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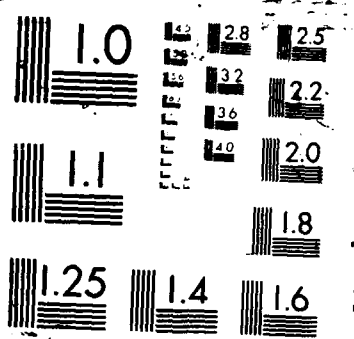
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William M. Brown, Ph.D.

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The Institute was founded in 1961 by the late Herman Kahn and colleagues from the Rand Corporation. Initially, the Institute's



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primary focus was on policy issues involving national security and international order. Subsequently, the Institute's research broadened to include non-military, domestic, and international policy issues. Studies in these areas resulted in several Hudson books including: The Emerging Japanese Superstate, The Next 200 Years, Our Children's Crippled Future, The Coming Boom, and Workforce 2000. The Institute's research has always emphasized the value of a long-term perspective on policy issues, and therefore the development of appropriate techniques for studying the future--especially the long-range future.

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TABLE OF CONTENTS

	<u>Page</u>
PREFACE.....	vii
EXECUTIVE SUMMARY.....	ix
 I. HISTORICAL PERSPECTIVE.....	 1
A. Oil Prices: 1960-1982.....	1
B. The Nature of OPEC.....	16
C. Institutional Forecasting of Petroleum Production and Prices.....	 24
D. The Ownership of Foreign Oil.....	33
E. Demand for Petroleum After 1978.....	26
F. Non-OPEC Petroleum Supplies.....	48
G. Natural Gas Supplies, Worldwide.....	51
 II. FUTURE PETROLEUM SUPPLIES.....	 55
A. A Perspective on Petroleum Resources.....	55
B. Long-Term Prospects for Petroleum Supplies.....	57
C. Unconventional Sources for Oil and Gas.....	62
D. Petroleum Technologies.....	65
1. Energy Chemistry.....	65
2. Advances in Petroleum Technology.....	66
E. The Mid-Term Outlook for Non-OPEC Crude Oil Production.....	 71
1. United States.....	71
2. Canada.....	74
3. Mexico.....	75
4. North Sea.....	78
5. Developing Countries (Non-OPEC).....	80
6. Communist Countries.....	84
F. Conclusions.....	87
 III. THE OUTLOOK FOR PETROLEUM PRICES (1987-2000+).....	 91
A. Changing Forecasts.....	91
B. The Lower Bound.....	91

TABLE OF CONTENTS (CONTINUED)

	<u>Page</u>
C. The Upper Bound.....	95
D. Price Fluctuations within the Upper and Lower Bounds.....	97
E. The Resolution of Iraq-Iran War.....	106
F. Energy Taxes.....	111
G. Buffer Stocks.....	114
H. Other Factors of Potential Significance.....	117
I. Scenarios and Price Trajectories.....	125
J. Summary.....	129

APPENDICES

LIST OF FIGURES

	<u>Page</u>
Figure 1 - Average Prices of Mid-East Light (Marker) Crude Oil 34.....	2
Figure 2 - Price of Saudi Arabian Light Crude (F.O.B. Persian Gulf).....	3
Figure 3 - Average Retail Fuel Prices.....	6
Figure 4 - OPEC Petroleum Production and Exports.....	8
Figure 5 - Crude Oil Prices.....	12
Figure 6 - World Crude Oil Production, 1960-1990.....	25
Figure 7 - Exxon Projections of World Energy Demand.....	27
Figure 8 - International Oil Companies' Equity Interest in Middle East Crude Oil Production, 1965-82.....	37
Figure 9 - Non-OPEC Free World Oil Production.....	42
Figure 10 - Changes in Petroleum Consumption since 1973.....	46
Figure 11 - Mexico's Crude Oil Production.....	49
Figure 12 - Worldwide Marketed Production of Natural Gas, 1970-1986.....	52
Figure 13 - Potential World Total Petroleum Reserves.....	61
Figure 14 - The Ever-Growing Computer Power.....	67
Figure 15 - Number of Active U.S. Drilling Rigs.....	73
Figure 16 - Reserves Proved Annually per Well.....	101
Figure 17 - Energy & Petroleum Consumption per Unit of GNP.....	123
Figure 18 - Future Oil Prices (Three Scenarios).....	126

LIST OF TABLES

	<u>Page</u>
Table 1 - Oil Company Projections for 1990.....	28
Table 2 - Past Petroleum Prophecies and Realities.....	30
Table 3 - U.S. Department of Energy Forecast.....	83
Table 4 - OPEC Capacity and Production.....	98
Table 5 - Comparative Gasoline Prices and Taxes.....	115
Table 6 - Major LDC External Debt.....	119

PREFACE

The widespread need for a realistic perspective on the likely trends in future petroleum prices first became obvious during the 1970s, and again in the mid-1980s. The initial shock of rapidly rising prices following the 1973-74 oil embargo aroused U.S. businessmen from their belief in the indefinite availability of cheap fuel--a conviction induced by over 30 years of remarkably stable oil prices (roughly \$3 per barrel at the wellhead). By 1981, the beliefs about price stability had become transformed into equally incorrect expectations about price increases--that petroleum and natural gas prices were on a one-way escalator and would rise more or less steadily over the foreseeable future.

Businessmen associated with the petroleum trade need a rational outlook on prices; judging from past experience, however, they seem ready to adopt whatever conventional wisdom emerges about likely future trends. One of the more surprising aspects of this phenomenon is the ease and uniformity with which each prevailing conventional outlook became accepted and sustained, even though, before long, it was found to have been wildly wrong.

One of the purposes of this analysis is to determine what led earlier forecasts so far astray, and to set forth some important lessons that could lead to an improved forecasting methodology.

A second purpose is to provide an analysis of the current situation in the international oil market and its implications for future petroleum prices over the near-term, mid-term, and long-term. By applying some realistic judgments about the

inherent uncertainties in the principal factors likely to affect those prices, a perspective is developed that is intended to be helpful to buyers, sellers, and governments around the world, even though it does not rest upon a single trajectory of likely future petroleum prices. *Excerpt from Economic Outlook
for 1975: Natural Gas; Crude Oil*

Financial support for this research has been provided by both Hudson Institute and the Center for Naval Analyses. The author is grateful for that support and for the encouragement given by Hudson's management. Special thanks are due to Maurice Ernst for substantive criticisms of the earlier drafts, to Karl O'Lessker and Carol Kahn for bearing up under two editorial reviews, and to Karen Whitehouse for her assistance in developing the graphics, organizing the material, and patiently typing the many drafts as well as the final version.

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EXECUTIVE SUMMARY

I. Historical Perspective

Much evidence exists which suggests that the principal economic forces behind the two oil crises of the 1970s were related to changing balances between supply and demand rather than to the machinations of the Organization of Petroleum Exporting Countries (OPEC). However, because the underlying economics coincided with various events (nationalization of oil properties, changes in contractual arrangements, the oil embargo, the media's conception of OPEC, and gasoline lines in the United States), it was relatively easy for the myth of the "powerful OPEC cartel" to arise and for a belief to develop that the cartel manipulated the rapid rise in prices. Indeed, by 1980, most of the world's foremost political and economic institutions had concluded that the cartel's existence had changed the nature of the petroleum market fundamentally, and that the world had entered "an era of ever-rising oil prices."

Once that conclusion had become generally accepted, it became difficult to reject; indeed, a great deal of hard evidence that conflicted with the accepted "wisdom" could easily be ignored or dismissed. In part, the proposed counter evidence for these erroneous conclusions stemmed from a simple, pervasive image, popularized in the early 1970s: the image portrayed the world's oil resources as quite limited, while an exponentially increasing demand threatened to exhaust them within a few decades--unless, of course, continually rising prices sufficiently restrained future demand. Even with effective price-regulated demand, forecasters expected that the exhaustion of supplies might be postponed for a decade or two, but for practical purposes the dire end result for the world would be essentially the same.

Belief in this concept also served the members of OPEC who, after basking for a few heady years in their newly acquired status, decided to institutionalize the inevitable consequences of that alarming scenario by establishing a long-term pricing policy that would reflect the upcoming shortage--i.e., future prices responsive to the "realities of the new era." However, consideration of that policy was quietly abandoned in 1982, as gathering market forces had already begun a prolonged process of exerting downward pressure on oil prices that OPEC found itself unable to restrain.

In retrospect, the underlying weakness of international cartels in general, and of OPEC in particular, is relatively easy to understand. Cartels, by their very nature, tend to bring about their own destruction, by providing incentives that create opposing economic forces. Over time, those forces increasingly tend to reduce the overall demand for a cartel's commodity, while breeding competitors who can undercut its prices. The net effect is to whittle down the cartel's share of the market and its ability to control prices. Eventually, the cartel, if it is to persist, must itself come to understand and respond appropriately to these economic realities.

OPEC's response to the changing supply-demand situation was relatively slow, in part because the cartel tended to believe the forecasts offered by the prestigious institutions of the developed world. All those forecasts (e.g., by the U.S. Department of Energy and by Exxon) led OPEC to expect both rising demand and rising prices in the years ahead, when in reality it was already in the midst of exactly opposite trends. For example, long after demand and prices for crude oil had started a decline in the early 1980s, OPEC was given repeated assurances that these

events were only temporary aberrations that would quickly disappear. Evidently, those assurances were accepted and, until 1985, may have prevented OPEC from dealing with the real problem that it had in part created and had been unable to accept--a rapidly decreasing market for its oil exports. OPEC had to learn the hard way that forecasts can be quite wrong, even when they are based upon complex mathematical models and are generally accepted as valid by nearly every major institution in the world.

Still, during the 1970s, the OPEC nations had managed to pull off a "caper" that I refer to as "the greatest heist in history." Before the 1970s, the crude oil reserves of the OPEC countries belonged to the international oil companies, in the sense that those companies (about 75 percent American-owned) had bought the rights to operate in those oil fields and possessed valid contracts that gave them those concessions. However, by 1980, these assets had been "voluntarily" returned to the host nations, without compensation other than that for the depreciated value of the above-ground installations. Actually, the oil companies had little choice but to accept the new arrangements, as neither the U.S. nor European governments during those years were willing to protect their companies' rights to the overseas oil resources they had found and developed, even though, at \$25 per barrel, that much oil could be sold over time for about \$25 trillion! That property, comparable in value to all the tangible property in the U.S., was relinquished without a struggle and with surprisingly little protest by the U.S. government.

Since the second oil crisis began in 1979, OPEC has lost about half of its oil export market. That loss, about 16 million barrels per day (MBPD), has come about from declining

world demand for petroleum and increased non-OPEC production, in roughly equal parts. The non-OPEC production increase has come from many parts of the world, prompted by a desire for the profits that higher oil prices promised, as well as by a perceived need among oil-importing countries: (a), to prevent an excessive outflow of hard currencies and (b), to reduce their vulnerability to foreign supplies and foreign influences. Although a large portion of the increased non-OPEC supplies came from Mexico, the North Sea fields, Egypt, and even the U.S., the Soviet Union also took advantage of the higher prices by diverting a greater portion of its oil output to Western markets. This occurred during a period when the Soviets were having difficulties meeting scheduled output goals and had even been expected (by the CIA) to become net oil importers. However, the Soviets were able to increase their oil exports largely, it appears, because of a rapid rise in their natural gas output.

Natural gas is widely used as a petroleum substitute, especially as a boiler fuel in factories and electric power plants. The more-or-less steady rise in natural gas production, worldwide, has therefore, helped reduce the demand for petroleum fuels and should continue to have that effect in the years ahead. Natural gas production is expected to rise about 3.5 percent annually during the next decade or so. At that rate, in ten years its growth would contribute about an extra 12 million barrels per day (MBPD) of crude oil equivalents to the world's markets.

II. Future Petroleum Supplies

Throughout the 118-year history of petroleum exploration, experts have offered estimates of the amount of recoverable petroleum in the world and the number of years those supplies could be expected to last. A review of that history makes clear that all of the early estimates were wildly wrong, and always in the same way: they turned out to be gross underestimates. The tendency to underestimate probably reflects a reluctance to place faith in the impressive technological advances that might reasonably occur, and that would greatly increase the available supplies. Thus, we need to ask whether current estimates of future oil and gas supplies are not similarly too conservative. If they are, then petroleum and natural gas supplies in the decades ahead might well be 50 to 100 percent greater than the expected amounts, and the calculated time to exhaustion of those resources would be increased from about 50 years to perhaps 70-80 years. These time estimates assume that demand for both oil and natural gas increases at about 2-3 percent annually.

Although an extra 20-30 years is not a long time in an historical context, it could be enormously important in a world that anticipates rapid technological progress. In particular, recent investigations of alternatives to conventional petroleum and natural gas have revealed enormous resources, categorized as unconventional sources of oil and gas. These resources, it is now believed, offer the potential of producing at least ten times as much oil and gas as the conventional ones. It will initially be more costly to produce, but over time, the combination of improving technology and more efficient ways to use these fuels will tend to make them competitive with the conventional alternatives. Therefore, on a worldwide basis, an extra 20-30 years

of supplies from conventional oil and gas resources could be very important. That extra time could help greatly in making a smooth worldwide transition away from dependence on conventional fuels to some of the newer unconventional sources.

Over the mid-term (the rest of this century), the outlook for non-OPEC oil production varies considerably for different countries. The U.S., for example, is expected to show a relatively large decline in output, as a result of the recent collapse in oil prices and the fact that it has already been much more intensively explored than any other country. Still, heavy drilling activity could resume either if world prices rose, or if domestic prices were kept at a relatively high level, through a political mechanism such as an oil import fee. In Canada, oil and gas activity should increase relatively more than in the U.S. because of its more promising resources--especially in natural gas--and because its government has recently adopted measures to promote exploration.

In other countries, future drilling activity will also be dependent in large measure upon government decisions. Mexico's ability to invest in exploration is hampered by the pressures of its huge debt, even as it needs greater oil revenues to help service that debt. Activity in the North Sea has been encumbered by the reluctance of the Norwegian and British governments to offset falling prices with lower taxes on production. In many of the developing countries, however, oil exploration continues largely unabated because contractual arrangements have been quickly adjusted to take lower price expectations into account. In other nations, contract negotiations are much slower, but overall, Third World production appears likely to keep pace with future demand.

In the Communist countries, oil production and export potential to the West remains obscure. The Soviet Union, for example, appears to be making major efforts to increase its production and shows some signs of succeeding, but definite results can only be seen after a few more years. Continued success in increased natural gas production, however appears to be assured. If the Soviets can substitute more natural gas for petroleum products in internal consumption, they could be in position to increase their oil exports over the mid-term. China is engaged in a growing effort to boost both oil and gas output; while promising, the outcome will be in doubt for at least a few years.

III. Petroleum Prices: Near- and Mid-Term Prospects

Although the collapse of oil prices during 1986 must have severely jolted forecasters who had anticipated ever-rising oil prices, it seems that the impact was only temporary. A new conventional wisdom quickly developed during late 1986 and early 1987: the new outlook still claims that oil prices will be rising during the 1990s (although not as rapidly as believed earlier), but the forecasters are less certain about price trends in the next two or three years.

Uncertainty is likely to bedevil forecasters for an even longer time, because of a large number of powerful factors that might impinge on the market. Nevertheless, for the short-term, it appears that oil prices in the Persian Gulf are likely to be contained between a lower bound of about \$8 per barrel and an upper bound of about \$20 per barrel--both in 1986 dollars. The

lower bound is determined by prices that would trigger a massive shut-down of production from sources that have high marginal costs of bringing oil to the market (e.g., the Alaskan North Slope, most U.S. stripper wells, heavy oils, tar-sands operations, and some North Sea wells). In addition, some fields could be shut-down by producers who simply chose to wait for better markets. If lower bound prices persisted long enough, they could reduce existing production from non-OPEC sources by 8 MBPD or more. And for that reason, they are unlikely to persist; the incipient shift of so great a demand to OPEC sources would create upward pressures on prices, causing them to rebound quickly after they approach the lower bound.

The upper bound is determined by OPEC's need to restrain outside competition and increase its share of the export market. The thought has been expressed at OPEC meetings and elsewhere that prices must be kept below the \$18-\$20 per barrel level, at least during the next two years, if non-OPEC competitors are to be adequately restrained. The closer prices get to the upper bound and the longer they stay there, the more likely it becomes that changing market forces--including various kinds of government intervention to protect domestic industries, boost domestic production, and reduce national vulnerability to interruptions of supplies or excessive price hikes--would force them back down. Government interventions could take forms such as internal energy taxes, an oil import fee, or an increase in national stockpiles.

Perhaps the most important factor over the next few years is the impact of various possible outcomes of the Iraq-Iran war.

That factor alone could result in severe upward or downward pressures on oil prices for several years. Two other important considerations are: 1) the resolution of the Third World debt problem, which currently appears to be in a crisis stage, and 2) the policies that both developed and developing nations adopt in regard to their levels of exploration for both oil and natural gas. The debt crisis can be expected to affect both the near-term economic growth rates of many Third World countries and their ability to pay for needed petroleum imports. The exploration issue is related to the perceived importance of greater oil and gas production over the mid-term, and to the economic and political problems of negotiating satisfactory contractual arrangements between governments and international oil companies.

Another factor of great potential importance for both the mid- and long-term oil price scenario is the impact of (likely as well as unforeseeable) technological developments that could affect both the demand for petroleum and the available supplies. For example, the successful development of an advanced battery could usher in an era of electric vehicles and thereby erode the long-term demand for petroleum fuels. That outcome might actually become part of the conventional wisdom in the next several years, as a result of intensive R&D efforts being pursued by many industrial laboratories in the developed nations. Also, technologically competent individuals and organizations in every country are seeking to use energy ever more efficiently, to improve the potential for exploration and production of oil and natural gas resources, and to develop alternatives to petroleum fuels. The increasingly rapid progress that has recently been experienced in nearly all technological areas is almost certain to impact future supply and demand levels of both oil and natural gas. Only the degree of that impact is uncertain.

To illustrate the point that future oil and gas prices are likely to be highly unpredictable, this analysis presents and discusses three alternative future-oil-price trajectories, each associated with a plausible--or at least not implausible--scenario. The first scenario represents the current conventional wisdom of slowly rising prices; the second, labelled "the accordion," shows the consequences of periodic troubles within the OPEC organization that lead to large price oscillations; the third represents one version of the consequences of a clear victory of Iran over Iraq, which occurs early in 1990 and leads shortly thereafter to \$50 oil decreed by an Iranian-dominated OPEC.

While the first scenario would be preferred by most of the world, it is also a quite unlikely one because it is too rational. The second scenario is the most likely of the three, except that the indicated timing of future price oscillations is arbitrary--and undoubtedly is unknowable. The third scenario depicts only one of very many possible wild or surprising outcomes; any one of these will seem quite unlikely, but all together they suggest that a stormy future may well be ahead for the international petroleum market.

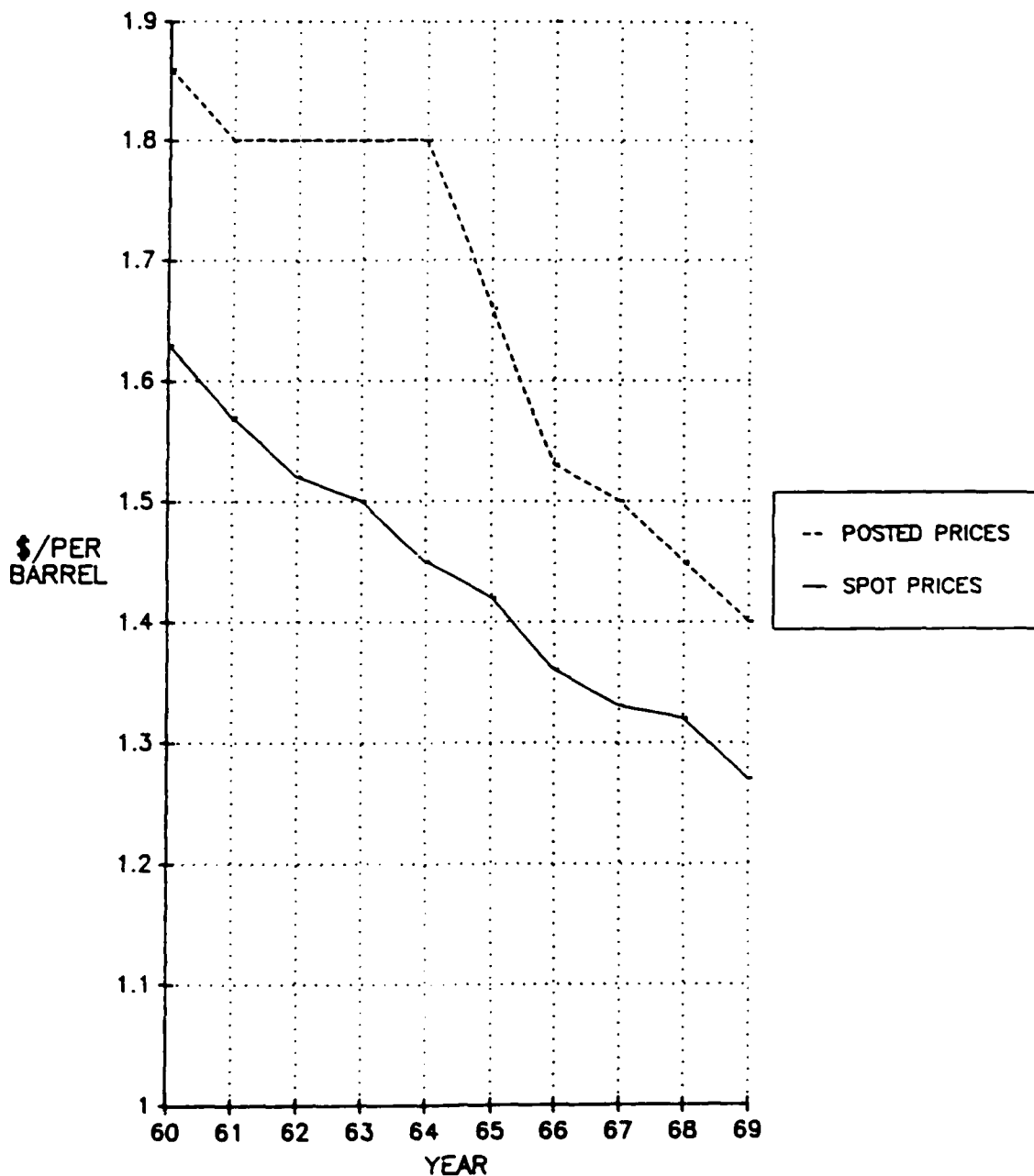
PETROLEUM PRICES: PAST, PRESENT, AND PROSPECTIVE

I. HISTORICAL PERSPECTIVE

A. Oil Prices: 1960-1982

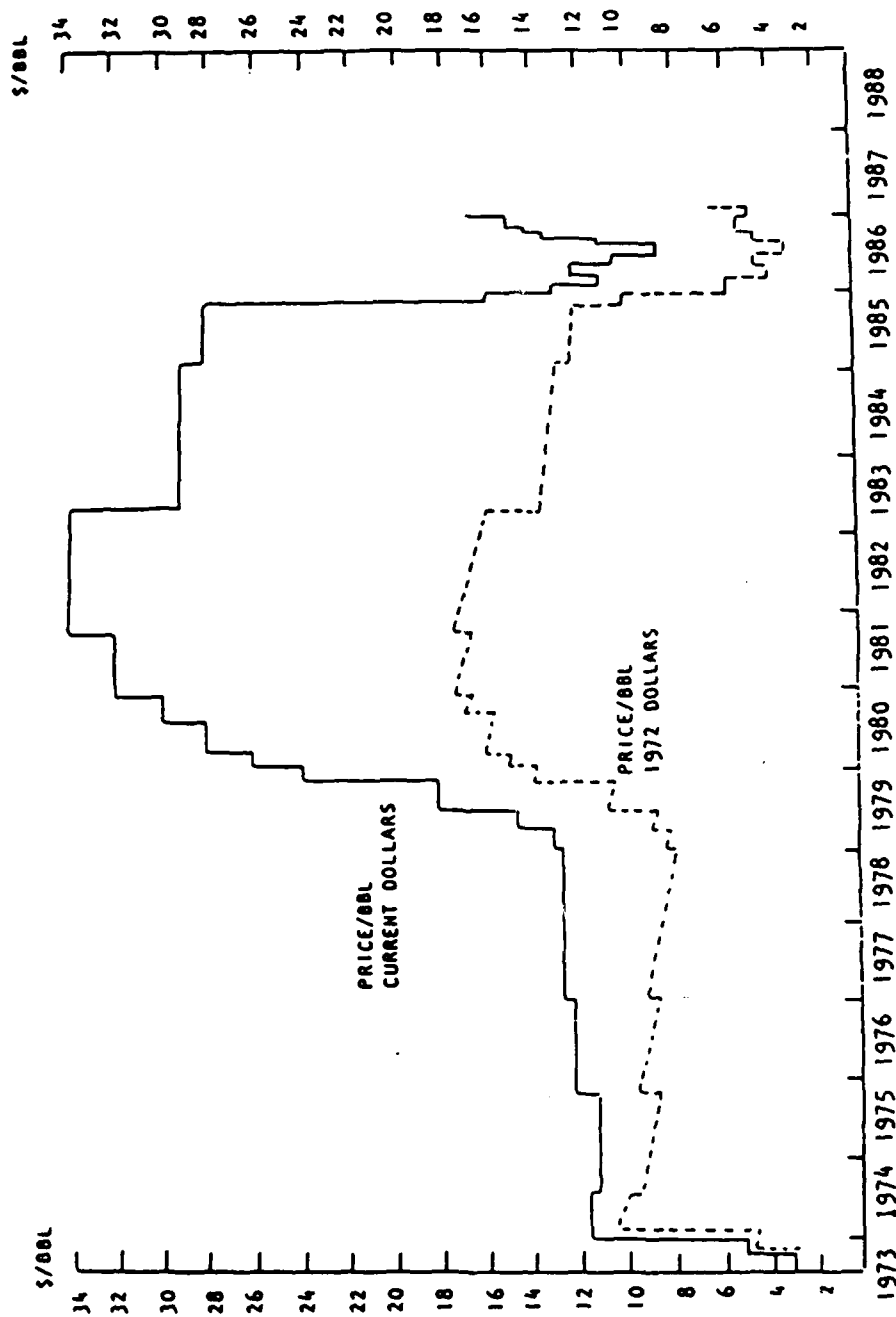
During the decade of the 1960s, spot prices for Persian Gulf oil averaged about \$1.50 per barrel; indeed, they had declined slowly (see Figure 1) from \$1.70 to about \$1.30 per barrel. In that decade of relative price tranquility, the world's supply of crude oil remained considerably in excess of demand, suggesting that considerable maneuvering by the international oil companies kept prices from falling faster than they did. However, just as the 1960s were ending, petroleum producers noticed that it was becoming more difficult to keep supplies well ahead of rapidly-growing demand, and that the amount of worldwide excess production capacity was likely to decline during the next few years. A few astute observers began to write about the emerging new threat--that world demand for oil might actually catch up to supply within a relatively short time. If that observation were to become commonplace, the international petroleum market could quickly change from a buyers' to a sellers' market.

As a result of the changing supply/demand relationship, the price of oil in the Middle East began to rise in early 1971, reaching \$2.00 per barrel by the end of 1972 and almost \$3.00 by October 1973, when the now-infamous Arab oil embargo set off a price explosion that radically changed conceptions about the nature of the petroleum market. That embargo marked the start of a series of events that have become known as the energy crisis of the 1970s. The erratically changing oil prices from 1973 to 1987 is depicted in Figure 2, in both constant and current dollars.

Figure 1**AVERAGE PRICES OF MID-EAST LIGHT
(MARKER) CRUDE OIL 34**

Source: Energy Information Administration, Annual Energy Review.

Figure 2

PRICE OF SAUDI ARABIAN LIGHT CRUDE
(F.O.B. Persian Gulf)

Sources: Petroleum Economist and OPEC Bulletin, as compiled by W.M. Brown.

The first major worldwide economic shock of the energy crisis occurred during the last two months of 1973, with an explosive rise in international crude oil prices. It culminated at the end of the year with an "official" OPEC quadrupling of those prices to nearly \$11.00 per barrel, as shown in Figure 2.* To many consumers, the perceived shock was even greater than the actual shock these numbers would suggest, since retail prices for petroleum products were often influenced by the prices of oil purchased on the spot market and those prices were often considerably higher than the "official" OPEC figures. In addition, for a few months after the oil embargo began, U.S. consumers at the retail level often had difficulty obtaining adequate supplies of various petroleum products, especially gasoline. This was caused, in part, by the nearly simultaneous decisions of many privately-owned institutions to stockpile unusually large quantities of crude oil or petroleum fuels, thereby exacerbating the crisis and contributing to local shortages. Hasty attempts by the federal and state governments to use bureaucratic controls in order to allocate gasoline supplies appear to have made many local shortages considerably worse, if they did not actually cause those situations.

