Platt's Oil Price Handbook*, 1974. 1967 equals 100. This index is designed to measure average price change of all commodities sold in the U.S., whether manufactured domestically or imported.

**Table 16. Prices of domestic refined products, 1973-74**

	Motor gasoline	Jet grade kerosene	No. 5 fuel oil
1973	22.45	23.43	4.70
1974			
January	41.86	48.45	9.03
February	46.39	40.53	11.25
March	52.74	36.12	11.38
April	49.25	29.70	11.38
May	46.00	29.50	11.39
June	43.06	30.83	11.58

Source: *Platt's Oil Price Handbook*, 1974. All prices are for Gulf Coast cargoes, FOB ship.

of oil disturbances. However, estimating these indirect impacts requires a rather elaborate model of the U.S. economy; and along with the elaborate modeling comes the increased probability of making modeling errors.

Despite the difficulty with estimating these macro impacts, a number of studies have been done to estimate the macro impacts of the 1973-74 disturbance. In this section of the paper the results of these studies are summarized. Some of the basic assumptions made in the studies are reviewed; however, a full description of the different methodologies and all the assumptions is beyond the scope of this paper. The actual performance of the U.S. economy just previous to, during, and after the 1973-74 disturbance is reviewed first. The various estimates concerning how that actual performance was impacted by the 1973-74 oil disturbance are then reviewed.

a. The actual performance of the U.S. economy

Mork and Hall (1980) summarize the performance of the U.S. economy over the years 1973 to 1977. In Table 17 that summary is reproduced. Real gross output decreased by 18.9 billion dollars (1972 dollars) between 1973 and 1974—a 1.5% drop. Real gross output decreased further in 1975 from 1229.9 billion dollars to 1219.8 billion dollars—a 0.8% reduction.

Consumption and investment also decreased over this same time period. Consumption decreased from 762.6 billion dollars in 1973 to 754.5 billion dollars in 1974—a 1.1% reduction. Consumption increased in 1975 to slightly below the 1973 level. Investment decreased from 203.0 billion dollars in 1973 to 176.8 billion dollars in 1974 and then further decreased to 140.4 billion dollars in 1975—30.8% below the 1973 level.

As can be seen from Table 17, both inflation and unemployment increased moderately over the 1974-1975 period. Inflation reached a peak at 11.0% in 1974. Unemployment reached a peak at 8.5% in 1975.

Economic recovery began in 1976, and by 1977 real gross output, consumption, and investment exceeded 1973 levels.

b. The impacts of the oil price increase of 1973-74

The various models that estimate the macro impacts of oil disturbances utilize a baseline forecast in which no severe oil price increase occurred and compare that forecast to what actually occurred. The difference between the forecasts is assumed to be the impact of the oil price increase.

Several studies have been done to estimate the impacts of the 1973-74 energy price shock: Mork and Hall (1980), Eckstein (1978), Perry (1975), Pierce and Enzler (1974), and the Office of Economic Impact (1974).

Mork and Hall (1980) summarize the impacts as estimated by some of the studies. That summary, along with information not covered in the Mork and Hall paper, is given in Table 18. As can be seen from the table, the estimates differ significantly in some cases. The impacts on inflation range from 1.3 to 4.1% in 1974; 0.8 to 2.3% in 1975; and from -0.4 to 1.2% in 1976. GNP is estimated to have decreased between 1.1 and 3.1% in 1974 as a result of the price shock; 1.7 to 5.2% in 1975; and 2.4 to 5.0% in 1976. Mork and Hall (1980) estimate that real output decreased by \$30 billion (1972 dollars) in 1974, \$66 billion in 1975, and about \$50 billion in 1976, 1977, and 1978. Investment and consumption also decreased. Investment was impacted most severely of all the macroeconomic indicators — between 7.4 and 33.5% in 1975. Overall employment impacts were moderate. Unemployment increased about 0.5% in 1973, 1.0% in 1974, and 1.9% in 1975 as a result of the price shock.

It has been argued that a superior way to measure the impacts of oil disturbances is to use total consumer and producer surplus losses rather than lost GNP, consumption, investment, and so forth.<sup>11</sup> There are two main arguments for this conclusion. First, GNP changes are not necessarily related to changes in social costs and benefits. Second, the use of GNP losses has no relevance in deciding how much should be spent to reduce the impacts of an oil disturbance. This occurs because of the multiplier effect; in other words, the nation should not be willing to spend a dollar to restore a dollar of lost GNP.

The impacts of the oil price increase of 1973-74 have been estimated by Tani and Boyd (1976). Assuming a linear approximation of the domestic demand for imports, they estimate the cost of the 1973-74 disturbance using consumer and producer surplus losses at \$17.9 billion.

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<sup>11</sup>Consumer surplus is a measure of how much consumers would be willing to pay for a given quantity of a good above what they must pay at the market equilibrium price. Producer surplus is a measure of how much producers would be willing to accept for a given quantity of a good below what they receive at the market equilibrium price. See Tani and Boyd (1976) and Curlee (1982b).

**Table 17. Actual performance of the U.S. economy, 1973-1977**

	Real gross output (billions of 1972 \$)	Consumption (billions of 1972 \$)	Investment (billions of 1972 \$)	Net export of goods and govt. expenditure (billions of 1972 \$)	Price level (CPI 1972 = 1)	Value of energy imports (\$ billions)	Real growth in gross output (%)	Inflation (CPI) (%)	Unemployment rate (%)
Actual levels									
1972	1186.1	733.0	184.3	268.8	1,000	4.8	6.5	3.3	5.6
1973	1248.8	762.6	203.0	283.2	1,062	8.2	5.3	6.2	4.9
1974	1229.9	754.5	176.8	298.7	1,179	25.5	-1.5	11.0	5.6
1975	1219.8	761.8	140.4	317.6	1,287	26.5	-0.8	9.1	8.5
1976	1287.7	803.8	171.7	312.1	1,361	34.0	5.6	5.8	7.7
1977	1340.6	835.9	195.7	309.0	1,449	44.5	4.1	6.5	7.0

Source: Mork and Hall (1980). Gross output is defined as total GNP minus the portion of GNP originated in the energy sector plus the value of primary energy inputs to the goods sector.

Table 18. Estimated macro impacts of the 1973-74 oil price shock

Differences in percent of actual levels

	Eckstein (Data Resources Inc.) (CPI)	Perry (Federal Reserve Board) (GNP deflator)	Perry (Michigan University) (GNP deflator)	Pierce and Enzler (MPS) (consumption price deflator)	Mork and Hall (price of gross output deflator)	Department of Commerce (deflator not given)
<b>Inflation</b>						
1973	0.3					
1974	2.5	1.3	1.8	2.6	4.1	
1975	1.7	0.8	2.3	-0.0	1.6	
1976		1.1	1.2	-0.4	0.4	
1977		1.1	0.0	-0.8	-0.2	
<b>GNP/gross output</b>						
1973	-0.4					-0.2 <sup>a</sup>
1974	-3.1	-2.0	-1.5	-1.1	-2.4	-1.3
1975	-5.2	-3.0	-4.0	-2.7	-5.4	-1.7 <sup>b</sup>
1976		-2.9	-5.0	-2.4	-4.2	
1977		-3.1	-4.4	-2.1	-3.7	
<b>Investment</b>						
1973	1.0					0.0 <sup>a</sup>
1974	-7.2	-3.8	-2.3		-3.8	-0.9
1975	-12.8	-7.4	-10.7		-33.5	0.0 <sup>b</sup>
1976		-3.8	-12.4		-17.8	
1977		-2.7	-8.6		-12.7	
<b>Consumption</b>						
1973	-0.4					-0.5
1974	-3.7	-2.6	-2.3	-1.9	-4.0	-1.9
1975	-5.0	-3.7	-4.4	-4.4	-4.7	-2.6
1976		-4.6	-5.6	-3.4	-3.3	
1977		-5.1	-5.6	-3.1	-3.3	
<b>Increases in unemployment<sup>c</sup></b>						
1973						0.5
1974					1.0	
1975					1.9	
1976						
1977						

<sup>a</sup>Last quarter of 1973 only.<sup>b</sup>First quarter of 1975 only.<sup>c</sup>Expressed as actual increases in the unemployment rate due to the price shock.

Sources: Mork and Hall (1980). Office of Economic Impact (1974).

### III. THE 1978-79 IRANIAN REVOLUTION AND THE 1980-81 IRAN-IRAQ WAR

The fall of the Iranian government in late 1978 and the Iran-Iraq War which began in September 1980 produced significant reductions in the productions of crude in those countries and, in the case of the Iranian Revolution, produced significant increases in world oil prices. This section of the paper addresses various issues raised by these two oil disturbances.

#### A. Sources of the Disturbances

##### 1. The 1978-79 Iranian Revolution

Increased domestic turmoil in late 1978 resulted in reduced exports of crude from Iran. The export reduction began in September 1978 and by December 1978 virtually all exports of oil had stopped from Iran. In percentage terms, however, the reduction in world crude was small — about 4% of free world consumption (compared to 9.5% during the Arab embargo of 1973). Yet, the Iranian Revolution resulted in world oil price increases that were larger in both absolute and percentage terms than the 1973-74 price increases that followed the oil embargo. As was the case in 1973-74, the problem was not one of drastic reductions in the availability of crude and product, but was one of drastically increasing oil prices. To understand the sources of these drastic price increases, we must look deeper than the reductions in crude availability.

The Iranian Revolution differed from the 1973-74 experience in several ways. First, the disruption was not aimed at any country or group of countries as was the 1973 embargo. Thus, the effects of the disruption were spread much more evenly over all the consuming countries. Second, there had been a substantial increase in production of crude from several non-OPEC producers since 1973 which helped to cushion the impacts of the Iranian disruption. Large amounts of oil were flowing, for example, from the North Sea and Mexico. Third, non-disrupted OPEC producers, such as Saudi Arabia, increased production at the start of the Iranian Revolution which eased the disruption's impacts. All of these differences would seem to suggest that the impacts of the Iranian disruption would be less than those of 1973-74.

There were differences, however, that increased the severity of the Iranian disruption. First, some countries — especially Japan — were purchasing oil on the spot market for stockpiles with very little concern for price. World prices were thus driven higher. However, the major difference between 1973-74 and the two oil disruptions of the late 1970s was the structural change that had occurred in the world market for oil. The major structural change involved the role of the major oil companies in the production and distribution of oil from the OPEC countries.

Prior to the Iranian Revolution and the Iran-Iraq War, a few large Western oil companies controlled a large part of OPEC oil production and distribution. The international majors directly handled about two-thirds of all OPEC oil. This volume was significantly in excess of the refining and distribution systems of the majors. Thus, it was possible to sell several million barrels per day to third party consumers, such as the Japanese. The majors had a great deal of control over what oil went where and therefore could match particular crude quantity and quality needs with the available crude types.

The Iranian Revolution resulted in the loss of about 3.3 million barrels per day to the seven major companies operating in Iran — British Petroleum, Royal Dutch/Shell, Exxon, Socal, Mobil, Texaco, and Gulf. Third party sales were cut as a result, and the distribution system of the majors began to break down. In a sense, the majors held a certain degree of monopsony control over the OPEC producers prior to the events of 1978-79; and after the Iranian Revolution that monopsony power began to decline. Additional competitive bidding occurred from the countries most vulnerable to oil disruptions, driving the spot price of oil extremely high. Therefore, the price increases that followed the Iranian Revolution did not occur so much because the quantity of crude was decreased drastically, but rather occurred because of a breakdown in the oil production and distribution system and the panic that accompanied that breakdown.<sup>12</sup>

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<sup>12</sup>For more on this issue see Hiraoka (1980), Alm (1981), Alm, Colglazier, and Kates-Garnick (1981), Neff (1981), and Nye (1981).

## 2. The Iran-Iraq War of 1980-81

The outbreak of fighting between Iran and Iraq in September 1980 resulted in drastic decreases in exports from those countries. Iranian exports decreased by about 1 million barrels per day — Iraq's about 3 million barrels per day.