When long gasoline lines first appeared in the United States late in 1973, they created considerable public anxiety about long-term energy prospects. That concern ultimately contributed to more effective energy production and conservation activities. These in turn were destined to have a surprisingly great impact on the world petroleum market.

*This \$11.00 was actually the posted rather than the real price, and was used by governments to determine tax rates that oil companies with concessions in their countries had to pay. The actual selling price was somewhat lower than the posted price--for example, the net per-barrel price received by the Saudi government was about \$8.50 in January 1974 and \$9.60 by May of 1974. (Middle East Oil and Gas, Exxon Background Series, December 1984).

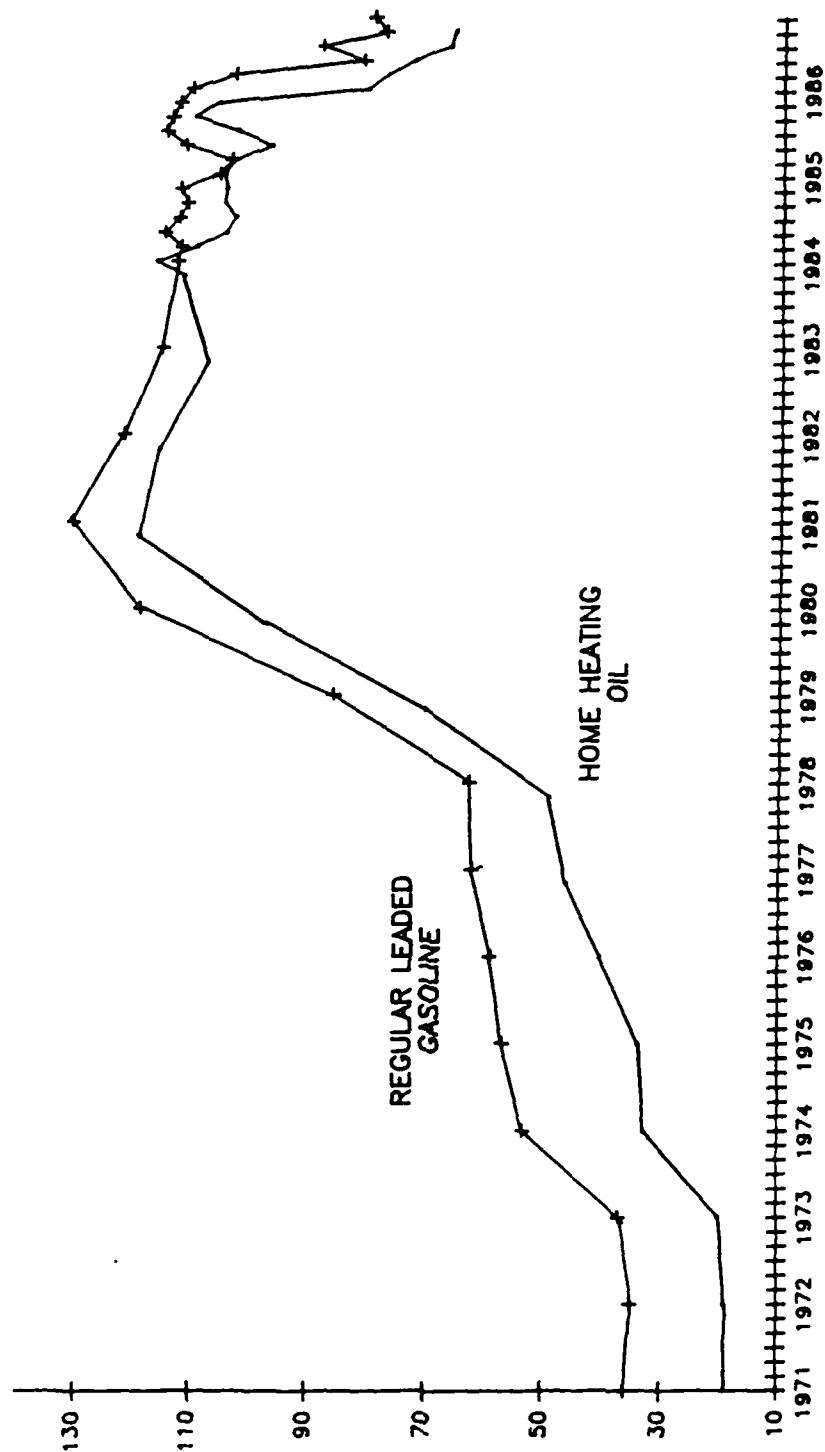
Shortly after the end of the Arab embargo was announced early in 1974, petroleum supplies quickly returned to "normal." By then, however, prices had become significantly higher in the U.S. and Europe (Figure 2) than before the crisis. Still, in some countries, most of the roughly four-fold increase in crude oil prices was not felt by consumers, in part because high government taxes obscured the increase, and in part because price controls on domestic oil production quickly came into being--particularly in the United States. Those controls, by restraining prices on both domestic crude oil and petroleum products, tended to cushion and/or delay the impact of rising international oil prices on consumers. Figure 3 shows that during early 1974, gasoline prices to U.S. consumers increased by only about 35 percent, or 15 cents per gallon.

This so-called shock occurred at the beginning of what was proclaimed to be a "new era" in which OPEC was to become a worrisome household word. As OPEC members were receiving the lion's share of the proceeds from international trade in crude oil, it was commonly supposed that those governments had formed the cartel specifically to lift the price of oil and keep it high. The cartel was expected to try to establish a price trajectory it believed would maximize oil income for its member nations over the long-term.

However, despite widespread perceptions and concerns about the threat of steadily rising prices, it is clear from Figure 2, that in terms of inflation-adjusted dollars, the price of oil actually declined significantly over the five-year period from early 1974 to late 1978, even though the nominal price was rising. Both the general public and the media tended to think about petroleum costs in nominal-dollar terms, focusing on specific price increases each time they were announced by OPEC. That tendency, coupled with expectations of rising oil prices,

Figure 3

AVERAGE RETAIL FUEL PRICES
(Cents per Gallon)



Source: U.S. Department of Energy/Energy Information Administration, Monthly Energy Review, August 1986.

made it difficult to recognize that real oil prices were actually declining substantially--roughly by 25 percent during that period--if the nominal prices are adjusted by the GNP deflator.

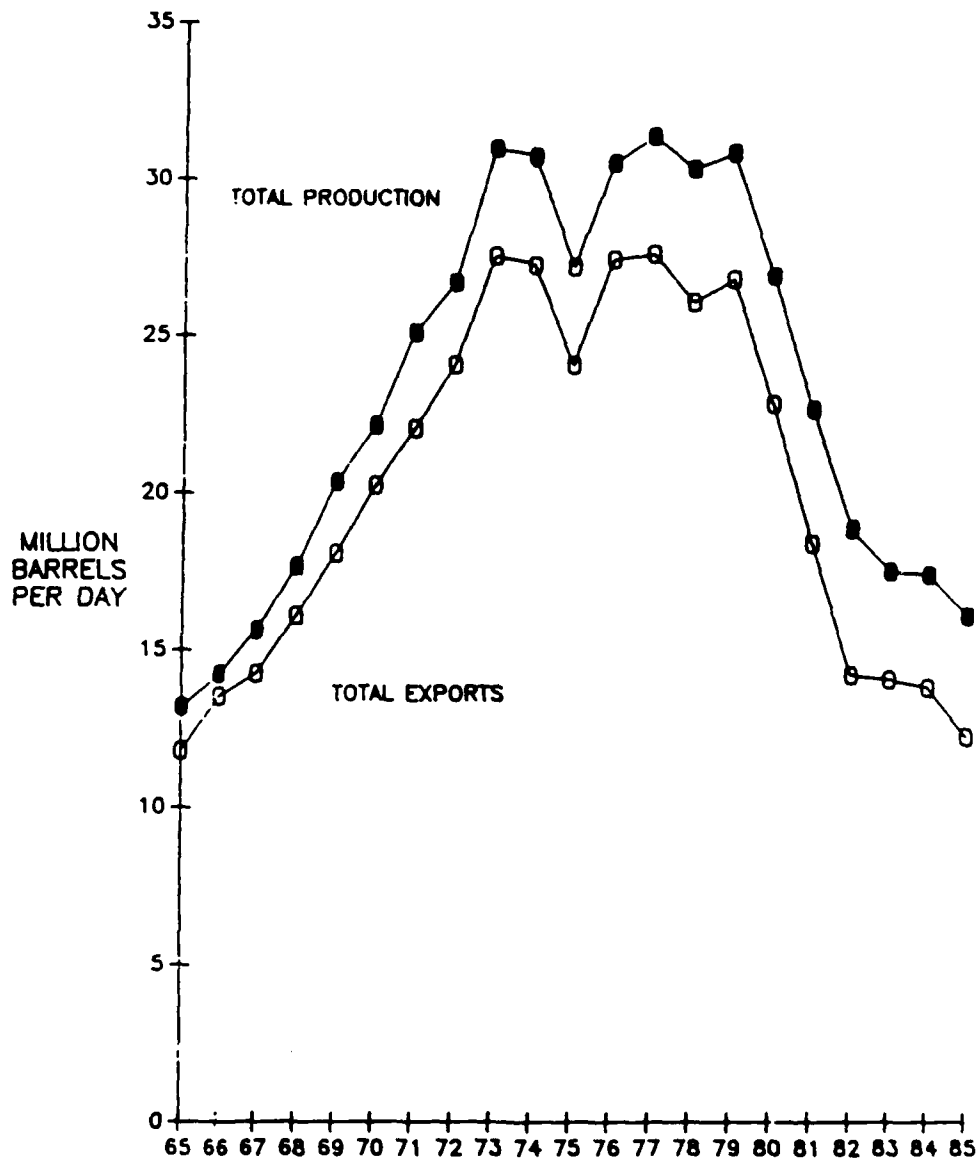
At the same time, three other factors further reduced the purchasing power of the oil sales by exporters in the Middle East and elsewhere. The first was the appearance and persistence of discounts to oil buyers during much of the mid-1970s. Those discounts apparently resulted from continuing increases in the world's oil production capacity, while growth in demand declined considerably after 1973. In fact, the growth in demand for oil from OPEC had "temporarily" stopped, and OPEC's export volumes remained approximately constant during the 1974-1979 period (Figure 4).

The second factor was financial. During the 1970s, when the dollar was experiencing a period of protracted weakness against other foreign currencies, crude oil was officially priced in dollars. As a result, the real income of the oil-exporting countries (whose expenditures in large measure were for goods and services from Japan and Europe, and therefore were payable in currencies that were rising relative to the dollar), was substantially affected. That is, the purchasing power of OPEC's dollar-denominated revenues was degraded, roughly in accordance with the relative amount of purchases made in other currencies.

Third, while U.S. inflation could easily be taken into account in determining the real price of crude oil by using the GNP deflator to adjust dollar revenues, the OPEC countries registered considerable protest when they discovered that the impact of inflation on the array of goods and services they were importing was considerably greater than that of the U.S. GNP deflator.

Figure 4

OPEC PETROLEUM PRODUCTION AND EXPORTS



Sources: Basic Petroleum Data Book, September 1985; OPEC Bulletin, January 1981; OPEC Annual Report 1984; and International Energy Statistical Review, November 1986.

When these three additional factors are added to the declining real oil prices shown in Figure 2, it becomes evident that the OPEC countries suffered a severe degradation of their purchasing power during the middle 1970s. Indeed, economic estimates made in 1979 found that the effective export value of a barrel of oil to the OPEC countries had fallen approximately 40 to 50 percent in real terms during that five year period.*

This evidence about the real nature of OPEC's "growing revenues" was frequently overlooked by major institutions and by the media during the 1970s. It should have been noted, and should have reflected considerable doubt upon the assumed competence or effectiveness of the "cartel" that had mesmerized so much of the world. The fact that it was largely ignored suggests how difficult it can be to change institutional convictions about the nature of reality once those convictions have become part of the conventional wisdom, evidence to the contrary notwithstanding.

During the mid-1970s, it became customary for buyers from large companies to purchase oil from OPEC producers on the basis of relatively long-term contracts (a few months to a year). But, there was also a reasonably active spot market, or free market, which was involved in about 5 to 10 percent of the international oil trade. Spot market transactions, however, were seldom in the news; they were generally confidential, complex, and informally "organized." The negotiations were conducted privately by institutions and independent entrepreneurs of many nationalities, mostly via telephone/telegraph. Indeed, it was often difficult for outsiders to determine current spot market prices as these were seldom published in any of the mass communications media.

*William M. Brown, "The Adequacy of Near-Term Oil Supplies," Research Memorandum #73 (Croton-on-Hudson, NY: Hudson Institute, September 1979).

Still, some professional journals, industry newsletters, and other specialized services did attempt to keep abreast of that market and regularly published reasonably accurate estimates of the relatively volatile price data, including the frequent changes that occurred during and after the 1970s. These publications also provided information about the discounts from OPEC's "official" prices that became available during soft-market periods.

During late 1973 and early 1974, when panicky worldwide buying first occurred, prices in the spot market could occasionally rise to over \$20 per barrel for the sale of relatively small volumes in sporadic transactions. The impact of even such limited higher-priced transactions on OPEC's members and other oil exporters was significant, since sellers usually try to obtain the highest possible price. Accordingly, when spot prices reached the \$15 to \$20 per barrel range, they tended to lift the prices of the much larger quantities of oil negotiated in long-term contract, thus making it relatively easy for OPEC to "establish" its unprecedented four-fold increase (to "only" \$10.50 per barrel) in January 1974. That price, in real terms, was not to be exceeded for the next five years.

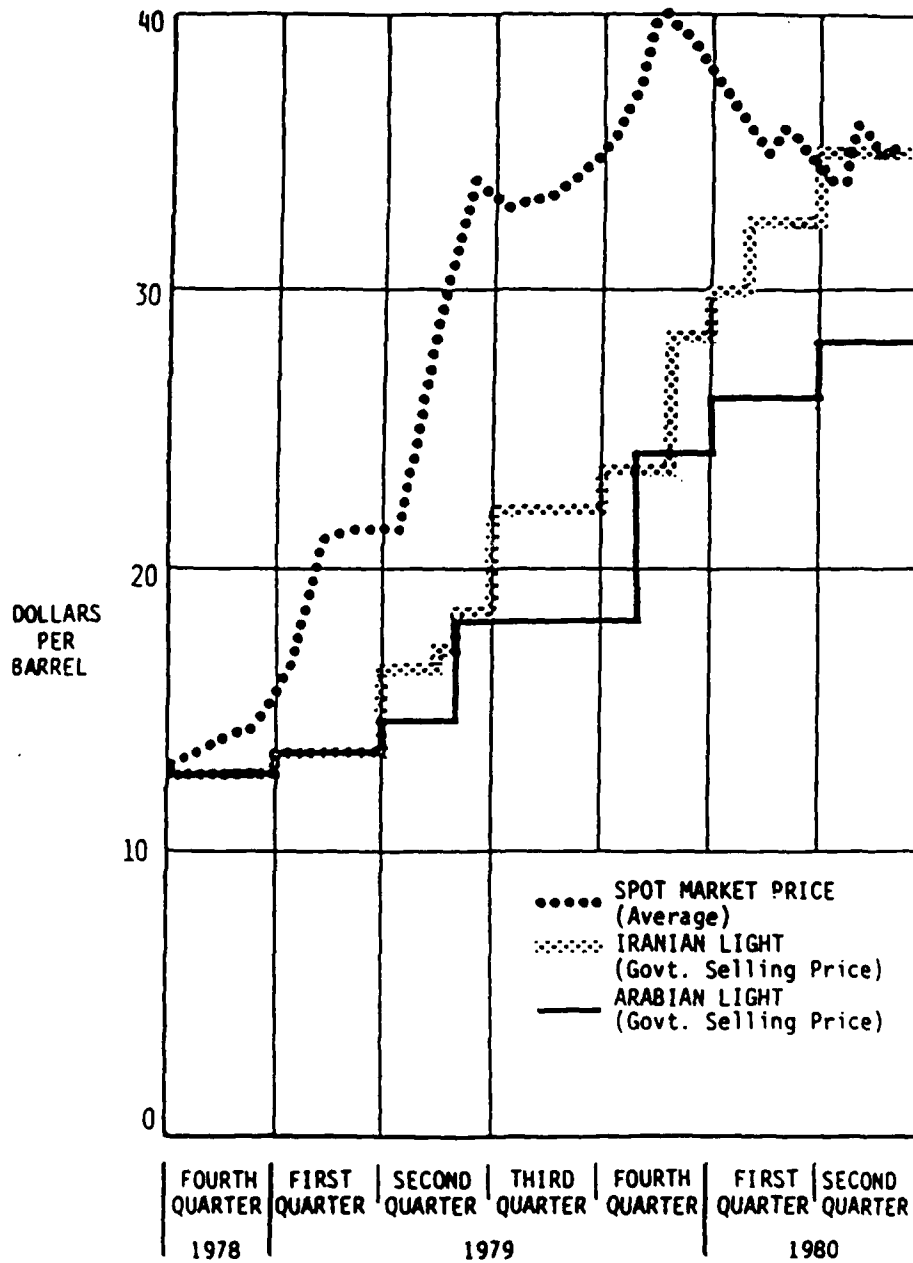
During the subsequent price shock of 1979-1980, the role of the spot market was even more pronounced. Early in 1979, activity on the spot market grew substantially, in part because the governments of the OPEC countries had taken over most of the ownership and marketing of petroleum during the 1970s. Some had yielded quickly to the temptation of slipping some crude oil into the higher-priced spot market, a tactic that may also have been used by some of the large international companies with oil to sell (although there is no compilation showing how much oil moved into the spot market in that way). However, measured either by the total amount of petroleum or the amount of money flowing through the spot market, it clearly grew substantially during the 1970s, especially after 1978.

By 1979, when the second oil shock began, timely data about spot market prices had become much easier to obtain. Such information allowed analysts to chart the changing relationship between spot prices and contract prices. That relationship, illustrated in Figure 5, indicates that during the panicky buying spree of 1979-1980, prevailing spot prices generally were considerably higher than contract prices and therefore could have been expected to exert an upward pull on OPEC's "official" prices. In fact, it seems likely that spot market quotations provided OPEC ministers with precisely the vital timely information they needed to rapidly adjust their contract prices to the soaring international market. If that view of the impact of the spot market upon the pricing behavior of OPEC members is correct, their behavior appears to have been quite rational.

Price quotations on the spot market had previously provided a sensible way for oil sellers to assess the changing value of their commodity. Unless buyers and sellers have access to a traditional marketing process or to an auction market, it is difficult to determine an appropriate price for any commodity. Thus, it is easy to understand that the OPEC ministers, upon assembling to "set the price" of oil, could hardly resist sanctioning a figure that reflected the most recent spot prices, especially when they were being inundated with offers to buy at those higher prices.

It is also important to recall that during the panicky period from early 1979 to late 1980, the major oil buyers and oil users, worldwide, were trying desperately to increase their oil stocks in order to obtain some additional protection against the possibility of higher future prices and/or actual oil shortages. An avalanche of such attempts quickly turned into an oil buying "stampede," which soon led most of the world's major oil refiners

Figure 5
CRUDE OIL PRICES



Source: Shell Oil Company.

to conclude that security of supply had become one of the newer and more important aspects of their business. Buyers from oil refineries around the world, especially from the larger companies, descended upon the oil exporters and pressed for contractual arrangements that would "guarantee" an adequate long-term supply of crude oil. Ministers of the oil-exporting countries were delighted to be besieged by would-be buyers who were unable to suppress their eagerness to enter into such arrangements. Clearly, the ministers would hardly choose to sell their nation's crude oil at prices much below those readily available through the spot market, especially as they were being pressed by anxious traders to purchase large quantities at those higher prices.

In between the scheduled meetings at which the so-called "official" prices were reviewed, it was not at all difficult for OPEC's oil ministers to ask for and obtain special premiums from their "regular customers," to make up most of the difference that may have developed between the "official" price and the prevailing spot market price. For example, if OPEC's price had been \$18 per barrel, but the spot market price had risen to \$24 per barrel, then a minister might suggest that a contract price of \$18 per barrel plus a \$4 or \$5 "premium" might be satisfactory--especially if the buyer would also pay a \$1 per barrel "sales commission" to the minister's brother-in-law.

During most of 1979 and 1980, OPEC prices were rising so rapidly (Figure 5) that any contractual arrangement soon became "obsolete" as a consequence of that "leapfrogging" phenomenon. That is, if a purchase contract had been signed at, say, \$20 per barrel plus a \$4 premium, a few weeks later it might have become "obsolete" because of the spot market price had risen to \$27 or \$28 per barrel. In principle, the exporting country should have

have been "stuck" with a long-term contract to deliver oil at least \$3-\$4 below the then prevailing price. In fact, the oil minister would usually call the buyers and inform them that unanticipated events gave him no choice but to change the earlier prices to a higher level, despite the existing contracts. Indeed, the minister not only mandated increases, he frequently also demanded that they be applied retroactively, typically by 4-6 weeks.

Still, during 1979-1981, was almost unknown for a buyer to refuse the new terms. Thus, whenever changed market conditions reflected significantly higher prices in the spot market, most of the purchase agreements between OPEC exporters and buyers were, in effect, torn up and replaced by new ones. The oil market was so tight that buyers generally felt forced to continue existing relationships with their OPEC suppliers at whatever terms were demanded. Evidently, most buyers were relieved when they acquired an assured source of supply, even though they quickly learned that there were few, if any, bargains to be had.

One prominent exception to the last statement existed for a few buyers who had signed purchase contracts with Saudi Arabia. The Saudis had become the best known of the "doves" in OPEC. Even before 1979, they appeared worried about the possible destabilizing impact of rapidly rising oil prices. Indeed, Saudi Arabia was the only OPEC member that did not ask its customers to pay premiums above its official prices during the 1979-1981 period. However, after formal price changes were announced the Saudis were not reluctant to apply any new "official" price retroactively, sometimes by as much as six or seven weeks. Nevertheless, prior to 1982, the Saudi price was often as much as

\$4 or \$5 per barrel below that of their OPEC associates. That difference became known as the Aramco advantage, as it provided the four Aramco partners (Exxon, Mobil, Texaco, and Chevron) as much as \$25 million daily in additional profits.

Outside of Saudi Arabia, however, little generosity was to be found among the OPEC members, at least not toward industrialized nations or private oil companies. In fact, most OPEC members not only insisted on attaching premiums to their announced official prices in order to obtain the highest possible revenue, but over time they increasingly attached other "premiums" of a political or economic nature. Those "premiums" sometimes took the form of instructions about whom the buyers were allowed to sell oil to, or whom not to sell to (for example, the Israelis); or about the specific days on which they were allowed to load oil and how much could be lifted at any one time, even though it sometimes required the lifting of only a partial shipload, which could substantially increase the buyer's transportation costs.

Before the 1979 panic buying had begun, and OPEC had established a committee to formulate an appropriate long-term pricing strategy, which, presumably, would be used to guide OPEC pricing through the decades ahead. During 1981, it became widely believed--because of leaked information about that committee's probable recommendations--that OPEC would establish a base price of \$34 or \$36/barrel, which it would maintain in real terms, while adding an escalation factor of about three percent a year. The expectation of that price trajectory became so widespread among major oil companies and financial institutions that it quickly became transformed into conventional wisdom, worldwide.

It is one of the ironies of history that most of the publicity about OPEC's potential long-term pricing strategy occurred

late in 1981, just as prices had peaked and a combination of declining demand and rising competition had begun to weaken OPEC's cohesion. After that, spot market prices began declining so rapidly that OPEC's intended strategy had to be quietly abandoned, before it could be either formally adopted or implemented.

B. The Nature of OPEC

OPEC was formally created in 1960, reportedly as a result of some discontent among oil-exporting countries about a 10-cent per barrel price drop during the early part of that year. Presumably, the creation of OPEC had the desired impact on the major international oil companies, as the 10-cent price cut was restored within a few months. In retrospect, however, it's not clear whether changing market conditions or pressures from the new organization were more influential in temporarily restoring the price cut. After 1960, OPEC became almost invisible for ten years, despite the fact that oil prices followed a long downward path, falling as low as \$1.30 per barrel during 1967. One explanation for OPEC's low profile was that individual OPEC nations had already completed negotiations with the oil companies that related their per-barrel revenues to posted prices, rather than to market prices. The market prices were under pressure during most of the decade, and were generally lower than the posted prices during the 1960s (Figure 1). In the later 1960s and early 1970s, however, as sales volumes grew and the supply-demand situation gradually tightened, the oil-exporting countries began to understand better how their latent power could be used to bargain with the oil companies and to affect prices in the international market. Demand for crude oil was about to catch up with the available supply.

By the mid-1970s, following the Arab oil embargo, the media was portraying OPEC as the most powerful cartel in history,

despite the fact that OPEC never considered itself a cartel. That label seems to have been affixed by the media and undoubtedly was appealing to editors and publishers; the word cartel evokes much stronger images and emotions than the word "organization."

Although a cartel would be illegal within the United States and many other industrialized countries, it is often viewed as a desirable marketing arrangement when authorized or created by governments, as OPEC was. Because most of its member countries were politically authoritarian, OPEC, for practical purposes, was an organization of sovereign leaders. Sovereigns expect to have their wishes, or even their whims, obeyed without question; they also tend to resist attempts to undermine even a little bit of their sovereignty. OPEC member countries, therefore, should have anticipated difficulties in operating an effective cartel. An organization of 13 kings, dictators, and other sovereigns that required unanimity to adopt or change any of its policies, as OPEC did, was one of the most difficult kinds of cartels to operate or even to maintain.

History has provided ample evidence that cartels of any kind tend to become vulnerable over time. Their existence creates opposing economic forces--competitors who erode their share of available markets and consumers who increasingly balk at paying rising prices--that could eventually destroy them. This outcome should be relatively obvious, as there are almost no examples of successful international cartels. Throughout history, such cartels that have been attempted have almost always failed within a few years. Nevertheless, during the 1970s and early 1980s, many businessmen and energy analysts found it easy to believe that it was logical from a purely economic point of view, for OPEC countries to establish a powerful cartel. They believed that these oil-exporting nations had actually cornered the bulk of the international petroleum market and would move to optimize their long-term revenues through cartel-like marketing arrangements.

Apparently, the validity of that conclusion was "obvious" to almost all businessmen. Its intrinsic rationality persuaded them that a true cartel had indeed been formed, had been operating, and probably would continue to dominate the international petroleum market for the indefinite future. Thus, the combination of the "rational" expectations of businessmen, coupled with frequent confirmations of those beliefs by high-ranking government personnel and supported by most energy analysts and the media, further entrenched and disseminated a "cartel mentality." OPEC, as a cartel, appeared to be a logical, rational development that had been imminent for years. There was little doubt that it would continue for the foreseeable future to insist on ever-rising international oil prices.

By the early 1980s, most energy analysts apparently had failed to notice, or had forgotten, that the members of the "cartel" had been unable to keep their real per-barrel oil income from falling by as much as 50 percent during the 1974-1978 period. Nor was it mentioned that the acid test of a cartel's effectiveness occurs not during a stable or rising market, but during a period of adversity. A cartel becomes vulnerable when: (a) supplies of the commodity it is protecting reflect a growing surplus, (b) prices have come under pressure, because some of its members have failed to constrain their output sufficiently, and (c) an increasing number of the cartel's competitors continue to enjoy full production, expanding sales, and rising incomes--all of which have been made possible by the cartel's restrictive policies.

The news media and most businessmen also failed to examine evidence that showed it was not OPEC's deliberate machinations that had twice caused oil prices to rise very rapidly, but rather the disappearance of a surplus of oil-production capacity. Moreover, few energy analysts had become sufficiently aware of the price leading role of the spot market, and had therefore not

understood the importance of the fact that spot prices generally remained well above official OPEC prices during the two crisis periods. In retrospect, it seems clear that such information alone should have made it obvious that each of the two price spikes had been created by an unusual and unanticipated change in the supply/demand balance, rather than from actions taken at OPEC meetings. But among those who "knew" that OPEC was in control of oil prices, not many were inclined to look for alternative explanations.

Perhaps a better characterization of OPEC, at least until very recently, would have been that of an influential but undisciplined and relatively incohesive organization in which Saudi Arabia--perhaps with occasional assistance from Kuwait and one or two other OPEC members--often played the role of price leader. Typically, a price leader is expected to set an example that the other members of the organization are encouraged to follow. Thus, the price leader will be the first to cut output rather than give discounts when the market is soft, and raise production in order to restrain "excessive" price increases when the market is becoming tight. But the ability of a price leader to resist the normal economic forces of a competitive market will depend on the specifics of the situation. In OPEC's history, the leadership of Saudi Arabia was accepted only occasionally and halfheartedly by most of the other members, and the Saudi's own performance has been less than sterling. Still, it may have been the only practical form of leadership acceptable to OPEC's sovereigns.

Perhaps the Saudi role, as well as the various roles adopted by the other OPEC members in the early 1980s, stemmed to a large extent from the delusion that OPEC actually would soon become an effective cartel, if it had not already achieved that goal. Self-delusion was the prevalent mode, as essentially all of OPEC's important commercial and political contacts were listening to and, through frequent repetition, amplifying the same

drumbeat. That is, the major oil companies, the World Bank, the national energy agencies (especially the U.S. Department of Energy), and essentially every financial institution and concerned government agency had come to accept the same picture: OPEC as solidly in control of oil prices for the long-term--or at least as long as their demands did not become wildly unreasonable. As a result, in the early 1980s many relatively pessimistic consumers and optimistic producers could readily be found offering predictions of oil prices reaching \$100 per barrel during the 1990s or sooner.

After 1981, a common expectation among commercial institutions was that OPEC would soon implement the long-term strategy that it had been developing since about 1978. They assumed that oil prices would rise steadily from about \$35/barrel to levels that reflected accumulated inflation plus about three percent annually. Indeed, to many observers that pricing scheme appeared to be relatively restrained in comparison with an alarmist scenario that feared prices of about \$100/barrel after a few more years of erratic price leapfrogging.

In face of the nearly universal conventional wisdom--which quickly accepted, adjusted to, and reflected the inevitability of that expected pricing trajectory--it is easy to understand that major institutions would be reluctant to accept the forecasts of a few isolated mavericks who were predicting a growing oil glut and international petroleum prices coming under pressure.* Indeed, with an astonishing unanimity, both public and private institutions ignored suggestions that real oil prices might even remain flat, let alone fall, during the 1980s.

*Articles by the author making such forecasts and offering supporting analysis appeared in Fortune magazine in July 1980 and November 1981. They are reprinted in the Appendix.

OPEC itself not only had the "benefit" of free advice from many large institutions, including the major oil companies, but also employed many economic, political, and/or technical specialists from the U.S. and Europe. Prior to 1982, these advisors had repeatedly informed OPEC that its long-term commercial prospects were undeniably optimistic, that it could look forward to an "era of ever-rising oil prices" and, for the foreseeable future, that it should expect increasing demand for its petroleum exports. Surprisingly, such advice was offered as late as 1982, after worldwide demand had fallen sharply for about three years. So strong had the prevailing belief in the "era of ever-rising oil prices" become, that for several years actual declines in world consumption were attributed to temporary abnormal factors that could be expected to vanish or to reverse themselves quickly. It was probably because of that persistent expectation that the committee of OPEC ministers, headed by Sheik Yamani, continued to develop its long-term pricing strategy, despite declining worldwide oil consumption and a steady stream of news about price-discounting by OPEC's own members. Moreover, as the full burden of that decline in demand for oil, plus the increase of non-OPEC supplies, had to be absorbed by the OPEC members, their own production by late 1981 had already fallen, on average, by more than 35 percent.

It took another three years of falling prices, erosion of their export market, price discounting, cheating on quotas, and other symptoms of an unraveling organization for OPEC's members (and their advisors) to recognize what appears to have been the underlying reality during the entire period: that market forces were dominant, and that individual OPEC members (or even OPEC as a group) were able to do relatively little about it. The Saudis, while attempting to play the price-leader role, watched their oil production drop from a high of about 10 MBPD in 1981 to a low of about 2.5 MBPD in August 1985, before they clearly saw the handwriting on the wall and, in effect, threw in the towel.

The Saudis decided, as of October 1, 1985, to offer a considerable portion of their oil production to large customers under nearly irresistible terms--namely at prices that would be based upon actual revenues from the group of refined petroleum products that could be extracted from the crude oil (termed netback pricing). In effect, they adopted a policy that soon became accepted as a preferred basis for crude-oil pricing by many other oil exporters. That arrangement enabled the Saudis to regain some of their prior market share, but it also laid the groundwork for the 1986 collapse in oil prices.

The earlier illusion prevailing among OPEC members, that they had somehow entered into a world in which they would continue to operate as an effective cartel, created many difficulties for themselves and others. For example, many U.S. oil producers had been led into excessively optimistic expectations about future prices that in turn induced them to borrow heavily against anticipated income. Subsequently, that expectation came back to haunt them, creating major financial difficulties for the producers and often for their bankers as well. Also, and long to be remembered in most OPEC nations, was an excessively rapid rise in industrial development projects, including many "white elephants" constructed as part of hasty, ill-conceived "modernization" programs. These were often financed by massive borrowings from Western banks, loans that are now threatening both the solvency of those lenders and the creditworthiness of the borrowers.

One more observation is in order about OPEC as a cartel. The notion that the OPEC "cartel" can be made to work effectively over the long-term is still strongly held by many people and institutions. This belief will probably continue to haunt the international petroleum market for a very long time. No matter

how inept OPEC may appear from time to time, or how erratic oil prices might be over the next few years, the fear of a reconstituted OPEC cartel will almost certainly remain. If, in the next few months, or in the late 1980s, the 1990s, or even in the post-2000 period, oil prices should start rising again, fear and suspicion will undoubtedly quickly arise that OPEC, or its successor, will once more gain firm control over the international petroleum market.

Given the enormous revenues involved, attempts to create and/or strengthen such a cartel undoubtedly will continue to be made during the near-term, as well as over the long-term. In my judgment, more than a brief period of success for such a cartel seems unlikely, although I expect that to be a minority opinion. Each such attempt, however, is likely to launch a new set of political and economic forces that could strongly affect international trade and prosperity.

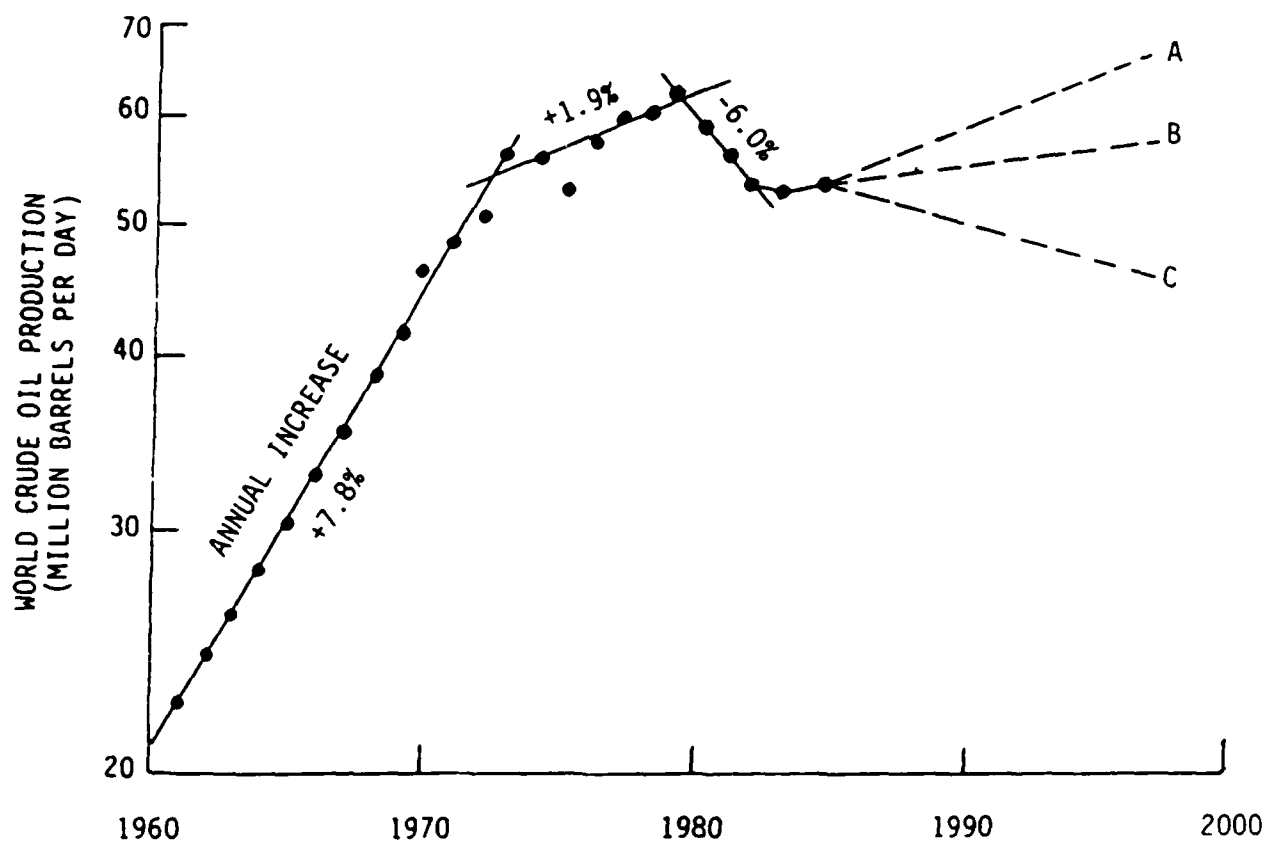
C. Institutional Forecasting of Petroleum Production and Prices

The twenty-five year period from the end of World War II to the beginning of the 1970s was marked by steadily rising demand for petroleum. During that period, worldwide demand rose about eight percent annually and was remarkably consistent from year to year (Figure 6). It was accompanied by about a five-percent annual rise in the combined demand for all commercial forms of energy, again on a worldwide basis. Consequently, prior to the first oil crisis of 1973, it was difficult for institutions or analysts to anticipate a major change in those steady long-term trends.

For several years after oil prices first began to rise significantly (1971), it somehow became intellectually fashionable in economic circles to assert that demand for petroleum was relatively inelastic to prices. From that premise, it followed

Figure 6

WORLD CRUDE OIL PRODUCTION, 1960-1990



Source: Data compiled by Department of Energy publications.

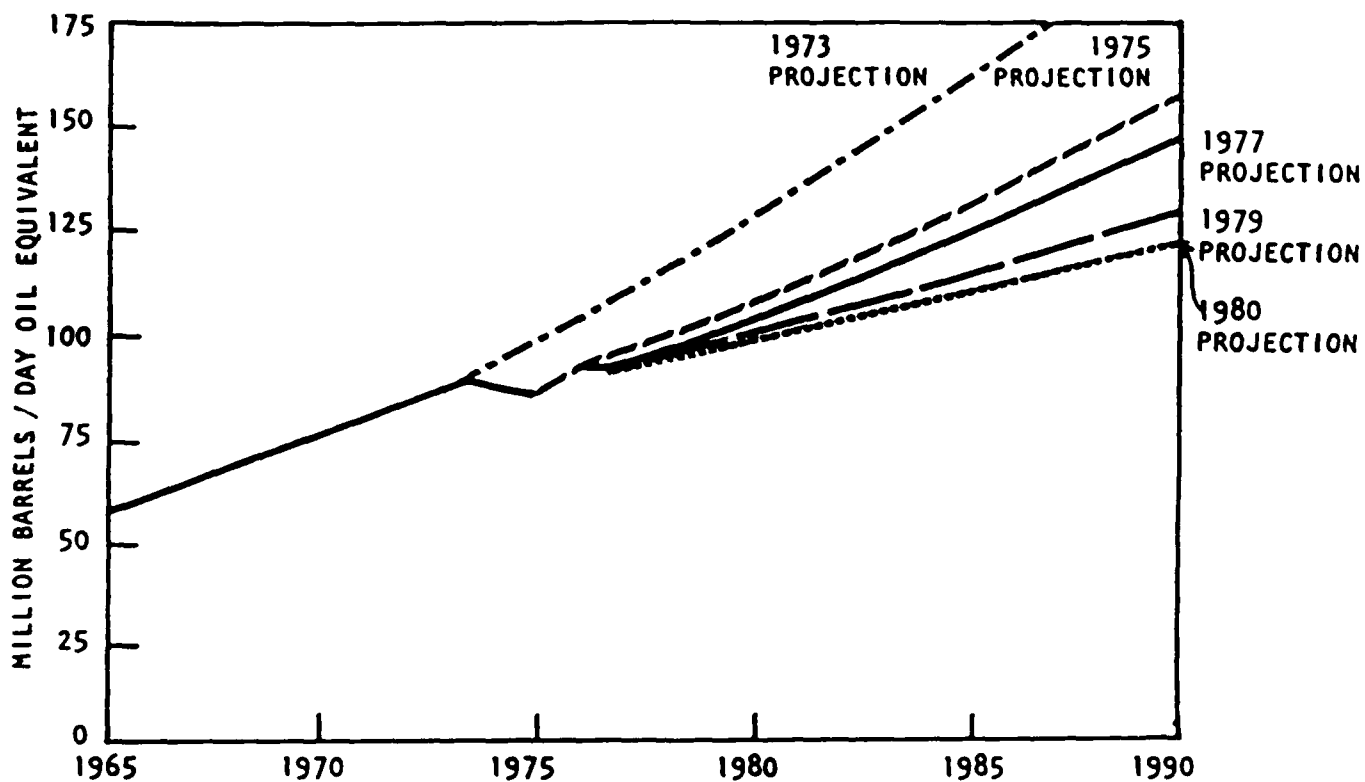
logically that, for economic growth to continue, demand for energy would also have to increase at about the same rate. Moreover, in January 1974, even after oil prices in the Persian Gulf had increased almost eight-fold since January 1971, it was still widely believed that demand for petroleum would hardly be affected. That is, no matter how high prices rose, oil consumers would presumably require nearly the same amount per unit of GNP. If the world economy was to keep growing, a corresponding supply of oil and of other commercial forms of energy would also be needed.

An institutional forecast of energy demand, typical of the 1970s, is shown in Figure 7. (Parallel forecasts of the demand for petroleum in the United States and for the Free World are shown in Table 1.) The forecasts were typical not only of major oil companies, but also of almost every major government institution, financial institution, private analyst, and international organization involved in energy or oil market forecasting. The remarkable similarity in the forecasts now appears to be especially surprising, not only because history was soon to show them to be wrong, but because they all erred in essentially the same way and to about the same degree.

In retrospect, it does not seem plausible that the conclusions were actually arrived at independently. Indeed, few of the institutional forecasts published during the 1970s provided the assumptions and the reasoning on which they were based. Typically, those forecasts were based on the output of mathematical models that required many numerical assumptions about supply, demand, elasticity, correlation coefficients, and other variables. Expectations of the supply/demand/elasticity

Figure 7

EXXON PROJECTIONS OF WORLD ENERGY DEMAND
(Excluding Communist Areas)



Source: Exxon Corporation, World Energy Outlook, April 1978, December 1979, and December 1980.

Table 1
OIL COMPANY PROJECTIONS FOR 1990

OIL COMPANY	FORECAST DATE	OPEC OIL, EXPORTS*	FREE WORLD OIL DEMAND	U.S. CONSUMPTION*	
				OIL	TOTAL ENERGY
Exxon	Apr 1977	48	76	23.6	54.3
Exxon	Apr 1978	45	72	20.4	48.6
Exxon	Dec 1979	33	60	16.4	43.0
Exxon	Dec 1980	30	55	16.0	40.5
Chevron	Jun 1983	18	49	15.0	39.5
Chevron	Jul 1984	21.5	49	15.85	39.3
Chevron	Jun 1985	20	49	16.7	39.0
Chevron	Jun 1986	15-21	48-52	16.2	39.0

*In million barrels per day of oil or oil equivalents.

relationships reflected the largely unchallenged prevailing institutional wisdom and thus tended to be similar. Consequently, although a large variety of models existed, they rather uniformly cranked out similarly incorrect projections. During the late 1970s and early 1980s, when the basic information about OPEC's future pricing strategy became available, most oil price forecasts again provided results that were remarkably consistent. That is, although they were nearly all incorrect, they were astonishingly consistent, as a group, with Sheikh Yamani's preferred pricing scenario. Thus, it seems that truly independent forecasts were seldom made; most forecasts published prior to 1986 reflected little beyond the conventional wisdom of the time.

That this type of forecasting can dominate a large segment of the economy need not be considered too surprising, as similar situations have occurred in the past. For example, Table 2 lists a series of forecasts about future petroleum supplies in the U.S. that were published by various government agencies (usually based on information provided by the oil industry). They reflect a long history of error. As Table 2 clearly demonstrates, all of the earlier U.S. petroleum supply forecasts were wildly wrong for over 100 years, always on the low side. From such evidence, it appears reasonable to conclude that forecasts made by large institutions--government or private--are almost always quite conservative and tend to reflect prevailing conventional wisdom.

The conservative nature of past petroleum forecasts also seems consistent with the hypothesis that it is very difficult for forecasters associated with large organizations to make substantial allowances for future advances in technology. Oil companies and financial institutions have typically been loathe to make long-term investments whose success would depend upon substantial technological improvements. If a forecaster were

Table 2**PAST PETROLEUM PROPHECIES AND REALITIES**

DATE	U.S. OIL PRODUCTION RATE (10 ⁹ Bbl/YR)	PROPHECY	REALITY
1866	.005	Synthetics available if oil production should end (U.S. Revenue Commission)	In next 82 years the U.S. produced 37 billion bbl. with no need for synthetics
1885	.02	Little or no chance for oil in California (U.S. Geological Survey)	8 billion bbl. produced in California since that date with important new findings in 1948
1891	.05	Little or no chance for oil in Kansas or Texas (U.S. Geological Survey)	14 billion bbls. produced in these two states since 1891
1908	.18	Maximum future supply of 22.5 billion bbl. (Officials of Geological Survey)	35 billion bbls. produced since 1908 with 26.8 billion reserve proven and available on Jan. 1, 1949
1914	.27	Total future production only 5.7 billion bbl. (Official U.S. Bureau of Mines)	34 billion bbl. produced since 1914 or six times this prediction
1920	.45	U.S. needs foreign oil and synthetics; peak domestic production almost reached (Director of U.S. Geological Survey)	1949 U.S. production in excess of U.S. consumption and more than four times 1920 output
1931	.85	Must import as much foreign oil as possible to save domestic supply (Secretary of the Interior)	During next 8 years imports were discouraged and 14 billion bbls. were found in the U.S.
1939	1.3	U.S. oil supplies will last only 13 years (Radio Broadcasts by Interior Dept.)	New oil found since 1939 exceeds the 13 years' supply known at that time
1947	1.9	Sufficient oil cannot be found in U.S. (Chief of Petroleum Division, State Department)	4.3 billion bbl. found in 1948, the largest volume in history and twice our consumption
1949	2.0	End of U.S. oil supply almost in sight (Secretary of Interior)	Petroleum industry demonstrated ability to increase U.S. production by more than a million bbl. daily in the next five years

Source: Presidential Energy Program, Hearings before the Subcommittee on Energy and Power of the Committee on Interstate and Foreign Commerce House of Representatives. First session on the implications of the President's proposals in the Energy Independence Act of 1975. Serial No. 94-20, p. 643. February 17, 18, 20, and 21, 1975.

to assume such developments, it might leave him vulnerable to criticism that, in a commercial context, could create serious problems between him and his supervisors. Somehow, it has almost always seemed safer to lean toward caution than to risk censure as an unrestrained optimist--for example, by predicting that sufficient world petroleum supplies would be available for another 50 years, despite increasing demand.

In defense of conservatism, however, one must acknowledge that it probably was "impossible" for forecasters in earlier times (say, 30 or more years ago) to assume that additional large oil reserves would be found in regions such as Mexico, which had already been explored. It also would have been excessively optimistic to assume that huge pools of oil might be found by drilling significantly deeper, when the state of technical knowledge at that time essentially ruled out the possibility that significant quantities of oil even existed at such depths, or that any substantial portion could be found and produced if it did. In addition, it was undoubtedly very difficult, say 50 years ago, for analysts to believe that the time would soon come when companies would drill for oil beneath the ocean floor on billion-dollar platforms located hundreds of miles from shore, where they would be subjected to hurricanes and other enormous stresses--and still be commercially successful.

Predictions of successful ventures based upon almost inconceivable technological advances require a leap of imagination uncharacteristic of most forecasters employed by conservative establishments. Such predictions tend to create an aura of science fiction, rather than one of "sound advice" upon which to base prudent investments or national policy.

Throughout the early 1980s, even as demand for oil was plummeting, nearly every public and private institution still expected world demand for oil over the next 20 years to rise steadily, and available reserves to diminish. That combination of a rising demand against a limited supply (most of which was expected to remain under OPEC's control) could have only one reasonable outcome--an era of ever-rising oil prices.

It should be recalled that an image of an increasingly resource-poor world emerged in the late 1960s and had become widely accepted by the early 1970s. Notions espoused initially by the Club of Rome became widely held--namely, that the world was rapidly running out of sufficient agricultural land and most commercial minerals, and that as we depleted the environment we were increasing the number of impoverished people and health-threatening pollutants. According to proponents of these ideas, the world was only a finite sphere containing a fixed amount of oil and gas resources that could be tapped when found, but clearly must soon be exhausted--especially as millions of holes had already been drilled and most of the larger fields, as well as most of the ultimate potential revenues, had already been discovered. It was a fairly simple picture, but an impressive one. It even affected supposedly sophisticated experts, such as college professors, commercial analysts, and private business consultants.

Even though such apocalyptic notions had lost much of their influence by the late 1970s, when the second oil shock was beginning, the image of a finite world faced with exponentially increasing demands upon limited material resources appears to have created a deep, persistent impression, especially on oil analysts. Thus, it apparently continued to be readily accepted as a valid basic image for analyzing the petroleum market. Moreover, as indicated earlier, with the emergence of OPEC, many observers were evidently willing to discard the applicability of

of the traditional economic law of supply and demand to the petroleum market. The result was a perception based on a powerful image of rising future prices, that essentially undermined the ability of most analysts associated with existing institutions to rationally examine the outlook for the petroleum market.

D. The Ownership of Foreign Oil

The occasional tendency of entire societies to accept, as an obvious truth, an idea which soon afterwards is shown by real events to be false, is not at all uncommon. For example, America in 1917 was persuaded to enter World War I because of a belief in the idea that doing so "would make the world safe for democracy," that it was "a war to end all wars." Those concepts might seem a bit naive in retrospect, but at the time appeared to have been quickly accepted and believed by a large majority of the U.S. population. Another example was the growing belief during the roaring 1920s that the stock market had, in effect, become a one-way escalator rising toward the stratosphere, that anybody with some capital and common sense needed only to jump aboard to become rich. Only after stock prices had reached an "astronomical height" that could no longer be sustained did the myth collapse and unpleasant reality set in, a reality that created a financial panic that contributed in substantial measure to the Great Depression of the 1930s.

Another idea that has been generally accepted during most of recorded history is that successful governments should create powerful armies and navies with which to conquer and colonize other countries. Colonization, which usually involved enslaving a supposedly inferior people, was simply accepted as natural. It was easily rationalized as appropriate behavior by successful adventurers and their societies. Might made right. Seen from that perspective, when American oil companies spread around the world in the search for petroleum early in this century, it was

commonly expected that any attempts by weak foreign governments to violate lucrative oil production agreements would be resisted by the U.S. government. If necessary, the U.S. Marine Corps could be counted on to make sure that potential offenders would be discouraged from behaving "improperly." So strong had this expectation become that for several decades prior to the 1960s, American oil companies had little cause for concern that even their most valuable foreign oil properties would be expropriated.

Societies often change in unexpected ways. In particular, American values started to change rapidly after World War II. Thus, the notion that a government has an inherent right to nationalize the assets of any or all foreign companies operating in its country became widely accepted. That concept included the expectation that the affected companies would be fairly compensated for any expropriated property. During the 1950s and 1960s, disputes over the nationalization of property without appropriate compensation arose many times but usually were resolved satisfactorily. However much various countries may have been attracted to the notion of expropriating American-owned property without offering adequate compensation, they were reluctant to act--probably because they feared the potential responses by the U.S. government.

As a result of decades of changing values in twentieth century Western societies, little by little the notion of adequate payment for expropriated properties evolved. In particular, with regard to properties or concessions purchased by American oil companies, Third World nations were heartened, and astonished, to discover that an acceptable definition of adequate compensation might be limited to the depreciated value of investments in wells and above-ground structures. Compensation might not have to include the most valuable subsurface property--namely, the pools of oil and gas that had been discovered. Thus, even though the contractual agreements by which international oil companies had

been induced to explore for and produce oil in foreign countries had transferred to them the ownership of that oil, it was subject only to stipulated production royalties to be paid to the host governments, and other matters of relatively minor significance.

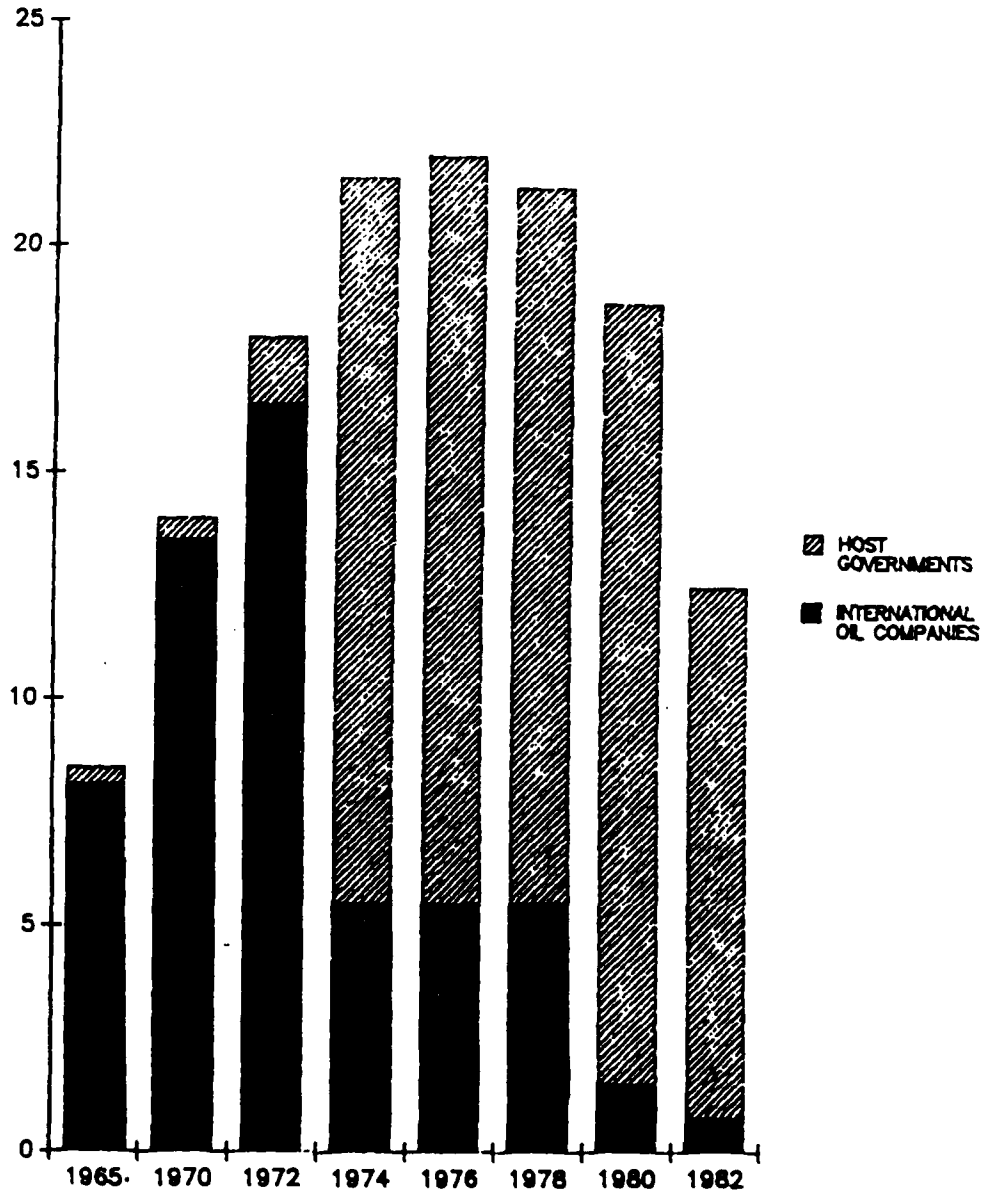
Changing interpretations of property rights, and a growing reluctance by the U.S. government to use military force to defend overseas property owned by American corporations, eventually led to an expropriation of nearly all oil-producing properties--an event which I have referred to as "the greatest heist in history." This "heist," in effect, was a consequence of the convenient interpretation by oil-producing nations of the Middle East and elsewhere that their contractual arrangements with the foreign (mostly American) oil companies could be unilaterally abrogated and the property nationalized, provided that those companies were compensated for the book value of their investments.