While the size of the disruption in percentage terms is about the same as the Iranian Revolution — about 4 to 5% of free-world production — the impact of the Iran-Iraq War on the price of oil has been significantly less. At least three reasons can be cited for this conclusion. First, the negative impacts that resulted from the change in the structure of the world oil market had already occurred during the Iranian Revolution. There has been no additional shock of this type during the Iran-Iraq War. Second, the worldwide slowdown in economic activity and the addition of more efficient fuel use capacity has reduced the world demand for oil. Third, private stocks of oil were at an all time high at the outbreak of the War.

Because of these and possibly other reasons, the Iran-Iraq War has not been a significant problem. The War continues at the time of this writing, and exports from Iran and Iraq continue to be disrupted, compared to their pre-war levels.

### B. Impacts on World Production and Prices

Table 19 shows how world crude production varied over the 1978 to early 1981 time period. The Iranian Revolution resulted in Iranian production being reduced from an average of 5.20 million barrels per day in 1978 to 2.37 million barrels per day in December 1978. A low point was reached in Iran in January 1979 when production was only 0.445 million barrels per day. Production increased slightly in February, and by March 1979 production had increased to 2.35 million barrels per day — a 55% decrease from the pre-revolution level.

The Iranian Revolution did not result in any reduction in world crude production in December 1978. In fact, significant production increases in both Saudi Arabia and Kuwait resulted in a small increase in Middle East production. There was also a production increase in the African producing countries of about 0.8 million barrels per day, roughly divided equally among Algeria, Libya, and Nigeria. Small production increases occurred in the Western hemisphere and Western Europe. The real reduction came in January 1979 when Iranian production fell about 2 million barrels per day and Saudi Arabia decreased production by 0.6 million barrels per day.

In terms of free-world total crude production, the impacts of the Iranian Revolution appear to be minor. Free-world production actually increased during December 1978 from about 46 to 48 million barrels per day. Production decreased in February to about 46 million barrels per day, but then increased in March to the pre-disruption level.

Following the Iranian Revolution, Iranian production did not increase to pre-disruption levels. In the months July through October 1979, production stabilized at about 3.8 million barrels per day — a 27% reduction from the pre-revolution level. Iranian production decreased steadily from October 1979 until the outbreak of the Iran-Iraq War. Fighting started in September 1979 and resulted in drastic reductions in crude production from both countries. Iranian production decreased from 1.1 to 0.45 million barrels per day from September to October 1979. Iraqi production fell from 2.9 to 0.15 million barrels per day over the same time period. Production remained at a low level in both countries in November 1980 and then began to increase gradually in the first quarter of 1981. At the time of this writing, production is still being disrupted by the War.

As occurred during the Iranian Revolution, Saudi Arabian production increased at the start of the Iran-Iraq War by about 0.5 million barrels per day. African producers increased production by about 0.5 million barrels per day. Production by other world producers remained fairly constant.

The overall impact of the Iran-Iraq War on the availability of free-world crude was roughly 2.4 million barrels per day — slightly larger than the impact of the Iranian Revolution. Both disruptions produced roughly a 5% reduction in the production of free-world crude oil.

**Table 19 World crude production, 1978-81**

Thousands of barrels per day

	November 1978	December 1978	January 1979	February 1979	March 1979	July 1979	October 1979	January 1980	April 1980	July 1980	September 1980	October 1980	November 1980	December 1980	January 1981	April 1981
<b>Western Hemisphere</b>																
Argentina	460	473	475	475	475	470	465	485	485	480	493	500	498	500	500	500
Canada	1 315	1 543	1 454	1 578	1 563	1 525	1 452	1 550	1 388	1 500	1 418	1 250	1 365	1 300	1 260	1 190
Mexico	1 215	1 366	1 390	1 396	1 400	1 415	1 510	1 721	1 887	2 014	1 124	2 182	1 901	2 027	2 219	2 538
U S	8 700	8 703	8 686	8 596	8 735	8 720	8 647	8 607	8 576	8 538	8 510	8 510	8 437	8 544	8 508	8 485
Venezuela	2 165	2 345	2 263	2 248	2 428	2 332	2 360	2 130	2 020	2 168	2 190	2 227	2 230	2 350	2 219	2 200
Other	930	931	845	962	960	926	969	987	1 030	1 005	945	989	1 000	957	967	1 005
<b>Total</b>	<b>14 785</b>	<b>15 361</b>	<b>15 237</b>	<b>15 355</b>	<b>15 561</b>	<b>15 388</b>	<b>15 403</b>	<b>15 480</b>	<b>15 388</b>	<b>15 705</b>	<b>15 680</b>	<b>15 658</b>	<b>15 431</b>	<b>15 678</b>	<b>15 673</b>	<b>15 918</b>
<b>Western Europe</b>																
Norway	355	355	359	365	358	376	357	550	540	267	501	529	537	553	537	511
U K	1 080	1 350	1 459	1 502	1 337	1 703	1 613	1 600	1 509	1 585	1 539	1 572	1 731	1 759	1 767	1 864
Other	280	313	318	324	325	320	303	295	298	313	325	325	326	325	287	291
<b>Total</b>	<b>1 715</b>	<b>2 018</b>	<b>2 136</b>	<b>2 191</b>	<b>2 020</b>	<b>2 399</b>	<b>2 273</b>	<b>2 445</b>	<b>2 347</b>	<b>2 165</b>	<b>2 365</b>	<b>2 426</b>	<b>2 594</b>	<b>2 637</b>	<b>2 591</b>	<b>2 666</b>
<b>Middle East</b>																
Abu Dhabi	1 445	1 462	1 456	1 455	1 454	1 455	1 485	1 390	1 348	1 360	1 298	1 308	1 337	1 338	1 249	1 289
Iran	5 200	2 371	445	700	2 350	3 800	3 800	2 300	1 800	1 500	1 100	450	700	1 200	1 600	1 600
Iraq	2 515	3 100	3 100	3 300	3 300	3 500	3 500	3 500	3 500	3 400	2 900	1 50	300	550	600	800
Kuwait	1 865	1 893	2 350	2 300	2 000	2 275	2 150	1 850	1 300	1 350	1 050	1 100	1 200	1 500	1 500	800
N Z	460	612	597	598	571	569	460	584	542	451	479	512	531	535	528	394
Oman	315	310	305	299	300	294	287	283	280	281	274	287	288	290	311	319
Qatar	480	583	548	554	368	519	488	502	498	460	461	440	475	483	507	513
S A	8 065	10 100	9 500	9 500	9 500	9 500	9 500	9 500	9 500	9 500	9 500	9 920	10 130	10 000	10 000	10 000
Other	620	681	678	674	669	700	603	618	625	605	629	620	615	625	582	628
<b>Total</b>	<b>20 965</b>	<b>21 112</b>	<b>18 975</b>	<b>19 380</b>	<b>20 512</b>	<b>22 612</b>	<b>22 273</b>	<b>20 527</b>	<b>19 393</b>	<b>18 907</b>	<b>17 691</b>	<b>14 787</b>	<b>15 576</b>	<b>16 521</b>	<b>16 877</b>	<b>16 343</b>
<b>Asia Pacific</b>																
Australia	430	425	432	423	399	471	454	414	423	436	388	431	265	448	436	430
Malaysia	455	480	490	495	500	500	500	526	556	560	511	510	513	515	514	520
Indonesia	1 635	1 590	1 600	1 619	1 630	1 600	1 575	1 568	1 580	1 550	1 565	1 575	1 621	1 635	1 636	1 600
Other	275	280	280	290	290	327	343	350	329	257	257	257	257	258	245	367
<b>Total</b>	<b>2 795</b>	<b>2 775</b>	<b>2 802</b>	<b>2 827</b>	<b>2 819</b>	<b>2 907</b>	<b>2 872</b>	<b>2 858</b>	<b>2 888</b>	<b>2 803</b>	<b>2 721</b>	<b>2 773</b>	<b>2 656</b>	<b>2 856</b>	<b>2 831</b>	<b>2 917</b>
<b>Africa</b>																
Algeria	1 100	1 225	1 225	1 225	1 225	1 000	1 000	1 000	1 000	900	900	1 000	1 000	900	1 000	850
Libya	1 975	2 200	2 100	2 131	2 140	1 020	2 030	2 100	1 750	1 680	1 680	1 665	1 680	1 680	1 600	1 600
Nigeria	1 910	2 396	2 448	2 428	2 435	2 350	2 135	2 150	2 150	2 101	1 600	1 879	2 062	2 018	1 900	1 623
Other	995	1 019	1 012	996	996	1 024	1 064	1 169	1 169	1 163	1 125	1 175	1 125	1 240	1 204	1 176
<b>Total</b>	<b>5 980</b>	<b>6 840</b>	<b>6 794</b>	<b>6 780</b>	<b>6 796</b>	<b>6 394</b>	<b>6 229</b>	<b>6 419</b>	<b>6 069</b>	<b>5 844</b>	<b>5 305</b>	<b>5 719</b>	<b>5 967</b>	<b>5 838</b>	<b>5 704</b>	<b>5 249</b>
<b>Free World Total</b>																
	46 240	48 106	45 944	46 533	47 706	49 700	49 050	47 729	46 085	45 965	43 762	41 374	42 224	43 530	43 676	43 039
<b>Communist</b>																
	13 690	14 075	14 250	14 110	14 110	14 133	14 338	14 360	14 520	14 640	14 677	14 640	14 535	14 505	14 331	14 500
<b>Total World</b>																
	59 930	62 181	60 194	60 643	61 816	63 833	63 388	62 089	60 605	60 064	58 439	56 014	56 759	58 035	58 007	57 593

Sources *Oil and Gas Journal* various issues *International Energy Statistical Review* various issues

Table 20 shows how the official sales prices for selected crudes changed over the time periods of the Iranian Revolution and the Iran-Iraq War. In terms of official sales prices, the Iranian Revolution did not result in drastic crude price increases. The price for Saudi Arabian light — the OPEC marker crude — increased from \$12.70 to \$18.00 per barrel from July 1978 to October 1979. The largest official price increase occurred between October 1979 and January 1980 when Saudi light increased to \$26.00 per barrel — a 44% increase. Prices in other OPEC producing countries increased roughly the same, given the variations in crude quality.

The Iran-Iraq War has resulted in few official sales price increases. Recall that the war impacted world production most severely in October and November of 1980. However, official sales prices increased only moderately during this time period. Saudi light increased to \$32 per barrel. There were significant price increases in Iran and Iraq; however, the average price for all OPEC crude increased from \$31.96 in October 1980 to \$34.18 in July 1981.

However, examining the changes in official sales price does not give a truly accurate picture of what happened to prices during these most recent oil disturbances. During the Iranian Revolution spot market prices increased significantly. Table 21 shows how the spot prices for Saudi light crude increased during and after the Iranian Revolution.

When the Iranian Revolution began, much of the oil that had been traded on the spot market was held back because of the uncertainty over future Iranian production. This reaction in combination with increased crude demand for stocks drove the spot price very high, very quickly. The spot market price for Saudi light increased by about \$4 from December 1978 to January 1979 — \$14.51 to \$18.49. The spot price increase in February was even more dramatic, increasing by about \$9 per barrel to \$27.38. Spot prices increased gradually in the following months.

Spot prices and official sales prices converged in the following months and by August 1980 were within \$7 of each other. Since that time the difference in the two prices has continued to narrow.<sup>13</sup>

### C. Impacts on the U.S. Economy

#### 1. Impacts of government measures

The U.S. government imposed various controls on the domestic oil market in response to the Iranian Revolution. As was the case in 1973-74, the government's program was quite complicated, and a complete analysis of the various regulations and controls is beyond the scope of this paper. However, the major initiatives are reviewed and their impacts summarized.

Government intervention took two major forms. First, the Department of Energy (DOE) used the powers given the executive branch during the 1973-74 disturbance to allocate crude and products domestically. Second, price controls on gasoline allowed refiners to raise the price of gasoline each month according to increases in crude cost incurred in the previous month.

Allocations were imposed in several ways. At the start of the Iranian Revolution, domestic stocks of distillate products were about 17% below what they were in the previous year. Because DOE feared that agricultural production might be hampered by the disruption, the agricultural sector was designated a priority fuel user. The increased flow of diesel to agriculture that resulted from the allocation program increased pressures on non-priority users, such as truckers, who depended on diesel fuel.

Government allocation powers also affected the supply of gasoline available to service stations. Supplies to service stations were between 80 to 90% of what they had been during the same time period in 1978. The availability of gasoline to non-priority users was restricted further because certain sectors — such as farming and emergency operations — were classified as priority users.