The petroleum resources "heisted" from the international oil companies during the 1970s probably contained about a trillion barrels of oil and natural gas, in crude oil equivalents. Over time, those resources could, at \$25 per barrel, have been sold for roughly \$25 trillion, an amount comparable to the value of all the tangible property in the United States, including land, buildings, contents, and vehicles. That enormous amount of property was relinquished by the U.S. government without a fight, and even without any unusually strong complaints. Obviously, strange things can happen in a rapidly changing world. The rapidity with which that heist occurred in the Middle East is indicated in a chart published by Exxon (Figure 8), which is worth pondering for a few moments. The heist occurred in full view of all interested observers with remarkably few shouts of "stop thief!"

Figure 8

INTERNATIONAL OIL COMPANIES' EQUITY INTEREST IN
MIDDLE EAST CRUDE OIL PRODUCTION--1965-1982

MILLIONS OF BARRELS
PER DAY



Source: Organization of the Petroleum Exporting Countries, Annual Statistical Bulletin; Exxon Corporation estimates.

E. Demand for Petroleum After 1978

It was shown earlier (Figure 6) that worldwide oil demand rose at a remarkably uniform rate prior to the 1973 crisis. After the rapid 1973-1974 price rise, demand growth declined substantially over the next few years, but usually remained positive. Available statistics show that nearly every major country continued to increase its petroleum consumption between 1973 and 1979, although the average rate of increase was much less than had been expected and some short-term downward fluctuations did occur, most of which were undoubtedly due to the 1975 recession. Nevertheless, even at the much higher price level prevailing in 1974, it seems that most nations (including the U.S.) continued to increase their oil consumption and, somewhat surprisingly, their dependence on foreign supplies. Still, that willingness to import increasing volumes of petroleum may have been coupled with an expectation that the period of rapid price rises had essentially ended, at least for several more years.

During the mid-1970s, at least a few energy analysts apparently expected that oil prices were as likely to fall as to rise. And, in fact, real oil prices did erode significantly, although that fact was not widely noticed by the public, while every "official" price rise agreed upon by OPEC after 1973 was strongly publicized and usually condemned as an unfair imposition upon consumers worldwide.

Clearly, some valid reasons did exist for worrying about a new round of rising prices. These worries were justified when, late in 1978, the Iranian revolution shut down oil production in that country and removed nearly all of the former excess production capacity from the international petroleum market. Yet as late as 1978 and early 1979, after the Shah of Iran had been exiled, very few petroleum experts in the industry or in government appeared to understand that another round of sharp

price rises was about to occur. In fact, when OPEC met in late December 1978, at a time when Iranian production had ceased, and announced that oil prices would be increased a total of 14.5 percent (about \$1.80 per barrel) in four increments over the entire year 1979, that announcement was vigorously protested as an outrageous burden for OPEC to place upon the Western economies, even though oil prices in inflation-adjusted terms had declined substantially during the previous five years (Figure 2).

Very little attention was given to another aspect of this "outrageous" increase: that since inflation had been running at high rates in the United States and most other Western countries during the 1970s, the announced price rise, if kept, could hardly have yielded OPEC members more than a 5 or 6 percent real price increase throughout that critical year. Moreover, the strong international protests that did occur point up the widespread illusion that prevailed at that time--that changes in oil prices were solely a consequence of OPEC deliberations.

Perhaps because of such misunderstandings about the real market forces it was not until the spring of 1979 that the buying panic became full-blown. That panic evidently occurred because: (1) spot market prices had risen well above the "official" OPEC price, (2) in their March 1979 meeting, OPEC members promptly abandoned the notion that the 14.5 percent price rise would be spread over the entire year (the full 14.5 percent rise was adopted immediately; "coincidentally," it lifted OPEC's prices to about the level of the spot market at that time), and (3) the Saudis, piqued at the lack of U.S. political support in another context (the Arab position in the Camp David accords), evidently decided to express their anger by wielding the "oil weapon." They deliberately reduced their oil exports by 1 MBPD, roughly 10 percent of their production, for a crucial 3-month period (April through June 1979). As oil buyers began to understand that prior price "commitments" by OPEC were apt to be quickly changed when

market conditions were appropriate, the buying panic became full-blown, and oil prices began to leapfrog earlier ones, as shown in Figure 5.

It did not seem to be well understood during the early 1980s that the second round of price increases had a much larger impact on oil consumers than the earlier one in 1973-1974, even though the initial one was almost 300 percent increase and the second about 150 percent. While the earlier price rise constituted an unanticipated nasty shock, it had not changed the prices of petroleum products enough to affect the lifestyle of Western consumers very much (Figure 3 shows two key prices observed by U.S. consumers). The 1979-1980 price rise, however, was passed through to consumers relatively quickly and represented a much greater burden to the public than had the prior one. For most Western families, it removed a very substantial portion of their former discretionary income and led to painful adjustments in budgets and lifestyles. The impact, of course, was even greater within many of the less developed countries, where government subsidies were seldom available.

Strangely, even after prices had risen to over \$30 per barrel, the oil companies and other commercial institutions still refused to grant much credence to the idea that future demand for petroleum would be significantly affected. It is true that during 1979, demand for crude oil and refined products was essentially unrestrained. In fact, throughout 1979 and well into 1980, all the petroleum that could be produced was quickly sold. However, it is important to distinguish between demand and consumption. During 1979-1980, much of the petroleum that was being purchased was not for consumption, but for storage as a hedge against an uncertain future.

Some confusion normally exists about the exact fate of crude oil after it is delivered; the rate at which petroleum was being

placed into inventory during the first few months of 1979, therefore, was not immediately known. Even today, reasonably reliable information is readily available only about oil placed into government storage and into the stocks of the refining industry within the developed countries, as these inventories are regularly measured and reported. During 1979-80, some analysts estimated, but without much confidence, that unreported private consumer storage roughly equalled the reported storage. Consequently, estimates of the overall amount of oil and or petroleum products going into inventories during those two years varied substantially, but usually ranged between 2 and 4 MBPD.

Even considering only the known storage activities of government and petroleum refiners, it had become clear before the end of 1979 that actual consumption of petroleum had fallen significantly. By then, it could also be calculated that the amount of oil entering into inventories was occurring at a rate that would necessarily have to end sometime during 1980, because by then all available storage tanks would be full, and there would be no physical way to accommodate additional inventory.*

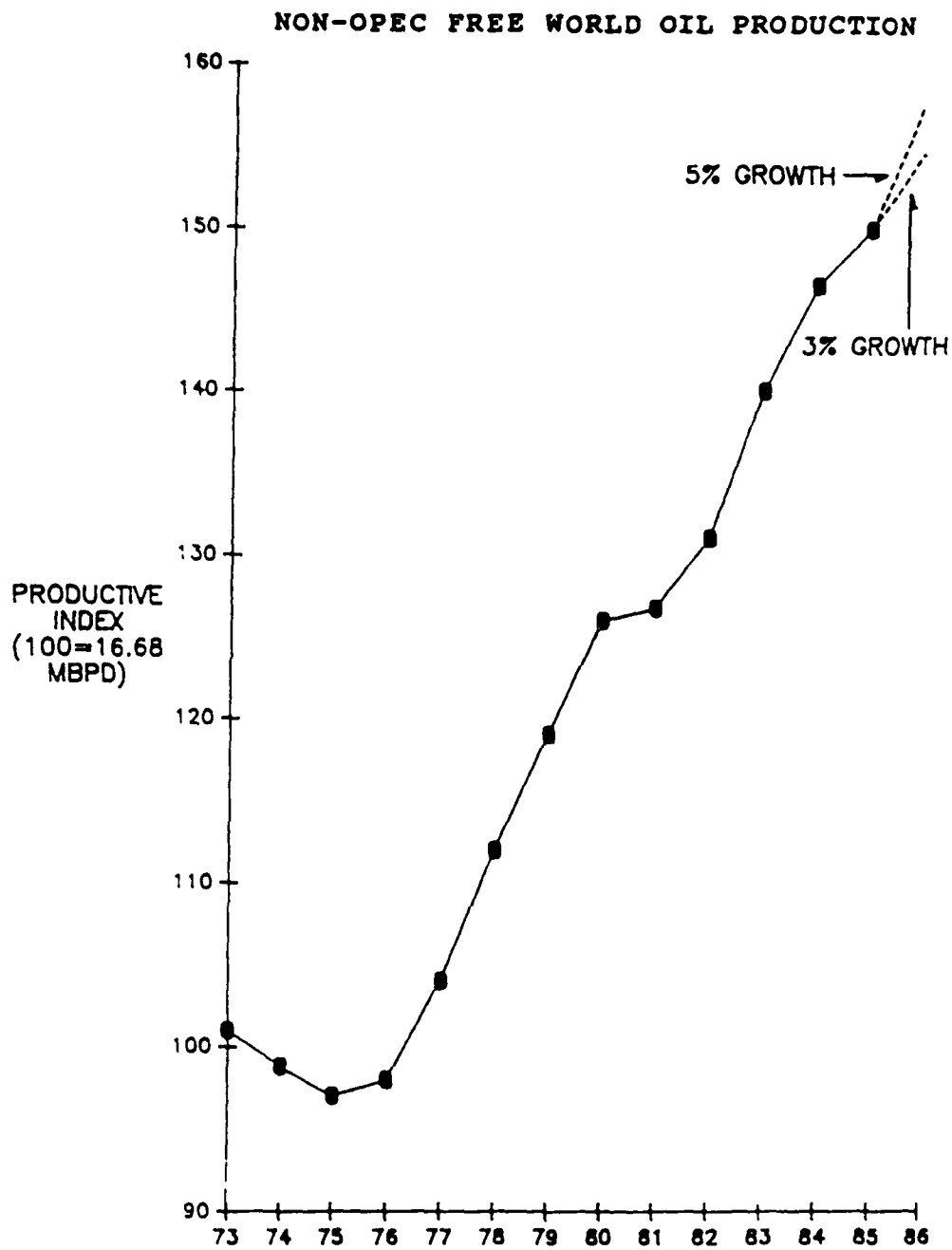
Confusion about the amount of petroleum actually consumed, and the belief that society's need for it was "naturally inelastic," may have prevented many institutions from recognizing that the law of supply and demand applied to oil consumption as much as it did to most other commodities. When later data showed that oil consumption had diminished significantly during the second half of 1979, it was almost universally interpreted to be a one-time "knee-jerk" reaction. During 1980, when consumption again fell by a steep six-percent on a worldwide basis, it was

*In a July 1980 Fortune, article Herman Kahn and I predicted that demand for OPEC supplies would drop by 4 MBPD within a year. About half of that drop was calculated to come from a decline in purchases due to a lack of storage capacity (see Appendix).

similarly rationalized as being the last expected drop in demand. Essentially the same experience recurred in 1981, and again in 1982. Each time, the same interpretations were offered, even for 1983, when worldwide oil demand again fell by about five percent (Figure 4).

By the mid-1980s the OPEC share of the world's export markets had shrunk from its peak by about 50 percent. Market conditions had forced a \$5 per barrel reduction in "official" prices early in 1983 while the real price decline had been exacerbated by a few years of inflation and frequent discounting, as OPEC members competed with each other to maintain market shares. Finally, in 1984, with both nominal and real oil prices at their lowest level in five years, worldwide demand for oil rose a little. The 1984 demand was 0.2 MBPD greater than in 1983, a tiny gain due in large measure to an unusually strong economic surge in the U.S. and Europe.

OPEC as a group did not participate in the slight gain in the demand for oil. It was absorbed by other Free-World producers (Figure 9) and by increased exports of the Soviet Union. In 1985, however, even with moderate economic growth, worldwide oil demand slid again, and prices declined further, to about \$26 per barrel (for Saudi light crude) at year's end, with a substantial further price decline expected by spring 1986, according to the quotations in the futures market. An expectation of sharply lower prices, however, still had not become part of the conventional wisdom, which, even in late 1985, continued to expect modest increases in demand coupled with prices somewhere between flat and sharply-rising during the rest of the 1980s. Those expectations were about to be severely jolted by the price collapse of early 1986.

Figure 9

Source: Petroleum Economist, August 1986.

One of the perennial lessons about human behavior epitomized by institutional responses to oil market experiences is that entrenched beliefs cannot easily be exorcised by mere logic or persuasive argument. Institutional expectations about an ever-rising oil market began to change significantly only after several years of diminishing demand and falling prices. Arguments contrary to the conventional wisdom failed to impress most decisionmakers; only repeated painful contacts with reality eventually accomplished that.*

The tendency to maintain long-held beliefs is so strong that, even during most of 1985, with OPEC in disarray and the events of the past several years more clearly focused, a general expectation still remained that oil prices would once more begin to rise, probably within two or three years and certainly by 1990. That expectation was published by several international oil companies as well as many financial institutions; it did not differ much from earlier forecasts, except that the "era of ever-rising oil prices" had been placed a few years into the future. The sharp fall and strong fluctuations in oil prices since late 1985 have sent most energy analysts "back to their drawing boards."

The rise and fall of OPEC petroleum production since 1965 is given in Figure 4. That figure sums up OPEC's "roller-coaster" experience with export demand during the 1970s and early 1980s. It shows that after 1979, its last boom year, OPEC exports declined every year through 1985, usually quite steeply. Then in

*During 1981 and 1982, I was involved in extensive discussions about future oil prices with executives of many institutions (oil companies, utilities, banks, manufacturers, etc.). I am not aware that my arguments setting forth the reasons for expecting a decline in oil prices during such discussions actually changed any operating policies. I am certain that I did not significantly affect the behavior of the chief loan officers of the Continental Illinois Bank, with whom I spent a day in November 1981, in such discussions.

1985, the decline in OPEC production once again exceeded the decline in worldwide demand and led OPEC into a new policy that precipitated the collapse of prices in 1986.

It is instructive to examine Figure 4 in the context of OPEC's underlying oil production capacity. During the early 1980s, the CIA estimated that OPEC's installed production capacity exceeded 41 MBPD. However, that 41 MBPD figure represented optimum production from all of the wells in OPEC countries, in reality an impossible feat. A more useful estimate is OPEC's sustained production capacity, which would normally be about ten percent less than the installed capacity, or about 37 MBPD. The actual OPEC production for 1985, however, was only about 16 MBPD, less than half of its theoretically sustainable level.

The actual sustainable level in the near future will depend upon whether or not the Iraq/Iran war continues. The war has probably removed between five and six MBPD from the sustainable production capacity of those two countries. Even subtracting that amount from OPEC's total, it is difficult to come up with an estimate of OPEC's current excess capacity that is less than 12 MBPD. That estimate might soon approach 20 MBPD, depending on the state of the Iraq/Iran war, and factors such as the willingness of the Saudis and other OPEC members to produce at maximum levels, if the demand should appear. The current level of excess capacity, whether 12 or 20 MBPD, represents an available supply that probably will be quickly responsive to any reasonable increase in world demand that could occur during the rest of the century.

Since 1978, a rather phenomenal change in petroleum consumption has occurred within the developed countries that are members of the International Energy Agency (IEA). Figure 10 shows that the Western industrialized countries, after recovering from the first oil shock, continued to increase their petroleum

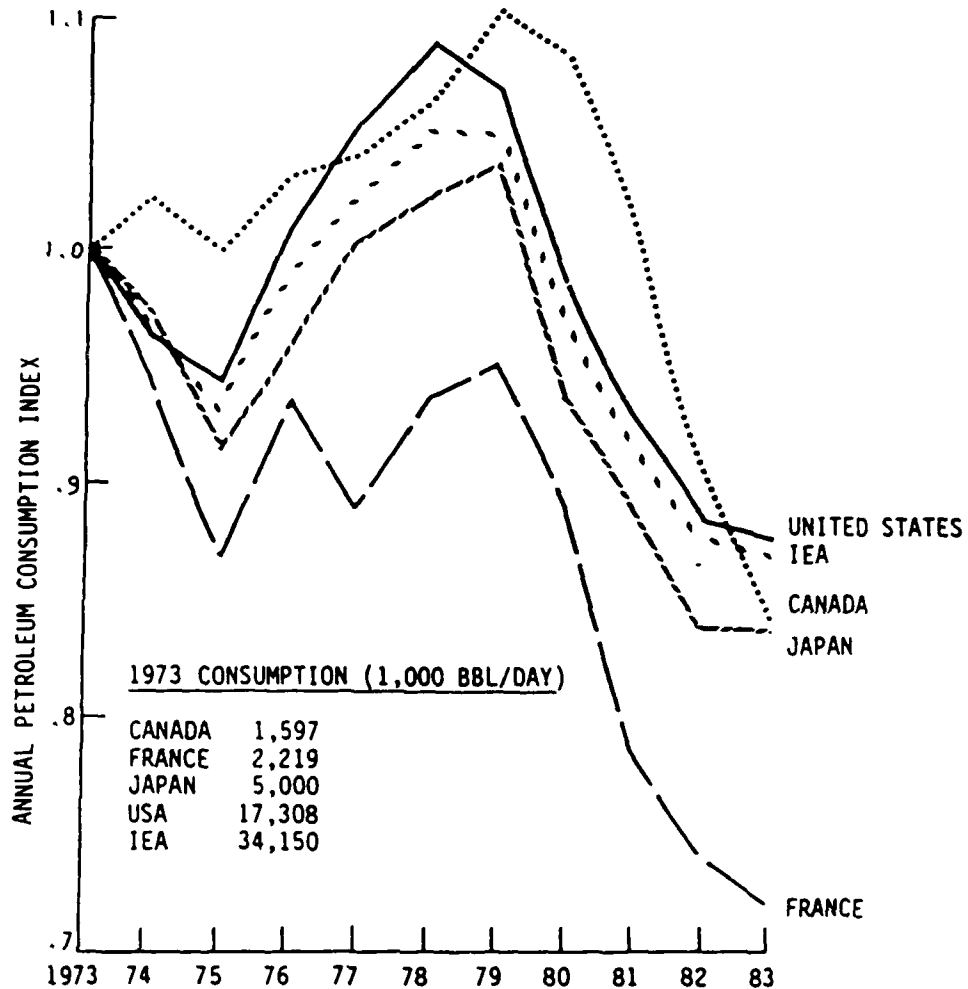
consumption. But then, in response to the second oil shock, they sharply curtailed demand. In the four-year period, 1979-1983, their petroleum consumption dropped an astonishing 25 percent.

Until 1981, when real oil prices reached their peak, the OPEC nations (and other oil-exporting developing nations such as Mexico and Malaysia) enjoyed relatively high export revenues and quickly adjusted their spending habits to the new income levels. When both real prices and production volumes started to drop, each country began to experience greater or lesser financial difficulties in accordance with newly acquired expectations and commitments. By 1985, the inflation-adjusted oil income of most of those nations had fallen at least 50 percent from its peak, and in some cases by more than 75 percent, with the worst yet to come. In 1985, because of recently changed lifestyles, each OPEC country found itself dissatisfied with its share of the market, dissatisfied with its level of oil revenues, and sought to improve that condition through additional exports. Each hoped for a turnaround in petroleum demand so that prices might remain steady or perhaps even increase over the next few years--in retrospect, an exceedingly optimistic point of view.

The Saudis, as noted, had watched their production fall almost 80 percent, from a high of about 10 MBPD to a low of just over 3 MBPD during August 1985. That sharp drop, coupled with lower prices, put them in a position where their budgeted expenditures greatly exceeded current oil revenues, requiring them to dip rather deeply into their liquid reserves. Saudi Arabia was one of the few countries to have accumulated a substantial hard currency reserve--which exceeded \$150 billion at its peak--and could thus offset their declining export income by drawing on that cushion. But it had become concerned that this cash cushion might disappear before the end of the decade unless a reversal of fortunes occurred or it changed its marketing policy.

Figure 10

**CHANGES IN PETROLEUM CONSUMPTION SINCE 1973
FOR SELECTED INDUSTRIALIZED COUNTRIES**



Source: Department of Energy, Energy Information Administration,
Monthly Energy Review, April 1984.

In August 1985, press reports indicated a major change in Saudi policy. Those reports, confirmed soon afterwards, noted that the Saudis were negotiating with several buyers to sell a substantial portion of their production at prevailing market prices by using a method known as netback pricing.^{*} The Saudis were determined to maintain a production level of at least 4 MBPD. That policy change became a milestone in the history of the international petroleum market and led to the sharp collapse of prices in 1986.

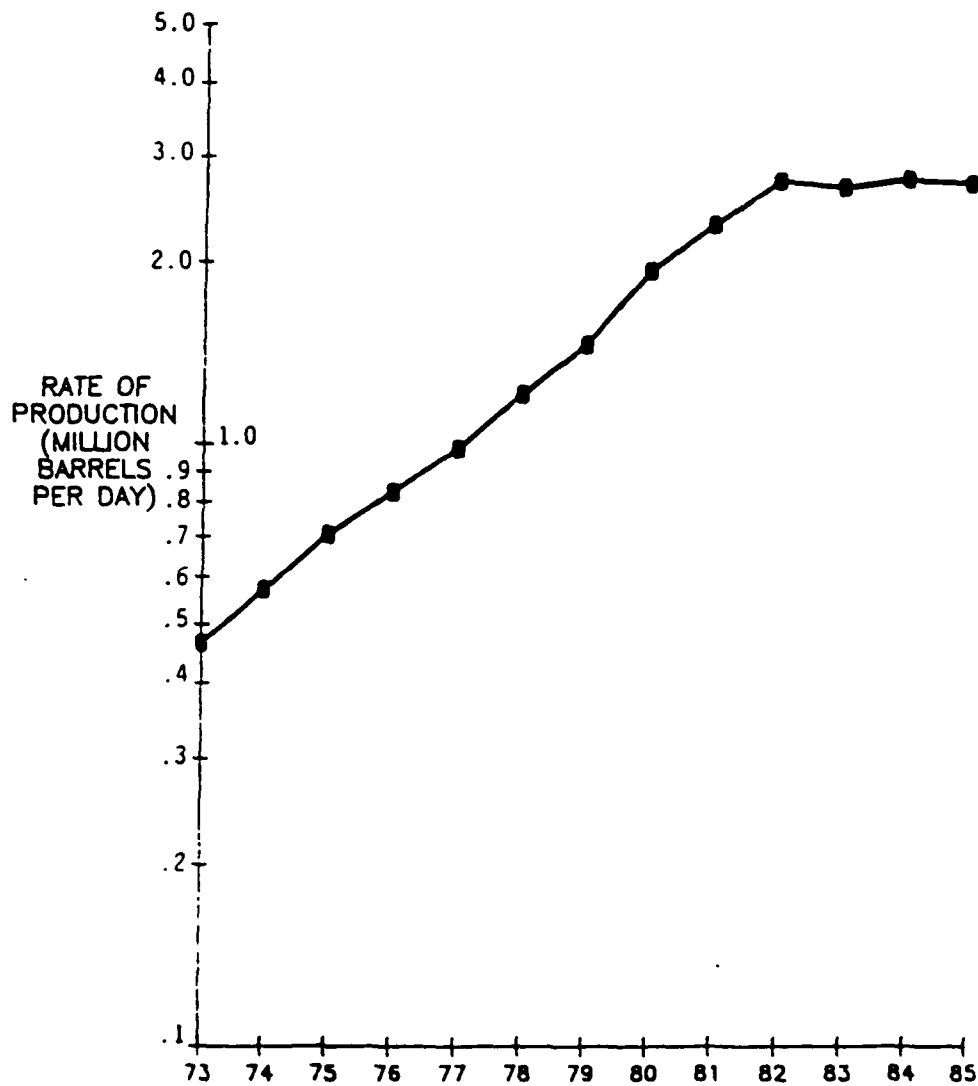
F. Non-OPEC Petroleum Supplies

The previous section presented some estimates of OPEC's oil production capacity and its relationship to former and current export levels. Non-OPEC production, unlike that of the OPEC members, has been and can be expected to continue essentially without constraints (other than normal economic ones), at nearly maximum sustainable capacity. The most important exception would be voluntary cutbacks to support OPEC pricing policies.

Prior to 1986, the only important non-OPEC oil-exporting country that had taken actions to coincide with OPEC's policies was Mexico. Mexico's production had been rising quite rapidly until 1982 (Figure 11) at which time, in response to a soft market and a reluctance to lower prices, the Mexican government announced it would restrain future oil production to a ceiling of approximately 2.75 MBPD. Figure 11 shows that Mexico has kept to that policy, although it is not clear to what extent practical difficulties in increasing oil output may have contributed to that adherence. As a result, Mexico may currently be producing oil at a rate quite close to its maximum sustainable capacity.

^{*}In netback pricing, refiners are charged a price for a crude oil shipment that is based upon prevailing market prices for petroleum products after that shipment is refined. In that way, the refiner in effect receives a fee for processing the crude oil, while the market risks stay with the supplier of the crude.

Figure 11
MEXICO'S CRUDE OIL PRODUCTION



Source: U.S. Department of Energy, Energy Information Administration, Monthly Energy Review, September 1986.

Mexico's problem in servicing its foreign debt reached a threatening level in 1982, and the government came under great pressure to restrain new investments in a great many projects, including investments in developing new petroleum production capacity. Thus, its announced restraint on oil exports might now be little more than camouflage to cover-up insufficient investments and production difficulties that may have arisen over the last few years.

Those kinds of problems, however, have not affected all of the non-OPEC oil-exporting countries. The changed output from the non-OPEC producers as a group is shown in Figure 8, which provides aggregated oil production data through 1985. It shows that shortly after the first oil-price shock, a strong persistent response to the higher prices arose among non-OPEC producers, increasing total production by about 1 MBPD each year since 1976. That increase has already removed about 8 MBPD from OPEC's export volumes. With the recent collapse of prices, non-OPEC production levels can be expected to decline in the near future, but perhaps not more than a few percent. While estimates vary, and much may depend on investments within areas such as the North Sea, Mexico, Brazil, and Egypt, over the next five years total non-OPEC Free-World production should not change much, and it could resume rising after a year or two, even though a more protracted decline seems likely to occur in the United States.

Another important aspect of the oil supply situation involves the oil and gas exports of the communist countries, particularly exports going from the Soviet Union to Western countries. Contrary to prior expectations, the Soviet Union substantially increased its oil exports to the West during the early 1980s. During 1984, for example, Soviet exports outside the Eastern Bloc averaged about 1.5 MBPD, compared to 1.0 MBPD in 1980 and 1981. Whether the Soviets will continue to expand oil exports is difficult to project with accuracy. It is known that their

exports declined about 30 percent during the first half of 1985 but then recovered to approximately 1984 levels.

Soviets are generally reluctant to give out technical information about their production prospects or export policies. However, most Soviet watchers have concluded that since the Soviets have had and will have a great need for hard currency income, they will continue to take substantial measures to prevent their petroleum revenues from declining. (See, for example, Petroleum Economist, February 1986, p. 45-46.) One approach that could help the Soviets maintain or increase their exports to the West is to substitute natural gas for petroleum fuels within their own country, and to send increased quantities of natural gas, rather than petroleum, to some of their satellites.

Soviet natural gas production is now the largest of any country in the world and has been increasing at a remarkably consistent rate of seven to eight percent a year, for quite a few years. In terms of BTU equivalents, Soviet natural gas production is now about 95 percent of its oil production and growing rapidly. Thus, over the near-term, each eight percent increase in natural gas production will constitute about a four percent increase in their total oil and gas production. In addition, to the extent that the Soviets can learn to operate in a more energy-efficient manner, they would free up a corresponding amount of petroleum that could be exported to the West.*

G. Natural Gas Supplies, Worldwide

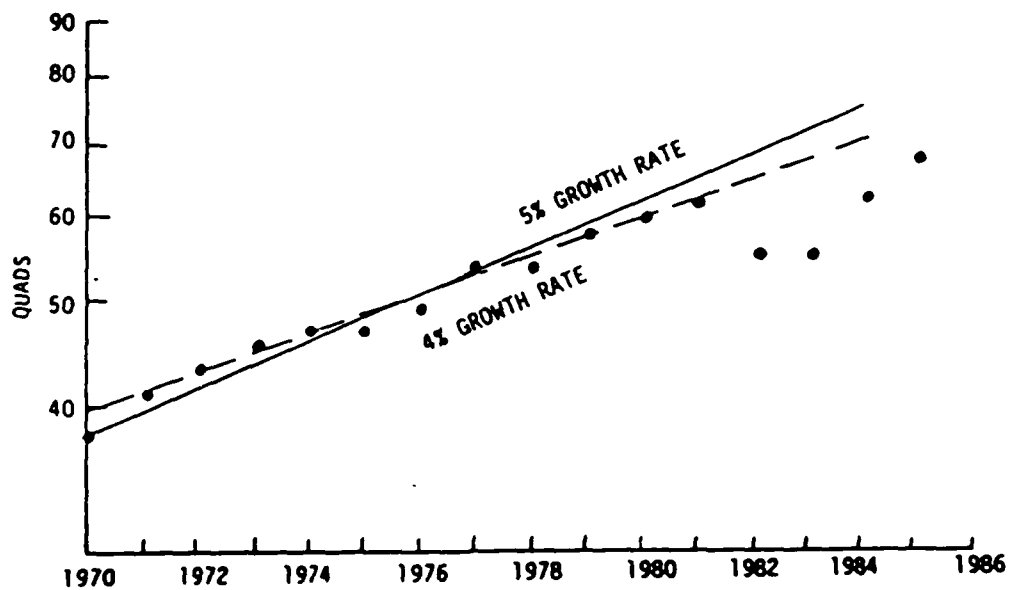
In the context of the adequacy of future petroleum supplies, it is necessary to examine the world's available supplies of

*Energy conservation is one of the major domestic goals announced by Soviet leader Mikhail Gorbachev. The current Soviet 5-year plan for 1986-1990 calls for 65-70 percent of additional energy needs to be met through conservation. (Reported in the Soviet journal, Planned Economy, March 1987.)

natural gas. Indeed, the interchangeability of natural gas and petroleum in many industrial processes suggests that it makes little sense to examine future crude oil supplies and markets apart from those for natural gas. Experience since 1970 has shown that the worldwide production of natural gas has grown about four percent a year (see Figure 12). That growth was interrupted in 1982 and 1983 as a result of the 1982 recession, the sharp drop in petroleum prices in 1983 (Figure 2), and a few other short-lived, localized factors.

Declining petroleum prices in the U.S., for example, while natural gas prices were rising due to a complex regulatory environment, led many industrial concerns to switch from natural gas to fuel oil. The decline in U.S. demand for natural gas was equivalent to approximately .7 MBPD in 1982 and about the same in 1983. During 1986, the rapid decline in oil prices once again made it cheaper than natural gas in many parts of the U.S., and natural gas consumption fell to its lowest level since the energy crisis began--about 25 percent below that of 1973. That sharp drop tended to support OPEC exports, as an equivalent amount of imported oil had to be burned instead.

Worldwide demand for natural gas has recently begun to increase; it now appears likely that demand will continue to grow at about three to four percent annually, perhaps for the rest of this century. If that occurs, supplies of natural gas will increase faster than the overall demand growth for energy (according to nearly all forecasts) and further displace oil exports. If future worldwide growth in natural gas production averages 3.5 percent, then an additional 1.0 MBPD of potential oil exports would be displaced each year. Over a period of ten years, the compounded impact of these volumes of natural gas production on oil exporters could exceed 12 MBPD.

Figure 12**WORLDWIDE MARKETED PRODUCTION OF NATURAL GAS, 1970-1986**

Sources: Various issues of Basic Data Petroleum Book; Oil & Gas Journal; and Department of Energy/Energy Information Administration publications.

To sum up, three major supply factors may be expected to impinge upon OPEC--if OPEC remains viable--during the rest of this century. These are: (1) non-OPEC oil production in the Free World, (2) oil exports from the communist countries, and (3) a rising supply of natural gas to compete with petroleum fuels in stationary applications.

II. FUTURE PETROLEUM SUPPLIES

A. A Perspective on Petroleum Resources

Assuming that the present consensus about the world's remaining extractable amounts of conventional crude oil and natural gas is correct, these resources could be nearly exhausted within the next 50-60 years. However, since similar claims have been made for over a hundred years (see Table 2) they should be tempered by estimates of unconventional alternatives. These include several known resources from which either oil or gas (or both) can be extracted; they are huge compared with conventional resources.

Technologies for commercially producing unconventional oil and gas resources have been under active development for many years and are likely to be phased in gradually over the coming decades--perhaps even fast enough to provide a smooth transition from the present dependence upon conventional sources. Technological developments in exploration and extraction of conventional oil and gas almost certainly will also make great progress, potentially adding substantially to current estimates of the oil and gas supplies ultimately available. These developments could stretch out and smooth out the anticipated long-term transition to non-petroleum forms of energy.

The outlook for petroleum production by non-OPEC countries during the rest of this century suggests that, in most areas, output is likely to rise. Once the fear of a severe price decline evaporates, exploration and production should begin to expand in nearly every region with reasonable petroleum prospects. The initial stimulus for such a prolonged effort was the recent oil crisis; most oil-importing countries with petroleum resources appear eager to reduce their former dependence on foreign suppliers and have been moving toward that goal, although the movement has frequently been erratic.

The sharp decline in oil prices that occurred in 1986 is unlikely to have a continuing impact on prior national programs designed to reduce oil-import vulnerability. As it generally takes from 10 to 20 years to discover and develop a significant fraction of undeveloped petroleum resources, national policies for reducing import dependence cannot reasonably be expected to change very much in response to short-term price fluctuations. This conclusion appears to be valid for both the developed and developing nations whose exploration efforts are guided by government policy.

The relatively great amounts of both conventional and unconventional petroleum resources, the impressive technological progress that is expected to occur in all important aspects of energy exploration and production during the next few decades, and the strong desire of most countries to reduce their dependence on foreign markets clearly suggest that future indigenous oil and gas supplies within countries possessing favorable prospects should gradually, if somewhat unevenly, come into better balance with demand. That also implies the possibility of a gradual diminution of demand in an increasing number of markets now supplied by OPEC and probably, also, of lower-than-expected international petroleum prices during and after the late 1990s.

The above perspective is diametrically opposed to the more pessimistic ones that were in vogue during the late 1970s and early 1980s when many analysts assumed that society must contend with ever-rising fuel prices.* Yet, since 1973, adjustments to new energy realities have been occurring more rapidly than expected, making earlier institutional projections of supply and demand obsolete. However, even at present, nearly all institutional

*For a typical example, see Daniel Yergin and Martin Hellebrand, eds., Global Insecurity: A Strategy for Energy and Economic Renewal (Boston: Houghton Mifflin, 1982).

institutional projections visualize a renewed wave of "ever-rising prices" beginning in the early 1990s,* based on assumptions of rapidly-exhausting supplies. That possibility will be examined in the next section.

B. Long-Term Prospects for Petroleum Supplies

In the past, many proponents of the preservation of non-renewable resources--in this case, petroleum--held a relatively simple image of the world's geological potential:

Within its upper crustal layer the earth contains a limited amount of crude oil and natural gas collected in pools of greatly varying sizes and depths. These pools, once discovered, are continuously tapped to provide society with its preferred fuels and with petrochemical feedstocks. Both independent geological experts and those associated with major oil companies have estimated that about 20 percent of the earth's extractable crude oil and perhaps 10 percent of its natural gas have already been consumed. According to a recent consensus of these experts, only about half--and a much more difficult half--of the original crude oil is still to be discovered, and perhaps 70 percent of the natural gas.

Worldwide, over 2.5 million wells have been drilled in search of these hydrocarbon pools, with about 96,000 drilled during 1981 alone, an historical high. Because of rapidly-rising consumption during this century, the combined production of oil and gas now exceeds 80 MBPD (of crude oil equivalents). Therefore, even a relatively low growth in the future consumption of these fuels, say two percent annually, implies that nearly all of the fluid hydrocarbons in the earth's crust will have been sucked out within a few decades and that very little would then be left for posterity. Consequently, our grandchildren, if not our children, are likely to inherit an earth almost barren of these fuels and will be forced to employ increasingly extreme, and expensive, energy conservation measures. They will also be required to make enormous investments in order to convert environmentally-dangerous solid fossil fuels

*See for example: Dermot Gately, "Lessons from the 1986 Price Collapse," Brookings Papers on Economic Activity, No. 2 (1986), pp. 272-282 and World Energy Outlook through 2000, Conoco Inc., Coordinating and Planning Department (September 1986).

into the desirable fluids. But, as even those resources are limited, it will still leave an important question, what about an adequate supply of fuels for their children and grandchildren?

This essentially simplistic perception has been more or less in vogue since petroleum was first discovered in 1859. Prior to that, preservationists were concerned with the possible exhaustion of other commercial fuels such as wood from forests--or even whale oil, when its use spread rapidly and its price rose to astonishing heights in the mid-19th century.

Past concerns about petroleum availability in the United States, including concerns expressed by the government, are reflected in Table 2. However, it is also clear from the table that human ingenuity, perhaps combined with a little luck, has managed to confound all of the earlier gloomy long-range prophecies. Nevertheless, evidence of past errors in prophecy has not deterred today's preservationists from making similar dire forecasts. The argument that the world will soon exhaust its petroleum resources has probably never been made more emphatically than during the last decade or so. As in the past, that argument usually relies upon the prevailing consensus among experts, which now asserts that only 1.5 trillion barrels of crude oil remain to be produced in the world.* That quantity would last about 75 years at current rates of consumption (about 20 billion barrels annually), or about 45 years with a two percent annual growth in consumption. The consensus also holds that a roughly similar quantity of natural gas (in energy equivalents) remains to be extracted and would last about 150 years at the current rate of consumption, but not quite 60 years at the three-percent growth rate that is commonly projected.

*For example, see Workshop on Alternative Energy Strategies, Energy: Global Prospects 1985-2000 (New York: McGraw-Hill, 1977).

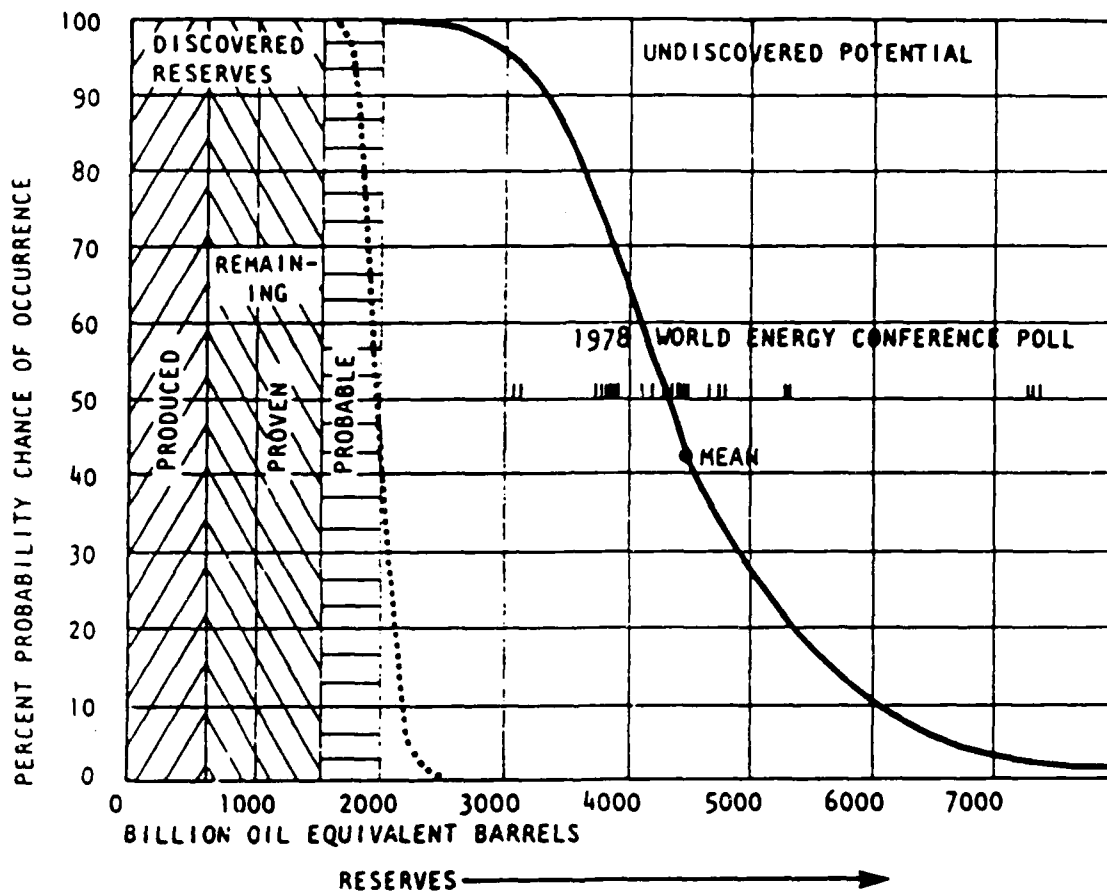
Although the decline in petroleum consumption since 1978 (Figure 9) led to a growing belief that demand for crude oil would not increase much during the rest of the 1980s, most large oil companies appear to believe that a slow (one-two percent) growth worldwide will persist from now through the 1990s, evidently until rising prices once again become high enough to restrain consumption.* Even with these modest increases, it is clear that there are not enough conventional petroleum resources in the world--according to the present consensus on the ultimate amount of oil and gas supplies--to last for more than about a half-century.

Whether the time available before the exhaustion of conventional oil and gas supplies occurs will be sufficient to develop and phase in enough alternative energy supplies is also part of a continuing debate. Clearly, if the above projections of a 50- or 60-year supply are reasonably correct, then before long consumers will again face a persistent upward pressure on oil and natural gas prices. Indeed, if those estimates can be trusted, companies producing oil and gas should now be excellent long-term investments, as the value of existing and new reserves should continue to increase.

However, the above perspective has some serious limitations and inherent uncertainties that need to be examined. Suppose that the present widespread expectation of rising prices (after 1990), combined with technological developments and a little bit of luck in exploration, should result in a revised consensus of an extra trillion barrels of crude oil plus an equivalent amount of natural gas. That outcome is, in fact, well within the range of uncertainty suggested by the consensus estimate (Figure 13). At current levels of world consumption, those extra quantities

*"Predicting Long-Term Oil Demand," Petroleum Economist, July 1983; and Chevron Corporation, Economics Department, World Energy Outlook, June 1986.

Figure 13

POTENTIAL WORLD TOTAL PETROLEUM RESERVES¹

Note: 1) In this figure, petroleum includes both crude oil and natural gas.

Source: How Much Oil and Gas?, Exxon Background Series (New York: Exxon Corporation, May 1982), p. 9.

would provide another 50 years of oil supplies and about 100 years of natural gas supplies. Assuming continued accelerating usage, as before, the additional supplies might last for only about another two or three decades beyond the 50-60 years to exhaustion based on the present estimates.

An extra 20 to 30 years should not be lightly dismissed. It could provide more than enough extra time for the world to develop satisfactory commercial alternatives to conventional oil and gas on a sufficiently large scale and at tolerable prices. If that conclusion is reasonable, then long-range investments in petroleum or natural gas may be no better now than many other opportunities. Indeed, even at present, it is widely anticipated that many commercial alternatives to conventional oil and gas will be developed over the next few decades from resources now called unconventional.

The most serious near-term impediment to rapid development of those resources is concern about future crude oil prices. The recent soft market for petroleum has weakened the astonishingly far-reaching belief in "ever-rising oil prices" that prevailed in the early 1980s. That change in market conditions led to the postponement or cancellation of many unconventional energy supply projects whose viability depended on expectations of firm, if not rising, oil prices. However, those or similar projects undoubtedly will be resumed when their prospects become satisfactory. Meanwhile technological progress continues in those areas, albeit at a somewhat slower rate than before.

C. Unconventional Sources for Oil and Gas

Currently, the more likely alternatives to conventionally produced petroleum include: (1) heavy oil deposits, (2) tar sands, (3) "tertiary" oil recovery--the extraction of crude oil from depleted fields--and (4) synthetic fuels, the liquids and gases

that can be produced from solid fossil fuel deposits--mainly shale, coal, and peat. In the U.S., the potential of the first three alternatives is large, but the fourth, synthetic fuels, is enormous compared with conventional petroleum resources.

Still other unconventional possibilities exist for the production of both oil and natural gas. For natural gas, the better-known U.S. sources include: (1) selected low-permeability formations (especially of the Rocky Mountain region), (2) methane, which can be drained from existing coal beds before they are mined, and (3) the Eastern gas shales. Within the U.S., the potential from each of these three sources appears to be comparable to or larger than our proven natural gas reserves.*

Data about the potential of unconventional resources in the rest of the world is not good, in large measure because of the relatively sparse amount of exploration that has occurred outside the U.S. However, no intrinsic technical reasons now exist to support the notion that the U.S. was nature's single preferred repository for such resources. Consequently, from simple geographical considerations alone (the U.S. has only about six percent of the world's land area), worldwide unconventional fossil fuel resources could eventually provide at least ten times as much fuel as the consensus estimate of the remaining conventional petroleum resources--that is, at least 40 trillion barrels of crude oil equivalents! Clearly, such numbers are speculative, but not without support. For example, Duncan and Swanson of the U.S. Geological Survey have estimated that the world's oil shale resources, considering only that portion which

*U.S. natural gas reserves are currently about 200 trillion cubic feet (TCF), the equivalent of about 30 billion barrels of petroleum.

can yield 10 or more gallons of oil per ton of shale, alone could produce over 300 trillion barrels of oil.*

Two important points need to be made about most of the alternatives to conventional petroleum supplies. First, once the need for them is perceived, two or three decades, perhaps more, will be needed in order to develop the technology and phase in a large commercial industry in the United States. Second, although the unconventional resources mentioned above are estimated to be very large compared with conventional ones--at least ten times--those resources do not exhaust all of the possibilities. Other speculative possibilities also might offer immense potential for additional supplies. Two such possibilities are: (1) the extraction of natural gas from the hydrates (or clathrates) located below the ocean floors of the earth's polar regions and (2) a possible but still very speculative potential for finding enormous deposits of abiogenic methane in non-sedimentary basins.**

*D.A. Brobst and W.P. Pratt (eds.), U.S. Mineral Resources, U.S. Geological Survey (Washington, D.C.: Government Printing Office, 1973).

**There is convincing evidence for the existence of methane hydrates in quantities that dwarf conventional gas resource. Daniel J. Milton of the U.S. Geological Survey reported that Soviet calculations of the amount of methane in hydrate formations, worldwide, exceeded 10^{18} m³. That is equivalent to the energy of approximately 6,000 trillion barrels of oil--or more than 1,000 times greater than the consensus estimate of total conventional petroleum resources. See The Future Supply of Nature-Made Petroleum and Gas, report of an international conference sponsored by UNITAR and IIASA (Elmsford, NY: Pergamon Press, 1976), Chapter 53, p. 928.

However, the abiogenic methane potential rests mostly on an imaginative but unproven theory that has been developed by Dr. Thomas Gold, a prominent physicist-astronomer at Cornell University. The U.S. investigation of that theory is now being supported by the Gas Research Institute which, together with the Swedish government, is supporting a test project in Sweden that hopes to prove Gold's theory by finding such a gas field.

In the hope of making some of the above alternatives commercial, many new technologies have been and are being investigated or developed. For any of them, it may take 10 to 20 years, perhaps more, before much confidence can be placed in the profitability of commercial operations. Their economic outlook will probably continue to improve in response to normal technological progress. Indeed, a reasonable possibility exists that one or more technological breakthroughs will occur that could substantially reduce the costs of producing such fuels. It has been conjectured, for example, that in-situ methods for extracting oil and gas from coal and/or shale deposits could, over time, become relatively impressive. During the transition period of the next several decades the energy industry will be developing several processes based upon recently-devised technologies to produce fluid fuels from unconventional sources, as well as improving the technologies now being used in conventional petroleum exploration and gas production. Changing technology may become crucial to the long-term viability of major segments of the petroleum industry; it is discussed below.

D. Petroleum Technologies

1. Energy Chemistry

Every student of elementary chemistry and physics soon learns that energy cannot be destroyed, that it can exist in many forms, and that these forms are interchangeable, in principle. That is, energy may exist as heat, light, or motion; it may be bound up, chemically, within many substances; and it may exist in the form of potential electric power from dammed-up rivers or from nuclear processes. The principle implies, for example, that sunlight can be converted into gasoline, water power into natural gas, or coal into either of these, or into light or motion. It implies that there can never be any real danger of exhausting any of the preferred forms of energy such as fuel oil, gasoline, electricity, methanol, or butane. As long as there are sufficient

amounts of some basic sources of energy--and for millions of years these obviously will exist in the form of sunlight, geothermal energy, and nuclear energy (both fission and fusion)--society is assured, in principle, of adequate supplies of the desired forms.

This inherent interchangeability of energy from one form to another is not debatable among scientists. However, it must be stressed that there are costs involved in making any of the desired transformations. Thus, the energy in coal can be converted into liquid fuels or electric power, but the conversion is not free. Indeed, it is possible in principle, though not commercially desirable, to make coal out of electric power or from sunlight. Although any conversions involve substantial costs, they are more apt to become commercially feasible when relatively high-grade forms of energy (light, electricity) are being created out of low-grade ones (heat, wind). The economic feasibility of any particular energy conversion technology should become just one of society's ongoing concerns.

The primary concern of this paper is with the future of petroleum, not conversion. The following discussion of new technologies is therefore, focused on a few notable developments in the petroleum industry.

2. Advances in Petroleum Technology

Possibly the most spectacular of the many impressive technological developments in the oil and gas industry during the last several years has been the amazing progress in the application of computers to seismic exploration techniques. Successful exploration increasingly relies on the ability of computers to process the enormous amount of data contained in man-made vibrations reflected from deep-earth strata and recorded at the surface by large arrays of seismic instruments. Because data-processing

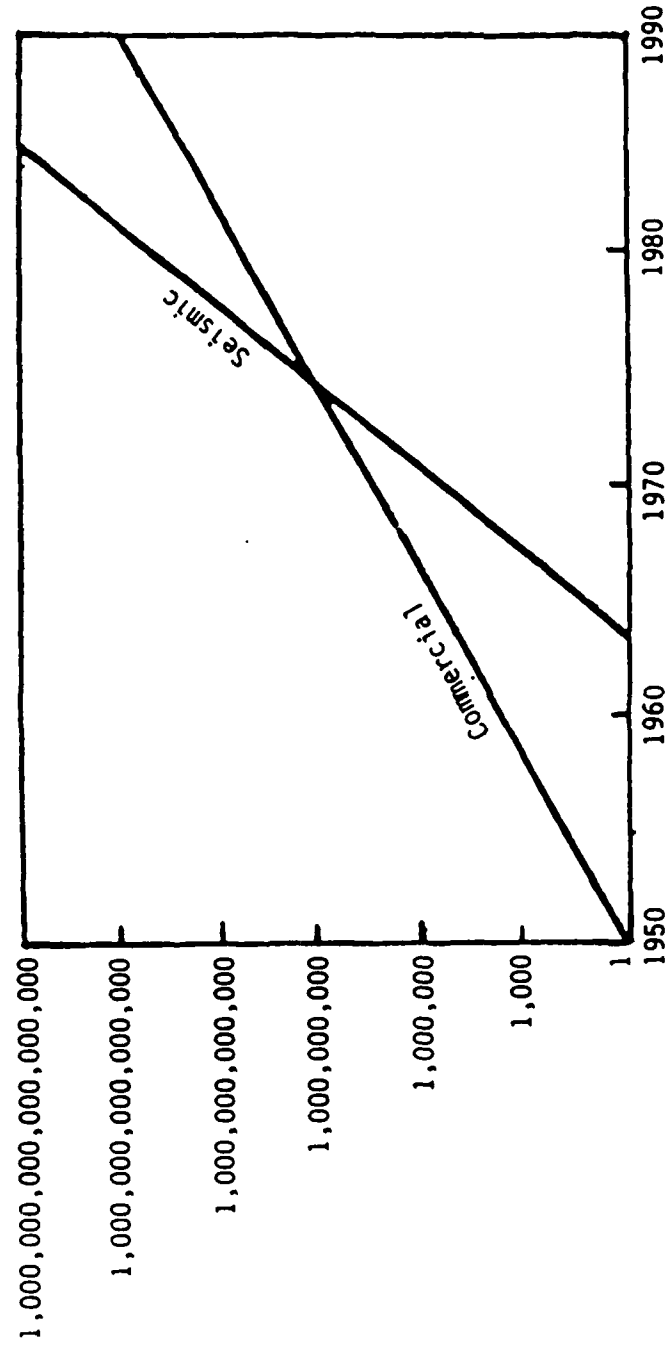
progress in this field has been so spectacular (see Figure 14), seismic exploration systems can now furnish high resolution "pictures" of the nature and geometry of deep rock formations. Specially-designed computer systems can now create such images rapidly, in three dimensions and artificial color, to enhance the desired visual details.

Such developments have already been credited for making possible many recent petroleum discoveries (for example, the Western Overthrust Belt in the U.S.). The new seismic techniques not only facilitate the discovery of new fields, they are also being used to delineate the boundaries of underground reservoirs so that the hydrocarbons in the reservoirs can be extracted more completely and with fewer dry holes.

The spectacular advance in the adaptation of computers to oil and gas exploration is only one of the many rapidly-developing technological areas in the industry. Since World War II, the exploration industry has been involved in a profound technological transition. It could hardly have been otherwise in such a complex, competitive industry that may be the world's largest. The trade literature regularly reports technological advances in drilling rigs, production platforms, deep sea well completion, advanced drill bits, the capability for directional drilling (which now permits horizontal boreholes to be drilled at almost any depth), "logging" tools that enable the presence of hydrocarbons to be sensed through the steel casing of either new or old wells, instruments for measuring important borehole parameters (such as pressure, temperature, conductivity) without removing the drilling apparatus from the borehole, new refinery catalysts for extracting 80 percent of light petroleum products from crude oil (where only 40 percent was feasible just a few years ago).

The newer exploration technologies are helping the discovery of greater quantities of fluid hydrocarbons and, in some cases,

Figure 14
THE EVER-GROWING COMPUTER POWER



Note: The seismic computers referred to in the above Figure are ones which have been and are being designed for the specific high speed "number crunching" tasks required in processing the data produced by the large array of seismometers routinely used in petroleum exploration.

Source: Carl H. Savit in Petroleum 2000.

are opening up vast new regions with great production potential. The newer regions are at the current frontiers of petroleum exploration. They include the usual frontiers such as the jungles, mountains, and polar regions where physical access is difficult and the environment is harsh. They also include the offshore petroliferous basins of the continental shelves in which ocean drilling may soon occur in water depths up to 12,000 feet, or more. Those deep ocean areas may yet yield as much petroleum as all the land areas of the world, according to some respected geologists.*

Another promising region--relatively unexplored even in the U.S.--exists in the deeper horizons of known petroleum basins. For economic reasons, over 95 percent of the existing basins have not been explored below 15,000 feet. After 1973, as incentives for such exploration increased sharply with higher oil and gas prices, so did the investments in deeper drilling. It is still too soon to estimate the ultimate oil and gas potential of the deeper horizons, but there is little doubt that they will be important. There is a good chance that they will prove to be astonishingly productive, as advancing technology makes them economic to explore. At present, much less than half of the world has been adequately explored, even to 10,000 feet. However, in my judgment, a hundred years from now, nearly all of the world's petroleum and natural gas resources at depths up to 40,000 feet, perhaps even deeper, are likely to have been carefully examined and delineated.

In part because of ongoing technological progress in conventional exploration, the world's need for alternatives to oil and gas seems likely to be pushed further into the future, perhaps by more than a decade or two. Steadily improving technological

*For example, see John M. Hunt, Petroleum Geochemistry and Geology (San Francisco: W.H. Freeman and Company, 1979), Part 12, pp. 534-541.

capabilities in finding and producing new supplies, coupled with flat or only slowly-rising demand for crude oil and natural gas, should help greatly in bringing relative stability to the international oil market over the next few decades.

The estimated quantities of conventional oil and gas that might eventually be extracted from the earth tend to reflect the optimistic or pessimistic views of the forecaster. It was shown earlier (Table 2) that the consensus of industry and government has been quite conservative in the past. It may take ten years or more before a new consensus emerges that, potentially, could forecast a much larger conventional resource base than the current one. There is little doubt but that the technological explosion now under way shows no signs of abating, and could enable the industry to bring forth significantly larger amounts of these fuels, probably at lower costs.

I referred above to estimates of the world's total petroleum reserves and potential resources (Figure 13). If crude oil and natural gas supplies are combined, the present consensus estimate is that the world's past production of these two resources, 600 billion barrels (of crude oil equivalents), is about one-third of the discovered proven and probable reserves to date. Adding the undiscovered potential for conventional oil and gas suggests that about one-seventh of the mean total estimate of ultimate production (4.5 trillion barrels of oil equivalents) has already been produced.

Some of the experts who were part of that consensus held a somewhat more conservative view--namely, that the world has already consumed as much as one-fifth of the total potential production. Others were more optimistic and concluded that less than one-tenth had been consumed. The optimistic view of ultimate production is at least twice the pessimistic; the difference is an enormous three trillion barrels of crude oil equivalents or

more. The world's economic development during the next century is likely to depend significantly upon the resolution of these different estimates. Over time, rapidly improving exploration and production technologies should allow a much more accurate projection of this crucial quantity to be made; perhaps that will happen before the year 2000.