Allocations also affected the distribution of crude to domestic refiners. Allocation was necessary because of the domestic crude price controls that were still in effect at the time of the Iranian disruption. Without allocations, some refiners might not have been able to obtain domestic crude at the

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<sup>13</sup>See Birdsall (1980).

**Table 20. Official sales prices for selected crude oils, 1978-81**

Dollars per barrel

	Saudi Arabia light 34° API 1.7% sulfur	Iran light 34° API 0.35% sulfur	Iraq 35° API 1.95% sulfur	Nigeria 34° API 0.16% sulfur	Libya 40° API 0.22% sulfur	Venezuela 26° API 1.52% sulfur
1978						
January	12.70	12.81	12.58	14.33	13.80	12.82
July	12.70	12.81	12.58	13.87	13.68	12.70
1979						
January	13.34	13.45	13.21	14.82	14.52	13.36
April	14.55	16.57	15.70	18.52	18.08	15.76
July	18.00	22.00	19.96	23.49	23.28	19.31
October	18.00	23.71	19.96	23.49	23.28	19.48
1980						
January	26.00	30.37	27.96	29.99	34.50	25.20
April	28.00	35.37	27.96	34.71	34.50	26.78
July	28.00	35.37	31.96	37.02	36.78	29.88
October	30.00	35.37	31.96	36.95	37.00	29.88
1981						
January	32.00	37.00	37.50	39.92	41.00	32.88
February	32.00	37.00	37.50	39.92	41.00	32.88
April	32.00	37.00	37.50	39.92	41.00	32.88
July	32.00	37.00	36.93	39.92	40.00	32.88

Sources: *International Energy Statistical Review*, various issues. *Petroleum Intelligence Weekly*, September 1, 1980.

**Table 21. Spot market prices for Saudi light crude, 1978-80<sup>a</sup>**  
Dollars per barrel

	Saudi light crude
1978	
January	12.70
February	12.70
March	12.70
April	12.70
May	12.70
June	12.70
July	12.77
August	12.75
September	12.70
October	12.90
November	14.72
December	14.51
1979	
January	18.49
February	27.38
March	24.18
April	25.29
May	30.59
June	32.81
July	31.47
August	30.54
September	30.52
October	32.50-36.00
November	36.30-39.50
December	36.30-39.00
1980	
January	38.00
February	36.00
March	35.75
April	36.00
May	35.50
June	36.15

<sup>a</sup>Rotterdam, nominal dollars.

Source: *Petroleum Intelligence Weekly*, various issues as given in Birdsall (1980).

lower domestic price. The refiners that could have obtained a large percentage of their throughput from domestic sources would have had a competitive edge over refiners forced to use imported crude. In order to maintain a "competitive" refinery sector some crude was transferred from large, sophisticated refineries to small, unsophisticated refineries. It has been speculated that this shift resulted in fewer light-weight products being produced because many small refiners do not have the capability to refine certain crudes into light-weight products such as gasoline.

Further, because of the low stocks of distillate at the start of the disruption, DOE encouraged refiners to build stocks of distillate. Some have argued that these requirements resulted in excessive stocks of heating oil to be accumulated. The DOE threatened to enforce refinery yield shifts if the stocks of distillate were not increased to the desired level of 240 million barrels.

Price controls on domestic crude and product resulted from (1) domestic controls on "old" domestic oil that continued throughout the Carter Administration, (2) price controls on gasoline at the refinery level, and (3) the price restraint program of the President's Council on Wage and Price Stability. Each of these controls may have made the Iranian disruption more severe. Price controls on domestic crude may have hindered the domestic response to the huge world oil price increase that followed the Iranian disruption. It is generally agreed that larger imports resulted from the crude price controls at a higher cost to the domestic economy. Further, prices for gasoline were set at the refinery level according to the cost of crude in the previous month. Because world crude prices were escalating at such a rapid rate, there was an incentive for refiners to accumulate stocks of gasoline so they could be sold at a higher price in some future month. This, of course, restricted the availability of gasoline on the U.S. market. It is unclear what impact the Council on Wage and Price Stability had on refined product prices during the Iranian disruption.

While the regulations and controls of 1978-79 were to some degree effective in reaching their designated equity goals, it is generally agreed in the literature that the government's actions during the Iranian disruption, like the government's actions during 1973-74, resulted in the disruption being more, rather than less, severe.<sup>14</sup>

## 2. Impacts on U.S. imports

Table 22 shows how U.S. crude oil imports changed during the Iranian disruption and Iran-Iraq War. The Iranian disruption of 1978-79 did not result in a significant reduction in U.S. imports of crude. In fact, the level of U.S. crude imports increased from 1978 to the first quarter of 1979 from 6.3 to 6.5 million barrels per day. Iranian imports were down significantly during this time period from 0.544 to 0.085 million barrels per day. Major import increases occurred, however, from Saudi Arabia and Nigeria totaling 0.7 million barrels per day. Crude imports decreased in April 1979 down to about 6.1 million barrels per day. While this reduction occurred at the same time Iranian imports reached a low point, it would not be correct to conclude that the quantity of imported crude was physically restricted into the United States. Rather, the import reduction was fairly evenly distributed across all importers indicating that the reductions in imports resulted from a response to the large price increases that occurred at that time. Crude was available but at a significantly higher price.

Neither did the Iran-Iraq War directly result in an import reduction for the United States. At the start of the War in September 1980, the U.S. did not import any crude from Iran and very little from Iraq — about 0.5 million barrels per day. All imports from Iraq ended in November 1980. U.S. imports of crude did decrease between June and September of 1980 from 5.5 to 4.7 million barrels per day. However, this reflects a decrease in imports from almost all importing sources, rather than a huge reduction in imports from a particular source.<sup>15</sup>

<sup>14</sup>For more on the government's response to the Iranian disruption see Verleger (1979), Alm (1981), Hiraoka (1980), and Alm, Colglazier, and Kates-Garnick (1981).

<sup>15</sup>Not all imports of crude were being consumed. Starting in late 1977 the U.S. Strategic Petroleum Reserve (SPR) started to be filled. During all of 1978 and the first part of 1979 the reserve was filled at between 100 and 250 thousand barrels per day. SPR imports were discontinued in September 1979 and resumed in September 1980 at about 150 thousand barrels per day.

**Table 22. Crude oil imports, 1978-81**  
Thousands of barrels per day

	Average 1978	First quarter 1979	April 1979	May 1979	June 1979	July 1979	August 1979	First quarter 1980	June 1980	September 1980	November 1980	December 1980	January 1981	February 1981	March 1981	April 1981
Algeria	617	603	660	696	517	558	645	509	486	354	462	367	309	338	314	254
Egypt	20	35	49	48	17	14	44	58	28	32	7	7	44	52	48	43
Iraq	61	91	55	41	239	49	69	49		48						
Kuwait	5	5					22	21	17	38	23					
Libya	828	625	771	644	751	607	644	618	561	493	500	641	493	468	485	488
Qatar	62	27	30	11	53	45	24	32	16		9	19				17
Saudi Arabia	1,136	1,480	1,484	1,267	1,262	1,307	1,306	1,430	1,320	1,098	1,201	1,293	1,288	1,077	1,027	1,047
U A E	378	317	285	292	290	244	268	292	178	107	105	83	93	93	47	84
Other	7	5		15	7			9					17	19	17	
Total																
OAPEC	2,914	3,188	3,334	3,014	3,146	2,824	3,022	3,018	2,606	2,170	2,307	2,410	2,244	2,047	1,938	1,933
Ecuador	38	42	16	26	35	19	26	23	23	13		37	11	16		3
Gabon	38	43	21	45	37	53	53	29	30		25	29	12	59	46	18
Indonesia	498	407	347	274	338	336	447	347	303	277	322	227	362	374	293	263
Iran	544	85	35	195	315	386	494	29								
Nigeria	895	1142	956	1095	925	938	1158	975	966	722	588	953	901	847	771	826
Venezuela	176	225	245	312	320	307	369	163	152	141	164	189	136	134	134	128
Total																
OPEC	5,076	5,092	4,905	4,898	5,082	4,849	5,525	4,517	4,052	3,291	3,399	3,838	3,605	3,406	3,117	3,128
Canada	246	299	334	249	238	220	260	247	186	184	181	201	199	199	176	141
Mexico	316	459	300	390	455	354	425	476	579	512	443	382	378	419	470	420
U K	166	201	174	198	259	281	74	209	146	218	151	199	214	227	263	402
Norway	105	60	26	34	115	48	68	163	132	121	177	98	137	102	178	38
Other	296	350	325	358	405	395	331	350	357	349	308	321	329	449	252	285
Total	6,232	6,501	6,113	6,190	6,588	6,161	6,727	6,029	5,480	4,707	4,666	5,046	4,923	4,873	4,521	4,457

Source: *International Energy Statistical Review*, various issues

Table 23 shows how total product imports into the U.S. changed during the Iranian Revolution and the Iran-Iraq War. Neither oil disturbance appears to have had any direct impact on the imports of refined products. There is a general trend over this time period to reduce product imports, but this can be explained by the large oil price increases that accompanied the oil disturbance.

### 3. Impacts on domestic stocks of crude and products

Table 24 shows how the stocks of crude and products changed over the 1978-81 time period. Figure 2 illustrates the trends in gasoline, distillate, and crude stocks over the same time period. Stocks of crude reached a low point in January and February of 1979 when they went down to about 303 million barrels — down from about 342 million barrels in January of the previous year. Crude stocks have increased generally since February 1979 to a high of 407 million barrels in April 1981. Crude stocks were not drawn down significantly during either the Iranian Revolution or the Iran-Iraq War. Rather, for whatever reason, crude stocks remained fairly stable during the Iranian Revolution and actually increased significantly during the Iran-Iraq War.

Most product stocks appear to have fluctuated moderately during the 1978-81 time period, with the exceptions of gasoline and distillate fuel. Gasoline stocks normally fluctuate from a high in the winter months when driving is down to a low in late summer-early fall. However, during June and July 1979 gasoline stocks actually increased. It has been speculated — as is discussed in an earlier section of this paper — that this stock buildup may have resulted from the pricing policy set by DOE. Recall that gasoline prices were set according to the price of crude in the previous month. During the first six months of 1979, spot prices for crude had increased about 75% (see Table 20), and there were pressures to increase contract prices. Thus, there was an economic incentive to hold gasoline stocks in anticipation of higher crude prices.

Distillate stocks also vary seasonally with a low point usually reached in March or April to a high point in October or November. The same seasonal pattern was followed during the Iranian Revolution and the Iran-Iraq War; however, the low point reached during March and April 1979 was much lower than in previous years. Stocks of distillate dropped to 113 million barrels in March 1979 which was 25 million barrels lower than in March 1978. As discussed in a previous section, this stock depletion led to government intervention to allocate distillate to priority users and to encourage refineries to increase their productions of distillate. Distillate stocks increased to their seasonally adjusted normal level in the fall of 1979.

Table 25 shows the ratio of crude and selected product stocks to daily average refinery runs of crude and the selected products. Again, the only real problem is with distillate stocks in the first few months of 1979. In April the ratio for distillate fell to 39.18. The ratio is usually in the high 60s to low 70s in that same time period in other years.

### 4. Impacts on the availability of crude oil types in the U.S.

Using the same methodology introduced in Sect. II.D of this paper, the impacts of the Iranian Revolution and the Iran-Iraq War on the types of crude available to U.S. refineries are estimated. Recall that crude oils were broken down into seven categories depending on sulfur content and specific gravity (see Table 7). Data concerning which oil types are produced in the producing states of the U.S. and foreign countries were obtained. Data were then obtained concerning the pre- and post-disturbance levels of domestic production and imports. The types of crude available on the domestic market before and after the disturbances were subsequently estimated. Tables 9 and 10 show the producer to crude category mappings.

Recall that this information is interesting because sudden and severe changes in the types of crude being input into refineries may result in a forced change in the end product mix. A shift from light, low-sulfur crude to heavy, high-sulfur crude could mean that light-weight products, such as gasoline, would be impacted more than heavy-weight products, such as residual fuel.