My view now leans toward the more optimistic side of the above supply projections. In part, this guarded optimism is based on the historical evidence that "official" long-range estimates of ultimate oil supplies have consistently proved to be gross underestimates. I have also observed that the consensus forecasts emanate mostly from personnel associated with large institutions, such as international oil companies and government agencies, who tend to avoid making projections that depend upon impressive future improvements in technology. Yet it is mainly just such developments that made all of the older forecasts obsolete. Conclusion: after the year 2050, petroleum prices, in 1985 dollars, may or may not be in the \$30-\$40 per barrel range (commonly projected for the year 2000), but adequate supplies will be available nearly everywhere.

E. The Mid-Term Outlook for Non-OPEC Crude Oil Production

1. United States

Projections made by the international oil companies in the late 1970s, of U.S. oil production during the 1980s, generally varied from relatively flat--that is, about ten million barrels per day (MBPD), including natural gas liquids--to steadily declining volumes that might even fall below 7 MBPD during this decade.* The more pessimistic of these projections might subsequently have been undermined by the enormous response of U.S. producers to higher oil prices in 1980 and 1981, when

*For example, Exxon Company, in its U.S. Energy Outlook (December, 1979), projected 6.1 MBPD of conventional oil production in the U.S. during 1990.

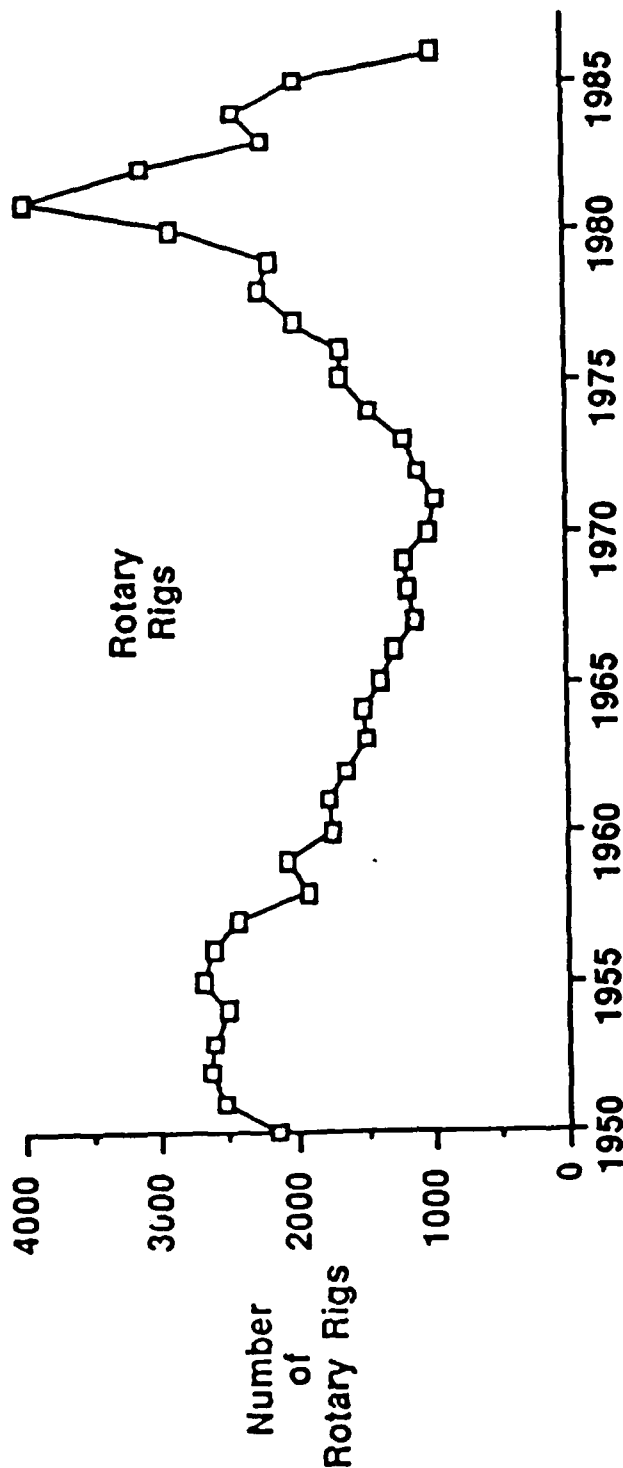
the number of active drilling rigs just about doubled. Data from the early 1980s indicated that U.S. oil production kept rising despite the rapid decline in drilling after prices began to weaken in 1982. By 1985, the number of active drilling rigs had fallen dramatically, to levels about half of their peak in 1981. For 1986, that number had declined by another 50 percent (Figure 15).

Forecasters are now somewhat uncertain about future U.S. drilling activity. The more optimistic view in the oil and gas industry is that drilling will once more become relatively active, that steady growth should resume soon and continue to rise during the rest of the century. The projection appears to be based on the belief that firm or rising oil prices will encourage an optimistic response. Oil industry spokesmen are usually reluctant to discuss the possibility that oil prices might fall considerably from current levels and induce still another substantial drop in U.S. drilling activity. However, that outcome should not be ignored. The drilling decline after mid-1982 suggests that some potential investors became hesitant about making commitments; they had perhaps concluded that oil prices, and therefore the cost of oil leases and services, were likely to decline in the near future. Now that a large drop in oil prices has occurred, it might be only a "short-term" experience, or it could last for several years. Either outcome is possible. But during that interval, oil exploration investments in the U.S. will probably remain substantially restrained.

A severe, prolonged drought in U.S. oil and gas drilling activity would not only substantially increase U.S. dependence on foreign imports in the 1990s, it could have other, earlier repercussions as well, including intense lobbying by the oil

Figure 15

NUMBER OF ACTIVE U.S. DRILLING RIGS



Source: U.S. Department of Energy, Energy Security: A Report to the President of the United States of America (March 1987), p. 69.

industry for some degree of price protection through "appropriate" forms of government intervention. In particular, a relatively strong effort has already arisen to promote the imposition of an oil-import fee. That action, if taken, could maintain internal oil prices substantially above international ones. It would probably be supported by a number of special interests, including most of the oil and gas industry, many banks, the auto industry, and conservationists. Indeed, strong national security arguments exist that also tend to support that type of intervention.*

2. Canada

In Canada, the national and provincial governments are both actively involved in exploration and production of oil and natural gas. The provinces own the rights to the minerals within their boundaries and demand substantial royalties and taxes from the companies involved in oil and gas production. The national government controls exploration and production in the northern territories and the offshore regions. In addition, Canada's national oil company, PetroCanada, has been active in most phases of the oil and gas industry.

Changing policies under the Trudeau government with regard to prices, royalties, taxes, export permits, exploration and production incentives, as well as the rights of foreign exploration companies, created a considerable amount of turbulence in the Canadian petroleum industry. In fact, the set of new energy policies adopted in 1980 led to a sharp decline in exploration and development during 1981 and 1982, just when those

*See William M. Brown, "Why We Must Keep Oil Prices High," The Washington Post (February 14, 1982, p. C-1.)

A similar view was expressed by economists Paul L. Joskow and Robert S. Pindyck in an article in The New York Times (May 1, 1983, Business Section). The 1986 literature may have thousands of articles on the topic.

activities were accelerating in most other countries. Recently, however, under Brian Mulroney, the new Canadian government has softened the former policies and provided substantial encouragement for new petroleum investments.

Although Canada is not a major factor in the world oil market, it imported about .4 MBPD during 1982, causing a cash outflow of about \$5 billion in that year. To stem the outflow and reinvigorate oil production and exploration, the Mulroney government took steps to remove price controls and reduce government taxes. The potential production from the new super-giant fields--in the Beaufort Sea and offshore in the eastern Maritime provinces--are expected to bring about a relatively vigorous exploitation of these areas once the outlook for international prices improves to about \$25 per barrel. Under any circumstances little oil can be delivered from them before the mid-1990s, but when those flows do begin, the Canadians could become significant oil exporters. Progress toward that goal would not only help the Canadian economy, it should also help to reduce the dependence of the Free World on OPEC supplies.

Another Canadian contribution to reduced dependence on OPEC may come from rising exports of natural gas to the U.S. Estimates of increases in potential gas exports during the next several years vary from 1 to 2 trillion cubic feet annually (equivalent to .5 to 1.0 MBPD of crude oil). Toward that end, the Canadian government has recently indicated that it is receptive to export prices that would make Canadian gas competitive in U.S. markets.

3. Mexico

Financial troubles in the Mexican economy have been making headline news for years. Somehow, in a prototypical Third World manner, Mexico's government has managed to "turn a silk purse

into a sow's ear." With a remarkable series of continuing successes in petroleum exploration and production, it should have been relatively easy for Mexico to absorb the small downward adjustments in oil prices between 1981 and late 1985, especially as available oil and gas export markets were essentially unlimited, except by its own choices.

In retrospect, it is hard to avoid the conclusion that much of Mexico's economic trouble stemmed from the latent greed and corruption that has long been entrenched in its political system. Evidently, earlier wishful expectations about ever-increasing oil prices and export volumes led international bankers to buttress the government's grandiose expenditure commitments. However, during 1982, a modest decline in international oil prices, coupled with accelerating financial obligations of its overheated economy, soon revealed Mexico's fragile economic underpinning and brought on a persistent series of financial crises.

So severe did the 1982 cash crunch become that expenditures were reduced substantially, even in petroleum exploration and development, which was probably the Mexicans' only major hope for overcoming their debt problems within a reasonable time (assuming the government spending spree has actually stopped and will not soon resume). Mexico's borrowing had grown so rapidly between 1972 and 1985 that it required about 80 percent of the income from its 1.5 MBPD petroleum exports in 1985 just to pay an estimated \$12 billion annual interest on its accumulated foreign debt (over \$90 billion for both public and private debt of 1985). With current oil prices about half those of 1985, Mexico's subsequent ability to service its debt obviously would be greatly assisted by the hoped-for firming of oil prices in the rest of the 1980s, an uncertain prospect, especially for prices above \$18-\$20 per barrel--as will be discussed later.

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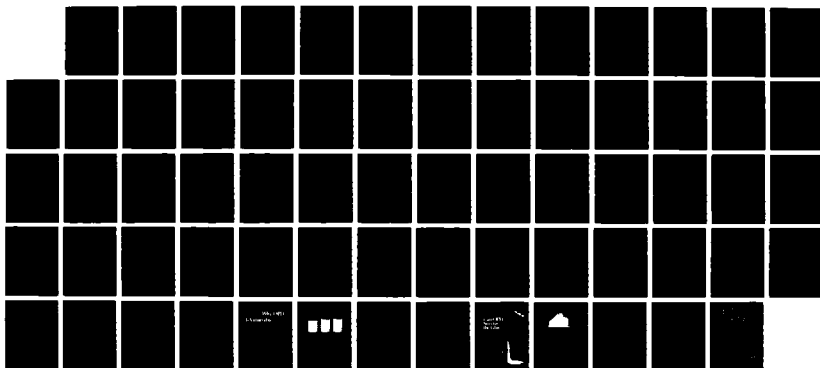
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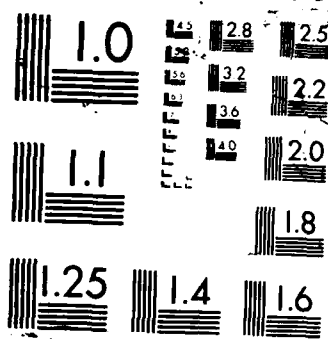
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Given its severe financial strains, almost any practical solution would seem to require a substantial increase in Mexico's exports of oil and natural gas. With reasonable management of its future oil investments, exports could probably be increased substantially--perhaps by as much as .5 MBPD (oil equivalents) per year for several years. At prices of \$18 per barrel, that would provide them with, roughly, additional annual revenues of \$3 billion after one year, \$6 billion after two years, and so on.

There is little question that Mexico has enough petroleum resources to maintain a healthy growth in oil production and exports (see Figure 11). Indeed, they may well have the world's best potential resource base outside Saudi Arabia. If the Mexicans are able to meet the above export goals and use the additional income to reduce their debt to a more manageable level over the next several years, they could still realize a substantial long-term income--even assuming \$15-\$20 oil prices persist--to devote to industrialization and modernization.

In whatever way President Miguel de la Madrid Hurtado or his successor might wish to handle Mexico's present debt, economic pressures to produce more oil and gas for export should be hard to resist. Any future weakness in oil prices should only strengthen that conclusion. Oil fields in southern Mexico are prolific and production costs quite low (perhaps \$2 or \$3 per barrel) compared to expected market prices. Moreover, at current production levels, Mexico's proved and potential hydrocarbon reserves, estimated at about 200 billion barrels, would last over 200 years. These reserve estimates, adjusted upward almost every year for the last 15 years, probably will be increased even further during the 1990s.

An increase in Mexican oil exports would add downward pressure on world oil prices. Without a sufficient resurgence of

demand in the Free World, some OPEC members would probably have to reduce anticipated increases in their export volumes in order to accommodate Mexico's need for a growing share of the international market. This would be a disturbing prospect for oil exporters who would face another especially difficult problem if the fighting between Iraq and Iran stops and those two countries, as expected, then attempt to export substantially greater volumes of oil.

4. North Sea

During the mid-1970s, production of oil and gas from North Sea resources--mainly by the U.K. and Norway--was expected to continue its rapidly-growing contribution to supplies during the early 1980s, and thereby help reduce the world's imports from OPEC significantly. Immediately following the period of rapidly rising prices in 1979 and 1980, an astonishing worldwide unanimity in the belief that oil prices were inevitably headed higher during the 1980s and 1990s led the British and Norwegian governments to become increasingly cautious about their future oil and gas depletion policies. That is, they feared that they had been selling oil too cheaply. Consequently, they demanded a greater share of the revenues from existing and new oil concessions, thus discouraging or delaying new investments by the major international oil companies. Probably because of the unexpected softness in oil prices after 1982, those demands were modified enough to keep exploration and development active. After prices plummeted in 1986, the situation changed again; the oil companies began to insist on revised terms for new projects.

As a result of these politico-economic processes, former expectations of rapidly-rising North Sea oil production became transformed into expectations of slowly-rising production, and now are expected to top out within the next two years and to

decline slowly during the 1990s. However, natural gas production should continue to rise slowly but steadily for several years.

Although estimates of the potential petroleum resources of the North Sea vary substantially, the most conservative estimates are typically the ones used by the governments involved as a basis for their production and export policies. They assume it is foolish to base policy decisions upon any reserves that are not proven--that is, reliably indicated by engineering data from actual measurements in producing reservoirs. Historical trends, geological potential, expanding technological capabilities, or promising unexplored territories are all largely excluded from energy policy considerations. This "banker's approach" prevails despite the near certainty that any policy based upon it will be short-lived and possibly counterproductive. One study of North Sea production potential, for example, concluded that the official estimates of its natural gas resources were grossly pessimistic^{*}--a conclusion that has long been held and promoted by "maverick" analysts such as Professor Peter O'Toole of the Netherlands. But such unofficial external studies seldom have much influence on government policymakers and should not be expected to in this case. The conservative assumptions on which such policies have been based tend to restrain new exploration, and sometimes therefore make those policies seem to be inherently correct in the short-run.

As discussed earlier, for over 100 years U.S. government agencies periodically claimed that the U.S. was on the verge of exhausting its oil supplies. The U.K. and Norway are relative

^{*}"Alternative Strategies for Natural Gas in Western Europe," report Commissioned by the Department of Defense, Economics and Science Planning Department, Washington, D.C. (Geneva, Switzerland: Energy Advice, 1982).

newcomers who have only had a few years of rising oil and gas production, but they tend to hold similar views about their petroleum resources. Their governments are unlikely to be swayed by technical arguments about a promising potential. To be fair, it should be emphasized that most governments (e.g., Canada, Kuwait, Australia, Argentina) have exhibited similarly conservative tendencies about their resources. We should expect those attitudes to be repeated in the future, especially where potential petroleum resources become transformed to producing reserves in some of the luckier countries.

5. Non-OPEC Developing Countries

A few of the non-OPEC developing countries are important oil exporters--for example, Mexico, Egypt, and Oman. Nevertheless, there is no reason to believe that any developing country is now content with its present energy situation. The oil exporters generally find a need for more revenue than they are currently receiving, while the outflow of hard currency continues to undermine the modernization hopes of those that must import oil. Consequently, not only are most of the developing countries trying to reduce oil imports through conservation and substitution of indigenous fuels, but there have been indications that those with potential petroleum resources have been finding it less difficult to arrive at acceptable exploration arrangements with the international oil companies. The number of active drilling rigs in Third World areas tended to rise until 1986, despite some softness in oil prices after 1981.

During 1986, international activities--as measured by active drilling rigs--declined about 25 percent in response to the price collapse. Part of this decline may be attributed to greater difficulty in determining appropriate contractual terms when prices are bouncing about in an unforeseeable manner and when

perspectives about the future suddenly become highly uncertain. Still, even if the longer-term price outlook were for \$15-\$20 oil, a pessimistic assumption, most of the countries with good petroleum and/or natural gas prospects should be expected to proceed with their exploration programs. That course is hard to avoid when in most cases, overall costs tend to be less than \$5 per barrel, and also because the lag between any exploration agreement and large scale production is usually ten years or more.

Many prospective petroleum areas are now under exploration in Third World regions, but it is too early to predict with confidence which of them might blossom into giant producers. Recent explorations indicate that substantial production increases are expected in the near-term in Brazil, Colombia, Egypt, Ivory Coast, Cameroon, Angola, Sudan, and India. For example, Brazil's daily oil production has more than doubled since 1979, to about 600,000 barrels per day, and the government expects that to increase substantially in the next few years; production in Cameroon increased almost six-fold (to 180,000 B/D) and is still climbing; Egypt's production has been increasing almost steadily and has about doubled over the last six years (to roughly 800,000 B/D); and India has demonstrated its great interest in reducing oil imports by increasing its production from 240,000 B/D in 1979 to 640,000 B/D in mid-1986. Although the promise may be great for exploration that is well under way in rank wildcat territory, such as politically-troubled Sudan or the Ivory Coast, their quantitative potential will probably not be known for several years.

The outlook for new petroleum supplies from any one of these relatively unexplored regions is necessarily highly uncertain. Projections of the combined future production for the non-OPEC countries in the Third World are also not reliable, but are a little better because of statistical aggregation and because investment capital will tend to flow toward the more successful

areas. However, there is no forecasting approach that does not involve considerable uncertainty. Aggressive changes in Mexico's export policies alone could raise the oil production of this group of developing countries by as much as 1 MBPD just during the rest of the 1980s.* This is roughly 15 percent of the recent combined production of those countries.

Estimates by major institutions (e.g., oil companies, the U.S. Department of Energy, World Bank, the International Energy Agency) generally foresee slow long-term growth in Third World oil production, although forecasts vary and often are hard to compare because their statistical aggregations differ. Still, the March 1987 forecast by the U.S. Department of Energy (DoE) is reasonably representative: it projected oil production of roughly 10 MBPD (Table 3) for the developing countries in 1990 and 1995, respectively.** During that period, about 30 percent of the total output is expected to come from Mexico. The current forecast is considerably less pessimistic than the ones offered in the early 1980s. For example, in its 1982 World Economic Outlook, the International Energy Agency forecasts that demand in these countries would exceed production by 8 to 9 MBPD during 1995!

For the oil-importing Third World countries, the DOE estimates for the 1990s are no longer grim. Overall growth in oil output is now expected to be comparable to the projected growth in demand. That change from the earlier expectations of a rapidly-increasing dependence upon oil imports is a much happier prospect, both for the developing countries and the OECD nations, especially if--as the DOE expects--oil prices are likely to be rising during most of the 1990s.

*In its January 1987 issue, World Oil reported that the Mexican government had increased the budget of Pemex, its national oil company, by 76.8 percent.

**The production numbers for each year represent low price and high price cases. 1987 production in these countries totaled 9.44 MBPD according to U.S. Dept. of Energy, Energy Security, March 1987.

Table 3

U.S. DEPARTMENT OF ENERGY FORECASTS

	1986	1990	1995
Non-OPEC Developing Countries			
Oil Demand (MBPD)	9.81	10.0-10.6	10.3-11.0
Oil Production (MBPD)	9.44	9.5-10.6	9.5-11.7

Source: U.S. Department of Energy, Energy Security: A Report to the President of the United States of America, March 1987.

I believe that at least a small likelihood exists that the post-1990 dependence of these countries may be even less than the amounts shown in Table 3. The outcome for Third World oil production will depend partly upon chance factors in exploration and technological progress, and partly upon reasonable government policies. The latter is obviously the more worrisome factor. Still, reality factors (such as a growing difficulty in obtaining new loans) will undoubtedly tend to restrain Third World oil dependence from rising. The above DOE projections may or may not seem reasonable; the agency has not had a good track record in its prior forecasts.

6. Communist Countries

For many years, there has been a net outflow of oil from the communist countries to the West. The Soviet Union has been the largest oil producer by far, supplying over 80 percent of the total output from communist countries in recent years. Evidence uncovered in the early 1970s that the former steady growth of Soviet oil production might be ending may have had a strong effect upon many analyses. While the growth rate of Soviet oil production slowed considerably in the 1980s, and output actually declined in 1985, there was a strong resurgence during 1986. Although production could decline further, it appears more likely to remain near its current level, a bit above 12.4 MBPD, or possibly grow very slowly during the next several years. The Soviets themselves insist that their oil production will rise significantly by 1990, but they will have to prove it with deeds to convince skeptics.*

*According to Petroleum Intelligence Weekly (Nov. 10, 1986), the Soviets currently have 2700 active drilling rigs. That is a surprising number when compared with about 2200 for the rest of the world!

Soviet natural gas production continues to rise at about six to eight percent annually and now is about to challenge Soviet oil production for first place in fuel-equivalent terms. Natural gas currently provides about 95 percent as much energy as oil production, and it should move into the lead during 1988. The rapid growth in its natural gas supplies is clearly one of the major factors that has enabled the USSR to continue, and even to expand, its oil shipments to the West. Indeed, during the 1982-1984 period, its level of petroleum exports to OECD countries increased by an estimated and surprising 40 percent over 1980-1981, although this was partly at the expense of exports to Eastern Europe.

It is possible, of course, that Soviet oil production will decline in the 1990s. The problem is that the unit cost of oil production has been increasing rapidly, requiring a sustained growth of investment in the oil industry just to keep annual output from declining. Because of the massive gas development and pipeline program, an increasingly costly coal program, and a large nuclear program whose costs will certainly be raised as a result of Chernobyl, the energy sector has recently been taking about 25 percent of total investment expenditures in the Soviet Union.* It is doubtful that Moscow will be willing to continue increasing this burden much longer, especially in view of the priority Gorbachev is giving to economic modernization.

At the same time, the Soviets will almost certainly attempt to accelerate the substitution of natural gas for fuel oil and to implement energy conservation. There is evidence that their oil consumption has been leveling off and may gradually decline despite existing rigidities in the Soviet system.

*Maurice Ernst, "Comments on Thane Gustafson's Article." Soviet Economy, Vol. 1 (April-June, 1985), p. 140.

The possibility that any expected drop in oil production could be offset by a decline in consumption would allow Moscow to sustain its oil exports near recent levels. Or, if this should prove impossible, the USSR would almost certainly make some cuts in its future oil exports to Eastern Europe and offer to substitute an equivalent amount of gas. Indeed, the importance of exported oil as a hard currency source for the U.S.S.R. virtually ensures that any shortfalls in anticipated supplies would be managed through adjustments to domestic demand or Eastern European exports.

It is unlikely, therefore, that Soviet oil exports to the West will decline, and it is possible that they will increase, at least during the next few years. Soviet gas exports to the West can be expected to expand over the foreseeable future, an increase that may be partly offset by an increase in East European oil imports from the West.

China is believed to have an excellent potential for increasing its petroleum output and has moved vigorously, with the help of international oil companies, to develop some of its prospects. Production levels have grown slowly, thanks partly to the application of Western technology to fields currently being exploited, but are unlikely to increase dramatically during the next several years because recent results of offshore exploration have been disappointing. Most of the more promising new oil producing areas onshore are in remote regions, and large scale development of China's oil and gas potential would require major investments by the international petroleum companies. These investments would depend upon confidence in China's political stability and in its oil exploration policies.

China is unlikely to become an important factor in the international oil market for at least several years, if then, although the importance of increased hard currency revenues for China's modernization program should ensure some growth in its oil exports. Around the year 2000, however, China's export potential might well become significantly higher. Optimistically, it could reach 2-3 MBPD by then.

F. Conclusions

1) Perhaps it has always been relatively difficult to have confidence that adequate oil and gas supplies for the longer-term would be found, while it has always been relatively easy to estimate the rate at which known reserves are being depleted. Thus, as the historical record clearly indicates, petroleum experts--particularly those associated with larger institutions, both public and private--generally have underestimated the potential for future production. Consequently, I expect that most of the supply estimates for the 1990s and beyond are also apt to be somewhat pessimistic, and the oil prices projected by traditional institutions to be unduly high.

2) During the last 14 years, each oil-importing country has twice faced the painful consequences of unexpectedly sharp price escalations, coupled with threats to the security of its fuel supplies even at those high prices. Moreover, similar threats are likely to persist--at least in most people's perceptions--probably for decades. The obvious scenario is easy to write:

Declining world oil prices during the 1980s increase demand for petroleum; that, coupled with reduced investments in new supplies and steadily increasing dependence on crude oil imports, set the stage for another round of price hikes. Through normal market forces, those higher prices could either develop slowly as the world's excess production capacity dwindles, or they might occur relatively abruptly after a major interruption in supplies, whether the interruption is willful or inadvertent.

However, the "once burnt, twice shy" maxim--in regard to petroleum--may now need to be replaced by "twice burnt, forever shy." The implication is that most countries will continue to seek to reduce their dependence on oil imports and to increase their domestic energy supplies. The result should be growing long-term efforts to develop alternative energy supplies, as well as to explore for conventional oil and gas. Although future oil production will undoubtedly be erratic, I do not expect that the degree of dependence upon imported petroleum that the world experienced in the late 1970s will be repeated, even if oil prices should decline again during the next few years.

3) For most countries, the importance of reducing dependence upon oil imports is usually much greater than reducing dependence upon imported commodities such as copper, sugar or steel. That follows, in part, because the value of international petroleum trade has been larger than that of all other basic commodities combined. Another contributing factor is the widespread belief among petroleum consumers that they will remain highly vulnerable to new price shocks. Rapidly-rising petroleum prices can severely damage the development prospects of an oil-importing nation--by extracting from it a large fraction of its discretionary hard currency.

Some economists have asserted that the two oil-price shocks of the 1970s were the single most important reason for the worldwide recession of the early 1980s. Whether or not that can be demonstrated, there is little disagreement that the oil price shocks contributed significantly to that recession.

In recognition of the potentially great economic impact of rapidly-changing petroleum prices upon world trade and prosperity, the policies of nearly all private and public

consumer institutions now include measures to reduce the potential vulnerability associated with future oil imports. Moreover, an impressive portion of the world's technological talent has become dedicated to similar goals.

Because the development of indigenous energy supplies on a large scale usually requires a long time, perhaps decades, a nation's energy-supply policies and programs cannot be expected to fluctuate parallel to rapid changes in market prices. Off-shore oil production in a difficult region (e.g., as in the North Sea) generally will take ten or more years to attain a substantial production capacity. Despite the recent decline in oil prices, the international effort in oil and gas exploration outside of North America is still quite strong. Over the decade ahead, it should continue to expand as long as oil-importing countries continue to see a potential threat to their energy security and while reasonable prospects exist for increasing domestic oil and gas supplies.

Except for a few countries like Mexico, which apparently have huge petroleum resources that can be developed for export, most non-OPEC countries with promising oil and gas resources will seek to stimulate promising investments that will reduce their future need for oil imports. The evidence is clear that such investments are still being encouraged and that production of oil and gas in most of those countries will be increasing. A major question each country must face is whether its future production of such fuels will rise as fast or faster than its demand for them.

4) The recent sharp decline in U.S. oil field activity should not be interpreted as a harbinger of similar changes in other countries. In the U.S., some difficulties in financing new petroleum ventures occur for reasons peculiar to its own

political, economic, geological, and institutional "structures," and will have little relevance for other countries. Indeed, in most other countries, decisions about investing in energy supplies are almost entirely a formal government function and are unlikely to change rapidly in response to fluctuating oil prices. Even in the U.S., it is widely believed that the conditions that recently led to sharp declines in drilling activity are temporary and that a resurgence should soon occur, although very rapid expansions, such as those of 1980-1981, are unlikely to be repeated.

5) A spectrum of professional opinion is almost always available about the future supply-demand balance for petroleum. Most forecasters appear to believe that Free-World demand is destined to rise substantially faster than supply and, therefore, that OPEC's members must then be called upon to provide the difference. A few believe that demand will rise more than non-OPEC supplies only during the near term while prices are below \$20 per barrel; if so, OPEC's production and prices could be restrained during most of the 1990s, assuming that OPEC remains viable. Regarding the balance of this century, my position is firmly with the latter group. For the decade of the 1990s, the price trajectory is likely to be erratic, but it appears very unlikely that those prices, in real terms, will reach those of the early 1980s.