Recall from Sect. III.C.2, that neither the Iranian Revolution nor the Iran-Iraq War resulted in a significant change in total U.S. crude imports. However, shifts in imports did occur — mainly

**Table 23. Total product imports, 1978-81**

Thousands of barrels per day

	Motor gasoline	Jet fuel	Distillate fuels	Residual fuel	Natural gas liquids	Total refined products
1978						
July	212	105	149	1,295	122	1,948
August	179	86	143	1,275	93	1,858
September	251	75	163	1,318	106	1,983
October	180	65	178	1,120	116	1,718
November	147	89	223	1,350	122	2,021
December	182	86	254	1,410	258	2,245
1979						
January	179	97	226	1,371	256	2,222
February	160	88	196	1,300	252	2,062
March	168	61	176	1,642	257	2,385
April	156	43	149	1,134	160	1,673
May	145	75	185	1,051	255	1,826
June	261	57	180	880	175	1,672
July	222	90	219	1,065	240	1,932
August	147	49	217	1,023	236	1,778
September	135	84	126	979	194	1,596
October	150	90	211	1,042	193	1,785
November	182	83	235	1,037	268	1,946
December	263	108	229	1,272	273	2,305
1980						
January	141	95	179	1,132	282	1,983
February	153	43	221	1,119	265	1,911
March	154	99	179	971	224	1,724
April	152	107	147	769	149	1,430
May	132	79	126	812	187	1,478
June	148	86	108	749	193	1,413
July	149	93	117	787	178	1,401
August	141	67	77	875	166	1,379
September	106	77	101	906	168	1,475
October	152	93	115	871	262	1,603
November	126	66	133	1,024	240	1,729
December	121	60	166	1,025	299	1,812
1981						
January	152	12	273	1,015	319	1,892
February	121	41	325	956	338	1,904
March	200	76	144	699	260	1,505
April	195	55	116	584	222	1,310
May	159	47	165	735	197	1,436

Source: *Monthly Energy Review*, various issues.

Table 24. U.S. stocks of crude and products, 1978-81

Thousands of barrels

	Crude oil stocks <sup>a</sup>	SPR stocks	Motor gasoline	Jet fuel	Distillate fuel	Residual fuel	Natural gas liquids
1978							
July	332,909	35,248	216,368	38,050	180,420	75,320	157,527
August	316,866	40,968	208,975	35,747	200,157	74,166	164,537
September	321,172	47,090	216,500	35,328	220,687	81,314	165,600
October	325,081	53,113	213,666	33,104	233,082	83,435	161,006
November	322,045	59,312	220,523	32,829	233,231	88,729	152,519
December	309,421	66,860	237,959	33,665	216,439	90,194	140,052
1979							
January	302,728	73,142	255,664	31,993	175,695	81,997	124,138
February	302,981	78,166	251,346	30,449	127,034	68,229	110,412
March	317,432	82,501	239,162	32,607	112,728	71,968	107,759
April	319,759	83,867	235,192	36,217	114,989	81,002	110,216
May	316,355	86,880	227,193	37,547	123,059	84,855	118,505
June	325,893	88,567	229,349	35,741	141,365	80,893	126,468
July	312,852	90,101	241,536	34,152	171,243	86,631	134,523
August	320,745	91,189	232,742	34,156	195,339	87,542	138,491
September	323,854	91,189	229,608	32,251	220,328	87,775	143,336
October	344,679	91,191	218,066	34,891	231,083	90,896	140,215
November	347,367	91,191	220,486	36,058	236,554	90,636	133,925
December	339,080	91,191	237,503	38,520	228,706	95,859	125,597
1980							
January	353,611	91,191	262,134	38,412	212,126	97,153	110,378
February	361,648	91,191	274,422	38,258	191,464	90,959	105,389
March	361,742	91,191	282,688	38,661	177,659	88,269	106,070
April	379,352	91,191	271,729	39,339	177,006	85,219	117,006
May	382,902	91,191	262,938	41,310	183,072	87,637	124,615
June	382,035	91,191	264,583	42,283	195,790	87,657	133,516
July	379,280	91,191	260,711	40,902	213,756	85,605	143,618
August	387,605	91,191	239,013	40,331	226,305	86,949	153,716
September	375,989	92,824	258,135	42,159	232,310	87,876	155,181
October	378,488	96,645	246,422	43,177	225,711	90,898	152,763
November	372,811	102,320	257,059	43,921	223,261	93,814	149,277
December	357,702	107,800	261,327	42,031	205,113	90,344	142,251
1981							
January	367,456	112,400	276,511	39,478	180,004	82,267	134,010
February	386,793	116,057	283,983	38,726	172,528	78,230	128,722
March	397,191	120,860	284,859	39,206	164,638	74,920	127,279
April	407,182	134,170	271,782	40,690	164,634	73,045	133,375
May	402,273	150,068	258,187	44,668	171,918	78,542	140,492

<sup>a</sup>Excludes SPR stocks.Source: *Monthly Energy Review*, various issues.

### Trends in U. S. Stocks of Crude and Products, 1978-81

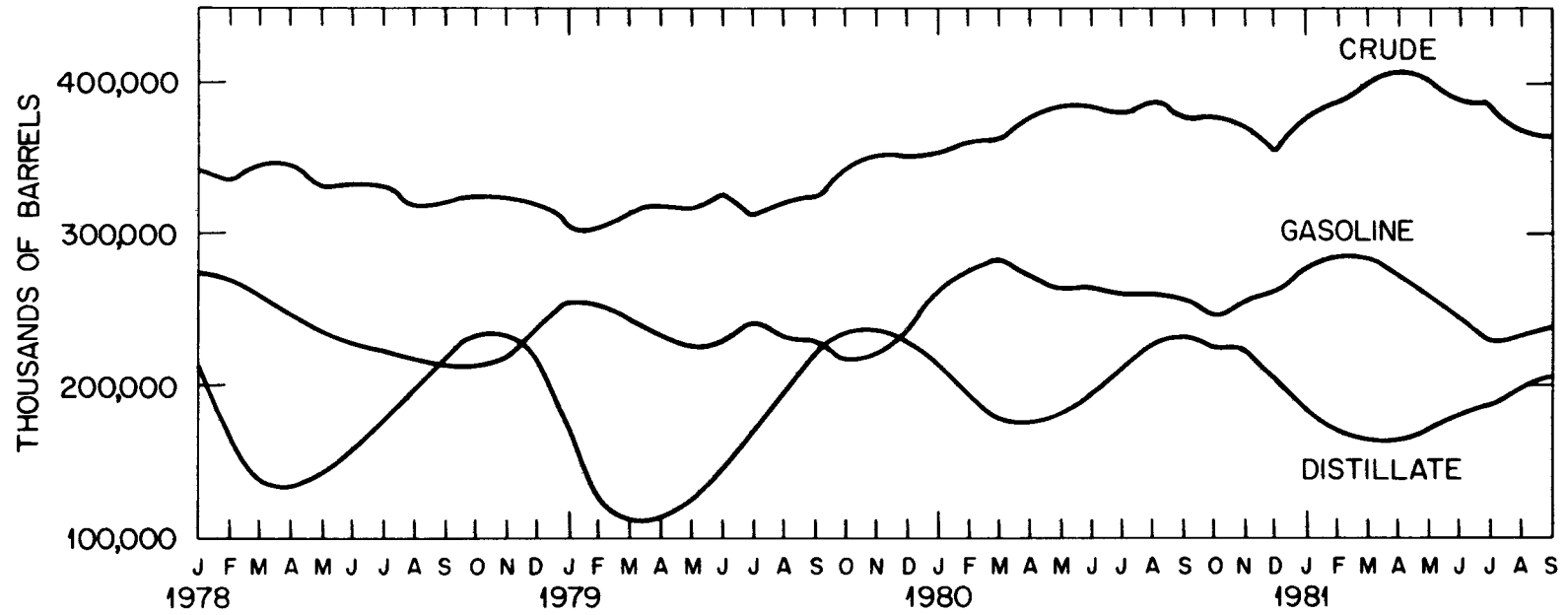


Figure 2

**Table 25. Ratio of crude and product stocks to average refinery runs**

	Crude oil	Gasoline	Distillate fuel
1978			
September	21.29	29.26	69.30
December	20.06	30.39	64.41
1979			
January	20.65	35.16	58.47
April	22.29	34.76	39.18
July	20.89	34.47	51.81
September	22.39	34.65	65.42
1980			
January	24.73	37.57	70.17
April	28.13	43.35	72.96
July	28.62	40.45	79.52
September	28.24	40.52	86.45
1981			
January	28.41	41.41	60.62
April	33.68	44.48	68.08
July	31.35	36.15	76.59

Source: Data from *Monthly Energy Review*, various issues.

decreases from Iran and increases from Nigeria and Saudi Arabia. Also recall from Table 19 that the level of production in the U.S. did not increase following either the Iranian Revolution or the Iran-Iraq War.

State-by-state production data were obtained from the *Oil and Gas Journal* and crude import data were obtained from *The Monthly Energy Review*. Table 26 shows the percentages of the seven crude types available in the U.S. in selected time periods.

As can be seen from the table, there was no significant change in the type of crude available during either disturbance. There was, however, a slight shift between 1978-79 and 1980. There was a slight decrease in the percentage of type I (light-weight, low-sulfur crude) and a slight increase in type V (light-weight, medium-sulfur crude). This is explained by decreases in imports from Indonesia, Libya, and Nigeria, and a slight increase in domestic production in California. However, these changes are not large enough to produce any significant changes in refinery activity.

Therefore, we can conclude that during neither the Iranian Revolution nor the Iran-Iraq War did the mix of crude on the domestic market change significantly.

##### 5. Refinery output changes

The total capacity of U.S. refineries in 1978 was about 17.6 million barrels per day — a 26% increase above the 1973 capacity. However, the average input of crude into domestic refineries was about 12.4 million barrels per day in both 1973 and 1978. In addition to having more excess refinery capacity in 1978 than in 1973, it is also important to note the shift in the type of refinery capacity that occurred during this time period. Specifically, U.S. refiners became more capable of refining higher-weight, higher-sulfur crudes into light-weight end products. Catalytic hydrorefining

**Table 26. Types of crude available on the U.S. market**  
In percentages<sup>a</sup>

Crude Type	November 1978	December 1978	January 1979	February 1979	March 1979	April 1979	August 1980	October 1980	November 1980	December 1980
I	30.9	30.3	30.5	30.4	31.7	30.9	28.2	28.0	27.4	28.3
II	25.5	25.2	26.0	25.8	25.9	27.0	26.4	27.2	27.2	27.3
III	04.2	04.3	03.8	04.2	04.7	04.4	05.5	04.7	05.0	04.7
IV	05.2	04.6	04.8	04.6	04.6	04.6	04.2	04.5	03.9	03.6
V	03.3	03.2	03.3	03.4	03.4	03.4	04.3	04.2	04.2	04.1
VI	08.7	10.2	09.0	09.9	10.4	09.1	08.2	09.2	10.2	10.0
VII	22.2	22.0	22.5	21.6	19.2	20.4	23.2	21.9	21.9	21.9

<sup>a</sup>May not sum to 100 because of rounding.

Sources: Denoya (1981); *Oil and Gas Journal*, various issues; *Monthly Energy Review*, various issues.

and catalytic hydrotreating capacities increased from 0.63 and 4.26 million barrels per day to 1.95 and 5.83 million barrels per day, respectively. Total U.S. refinery capacity increased further to 19.4 million barrels per day in 1981, while the average daily runs increased to only 12.6 million barrels. Domestic refineries continued to become more sophisticated.<sup>16</sup> This suggests that domestic refineries were better equipped to refine crudes of varying types into roughly the same end product mix in 1978 and 1981 than they were in 1973.

Table 27 shows how U.S. refinery inputs and outputs changed during the 1978-81 time period. Neither the Iranian Revolution nor the Iran-Iraq War resulted in any significant shifts in refinery operations. As was concluded in the previous section, neither event resulted in a significant shift in the mix of crudes available to U.S. refineries. Thus, we would not expect a significant shift in the end-product mix because of technological constraints at the refinery level.

Refinery inputs remained fairly constant over the 1978-79 time period at about 14.6 million barrels per day. There was a slight decrease in refinery inputs in February and March of 1979 of about 0.5 million barrels per day. There was no apparent drop in refinery inputs at the start of the Iran-Iraq War.

Product output also did not change significantly as a result of either disturbance. There was a slight decrease in the production of gasoline in the first quarter of 1979 and a slight increase in the production of distillate fuel during the last half of 1979. However, neither varies significantly from the seasonal norm.

#### 6. Domestic refined product price changes

Because domestic price controls were in effect during the most recent disturbances, the changes in end-product prices do not necessarily reflect the prices that would have occurred in a free market. Nevertheless, price trends are important to understanding the overall impacts of disturbances. Table 28 shows how selected end-product nominal prices changed over the 1978-81 time period.

All product prices were fairly stable in 1978, while severe price increases occurred in 1979. Gasoline prices increased by 50%; No. 2 diesel by 84%; No. 2 heating oil by 68%; and No. 6 residual oil by 84%. Prices for all products continued to increase in 1980 and 1981 but at a much lower rate.

#### 7. Macro impacts

At least two studies have been done to estimate the macroeconomic impacts of the 1978-79 Iranian disruption — a study by the General Accounting Office (GAO) published in 1979 and a study by Knut Mork and Robert Hall published in 1980. Both studies first do a base case simulation of the U.S. economy and then estimate the deviation from that base case caused by the oil price shock of 1979. A summary of these estimates is given in Table 29.

The GAO's results were obtained from the Data Resources Inc. quarterly econometric model. The Mork and Hall model is a much smaller macroeconomic econometric model of the U.S. economy. The model contains only about ten equations but is modeled with energy questions in mind.

Both models estimate that the 1979 oil price shock caused moderate increases in the U.S. inflation rate of between 0.7 and 1.8% in 1979. Inflation impacts were smaller in subsequent years. Real gross output decreased most in 1980. The GAO estimates a loss of 14.0 billion dollars and Mork and Hall a loss of about 54.7 billion dollars. According to Mork and Hall, real gross output impacts will continue to be severe through 1983. According to both studies, unemployment was impacted moderately. The estimates range from a low of 0.1% additional unemployment in 1979 to a high of 1.2% additional unemployment in 1980.

Recall from Sect. II.D.7 that there are alternative ways to measure the macroeconomic impacts of an oil disturbance. Tani and Boyd (1976) measured the cost of the 1973-74 oil embargo in terms

<sup>16</sup>Compiled from *Oil and Gas Journal* and *Monthly Energy Review* data.

Table 27. Refinery inputs and outputs, 1978-81

	Crude input to refineries	Motor gasoline	Jet fuel	Distillate fuel oil	Residual fuel oil	Natural gas plant liquids
1978						
January	14,150	6,933	921	3,067	1,868	326
February	13,969	6,631	989	2,952	1,795	338
March	14,148	6,750	967	3,014	1,751	361
April	13,886	6,668	980	2,959	1,548	352
May	14,996	7,059	1,011	3,250	1,653	363
June	14,693	7,210	963	3,109	1,572	367
July	14,911	7,264	923	3,123	1,586	348
August	15,196	7,454	966	3,296	1,630	351
September	15,085	7,399	989	3,185	1,636	379
October	15,005	7,176	932	3,299	1,564	352
November	15,336	7,583	1,011	3,366	1,662	357
December	15,421	7,831	989	3,360	1,750	363
1979						
January	14,658	7,272	950	3,005	1,907	337
February	14,121	6,941	996	2,863	1,792	325
March	14,062	6,654	1,097	2,992	1,718	333
April	14,346	6,765	1,040	2,935	1,643	354
May	14,273	6,786	976	3,064	1,588	389
June	14,655	6,987	956	3,137	1,534	382
July	14,977	7,006	964	3,305	1,576	361
August	14,827	6,882	1,040	3,332	1,590	363
September	14,461	6,626	958	3,368	1,638	323
October	14,330	6,483	1,046	2,248	1,611	321
November	14,397	6,654	1,027	3,257	1,742	323
December	14,817	6,962	1,068	3,238	1,879	343
1980						
January	14,298	6,977	1,004	3,023	1,766	698
February	14,189	6,851	1,026	2,778	1,770	572
March	13,709	6,512	1,031	2,564	1,581	518
April	13,484	6,268	1,023	2,462	1,591	507
May	13,326	6,294	1,001	2,471	1,507	428
June	13,705	6,552	1,004	2,645	1,575	386
July	13,251	6,446	974	2,688	1,480	455
August	13,011	6,437	959	2,462	1,444	417
September	13,312	6,369	1,041	2,687	1,497	463
October	12,777	6,124	977	2,589	1,513	501
November	13,119	6,456	988	2,699	1,577	528
December	13,648	6,632	962	2,892	1,661	545
1981						
January	13,248	6,677	956	2,987	1,611	611
February	12,903	6,269	949	2,809	1,565	560
March	12,383	6,202	995	2,484	1,423	484
April	12,090	6,110	960	2,418	1,320	462
May	12,309	6,119	1,006	2,454	1,222	443

Source: *Monthly Energy Review*, various issues.

Table 28. Domestic refined product prices, 1978-81

	Wholesale			
	Cents per gallon		Dollars per barrel	
	Gasoline (average all types)	No 2 diesel	No 2 heating oil	No 6 residual oil
1978				
January	63 1	36 6	38 1	11 33
February	63 0	36 6	37 8	11 25
March	63 0	36 7	37 6	11 36
April	63 2	36 5	37 6	11 57
May	64 0	36 6	37 6	11 70
June	64 8	36 7	37 7	11 41
July	66 1	36 4	37 7	10 86
August	66 8	36 6	37 9	10 70
September	67 2	37 1	38 6	11 26
October	67 2	37 7	39 6	11 76
November	68 2	38 6	40 5	12 36
December	68 9	39 1	41 3	12 57
1979				
January	69 8	39 7	42 1	12 78
February	71 0	41 8	44 5	13 72
March	74 0	44 5	47 0	14 82
April	78 4	47 7	49 3	15 51
May	82 9	53 4	52 6	15 71
June	87 9	58 7	56 9	17 81
July	92 6	62 4	61 1	19 18
August	96 7	66 0	64 6	19 00
September	99 4	69 0	67 8	19 62
October	100 5	71 1	68 1	20 88
November	101 8	70 3	69 0	22 00
December	104 6	73 0	70 8	23 55
1980				
January	111 0	76 0	75 2	24 41
February	118 6	78 3	79 0	23 34
March	123 0	79 8	80 4	21 11
April	124 2	80 4	81 0	19 09
May	124 4	80 5	81 4	20 22
June	124 6	81 7	82 5	20 44
July	124 7	81 9	83 0	21 28
August	124 3	81 6	82 9	22 25
September	123 1	80 3	83 0	22 47
October	122 3	81 5	83 7	24 06
November	122 2	83 6	86 1	28 12
December	123 1	87 5	91 3	29 76
1981				
January	126 9	92 5	98 6	31 14
February	135 3	99 5	106 0	31 81
March	138 8	101 7	106 3	31 78
April	138 1	101 3	105 2	30 56
May	137 0	100 8	104 0	30 41

Source *Monthly Energy Review*, various issues

Table 29. Macroeconomic impacts of the 1979 oil price shock

	General Accounting Office DRI quarterly model		Mork and Hall	
	Deviations in percent of baseline	Absolute <sup>a</sup> deviations	Deviations in percent of baseline	Absolute <sup>a</sup> deviations
<b>Inflation</b>				
1979	0.7		1.8	
1980	0.4		1.3	
1981			0.1	
1982			-0.2	
1983			-0.1	
<b>Real gross output</b>				
1979		-8.5	-1.1	-15.1
1980		-14.0	-3.8	-54.7
1981			-3.5	-51.9
1982			-3.1	-46.2
1983			-2.5	-38.9
<b>Investment</b>				
1979		-2.3	3.6	7.9
1980		-6.0	-12.6	-28.2
1981			-14.8	-33.8
1982			-11.7	-27.5
1983			-8.0	-19.6
<b>Consumption</b>				
1979			-2.6	-23.0
1980			-2.9	-26.5
1981			-2.3	-21.1
1982			-2.3	-21.8
1983			-2.3	-22.4
<b>Unemployment</b>				
1979	0.1		0.4	
1980	0.2		1.2	
1981			0.9	
1982			0.5	
1983			0.2	
<b>Real growth</b>				
1979			-1.1	
1980			-2.9	
1981			0.3	
1982			0.5	
1983			0.6	

<sup>a</sup>Absolute deviations in billions of 1972 dollars for Mork and Hall and 1978 dollars for the GAO study.

Sources: General Accounting Office (1979), Mork and Hall (1980).

of lost consumer and producer surplus. Using the same methodology used in Tani and Boyd, the consumer and producer surplus losses imposed by the Iranian disruption of 1979 were estimated.

To determine this measure of cost, one first observes how the price of petroleum increases as the disruption restricts the quantity of crude on the world oil market. One then determines the change in the level of imports that occurs during the period of the price change. If we approximate the relationship between price and quantity of crude linearly, the surplus cost can be estimated easily as the hatched area in Fig. 3.

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### The Surplus Loss Imposed by an Oil Price Shock

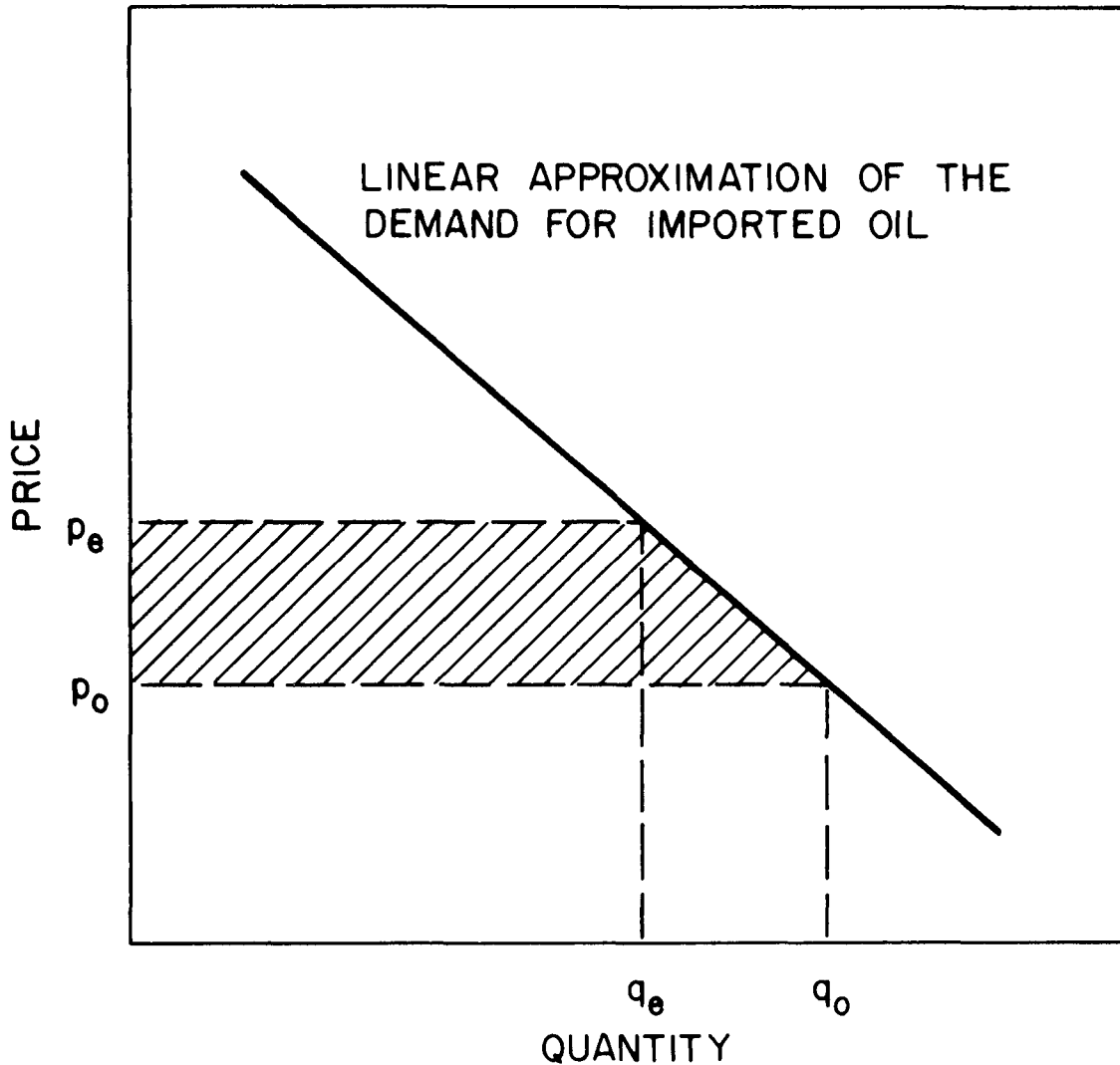


Figure 3

The cost of the oil price shock can be estimated by

$$C = 0.5D(p_e - p_o) (q_e + q_o)$$

where

- $q_o$  == quantity of oil imported before the price shock,
- $q_e$  == quantity of oil imported following the price shock,
- $p_o$  == price of oil before the price shock,
- $p_e$  == price of oil following the price shock and,
- $D$  == duration of the price shock.