III. THE OUTLOOK FOR PETROLEUM PRICES (1987-2000+)

A. Changing Forecasts

The 1986 collapse in oil prices severely rattled the international petroleum market and created a need for a better perspective on possible future price trajectories. That need led many analysts from government agencies, oil companies, and financial and other institutions to issue revised forecasts--some for the near-term, some well beyond that. As a result, a new conventional wisdom has emerged. Nearly all international petroleum forecasts now show rising prices during the 1990s, but express considerable uncertainty about prices during the next two or three years. The dominant view among analysts appears to be the expectation that \$16-\$19 prices for Saudi crude oil are most likely to prevail during the rest of the 1980s; however, a careful line of reasoning from which such forecasts are drawn is seldom available.

Most of the recent forecasts appear to lack adequate justification, especially those projecting a smooth course for near-term prices. Indeed, it seems to me that so many factors can significantly affect the supply/demand balance in the oil market over the next few years that it is intrinsically difficult, if not impossible, to place much confidence in any specific price trajectory. Still, I have found some utility in the conclusion that there probably exist reasonable lower and upper bounds to near-term crude oil prices, a conclusion that can be defended with at least moderate confidence. These two bounds are defined below and discussed, both qualitatively and quantitatively.

B. The Lower Bound

It should be relatively obvious that the lower bound is simply the price that could reasonably be expected to prevail if the petroleum market were to evolve into a free-for-all in which

essentially the only important economic forces that remain would be those of a free market. The petroleum market is unlikely to become and remain a completely free one, but, for relatively short intervals, it may be possible for free market forces to become dominant. Thus, we have to ask, what price level would be likely to prevail internationally should such forces dominate the oil trade? I suggest that those prices, in the United States, would very likely fall to between \$7 and \$9 per barrel, in 1986 dollars, for oil equivalent to Saudi Light Crude. Subtracting transportation costs, that would be roughly equivalent to \$6-\$8 per barrel in the Persian Gulf.*

Why would prices stop falling after reaching the \$7 to \$9 per barrel range? Because that appears to be roughly the level at which a great amount of the existing production capacity would become uneconomic within the United States, Canada, the North Sea, and several other regions of the world. That is, it constitutes a price significantly below the marginal operating costs of several million barrels per day (MBPD) of present crude oil production. That amount of production within the regions mentioned would soon have to be shut in, at least temporarily, because otherwise the net revenues to its producers would be less than zero. When oil prices fall from very low to even lower levels, one can soon expect the shutting down of producing wells that shortly before had only barely provided a positive cash flow. The associated investments that had been sunk into those enterprises may also have become worthless, again at least temporarily.

*According to data from the U.S. Department of Energy, the lowest price for Saudi Light crude during the summer of 1986 was \$8.03 per barrel. See Monthly Energy Review, October 1986, p. 92.

There are many oil fields in the world--especially in the U.S.--in which the ongoing operational costs exceed the lower bound prices given above, and which would have to be shut-in for the duration of the price collapse period. For example, the approximately 2 MBPD that now flows through the Alaskan pipeline would almost certainly have to be suspended. The transport costs to move North Slope oil through the pipeline are about \$5 per barrel. That, together with additional costs for shipping from the port of Valdez to Texas refineries (perhaps \$2-\$3 per barrel) and the Alaskan production costs (estimated at \$2 per barrel), suggests that \$9 per barrel is the minimum at which oil could be produced and moved from Alaska's Prudhoe Bay without sustaining a significant negative cash flow.

While careful estimates would need to be made (probably on a well-by-well basis) to determine the extent of present oil production that could continue at lower bound prices, the relatively small average production per well that is typical in the United States suggests that essentially all U.S. stripper wells (which together yield about 1.3 MBPD) and perhaps half the rest of U.S. oil production, simply would not be sustainable at lower bound prices. Consequently total U.S. production, now about 8.5 MBPD, would probably decline by approximately 5 MBPD, including the loss of Alaskan production. From .5 to 1.0 MBPD of Canadian production would also have to be shut down, plus 2-3 MBPD from other marginal wells around the world, including the North Sea and the less-developed countries.

With oil selling near lower bound prices, a number of producing countries, and possibly many private producers, might choose to temporarily suspend a part of their production, even if their cash flows were still marginally positive. That is, those

investors might believe that keeping oil in the ground while such low prices prevailed would be a good short-term investment, possibly even a good mid-term investment. The low risk associated with temporary suspensions might bring substantially greater profits within a few months or years.

Consequently, after a year or so of prices near the lower bound, it is not difficult to surmise that demand for oil imports from present OPEC members could, on a worldwide basis, rise relatively quickly, theoretically by as much as 8-10 MBPD above their current export level. Indeed, it would probably be difficult for prices to fall to and remain at such a low level for more than a few months, because of the expectation that many potential investors--private, institutional, and national--would view that situation as an opportunity to acquire great bargains on petroleum reserves.

During the past several years, the financial news media has been quick to observe and report the eagerness with which U.S. corporations sought to buy oil reserves on a relatively large scale each time its price weakened. Such purchases were even popular while crude oil was selling in the \$25-\$30 per barrel range. The seemingly unquenchable desire of major corporate investors, especially the international oil companies, to accumulate relatively inexpensive oil reserves has been well documented during the last few years. It would be no surprise if this process should continue or perhaps even accelerate, especially if the price of oil falls close to the lower bound and remains there over a period of a few months or more. Such responses would tend to shorten the interval during

which oil prices might be found hovering near the lower bound and subsequently might even help to lift the level by a significant amount.

C. The Upper Bound

The upper bound over the near-term--the rest of the 1980s--is one I would now set at \$20 per barrel, in 1986 dollars, for crude oil in the Persian Gulf. The main reason for choosing this \$20 number is that it appears to be close to the ceiling preferred by the Saudis and other Gulf producers. These OPEC members now appear to believe that an \$18-\$20 level is one that should not be exceeded, if the development of new reserves by potential competitors around the world is to be adequately discouraged. The Saudis, as well as most other Persian Gulf producers, have had an extraordinarily bitter experience during the last few years, one which appears to have taught them a practical lesson about the futility of trying to maintain crude oil prices considerably above any reasonable market-clearing price. They now appear to believe that their maintenance of prices well in excess of free market prices led to a rapid growth of competition from producers outside OPEC, and that their competitors benefited by being able to sell all of their rapidly rising output at those higher prices. If OPEC wishes to administer petroleum prices, one its primary tasks must be to restrain any future growth of their competitors as a group.

In addition, since early 1979, the combination of high oil prices and widespread expectations of even higher ones in the future clearly tended to reduce overall demand for petroleum. This trend eventually forced OPEC producers to shut in about half their capacity and created an enormous excess of supply. As long as crude oil prices remain below \$20 per barrel, worldwide

demand should be expected to resume a slow but steady rise of about 1 percent per year, possibly 1.5 percent. That view has been expressed without challenge in many recent forecasts.

By now, OPEC nations in general, and Persian Gulf producers in particular, appear to have adapted to the idea that they must follow a pricing policy that will discourage competition and encourage both petroleum producers and consumers to believe that crude oil prices are likely to rise only modestly in the years ahead. This changed perception needs to be accomplished if the future oil revenues of Persian Gulf producers are to be optimized. Although this view may not yet have been accepted by all OPEC countries--for example by Iran and Libya--nevertheless, it is the Arab producers in the Persian Gulf area who have become the dominant factors in OPEC's pricing and production decisions. Certainly, it is hard to find a different interpretation in outcomes of recent OPEC meetings.

Indeed, even at \$18-\$20 per barrel, there is likely to be much concern within OPEC that its competitors might continue to increase their share of the market significantly. Although that may be an arguable proposition, it is probably not arguable that a price somewhat less than \$20--perhaps \$16 or \$18 per barrel--should be low enough to allow OPEC to become confident of significant (1 MBPD) medium-term growth in its oil exports. The message offered here is that a price somewhere in the upper teens is likely to be selected as the least unsatisfactory one by the Arab producers in the Persian Gulf; it therefore would lie somewhere near the practical upper bound. Of course, OPEC's members would also have to accept and be "satisfied" with their individual market shares, if administered prices are to be set and kept at levels near the upper bound over the next few years. That will probably be a very difficult adjustment for a few of the more "hawkish" producers to accept for more than a few

months, without feeling that they are being taken advantage of by the others. For that and other reasons to be discussed below, it is also an adjustment I believe is unlikely to last, even if it does get off to a good start.

Assuming that a per barrel price somewhere close to \$20 per barrel constitutes a reasonable upper bound, we now need to examine whether, in the near-term the actual price is more likely to hover close to the upper bound or to the lower bound, and whether it can be expected to be reasonably stable at any level.

D. Price Fluctuations Within the Upper and Lower Bounds

Several major factors could have a significant impact on crude oil prices during both the near-term and mid-term (and in some instances also over the long-term). Of the factors that might have a strong influence on prices during the near-term, perhaps the most important is OPEC's huge excess capacity for petroleum production (see Table 4). The table clearly indicates that, even after allowances are made for earlier national policies by some OPEC members to keep production below their maximum sustainable capacity, and allowances for production and shipping difficulties due to the Iraq-Iran war, an astonishingly large capacity for production remains within the OPEC nations. The excess capacity is now shut in because of the lack of demand at current prices.

Quite generally, oil producers hate to shut in any production capacity. After all, investments have been made in exploration, field development, processing facilities, pipelines, docks, tanks, and also often in tankers. Whenever these facilities are not being fully utilized, part of the investments have become non-productive, and disturbing changes have to be made

Table 4

OPEC COUNTRIES: CRUDE OIL PRODUCTIVE CAPACITY
(Thousand b/d)

	Capacity		Production (12/86)	
	Installed	Maximum Sustainable	Available	
Saudi Arabia	12,500	10,000	8,500	5,000
Iran	7,000	5,500	3,400	2,200
Iraq	4,000	3,500	1,750	1,550
Kuwait	2,900	2,000	1,950	1,300
United Arab Emirates	2,550	2,415	1,550	1,201
Qatar	650	600	600	350
Neutral Zone	680	600	600	333
Gulf Total	30,280	24,615	18,350	11,934
Venezuela	2,600	2,500	2,400	1,585
Nigeria	2,500	2,200	1,800	1,300
Libya	2,500	2,100	1,600	1,000
Indonesia	1,800	1,650	1,650	1,188
Algeria	1,200	900	900	662
Gabon	250	150	185	180
Ecuador	300	285	330	285
Other OPEC Total	11,150	9,785	8,865	5,030
OPEC TOTAL	41,430	34,400	27,215	16,964

Source: Central Intelligence Agency, Directorate of Intelligence, International Energy Statistical Review (31 March 1987), p. 2.

in employment, contractual commitments, and planning. Moreover, when large amounts of shut-in capacity also exist in other oil-exporting countries--that is, among competing producers--then it must be assumed that those competitors will be seeking to increase their market shares. That situation obviously implies that oil producers with spare capacity are or will be seeking to take markets away from some of the other producers. It is exactly that persistent threat that now worries nearly all of the world's oil producers. A failure by OPEC adequately to restrain the tendency of its members to expand market shares can only lead to a growing downward pressure on oil prices, thereby forcing them towards the lower bound.

OPEC's current excess production capacity is still approximately 10 MBPD, even after making allowances for the impact of the Iraq-Iran war on the output potential of those two countries. Should the Iraq-Iran war end in the near future, OPEC's excess capacity could grow to perhaps 15 MBPD within about two years. Moreover, should producers in the Persian Gulf decide upon preferred production levels close to their maximum sustainable capacity rather than some lower arbitrary amount that occasionally has been set by government policy (for example the frequently announced preference of the Saudis for an 8.5 MBPD output), OPEC's excess capacity would rise still further. In that way, it could reach its maximum level of about 18 MBPD within a few years.

That much excess capacity, or even the lowest of the above estimates--10 million barrels per day--is an enormous amount that cannot reasonably be expected to be eliminated in less than 10 years.* Even the elimination of 10 MBPD in 10 years would

*The Chevron Corporation, for example, estimates in its June 1986 World Energy Outlook that OPEC production will increase by 10 MBPD over the next 14 years. That forecast assumes world demand for oil increases by 1 percent per year through 1990 and 1.5 percent per year subsequently.

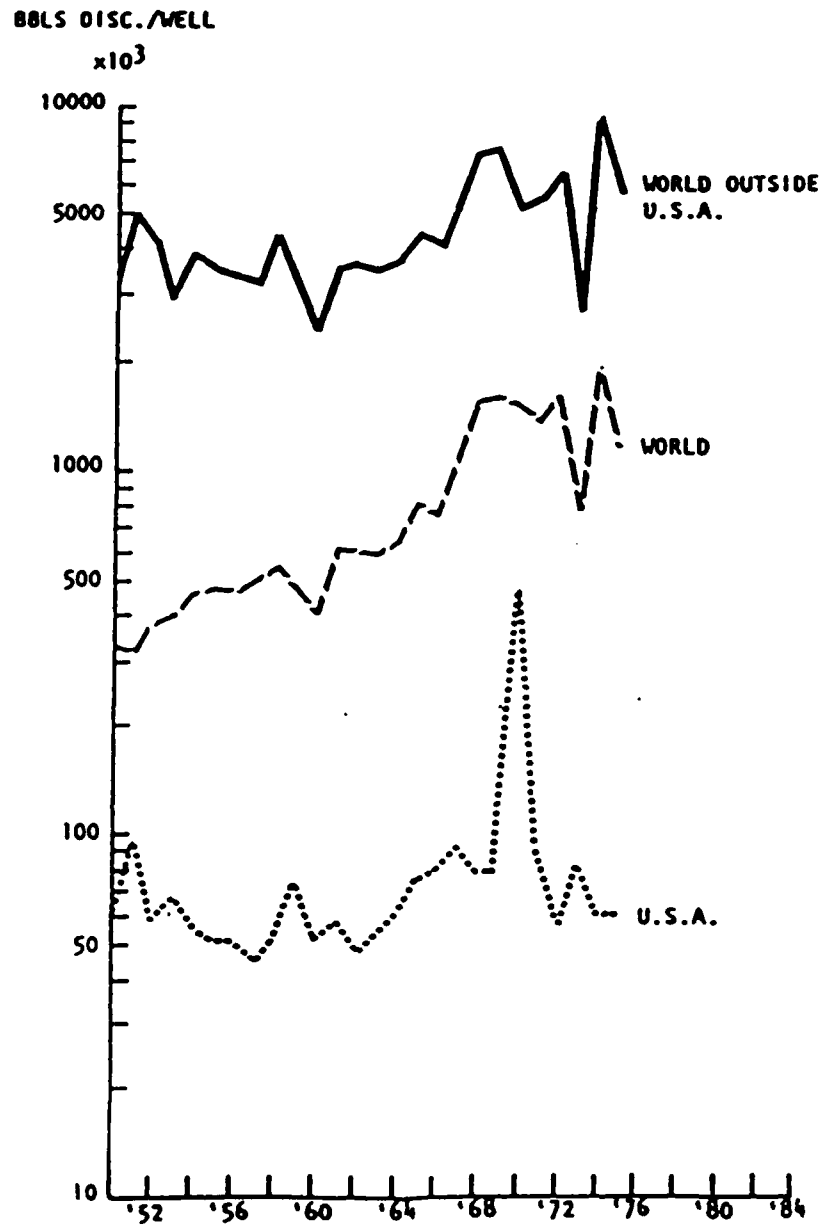
probably depend on international prices remaining below the upper bound, and on the creation of a persistent expectation among potential producers that oil prices are likely to remain so low in the years ahead that it would be very risky for them to invest in exploration and/or development activities that require oil prices of more than, say, \$15 per barrel in 1986 dollars.

It is probably true that drilling for oil in the United States cannot be expected to increase significantly until producers become confident that oil prices will rise to, and remain near, the upper bound; if so, they would perhaps increase substantially beyond that sometime during the subsequent decade. However, that conclusion or expectation need not apply in many, perhaps most, other countries in the world. The average cost of oil production in most countries has been considerably below \$10 per barrel, if government taxes and royalties are excluded from costs. Nations that do not produce enough oil internally to meet their requirements will be forced to import the needed crude, or the refined products, and will have to earn or borrow the hard currency required to pay for those imports. Since borrowing has become more difficult for most Third World countries than it used to be, many will be motivated to expand their own production of oil and/or natural gas (which readily substitutes for oil in many of their fuel needs). Indeed, even though there has been a sharp drop in petroleum exploration and development during the last several months, that decline has been much greater in the United States, where new wells are much less productive on average than in other parts of the world.

Since at least 1950, a foreign oil well has, on average, been from 50-100 times more productive than one in the United States (Figure 16). Consequently, even though the exploration and

Figure 16

RESERVES PROVED ANNUALLY PER WELL
(All Wells)



Source: DeGolyer & McNaughton (U.S.A.)
World Oil (World)

development costs per well may be substantially higher in Third World countries, the huge difference in the expected production volume, on average, has meant that the oil produced there could be profitable at a price of \$10 a barrel--even highly profitable.

In recent years the principal "cost" of oil production in most Third World countries has come from the demand by those governments for high levels of royalties and taxes. That is, the current owners of the oil (the countries involved) have been garnering the lion's share of the available revenues and leaving a relatively small fraction to compensate the oil companies for the work and risks of exploration and development. However, the earlier formulas for dividing oil revenues between the governments and the oil companies have been changing, because of the unwelcome recognition of the fact that oil prices can fluctuate substantially. As a result, it has been observed that the more recent contracts between international oil companies and sponsoring countries take into account the possibility of fluctuating prices.

Internationally, the decline in oil exploration has been far less than that within the U.S. The reported decline in drilling outside of North America during the last year was approximately 25 percent (as of October 1986), compared with approximately 70 percent in the U.S. over the same period. Moreover, a significant part of the 25 percent decline is probably related to the time it takes for unfamiliar new terms to be negotiated between producing countries and the oil companies involved. During 1986 when it became evident that a significant number of the existing contractual arrangements between the international oil companies and the oil-producing countries had failed to take into account the possibility of a price collapse to the levels that prevailed during 1986, that failure created many difficulties in many country-company relations. Clearly, it

will take some time for those difficulties to be resolved, if they can be, and for new contracts to be negotiated that will provide reasonable conditions for future exploration and development.

The OPEC producers are now "stuck" with much excess capacity and all of them would undoubtedly like to substantially increase their exports. However, they are likely to find, over time, that the more international oil prices hover around the upper bound, and the more that they are expected to stay near to or perhaps rise above it in the near to mid-term, the more likely it is that competing investments in new production will rise--albeit more cautiously than in prior years. It may take a few years before sufficient data from international exploration arrangements become available to enable analysts to understand how much the 1986 decline of prices to the \$10-15 per barrel range, followed by the subsequent erratic recovery of prices to somewhere near the upper bound early in 1987, will affect OPEC's potential competitors. Until that outcome can be satisfactorily estimated, both OPEC and non-OPEC producers should be affected by a nagging fear that the overhang of excess capacity will remain oppressive for many more years.

Even though the conventional wisdom reflected in current forecasts of major oil companies now indicates that demand for oil from OPEC will rise steadily over the next several years or more (even if the price hovers near the upper bound), there can be no certainty that reality will correspond with those forecasts. The OPEC nations now know all too well that their own prior forecasts, which also were probably derived from those of the major international oil companies, have been extremely unreliable. Thus, it is doubtful that they could accept any of the current forecasts as dogma.

Perhaps even more important, the various OPEC nations are likely to have differing images about what prices and export demand the future is likely to bring, and differing judgments about their probable future revenues and needs. In fact, the extensive disarray within OPEC, especially during the last few years, is the second factor to affect near-term prices. The disarray seems very likely to continue during the years ahead, or at least as long as OPEC's members come from many countries with widely differing cultures, resources, and needs, as they do currently.

There appears to be a tendency among American, European, and Japanese businessmen to believe that the OPEC countries will soon see the wisdom of working out a rational agreement for allocating the petroleum export market, and that such an agreement will enable those countries to establish prices close to the upper bound and thereby optimize their revenue streams. Indeed, it has been my observation that Western businessmen are strongly inclined to believe, despite much evidence to the contrary, that, if OPEC has not developed such an effective organization during their last meeting, then they probably will during the next one or the one after that. What seems to be very difficult for Westerners to accept is that, in practical terms, OPEC will fail again and again--or that if OPEC finally does manage to get together and behave "rationally," within a few months it would once again be beset with cheating, squabbling, and a failure to act coherently.

It should by now be apparent from its history that the current structure and membership of the OPEC would-be cartel almost guarantees future failure. In this respect, it is important to distinguish between the record of OPEC's apparent operational success, which occurred during periods when rapid changes in the balance of supply and demand created a rising market (in 1973 and again in 1979-80), and its responses to the challenges that arose during times of adversity (the 1974-78

period, and again since 1981, when market forces were effective in reducing prices). That is, OPEC's past behavior suggests that it is an organization that has had enormous difficulties in coping with normal problems of prices, market shares, and internal discipline, except during brief periods or when, through chance factors, normal economic forces were supporting its preferred policies. Moreover, I find little reason to conclude that this general syndrome will be much different in the future.

Of course, it is also true that when disarray within OPEC permits existing market pressures to lead oil prices to the lower bound--that is, towards single digits--the extreme economic distress accompanying that price trend will create some countervailing pressures. These pressures provide OPEC members with incentives to reassemble and seek some kind of concerted action to increase their revenues, at least temporarily. Even then, as we have seen in recent months, a resurgence in spot prices and those in the oil futures market may come about, but not necessarily from sensible decisions that OPEC deliberately makes. Rather, it can occur because many traders operating in the oil market anticipate that imminent OPEC decisions will tighten the supply-demand balance and lift prices well above the lower bound. That is, both OPEC members and many non-OPEC investors involved with petroleum trade tend to interpret oil prices close to the lower bound as ridiculously low or intolerable. Therefore, many businessmen at least, are inclined to believe that such low prices are unlikely to be sustained for a prolonged period and provide a good investment opportunity.

OPEC members now appear to be trapped between the two horns of an unstable dilemma: that the lower bound prices are intolerable and unlikely to last very long, and that the upper bound prices, in addition to spurring non-OPEC competitors,

induce internal frictions, bickering, cheating, competition for market shares, and political fears that lead to increasing disarray within the organization. Consequently, as long as a large excess capacity exists, when prices are near the upper bound, they will tend to decline just as those near the lower bound will have a tendency to rise. Moreover, several other political or economic forces may soon come into play that would also tend to destabilize the current supply-demand balance, and therefore prices. In fact, these forces might exacerbate the likelihood or frequency of relatively strong price oscillations within the two bounds. Some of these forces are discussed below.

E. The Resolution of Iraq-Iran War

It may be difficult for some Westerners to understand the importance that the eventual outcome of the Iraq-Iran war is likely to have on the future of the international oil market. That war has sometimes been dismissed as just one more of the seemingly endless troubles that beset Middle Eastern countries, troubles that appear to be synonymous with the image of that region as a perpetually boiling cauldron of antagonism. That image appears to have been reasonably valid over a long-term historical context covering hundreds if not thousands of years. Nevertheless, because of the expected future growth in worldwide crude oil exports, a large share of which must originate from Middle East countries, that boiling cauldron has taken on new international significance.

In particular, the rise to power of the Ayatollah Khomeini in Iran, following the Iranian revolution of 1978, significantly changed previous perceptions about Iran's role in world affairs and its potential impact upon near-term availability of crude oil supplies from the Persian Gulf. The unanticipated regional appeal of the fundamentalist Islamic movement led by Khomeini has

caused nearly all the other governments in the Persian Gulf region to regard Iran as a major threat--perhaps the major threat to their survival over the near-term. That prospect has for several years greatly disturbed both Saudi Arabia and Kuwait. As a result, those two countries are the most visible among the Arab nations providing support to Iraq in its war with Iran.

Undoubtedly, a great worry among the members of the Saudi royal family is that Iran might soon win the Iraq-Iran war decisively, and then turn its attention relatively quickly to gain political dominance over the other Gulf countries: first Kuwait and Saudi Arabia, then the rest of the region. Indeed, a military push towards Kuwait by Iran may even be possible while the current stalemate in its war against Iraq lingers on.

One of the major current problems for Iran is that the Arabic nations of the Persian Gulf are now organized to assist Iraq in its military efforts against Iran--mainly through supplying financial support to Iraq in the form of "loans" that probably will not need to be paid back. Also, during 1985 and 1986, Iran openly accused the Saudis and Kuwaitis of supporting changes in OPEC's pricing policies that were designed to reduce Iran's oil revenues. Those revenues are currently Iran's only major source of the hard currency it needs desperately in order to obtain arms and ammunition for prosecuting the war.

During 1986, Iran watched helplessly while its oil revenues were severely impacted, not only by the rapid decline in international oil prices but also by its difficulty in exporting whatever oil it could produce, because of the bombing by Iraqi aircraft of its export facilities at Kharg Island and of the tankers seeking to lift Iranian oil. In addition, the bombing of some Iranian refineries also required them to import various petroleum products. Because of war damage, Iran has often had great difficulty in attempting to meet its oil export quota

assigned by OPEC. Moreover, its declining oil revenues have been needed, not only for purchasing war materiel and importing petroleum products, but to pay for food imports (Iran has been a food importing country for years).

The strange relationship among OPEC members who must watch while Iran pursues a war with one of their "colleagues," Iraq, and also is symbolically at war with the Gulf countries supporting Iraq--especially Saudi Arabia and Kuwait--cannot but have a strong deleterious impact on the cohesiveness of OPEC. For example, press reports about official OPEC meetings contain many angry Iranian allegations that the Saudis deliberately arranged the collapse of oil prices in order to create economic difficulties for Iran. While the Saudis have denied those allegations, there probably is at least a grain of truth to them.

From the Saudi point of view, its ruling family almost certainly would lose its independence, or be deposed, should Iran emerge triumphant from its war with Iraq. Clearly, a similar fate would also befall Kuwait, and probably the United Arab Emirates as well. These countries must expect that a clear victory by Iran would require them to install "compliant" governments that would probably become little more than puppet regimes controlled by the Ayatollah Khomeini or his successors. In the hope of forestalling such events, the Persian Gulf Arab countries must be expected to make relatively great sacrifices. At present, one of the easier "sacrifices" is to help keep the international price of crude oil relatively low, compared with pre-1986 prices. That not only hurts Iran in the near-term but also over time tends to solve or ameliorate one of OPEC's major problems, the hugely excessive oil surplus available for export.

The Iraq-Iran war has already lasted more than six years and might continue for many more. Whether or not that will happen is conjecture. Some analysts have speculated that the war could be settled fairly rapidly and peacefully if the Ayatollah Khomeini or President Saddam Hussein of Iraq should die or be deposed, but neither of these events might be sufficient to bring about a peaceful negotiated settlement. However, the potential impact of any such settlement on the international oil market could be oppressive to other oil exporters. Because the Iraq-Iran conflict has prevented those two warring countries from developing most of their oil-export potential, the temporary result has been a reduction of OPEC overall production capacity by perhaps as much as 7 MBPD. Most of that extra capacity probably would become available within a few years once the conflict ends.

However, with only slow growth expected in the current market for crude oil, it is not at all clear that it would be possible for OPEC to make much room for increased exports from either Iran or Iraq. It is hard to believe that any of the other oil exporting nations would volunteer to accept substantial cuts in market shares in order to accommodate those two Gulf countries. Thus, from the point of view of the Saudis and the other members of the Gulf Cooperation Council (the GCC, composed of six Gulf Coast Arab states, includes Kuwait and the UAE, but not Iraq), a peaceful resolution of the Iraq-Iran war would pose a dilemma over the near-term at least. On one hand, the war ending in an Iranian victory poses the greatest potential calamity. On the other hand, should the war be settled soon, a different "calamity" would be anticipated from the expected rapid increase in available market-seeking crude oil from both the Iraqis and the Iranians.

To OPEC members, an Iranian victory could have only a distressing effect--a great deal of downward pressure on oil

prices as various oil-exporting countries strove to preserve their market shares. Consequently, from the point of view of the GCC members, the preferred outcome over the next few years may well be a prolongation of the Iraq-Iran war, even though they would have to pay a part of the continuing cost of that war. It is not at all likely, however, that such preferences, based almost purely on considerations of self-interest, would be effective in preventing an early resolution of the conflict, once the two warring nations become so inclined.