To estimate the impact of the Iranian Revolution in 1979 consider the following numbers that roughly describe the reactions of the world and domestic markets to the price shock that followed the Iranian event:

- $q_o$  == 6.195 million barrels per day,
- $q_e$  == 6.411 million barrels per day,
- $p_o$  == \$14.57 per barrel of crude,
- $p_e$  == \$21.67 and
- $D$  == 365 days.

The numbers for  $q_o$  and  $q_e$  represent the average daily imports of crude for 1978 and 1979, respectively; the numbers for  $p_o$  and  $p_e$  are the average prices for imported crude in 1978 and 1979, respectively.<sup>17</sup>

Using this methodology, the estimated cost of the Iranian oil price shock in 1979 was about 16.33 billion dollars. This is roughly equal to the loss in real gross output estimated by Mork and Hall for 1979.

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<sup>17</sup>The data are from the *Monthly Energy Review*.

#### IV. FUTURE OIL DISTURBANCES AND THEIR LIKELY IMPACTS

A large number of books and papers have been written on the types, probabilities, and likely impacts of future world oil disturbances.<sup>18</sup> In this section the general consensus of those works is summarized and in some ways extended. In the first part of this section, the most probable sources of future disturbances are reviewed. The second part then concentrates on the impacts these disturbances might have on both the world and domestic oil markets.

##### A. What Can We Expect in the Future?

The general consensus among those who have written in this area is that future oil disturbances will result from four main sources: (1) internal political instability in the Persian Gulf region, (2) political embargoes, (3) regional conflicts in the Middle East, and (4) international conflicts that hinder the production and/or transportation of crude and product.

##### 1. Internal political instability

It is generally agreed that during the 1980s and 1990s the governments in the Persian Gulf region will come under additional attacks [Aikens (1980)]. The recent revolution in Iran and increased political problems in Saudi Arabia and other Arab states point to increased instability.

It is interesting to note the types of government that currently exist in the region (Table 30). Iraq has the only socialist government. The other major oil exporters have either a sheikdom or monarchy type of government. These types of governments are increasingly unstable given the affluence that has resulted from oil exports.

The oil producing countries of the Middle East also face increased domestic turmoil because of internal political and religious conflicts. The religious conflicts are exemplified by the tensions between the Sunni and Shiihite Muslims, especially in Saudi Arabia. In several of the producing countries there are rather strong Marxist factions that oppose both the Muslim religious leaders and any U.S. involvement in the region.

Saudi Arabia poses the most severe problem. The overthrow of the Saudi government by a radical Islamic group would probably result in a reduction of their exports to three million barrels per day (a loss of four to five million barrels per day). It has been estimated that the Saudis would need a minimum of three million barrels per day in exports to sustain their economy [see Feer (1980)].

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<sup>18</sup>See, for example, Aikens (1980), Deese and Nye (1981), Feer (1980), Curlee (1981a), Jacoby and Padock (1980), Stobaugh (1979), Stobaugh and Yergin (1980), Klass, Burrows, and Beggs (1980), and Krappels (1980).

**Table 30. Governments of  
Persian Gulf countries**

Country	Type of government
Iran	Islamic Republic
Iraq	Socialist
Kuwait	Sheikdom
Bahrain	Sheikdom
Qatar	Sheikdom
UAE	Sheikdom
Oman	Sultanate
Saudia Arabia	Monarchy

Another interesting problem that might result from a change in Saudi leadership would be a change in the ratio of light to heavy oil exports to more closely reflect Saudi reserves. The current Saudi production ratio is two to one light to heavy crude. Reserves, however, are one to two light to heavy. It is possible that the Saudis could totally stop the export of light crude, even in the short run. While this shift in production should not cause significant problems for world refineries, minor problems could arise.

Furthermore, the fall of the Saudi government could possibly signal the fall of neighboring governments in Kuwait, Oman, and the United Arab Emirates.

## 2. Political embargoes

A renewed Arab-Israeli War could lead to another political embargo by OAPEC. A total cutoff of exports is, however, not likely. The economies of the producing countries require some minimum level of exports, and unless the producing countries back up an embargo with a corresponding decrease in production, the embargo could have little effect. While direct imports from OAPEC countries might not be possible, oil probably could be obtained indirectly through countries not embargoed. It is interesting to recall that during the 1973 embargo, OAPEC reduced production by only 25% for about 2 months. Most experts conclude that a future OAPEC embargo would result in no more than a 50% cutback by OAPEC producers for no more than one year [see, for example, Akins (1980)].

However, there are reasons the U.S. and other consuming countries should remain very concerned about the possibilities of political embargoes. The world market for oil has undergone several structural changes since the previous embargo in 1973. Specifically, the OAPEC countries have much more control today over both the transportation and refining of oil than they had in 1973. Thomas Neff (1981) has written an interesting paper on the changing world oil market. In that paper Neff states that prior to the 1973-74 disturbance, the seven major international oil companies produced and distributed over 90% of all OPEC oil. This gave the majors (even during disturbance times) a great deal of flexibility to route oil to various destinations depending upon particular needs. For example, heavy, high-sulfur crude could be distributed to refiners that had the capacity to process such crudes.

Today the majors have control over only about 55% of OPEC production. The producers are now using direct sales to increase their control over the world oil market and to further their own political and economic objectives. Destination restrictions have been imposed in some cases to prevent the sale of OPEC oil to certain boycotted countries such as Israel. Resale restrictions have been imposed to prevent third-party sales and exchanges between the international companies. Oil is sometimes restricted to be used only in the refining and distribution systems of the purchaser's home market. While the effectiveness of these various controls is questionable during normal times, and especially during a severe oil disturbance, there is no question that the producing countries have a greater degree of control over the distribution and refining of oil today than they had in 1973. As a result, a political embargo targeted at a particular country or group of countries could be more effective today than it was in 1973.

## 3. Regional conflicts in the Persian Gulf area

Regional conflicts between oil producers in the Persian Gulf region could result in the loss of exports from those countries — the Iran-Iraq War being an example. There is some concern that the Iran-Iraq War could involve additional producing countries such as Saudi Arabia.

Three additional regional conflicts are of concern. The first is a conflict between Iraq and Kuwait over border issues. The second is a conflict between Saudi Arabia and one or more of its Arab neighbors. The third is a conflict between Iran and Oman or any other conflict that would result in the closing of the Straits of Hormuz.

Although Iraq is currently at war with Iran, a future conflict between Iraq and Kuwait is considered probable. A war between Iraq and Kuwait would probably result over the long common

border which has been disputed over the past twenty years. The disruption that could result from such a war would not in itself pose a severe problem, but could become severe if neighboring countries became involved.

A regional conflict between Saudi Arabia and another Arab country, has the potential of being very damaging because it would probably result in the loss of a large percentage of Saudi production—largest in the Persian Gulf region and third largest in the world. One of the major sources of concern is the growing dominance of Iran. A conflict could possibly occur if Iran attempts to extend its radical Muslim ideas into Saudi Arabia by using military force. A conflict involving Saudi Arabia could result in the loss of all their production—about 8 million barrels per day—from the world oil market.

Unprobable, but potentially damaging, is a conflict involving the closing of the Straits of Hormuz. A successful blocking of the Straits could result in a loss of between 10 and 12 million barrels per day to the world market. Bordered by Iran on the north and Oman on the south, the Straits are only 45 miles wide. A conflict between Iran and Oman could close the Straits, but such a conflict is not likely. Iran might attempt to close the Straits, but again this is unlikely since almost all of Iran's exports are shipped through the Straits. Terrorists probably could not close the Straits with military force but could greatly increase the risks oil-tanker owners would bear. Tanker owners might refuse to send their ships in the region which would in effect cut off supplies.

#### 4. International conflicts

An international conflict, that would either disrupt the production of, or impede the flow from, producing countries, could result in the loss of all exports from the Middle East — approximately 12 million barrels per day. Such a conflict is, of course, a Soviet intervention scenario and represents the worst case.

#### B. The Likely Impacts of Future Disturbances

In this section the impacts of four selected oil disruptions are estimated. Those disruptions are (1) a 25% cutback of OAPEC production, (2) a 50% cutback of OAPEC production, (3) the loss of all Saudi Arabian production, and (4) a loss of all Persian Gulf oil. It must be stated at the outset, however, that these are rough estimates based on the most recent available data. The world and domestic oil markets are very volatile currently which adds greater uncertainty to the analysis. For example, U.S. imports of crude oil are decreasing rapidly — from 4.3 to 3.3 million barrels per day from July 1981 to February 1982. Imports in March 1982 were only about 2.7 million barrels per day. This most recent data is not complete, however. With these caveats noted, rough estimates of these disruption impacts are made.

##### 1. Impacts on the world oil market

The Organization of Arab Petroleum Exporting Countries (OAPEC) is composed of Saudi Arabia, Kuwait, Qatar, the United Arab Emirates, Iraq, Libya, Algeria, Syria, and Bahrain. Egypt is a member but has been suspended since the Camp David agreements. With the exceptions of Syria, Bahrain, and Egypt, all OAPEC members are also members of OPEC. Iran, Indonesia, Nigeria, Gabon, Venezuela, and Ecuador are members of OPEC but not OAPEC.

During the embargo of 1973, only OAPEC members participated. It is assumed that only OAPEC members would participate in a future embargo. It is further assumed that non-OAPEC producers will act as price takers during a severe disruption and produce crude at their full capacity levels. It is assumed that in the event of a Saudi Arabian production disruption, that all remaining producers will produce at full capacity. Given these assumptions, the levels of world crude oil production given the four selected disruptions can be estimated.

Table 31 shows the maximum sustainable capacity figures for the major producing countries with excess capacity.<sup>19</sup> It is assumed that in the short-run time period of a disruption (less than one

<sup>19</sup>Maximum sustainable crude production capacities were obtained from the *International Energy Statistical Review* and from personal conversations with Wendell Cootes of the Foreign Assessment Center in the Central Intelligence Agency.

**Table 31. Maximum sustainable crude production capacities for selected countries**  
Thousands of barrels per day

Algeria	1,100
Ecuador	225
Gabon	200
Indonesia	1,650
Iran	5,500
Iraq	3,500
Kuwait	2,200
Libya	2,100
Neutral Zone	600
Nigeria	2,200
Qatar	600
Saudia Arabia	10,000
United Arab Emirates	2,415
Venezuela	2,035
Canada	1,400
Mexico	2,800
Total	38,890

Sources: *International Energy Statistical Review*, January 1982.

Personal conversation with Wendell Cootes, Foreign Assessment Center, CIA.

year) these maximum capacities could not be changed significantly. The expert opinion is that there is no significant excess crude capacity in the U.S. currently.

Table 32 shows the current productions of crude from all producers in October 1981 and shows how that world production would be affected under the four disruption scenarios. Note that the majority of all excess crude production capacity is in the OAPEC countries. Most of the excess capacity is located in Saudi Arabia, Kuwait, the United Arab Emirates, Algeria, and Libya. Nigeria has excess capacity of about 1 million barrels per day.

Table 32 shows that, under the assumptions made, a 25% OAPEC cutback reduces world crude production by about 2 million barrels per day — roughly equaling the world production reduction following the Iranian Revolution in January 1979. A 50% OAPEC reduction results in a world production decrease of about 5.4 million barrels per day — compared to the 4.6 million barrel per day reduction in November 1973 during the OAPEC embargo. A Saudi disruption results in a 3.2 million barrel per day loss; a loss of all Persian Gulf crude reduces world supplies by 11.7 million barrels per day.

## 2. Impacts on the U.S. market

It is very difficult to speculate as to how these disruptions would impact the importation of crude into the United States. U.S. imports would depend, upon other things, the flexibility of the world crude distribution system, the amount of crude traded under long-term contracts versus the amount traded on the spot market, and the degree to which crude prices would increase (which is extremely difficult to predict given past experience with disruptions).

It is helpful to note the sources of our current imports. Table 33 shows U.S. crude imports by source for July 1981. The only disruption that would severely and directly impact the U.S. would be

**Table 32. Current world crude production and projected production under various disruption scenarios**

	Current production October 1981	25% OAPEC reduction	50% OAPEC reduction	Saudia Arabian production loss	100% Loss of all Persian Gulf production
Western Hemisphere					
United States	8,618	8,618	8,618	8,618	8,618
Canada	1,119	1,400	1,400	1,400	1,400
Ecuador	220	225	225	225	225
Mexico	2,488	2,800	2,800	2,800	2,800
Venezuela	1,970	2,035	2,035	2,035	2,035
Other	1,315	1,315	1,315	1,315	1,315
Western Europe	2,568	2,568	2,568	2,568	2,568
Middle East					
Bahrain	43	32	21	43	0
Iran	1,000 <sup>a</sup>	1,000 <sup>a</sup>	1,000 <sup>a</sup>	1,000 <sup>a</sup>	0
Iraq	1,100 <sup>a</sup>	1,100 <sup>a</sup>	1,100 <sup>a</sup>	1,100 <sup>a</sup>	0
Kuwait	800	600	400	2,200	0
Neutral Zone <sup>b</sup>	374	280	187	600	0
Oman	324	324	324	324	0
Qatar	359	269	179	600	0
Saudia Arabia	9,500	7,125	4,750	0	0
Syria	170	127	85	170	0
U A E	1,478	1,108	739	2,415	0
Africa					
Algeria	700	525	350	1,100	1,100
Libya	700	525	350	2,100	2,100
Nigeria	1,249	2,200	2,200	2,200	2,200
Other	1,296	1,296	1,296	1,296	1,296
Asia Pacific					
Indonesia	1,600	1,650	1,650	1,650	1,650
Other	1,240	1,240	1,240	1,240	1,240
Total	40,232	38,362	34,832	36,999	28,547

<sup>a</sup>It is assumed that Iranian and Iraqi production would not be impacted by an embargo action because of their current war

<sup>b</sup>The Neutral Zone's capacity and production is shared equally by Saudia Arabia and Kuwait

Source *International Energy Statistical Review* January 1982 Personal conversation with Wendell Coates, Foreign Assessment Center, CIA

a disruption in Saudi Arabia, since that country currently provides the U.S. with 24% of our total crude imports.<sup>20</sup>

However, trying to predict the impacts of a disruption by predicting the impacts of that disruption on the level of U.S. imports can be very deceiving. History tells us that the main problem with disruptions is not the level of crude disrupted, but rather is the huge world price increase that accompanys the disruption. Predicting the price increases that would occur from the selected disruption scenarios is beyond the scope of this paper. Therefore, reliable estimates cannot be made here concerning the economic impacts of likely future disruptions.

<sup>20</sup>It is interesting to note at this point that the recent U.S. boycott against Libyan crude should have a small impact on the U.S. market. In July 1981, Libyan imports composed only about 6% of total U.S. imports

**Table 33. U.S. crude imports by source, July 1981**  
Thousands of barrels per day

	July 1981	%
Algeria	277	6.4
Libya	251	5.8
Qatar	20	0.5
Saudia Arabia	1,044	24.0
U.A.E.	80	1.8
Gabon	7	0.2
Indonesia	297	6.9
Nigeria	626	14.4
Venezuela	209	4.8
Canada	132	3.0
Mexico	342	7.9
U.K.	553	12.8
Norway	130	3.0
Other	368	8.5
	4,336	100.0

Source: *International Energy Statistical Review*, January 1982.

### C. Impacts of Future Disruptions on the Availabilities of Crude Types

A major emphasis of this paper has been on the impacts past disruptions have had on the types of crude oil available to U.S. refineries. Recall from previous sections of this paper that previous disruptions have not resulted in significant changes in the mix of crude oil on the domestic market. In this section the probable impacts of the four disruption scenarios (described in the previous section) on the mix of crude oil available on the world oil market are discussed. In addition, the trends in U.S. refinery capacities are reviewed briefly. This information, in turn, allows us to speculate about the flexibility of U.S. refiners to changes in the mix of crude caused by severe world supply disruptions.

Concerns have been raised recently about the ability of U.S. refiners to respond to changes in their crude mixes resulting from crude disruptions. Thomas Neff (1981) has argued that the greater degree of control that the oil producing countries maintain over the oil distribution system may imply that the crude that is available during a disruption will not go to the refinery that can process that crude into the most needed end products. The result could be smaller production of lightweight products such as gasoline.

Ursula Guerrieri (1980) argues that the entitlements program of the 1970s provided a subsidy to small, unsophisticated refiners. As a result many small refineries were built that cannot process heavy, high-sulfur crudes into lightweight refined products. Guerrieri's conclusions suggest that the U.S. may be more susceptible to crude mix changes than other importing countries.<sup>21</sup>

<sup>21</sup>In a recent study by the National Petroleum Council (1980) the impacts upon major end products of various foreign crude disruptions were examined. The study considered a 2.0 million barrel per day reduction in U.S. imports with and without replacement by other crude types and a 5.0 million barrel per day import reduction of foreign average crude oil. The major conclusion of the study was that in any of the three cases "there is sufficient flexibility in the U.S. refining system to reflect 75 to 80% of the volume loss in reduced motor gasoline output as opposed to other products such as heating oil" (page 6).

While the Council's conclusions are interesting, it is unclear why they selected to impose the entire burden of the disruption on the domestic gasoline market. The more interesting question would appear to be whether the U.S. refinery system could satisfy the projected demands for all refined products (including gasoline) given the selected disruption scenarios.

## 1. Trends in U.S. refinery capacities

Table 34 shows how U.S. refinery capacity changed from 1972 to 1981. The total number of refineries has increased from 247 in 1972 to 303 in 1981, while average daily refinery capacity has increased from 55.5 to 63.9 thousand barrels per day. Simple averages are somewhat deceiving, however. Guerrieri (1980) concludes that while the average refinery size has increased in recent years, there has been a trend toward relatively small refineries and relatively large refineries and a trend away from refineries of medium capacities. The market share of domestic refiners with capacity of less than 50 thousand barrels per day increased from 8.5 to 13.5% from 1972 to 1977.

Refineries as a whole have become more sophisticated in recent years. This is reflected by the large increases in catalytic reforming, catalytic hydrocracking, and catalytic hydrotreating. Catalytic reforming capacity, a process that utilizes platinum to convert low-grade naphthas into high-octane motor fuels, has increased from 1.7 to 4.1 million barrels per day. Catalytic hydrocracking is a process that breaks heavier crudes into lighter products. Catalytic hydrocracking capacity has increased from 0.84 to 0.91 million barrels per day from 1972 to 1981. Catalytic hydrotreating capacity, a process predominantly devoted to the removal of sulfur and nitrogen, has increased from 4.3 to 6.6 million barrels per day over the same time period. The conclusion that can be drawn from this trend is that domestic refineries on the whole are better equipped to process crudes of higher specific gravities and higher sulfur contents today than they were in 1972. Therefore, U.S. refineries would be more resistant to changes in the crude mix resulting from a supply disruption today than in 1972.

## 2. Crude mix changes resulting from supply disruptions

Using the crude oil classification scheme developed in Tables 7, 8, 9, and 10, the changes in the world-market crude oil mix that would result from our four disruption scenarios are discussed in this section. World production data, given the various scenarios, is taken from Table 32. Table 35 shows how the percentages of the seven crude types change given the four disruption scenarios. It should be noted that assay information was not available for all world producers. Those countries for which there was no assay information were assumed to produce the average world crude.

While the numbers in Table 35 are only rough approximations of what might actually occur under the four selected scenarios, they do suggest some general conclusions. First, if the assumptions made hold true, none of the four scenarios results in a drastic shift in the mix of crude available on the world market. Type VII (lightweight, high-sulfur crude) is impacted most. In the case of a total loss of Persian Gulf production, the percentage of type VII crude decreases from 0.453 to 0.235% of world production. Second, while the percentage of type VII crude decreases significantly under the most severe disruptions, the percentages of type I (medium-weight, low-sulfur) and type II (lightweight, low-sulfur) crudes increase significantly. Since the lighter-weight, lower-sulfur crudes are easier to refine, this analysis suggests that the disruption scenarios discussed here would not imply that lightweight, end-product production would be disrupted. Much of the world's high-sulfur crude is produced in the Middle East — Saudi Arabia in particular. Thus, a drop in Middle East production shifts the mix of world crude toward a "sweeter" mix of crude. Third, as shown in Table 34, U.S. refinery capacity has increased in size as well as sophistication since the 1973 embargo. Average daily refinery runs were about 12.5 million barrels per day at the time of the 1973 disturbance, implying excess capacity of about 1.2 million barrels per day. In February 1982 average daily refinery runs were only about 11.3 million barrels per day, suggesting excess refinery capacity of about 8 million barrels per day. Further, the increased refinery capacities for catalytic reforming, catalytic hydrorefining, and catalytic hydrotreating suggest that U.S. refiners on the whole are more prepared to adjust to an altered refinery mix today than they were in 1973.

**Table 34. Trends in U.S. refinery capacity, 1972–1981**

Year	No plants	b/cd capacity	b/sd capacity	Vacuum distillation	Thermal operations	Cat crack fresh feed	Cat crack recycle	Cat reforming	Cat hydrocracking	Cat hydrotreating	Cat hydrorefining
1972	247	13,087,223	13,709,442	4,852,005	1,531,053	4,574,811	1,256,110	1,169,125	839,081	633,888	4,259,605
1973	247	13,382,955	13,991,580	5,150,703	1,441,390	4,512,550	1,048,990	3,278,118	865,050	844,890	4,391,298
1974	247	14,216,287	14,876,050	5,300,006	1,491,950	4,618,580	1,061,035	3,358,038	855,840	1,019,830	4,760,280
1975	259	14,845,407	15,463,650	5,497,143	1,484,742	4,677,414	933,855	3,461,955	880,009	1,087,328	4,906,825
1976	256	15,074,845	15,687,321	5,672,893	1,459,608	4,744,914	930,190	3,592,786	893,309	1,276,788	5,211,888
1977	266	16,170,570	16,912,596	6,216,729	1,506,369	4,932,022	890,080	3,670,206	907,823	1,808,628	5,567,647
1978	285	16,848,684	17,618,955	6,318,216	1,497,103	4,956,682	896,829	3,781,598	912,679	1,944,678	5,830,946
1979	289	17,169,909	18,050,957	6,532,072	1,496,658	4,985,420	884,455	3,794,489	887,089	1,958,078	5,934,117
1980	297	17,790,844	18,708,528	6,685,862	1,556,425	5,304,906	817,194	3,924,469	888,278	1,956,384	6,341,275
1981	303	18,465,399	19,370,529	6,996,660	1,600,058	5,531,256	870,577	4,051,419	911,788	2,159,444	6,625,115

Source *Oil and Gas Journal* various issues

**Table 35. World crude mix changes resulting from supply disruptions**  
In percentages<sup>a</sup>

Oil type	Actual production July 1981	25% OAPEC reduction	50% OAPEC reduction	Saudia Arabian production loss	100% Loss of all Persian Gulf production
I	13.7	16.1	17.6	19.7	22.0
II	21.1	22.7	24.2	30.5	34.2
III	02.8	02.9	03.3	03.3	03.7
IV	06.0	05.1	04.5	10.0	02.3
V	02.1	02.2	02.5	02.4	02.8
VI	08.9	09.7	10.6	10.9	11.6
VII	45.3	41.1	37.3	23.0	23.5

<sup>a</sup>May not sum to 100 because of rounding.

Source: *International Energy Statistical Review*, various issues.

It is, of course, very difficult to predict how a world production disruption might translate into changes in crude import quantities from the producing countries. As stated before, the most severe short-term impacts for the U.S. would result from a loss of Saudi Arabian production since about 19% of all our crude and product imports is accounted for by that country. However, even under the worst case scenarios considered here, the mix of crudes on the world market shifts to a sweeter crude. If U.S. imports of crude shift accordingly, no refinery constraints should occur because of an altered crude input mix.

## V. CONCLUSIONS

The drastic oil price increases that occurred prior to and during the 1973-74 Oil Crisis signaled the end of both cheap energy and secure energy supplies. Since the disturbance of 1973 the world oil market has been shocked by two additional disruptive events. Those events brought the realization that the United States and other oil consuming countries are not only vulnerable to political actions against the consuming countries, but are also vulnerable to political events within and between the major producing countries. And although future disruptive events are anticipated, there is still no general consensus on how either the public or private sectors will or should respond to the probabilities of future oil disturbances.

One way to obtain a clearer perspective of our current oil vulnerability problem is to understand the causes and impacts of past disturbances. Understanding these causes and impacts may, in turn, suggest what can be expected in the future and how government and the private sector should, and should not, respond to those events.

The major objective of this paper has been to present an historical perspective of the so called 1973-74 Oil Crisis, the 1978-79 Iranian Revolution, and the 1980-81 Iran-Iraq War. Several different yardsticks or measures have been used to describe the impacts of those events. They include impacts on world petroleum flows and prices, impacts on U.S. petroleum imports and end product prices, changes in domestic crude production and product stocks, and impacts on macroeconomic indicators such as gross output, inflation, and unemployment. Also of concern were the impacts previous disturbances had on the types of oil (defined according to specific gravity and sulfur content) available to domestic refiners.

In addition to examining past disturbances, this paper also considers the likely causes and impacts of future disturbances. Given fairly general assumptions, the impacts of four disruption scenarios on the availability of world crude are considered.

In this final section, several general conclusions are drawn from the analysis presented in the preceding sections. The emphasis here is not on the actual numbers that describe the previous disturbances, but rather is on how those numbers can be used to better understand the expected impacts of, and proper responses to, future disturbances.

### A. General Conclusions

- The first thing that one must understand about previous oil disturbances is that the impacts of those disturbances did not result directly from the disruption of crude oil production. During the 1973-74 disturbance, non-communist production fell only about 9.5%. During the Iranian Revolution and the Iran-Iraq War, free-world production fell a maximum of only 4 to 5%; and in all three cases the durations of the production reductions were only about 2 to 4 months.

The real problems with past disturbances were not huge losses in the production of crude, but rather were the large oil price increases that accompanied the events. Saudi Arabian light crude increased in price from \$2.10 to \$9.60 per barrel from January 1973 to January 1974. The official sales price of Saudi light increased from \$13.34 to \$30.00 per barrel from January 1979 to October 1980. The spot price for the same crude escalated from \$18.49 to \$36.00 per barrel during the same time period. In order to understand the oil disturbances of the 1970s and early 1980s one must go beyond understanding how the productions and flows of oil were altered by disruptive events. One must understand why relatively minor supply disruptions resulted in huge price increases that persisted after the disruptions ended.

- The sources of previous disruptions have differed greatly. The 1973-74 Oil Crisis resulted from (1) the large price and benefit concessions achieved by the OPEC countries during 1973 and (2) the embargo on oil exports to the U.S. and the Netherlands by OAPEC that resulted as a response to the Arab-Israeli War. Given the increased cohesiveness obtained by the OPEC countries in the early 1970s, it is likely that large price increases would have resulted in 1973-74 in the absence of an embargo and subsequent production reduction. In fact, major concessions were

obtained by OPEC prior to the start of the Arab-Israeli War. There is little doubt, however, that the OAPEC production reductions in late 1973 and early 1974, along with the confusion of redistributing world oil to meet U.S. needs, put upward pressure on the world price.

The Iranian disruption of 1978-79, of course, resulted from the fall of the Iranian government. The disruption of production in Iran and Iraq in late 1980 resulted from fighting between those two countries. Thus, previous disturbances have resulted from four sources: (1) greater cohesiveness and bargaining power within OPEC, (2) an embargo on oil sales to selected countries, (3) internal political problems within a major producing country, and (4) war between two producing countries.

- History suggests the future causes of disturbances. Short of an international conflict in the Persian Gulf region, a conflict involving Saudi Arabia would be most severe, since Saudi Arabia is the largest OPEC producer and third largest producer in the world. Internal problems within, or a military confrontation involving, Saudi Arabia would be more severe than another political embargo. During a political embargo, it is not likely that the producing countries would reduce production enough to harm themselves significantly. During the 1973 embargo Arab production was reduced a maximum of 25%. The same assurance does not exist given a war or internal political disturbance. Further, the duration of an embargo would be limited by the negative impacts the embargo imposes on the producing countries. The duration of a war or political disturbance is much less certain — the Iranian Revolution and Iran-Iraq War being cases in point.
- During previous disruptions, the impacts imposed on the United States and world oil markets have been crucially linked to the abilities of the major oil companies to allocate the remaining oil to the various oil consuming countries. During the 1973 embargo, the majors had a great deal of control over both the production and distribution of OPEC oil. This control enabled the majors to shift oil flows during the embargo to help minimize its negative impacts. Of course, price increases occurred, but they were much more orderly than those that would have occurred had the majors maintained a lesser degree of control over OPEC oil.

The importance of the major's control over OPEC oil was shown during the Iranian Revolution of 1978-79. The majors control over the production and distribution of OPEC oil was much weaker in the late 1970s than in the early 1970s. As a result, the loss of Iranian exports led to severe competitive bidding for the remaining oil by the consuming countries — exemplified by the huge increases in the spot prices for oil.

- It is clear that the less monopsony control held by the major oil companies, the more severe disruptions of world oil become. One of the major concerns today is that the lack of control by the majors over the distribution of OPEC oil could result in a fairly small political embargo imposing rather severe impacts. It is clear that a political embargo is effective only to the extent that the producing countries (1) reduce production according to the size of the embargo and/or (2) exercise control over the distribution and refining networks of the world market. It is generally agreed that OPEC and OAPEC have greater control over the second today than they had in 1973.
- The impacts of previous oil disturbances on the United States market have been greatly affected by government regulations and controls. Forced allocations and price controls existed during both severe disturbances — the 1973 Oil Crisis and the 1978-79 Iranian Revolution. From an efficiency perspective, it is generally agreed that those government programs resulted in the impacts of the disturbances being more, rather than less, severe. It is clear that the major objective of the controls was equity rather than efficiency; and from that perspective it is generally agreed that the programs were to some extent effective. Certainly, designated priority fuel users, such as farmers, were impacted much less by the disturbances than non-priority users, such as truck drivers and automobile owners. There is, of course, no way to evaluate the success of these equity programs, other than from the perspective of the individual.

Further, it is clear that efficiency was sacrificed in the name of preserving a "competitive" domestic refinery industry. It is generally concluded that the allocations of crude from large to small refiners during previous disturbances resulted in fewer light-weight end products being produced.

Price controls on domestic oil and refined products reduced domestic production of crude and increased domestic consumption of end products, respectively. The effect was to increase the level of imports at a price higher than was paid to domestic crude producers. These actions were taken to prevent excess profits being made by domestic producers. From an efficiency perspective, these controls were clearly not optimal.

- The public and private sectors can respond to oil disturbances in two fundamental ways if efficiency is the objective. Both responses require preparations before the oil disturbance occurs, rather than makeshift actions taken in response to a disturbance — such as price controls and allocations. First, stockpiles of crude and products can be accumulated in nondisturbance time periods and released during disturbances to prevent the world price of oil from going as high as it otherwise would go. Second, suppliers and demanders of oil (including the government) can maintain supply- and demand-side capital stocks that are flexible to sudden, severe oil price shocks. In other words, demanders of oil can maintain a capital stock that can be switched quickly from the use of oil to the use of another fuel. Suppliers of oil can maintain excess-production capacity so that when the price of oil increases, that excess capacity can be made operational very quickly.

During previous oil disturbances there was virtually no response by either the government or the private sector in either of these basic ways. No government strategic stocks of oil existed in 1973, and while the Strategic Petroleum Reserve (SPR) began to be filled in October 1977, there were only about 60 million barrels in the SPR when the Iranian Revolution began. No SPR stock release was called for, nor would it have had any significant effect, given the SPR's very small size at that time.

Private stocks of crude and product generally increased during previous disruptions. Therefore, rather than making the disturbances less severe by releasing stocks, the private sectors put additional pressures on world price increases by increasing stocks.

While SPR stocks are currently about 250 million barrels, it is very unclear how or if those stocks would be used during a disturbance. And if history is a guide, one can expect private stocks to increase during future disturbances.

It is much more difficult to determine the levels of flexible oil supply- and demand-side capital stocks that were available and used during previous disturbances. There appears to have been little flexible-oil-use capacity in the United States; however, this is difficult to determine given that product prices were kept artificially low by price controls. There also appears to have been little domestic excess-production capacity during previous disturbances. In fact, domestic production actually decreased during the 1973-74 and 1978-79 disturbances. Once again, however, it is difficult to say what might have occurred had price controls on domestic production been lifted.

The conclusion here is that neither the U.S. government nor the domestic oil industry responded to previous disturbances in a way that made their impacts less severe. Any analysis of future disturbances must consider that the same public and private sector reactions could recur.

- Recently, some concern has been raised concerning the ability of U.S. refiners to process crudes of varying specific gravities and sulfur contents, given a disruption of crude from a particular region of the world. In this study, crude was divided into seven types, and the changes in the relative percentages in the crude types available on the U.S. market were estimated prior to and during the previous disturbances. In all cases it was determined that the mix of available crudes in the U.S. was not changed significantly.

In addition, the impacts of four selected disruptions on the mix of crude available on the world market were estimated. Given the assumptions made, it was estimated that the mix would not shift to crudes of greater refining difficulty. Since most Middle East crude has a relatively high sulfur content, the most likely disruptions result in a world crude mix of lower sulfur content.

Further, even if the mix of crude became higher in sulfur content and heavier, the domestic refinery capacity as a whole is more equipped to process these crudes today than it was in the early 1970s. The only foreseeable problem at the refinery level from a national perspective would occur if the available crude was allocated to small unsophisticated refineries away from large sophisticated refineries during a disturbance.

- Several papers that estimate the macroeconomic impacts of previous oil disturbances were reviewed in this study. Several macroeconomic indicators were considered, such as GNP, investment, inflation, and unemployment. The review concluded that the estimates vary significantly in some cases and depend heavily on the assumptions made. Because of these reasons, these macroeconomic impacts must be considered carefully.

One error that is sometimes made when considering these macroeconomic impacts is that the impacts could have in some way been prevented. If, however, the U.S. had little control over the events that precipitated the disturbances, all of the negative impacts of the previous disturbances could not have been prevented. The macroeconomic impacts are most valuable when viewed as a base case from which the benefits of various actions could, or can, be estimated. For example, what would have occurred if oil storage had been available and released during the disturbances or if additional excess capacity and switchover capacity had been available? What impacts would an import tariff on oil have had on the U.S. economy. These actions would most certainly not have prevented all the impacts of past disturbances. However, many who specialize in this area believe that these actions would have reduced the impacts.

#### B. Final Conclusions

This analysis suggests that previous oil disturbances did not result in a large percentage of the world's crude production being lost for a long period of time. The problem has been that these relatively small disruptions have led to sudden, severe world oil price increases. The reasons why these large price increases occurred depend upon the particular disruption; and the reasons why the price increases imposed severe impacts is complicated and not at this time completely understood.

It is clear, however, that the actions by private firms and government officials that followed the disruptive events for the most part made the impacts of the disturbances more, rather than less, severe. Any analysis of future oil disturbances must recognize that the panic that followed past disturbances could recur.

Much can be learned from past oil disturbances that can be used to prepare for the future. The failure to recognize our past failures, as well as accomplishments, can only lead to a worsening of our oil vulnerability problem.

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