Those concerned with near-term oil prices must live with the uncertainties implied by various possible outcomes of the Iraq-Iran war. If news should arrive about the demise of Ayatollah Khomeini, it might bring joy to those opposed to his Islamic movement, but oil futures would probably decline precipitously in anticipation of sharply increased supplies of petroleum. Meanwhile, while the war continues, any news about another bombing of Kharg Island, the destruction of pipelines in Iraq, or a successful Iranian thrust that could hamper Iraqi oil exports, would probably cause oil futures to rise significantly, at least temporarily. It also appears that Iraq has not been trying to win the war through a strong military offensive. Instead, Iraq seems to be content to fight a defensive war until the Iranians are exhausted or until a negotiated settlement is somehow facilitated. Thus, depending on which scenario proves to be correct, the eventual impact of the war's end upon oil prices could go in either direction.

A decisive Iranian victory would not only create severe political problems for the GCC's oil producers, it could, in principle, soon place nearly all of the Gulf's future oil exports under the influence, if not the direct control, of the victorious Iranian regime. That is, a resounding military victory by Iran

over Iraq could establish Iranian hegemony over the entire Persian Gulf region within a relatively short time, and thereby allowing Iran to gain effective control of subsequent OPEC policies. Assuming that such control were established, it is easy to visualize that one of the likely results would be a rapid increase in the price of oil, to a level determined by the Iranians. Certainly, \$40 or \$50 oil could not be deemed improbable under such circumstances. If the Ayatollah--or his successor--finds himself in a position to control the production and shipment of oil from all the Persian Gulf countries, then Iran would control the bulk of the oil reserves and the production potential relevant to the international market. Such control would, in the postulated scenario, certainly be employed to benefit both Iran and the Islamic movement, but could hardly be viewed as anything but an exceedingly unpleasant prospect for the oil-importing countries of both the developing and developed world.

F. Energy Taxes

The recent decline in oil prices has led to a burgeoning movement among U.S. oil producers, and the associated oil service industries, to promote an appropriate oil import fee. The stated purpose is to raise the minimum price of oil inside the United States to a level that would encourage domestic oil exploration and development, and allow it to proceed at a substantially higher level than at present. From an oil industry point of view, a reasonable price level is usually in the range of \$22 to \$27 per barrel--a little above the price that would exist in the U.S. if the upper bound price prevailed in the Persian Gulf. Usually, it has been suggested that the proposed oil import fee should be variable to reflect any significant changes in international prices. The idea would be to keep the internal crude oil price roughly stable at some federally-preferred level, as long as weakness persisted in the international market.

Obviously, an oil import fee would not only lift the price of imported oil, it would also lift the price of domestically-produced oil--and, almost certainly, domestically produced natural gas as well. Because oil imports are now about 20 percent of total oil and gas consumption, each billion dollars collected by the federal government through the oil import fee would burden U.S. consumers with about \$5 billion in higher prices for oil and gas. Understandably, there has been considerable consumer resistance to an oil import fee. Still, the possibility cannot be ruled out; it is probably reasonable to surmise that the more the price of oil declines in the international market, and the longer that decline persists, the more likely the imposition of an oil import fee. Its major benefit would be the revival and protection of the domestic oil industry, but political arguments favoring it tend to stress the nation's need for greater military security, for greater conservation efforts, and for creating a buffer--in the form of greater domestic output--against the possibility of rapidly escalating petroleum prices in the future.

Although a suitably structured oil import fee would keep the internal price of oil reasonably stable for a substantial period of time, the higher price level would also tend to decrease the consumption of petroleum products within this country and other countries that follow a similar path. By promoting conservation, efficiency, and substitute fuels, an import fee would restrain growth in demand for petroleum and hence create additional problems for the OPEC countries, both in the near- and the longer-term. It would also raise the costs and competitiveness of exports. Presumably, that impact will have been appropriately considered by any nation that imposes such fees.

I will not discuss all the pros and cons of an oil import fee, as that could lead to a very complicated, and nearly endless, series of arguments with economic, political, strategic,

and social overtones. But it is important to understand that political pressures favoring the imposition of such a tariff on imported oil are likely to persist as long as international oil prices threaten the viability of domestic U.S. oil and gas industries.

Other forms of energy taxes would also tend to reduce demand for petroleum products, and probably for natural gas too, depending on the nature of the taxes. For example, the U.S. could impose an across-the-board excise tax equivalent to \$10 per barrel on all crude oil and petroleum products consumed in the U.S., and a roughly equivalent tax of \$1.50 per million BTUs on natural gas. Over time, such taxes would probably have a relatively strong impact on demand for both petroleum products and natural gas; it would also bring substantial revenues to the U.S. government--roughly \$90 billion annually. Excise taxes would not only promote conservation of oil and gas, but would also encourage efforts to substitute other fuels, such as coal, bio-fuels, and solar energy, as well as nuclear power. The longer-term impact of such taxes on the OPEC countries could be substantial, restraining the outlook for rising petroleum consumption, at least within the U.S. and any other countries that impose similar taxes.

Another approach might be a substantially increased gasoline tax--for example, an additional \$1.00 per gallon within the United States, phased in, say, over a five-year period. That would probably result in a significant decrease in the near-term demand for and medium-term consumption of gasoline. It might even result in a prolonged decline in demand as the population gradually reduced annual mileage per vehicle and/or switched to more fuel-efficient automobiles. Indeed, if such a tax was legislated and were seen as likely to become permanent (a

reasonable assumption), it would probably spur demand for a new generation of vehicles powered by electricity or possibly other non-petroleum fuels. Over time, a trend towards transportation independent of petroleum fuels might become quite significant. In this context, it should be pointed out that the U.S. currently has one of the lowest rates of gasoline taxes among the developed countries. Even additional new taxes equivalent to \$20.00 per barrel (roughly \$.85 per gallon) would not bring gasoline prices in the United States up to those recently prevailing in Japan, Italy, or West Germany (Table 5).

G. Buffer Stocks

Recent experiences with oil price shocks and the associated threat of inadequate future fuel supplies that might result from embargoes, wars, or other possible interruptions in the international petroleum trade, have led most of the developed countries to look favorably upon the idea of establishing strategic petroleum reserves as a buffer against potential emergencies. As a result, non-OPEC countries have now accumulated about one billion barrels of oil in readily available stocks for such emergencies, about half of which is now in the strategic petroleum reserve of the United States. Most of these reserves were accumulated when the price of oil was about \$30 a barrel or more. Now that the price is roughly \$18-\$20 a barrel, might it not be reasonable for those same countries to conclude that their buffer stocks should be increased substantially? After all, why not stockpile crude oil for future emergencies while prices are low rather than high?

Strangely, it seems that such policies still have to evolve among most governments that have the wherewithal to support them. Decisions gradually to increase the emergency oil stocks in the U.S. above the .5 billion barrel level (reached in December 1985), have developed slowly and only on a somewhat ad

Table 5

COMPARATIVE GASOLINE PRICES & TAXES IN 1984
(Annual Average at Retail Level)

Country	Total Price (\$ Per Barrel)	Taxes (\$ Per Barrel)	Taxes ¢ Taxes
France	93.04	52.37	56.5¢
West Germany	80.67	38.48	47.7¢
United Kingdom	101.00	49.22	48.7¢
Japan	100.19	37.61	37.6¢
Italy	114.52	75.98	66.5¢
United States	51.96	12.91	24.9¢

Source: Organization of the Petroleum Exporting Countries, Petroleum Prices and Their Components in Selected Countries--1984. (Vienna, Austria: OPEC, 1985).

hoc basis, but that need not persist. Because conventional wisdom now expects the next major period of potential threat to oil-importing countries to arise sometime during the mid- or late 1990s, it would seem reasonable for countries concerned about such eventualities to create more substantial stockpiles now, when oil prices are relatively low--that is, while crude oil remains readily available and can be stored in large quantities, without unduly affecting the market.

If, under coordinated policies, the major developed countries were to buy and store crude oil at the rate of one million barrels per day, then an additional billion-barrel reserve could be created about every three years. Then, if an oil emergency arose in the mid-1990s or beyond, not only would those larger stocks provide a large buffer that could prevent a sharp economic recession, but the rise in petroleum prices associated with that emergency could even turn those reserves into a handsomely profitable venture. Oil purchased for \$15-\$20 per barrel in the late 1980s presumably could be sold between \$30 and \$60 per barrel during any serious emergency in the 1990s, and at that time, would undoubtedly be regarded as the extremely prudent investment it turned out to be.

The extent to which governments of the developed world might proceed with such policies cannot be predicted with confidence, but it should be clear that prudent programs of that type can probably be conducted with only a small impact on near-term international oil prices, and are likely to provide a significant stabilizing impact on mid- to long-term prices.

H. Other Factors of Potential Significance

Petroleum markets are sensitive to many factors, including those discussed above and those related to political decisions, economic booms and recessions, and to various economic policies

established by governments for reasons only indirectly related to oil prices. For example, a change in Soviet foreign trade policy that increases Soviet imports of Western goods also has a significant impact on the oil market. Currently, if the Soviet government wishes to obtain additional hard currency revenues in order to import more Western goods or technology, it has few options other than to increase its exports of crude oil and/or natural gas. But substantial increases in such exports, especially if directed to the West, would be expected to reduce crude oil exports from OPEC sources by an equivalent amount.

The policies of Third World countries related to the development of indigenous oil and/or gas resources were mentioned above in another context. Clearly, a significant change in those policies can affect international oil prices, although more in the mid- than the near-term. Still, the current widespread belief that prices are apt to rise significantly during the 1990s should induce many countries with promising resources to start new exploration programs or increase existing ones in the very near future.

Much of the growth in petroleum demand during the next 15 or 20 years is expected to come from the developing rather than the developed countries, due to their relatively rapid economic growth. However, such growth is not assured, as it will depend substantially upon the financial policies of the wealthier countries whose willingness to finance it may be more limited than heretofore. If we examine the relatively recent "explosion" of debt in many Third World countries (Table 6), the enormous expansion of credit extended by the developed countries to the developing ones is startling.

In the last few years, many Third World nations have had severe problems in servicing their huge debts. This has exposed the vulnerability of the lending banks to those weak loans and

Table 6

MAJOR LDC EXTERNAL DEBT
(Billions of US \$)

	End 1973	End 1985	Average Compound Annual Growth Rate
<u>Latin America</u>			
Argentina	2.8	48.3	29½
Brazil	12.7	105.1	21
Chile	3.2	21.1	18
Mexico	5.6	97.3	29
Venezuela	1.5	35.7	33
<u>Asia</u>			
Indonesia	5.3	37.1	17
South Korea	3.8	57.3	25
The Philippines	1.9	26.3	27
<u>Middle East and Africa</u>			
Egypt	2.2	29.0	24
Israel	4.5	30.2	19
Turkey	3.0	28.5	21

Note: Data for 1973 does not include short-term debt; short-term debt was relatively insignificant. However, the growth rates must be used with extreme caution since the degree of error for any specific country could be significant.

Source: Morgan Guaranty Trust Company, Morgan International Data (April 1987); The World Bank, World Debt Tables, 1983-84 edition.

led to a credit crunch. The availability of new credit has become much more difficult. Thus, not only should a slower rate of overall growth be expected in the developing countries, but also the possibility of a substantial recession. Some international economists have expressed concern that the debt crisis could even result in a worldwide depression. For example, if the bulk of the developing countries find themselves unable to service their debt, they might find it necessary to severely limit their debt payments or even to renounce those obligations. In the latter event, some observers have postulated an almost complete collapse of the international financial system. That scenario is mentioned here not as a likely one, but as a possibility that should not be overlooked and certainly not be casually dismissed.

Another possibility that almost always exists, although more for the mid- and long-term than the near-term, is the potential impact of relatively unforeseeable technological developments on demand for petroleum products. A series of such developments might allow novel forms of energy to begin displacing petroleum fuels. It is well-known, for example, that the greatest impediment to the development of electric automobiles has been the lack of an adequate battery. However, many industrial firms have been working on various concepts for new batteries and many promising, even revolutionary, concepts are under development, each with its own set of difficulties that must be overcome in order to offer a reasonable probability of commercial success. Although I cannot forecast with confidence that a major breakthrough will occur within the next few years, it is not unlikely within the next ten years. Even though it would probably take 10 to 20 years for electric automobiles to be produced on a large scale, once an adequate new battery becomes commercially available, the anticipation of such a development could have a relatively large impact on both short and mid-term petroleum markets. For example, analysts would quickly adjust

their estimates of the long-term demand for gasoline and other petroleum products as a result of a projected market for electric vehicles. The value of petroleum resources still in the ground could erode substantially if their owners were to face a declining market for motor fuels because of an expected long-term surge in electric vehicles--and possibly other technological breakthroughs.

Early this year, for example, the scientific world was suddenly astonished to discover a major advance in superconductivity that even cautious scientists have referred to as revolutionary. It is already reasonably clear that new superconductive materials are likely to bring about major changes in electric power generation, transmission, and storage that over time would greatly reduce the use of both oil and gas by electric utilities in most countries--and substantially increase the overall efficiency of both production and consumption of electricity. In addition, it promises to bring forth a new generation of very fast electric trains that float on magnetic cushions, and may possibly also be applicable to a range of motor vehicles. It is too early to make quantitative estimates of the impact of superconductivity on the international oil market, but it is probably safe to suggest that such effects will grow; they could become huge.

Another possibility--one which received national publicity last year--is the possibility of very efficient solar cells. One new variety, according to recent reports (The New York Times, September 9, 1986), might provide roughly five times the conversion efficiency of the best existing commercial solar cells. It has been claimed that these devices could be made commercially for perhaps one-third of the present cost of conventional solar cells. While this novel process is still in the laboratory stage, its potential was reported to be exciting

enough that a major oil company offered \$9 million for the rights to the process. The offer was rejected.

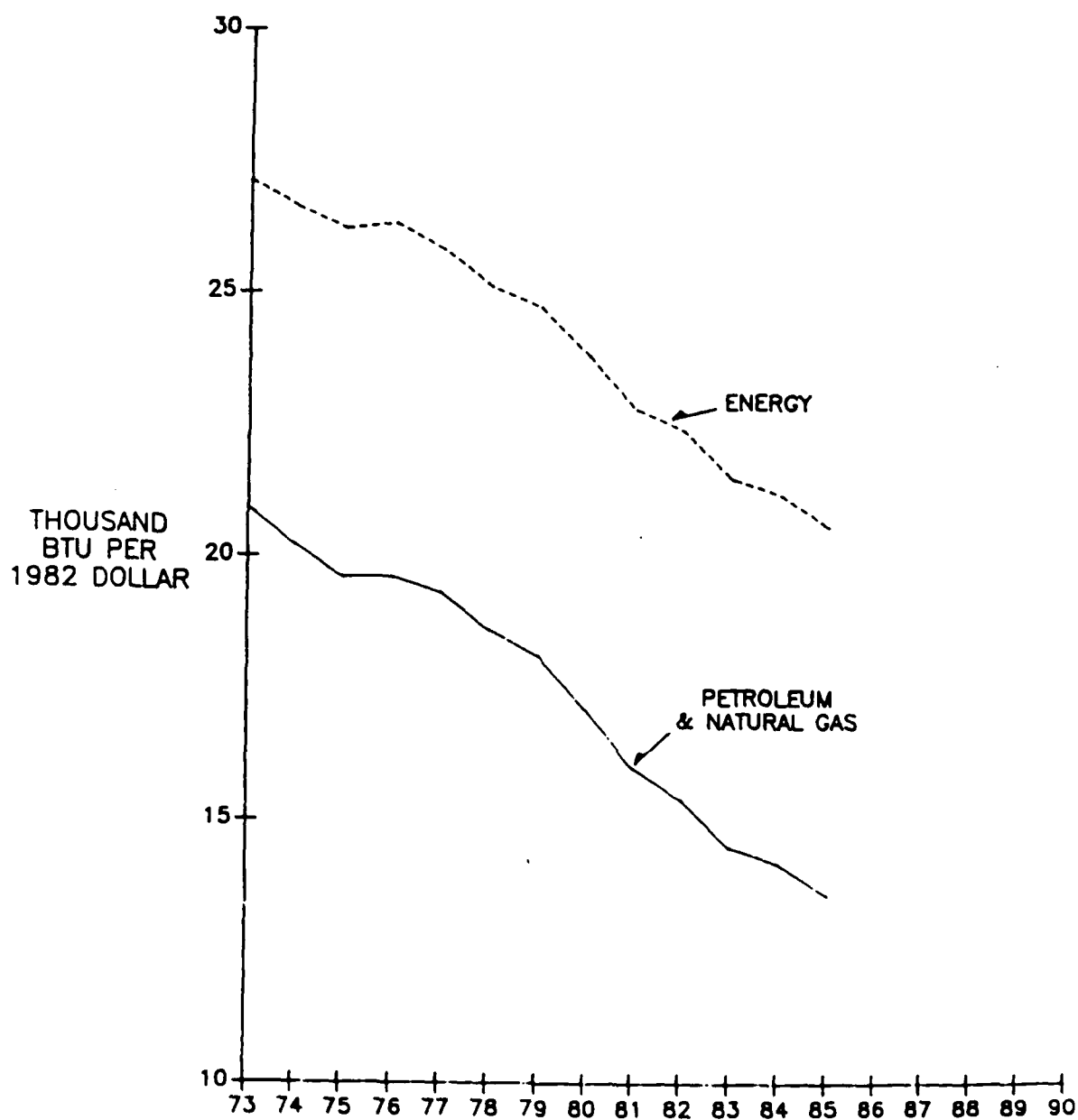
Although efficient solar cells are certainly an interesting, even exciting technological prospect, there is no assurance that a commercially viable new form of cheap electric energy is actually going to appear soon. What I find interesting about the claims for this particular invention--assuming that the stated estimates of efficiency and cost are valid--is that it essentially would constitute a "revolution" in the form of inexpensive electric energy, which presumably would be available to both the developing and the developed countries. Clearly, it would also tend to displace conventional fuels or at least much of the anticipated growth in the consumption of conventional fuels. In particular, it would provide an enormous source of alternative energy that would tend to create a long-term ceiling on the future prices that could be charged for crude oil and/or natural gas.

Some technological possibilities are very promising, some are marginal, and the potential of some is still merely unknown. Over time, however, it has been demonstrated that the energy intensity, and in particular petroleum intensity (see Figure 17)--which may be interpreted as quantitative measures of the overall impact of new technologies on the energy and petroleum markets--have already shown a significant downward trend in the U.S. and elsewhere.* Most energy analysts now expect that with respect to petroleum intensity, the trend should continue for the indefinite future--at least while the longer-term expectation for oil prices is an upward trajectory. If correct, that trend does not necessarily imply that absolute demand for petroleum fuels will decline in the future, but that the future growth of the world's demand would at least be substantially less than the growth of gross world product.

*Energy intensity for a country is defined as the ratio of energy consumption to GNP in constant dollars. Petroleum intensity, similarly, is the ratio to GNP of petroleum products consumed.

Figure 17

ENERGY AND PETROLEUM CONSUMPTION PER GNP



Source: U.S. Department of Energy/Energy Information Administration, Monthly Energy Review, June 1986, p. 16.

Clearly, the greater the threat of rising fuel prices in the future the greater will be the interest in new energy sources and in energy-efficient technologies. When that interest is coupled with the recent widespread phenomenon of increasingly rapid technological developments in many fields, which in large measure has been due to the information revolution, it also becomes theoretically possible that a moderate rate of economic growth (say 3 percent) could occur on a worldwide basis for a decade, or even two, with little if any increase in petroleum consumption. However, the possibility of zero growth in demand is unlikely in the near-term, unless petroleum consumers receive clear economic signals through rising prices, increased taxes, and/or government policies that support constraints against any greater future dependence on oil imports. Consequently, these signals probably will not occur before oil prices burst through the upper bound. That is not likely, at least during the next two or three years.

A few of the major factors that may be important to the petroleum market have been mentioned above. Some are in the category of events that cannot accurately be predicted, some involve potential policy decisions by various governments, and some are related, but only dimly, to foreseeable technological and economic changes. Clearly, it is not possible to anticipate all the specific factors that will become relevant, let alone the degree to which they will be relevant. The future always furnishes surprises, and some of them (for example, a worldwide depression or a major war) might be more significant than any mentioned above. The major point is that so many powerful potential factors exist that can affect the future price of oil, either positively or negatively, and in both the near- and long-term, that it is essentially impossible for any single price trajectory to provide an accurate forecast of future petroleum prices.

I have suggested that both a lower bound and an upper bound are likely to constrain oil prices, at least for the near-term.

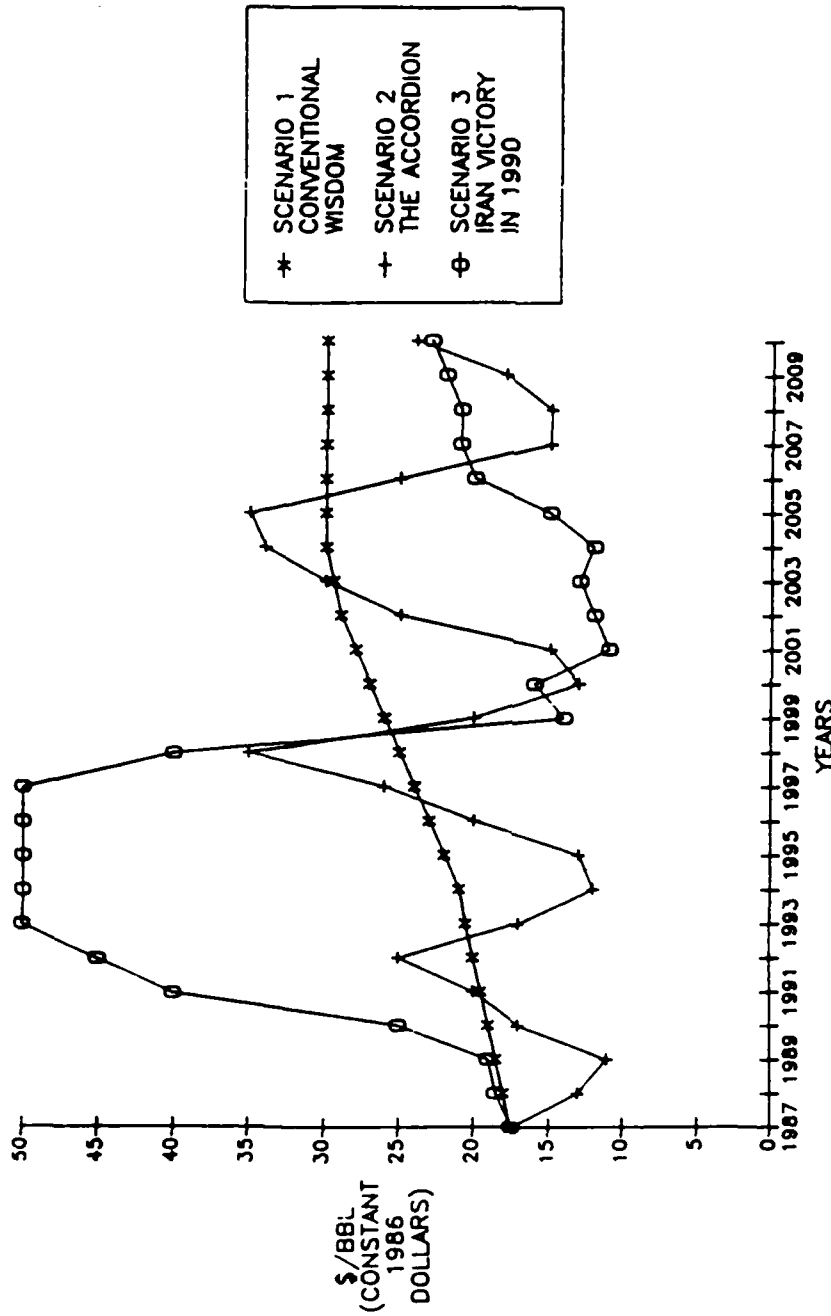
Such bounds may or may not provide much comfort to those who wish to have a narrower range for adequate planning. However, the reality is that petroleum prices are apt to bounce around considerably during the next few years between the bounds that I have defined.

I. Scenarios and Price Trajectories

Although the level of oil prices during and after the 1990s appears to be highly uncertain, it still may be useful for analytical purposes to express the character of that uncertainty through a few hypothetical price trajectories. For that purpose three trajectories have been selected, each of which represents a specific scenario; together, they illustrate the potential variance in oil prices at various times in the future.

A smooth price trajectory (Figure 18) is associated with the first scenario; it is labelled "conventional wisdom." It is, I believe, a projection that represents the current expectations of some large oil companies and financial institutions, and probably those of several OPEC nations as well. Because it is a smooth, slowly-rising curve, it represents a relatively stable international oil market dominated by the preferences of Saudi Arabia and other Arab members of OPEC. It presumes that they maintain effective control of OPEC and follow a long-range plan that allows oil prices to rise only very slowly, in order to keep their competitors' share of the world market from rising substantially during the 1990s. Therefore, even by the late 1990s, oil prices are still substantially lower than those of 1985. However, each OPEC member by then has increased its market share by about 50 percent (totalling about 25 MBPD for the group) and can look forward to gradually increasing revenues from both rising prices and rising export volumes, although both together may contribute less than 10 percent annually to real revenue growth.

Figure 18
FUTURE OIL PRICES (THREE SCENARIOS)*



*Each point represents the price of Arabian Light Crude Oil, f.o.b. the Persian Gulf.

Scenario #1 appears to be eminently reasonable, which implies that OPEC would have learned, and applied to its business, the major economic lessons from both the spectacular 1970s and the troubled 1980s. The scenario is also associated with a prospering world in which overall economic growth is maintained at about 3 percent per annum. It is also one in which OPEC's potential competitors accept implicit restraints on their oil output, because they understand that excessive growth in non-OPEC exploration and development could quickly become counterproductive. In effect, a widespread de facto acceptance of the desirability of the smooth, slowly-rising price trajectory occurs and none of the major players, whether a large international oil company or an oil-exporting nation outside OPEC, attempts to upset the stability that has been created. Of course, or perhaps because it is so smooth and rational, it is hard to place much confidence in scenario #1, except as an ideal toward which various governments and private producers might strive.

Scenario #2 is labeled "the accordion," because it portrays a particularly wavy representation of the way future oil prices might oscillate as various economic and political forces influence oil producers, both in and out of OPEC. The associated price trajectory begins with growing trouble among OPEC producers, which could arise from "cheating" on quotas and prices, or perhaps out of a negotiated settlement to the Iraq-Iran war. Two years of declining prices and difficult relations among OPEC members drop oil close to the \$10 level, and once again create economic havoc for most of the world's oil producers. As a result, the U.S. imposes an oil import fee to protect its industry, and several other industrialized countries follow. During 1990, however, OPEC becomes revitalized. It then manages to maintain a respectable level of cohesion among its members for almost three years; prices rise to over \$25 per barrel; serious internal troubles arise once more.

In scenario #2, price oscillations continue throughout the 33 year period depicted. The reasons for each new price decline and subsequent increase are generally different for each oscillation. This scenario represents the kind of variations that have been present in various commodity markets throughout the twentieth century. Historically, future commodity prices have almost always been unpredictable, and the variations have been quite large.

Scenario #3 posits an impressive Iranian victory over Iraq early in 1990. Oil prices quickly start to rise in anticipation of hawkish Iranian policies. A buying panic ensues during 1991, when the worst fears of oil-importing countries are nearly realized. Iran becomes the effective leader of OPEC and then delights its members, and other oil exporters, by establishing a rigid \$40 oil price. Iran also instigates strong measures to assure "cooperation" by both OPEC members and most other major exporters who might be tempted to act independently. By 1993, the official OPEC price reaches \$50 per barrel (in 1986 dollars) and is maintained there for almost six years.

By late 1998, escalating responses by the industrialized nations to the perceived threat, through vigorous explorations, conservation, new technologies, and alternative energy sources reduces demand for imported oil and gas from OPEC and its associates to less than 10 MBPD of oil equivalents. Moreover, demand is expected to continue falling rapidly. The Iran-dominated OPEC then collapses into a free-for-all battle for export markets, and the international price of oil goes into a free-fall. By that time, the oil-importing industrialized nations have established sufficiently high minimum internal prices to keep their domestic oil and gas industries active, while tariff walls help to keep external prices low.

Low international oil prices and export volumes persist for several more years, leading to great political turbulence within

many oil exporting countries--especially within Iran, which is blamed for the calamity by disenchanted internal groups, as well as by neighboring Persian Gulf countries. Oil prices begin to only gradually rise from the nadir after the year 2005. But export volumes in the world oil trade remain at less than 12 MBPD for the next several years.

If these three scenarios convey the image of a wildly uncertain future for oil prices, then they have been appropriately chosen. However, they do not represent the most extreme possibilities. Those could depict oil prices dipping as low as \$5 or rising above \$100. Still, the scenarios seem to imply that, when prices go to an extreme in one direction, we should expect them subsequently to start moving toward an opposite extreme. As any analysis of past markets undoubtedly would show, prices averaged over a suitably long period should allow the petroleum industry to operate profitably. Of course, those countries or investors who are excessively optimistic, pessimistic, speculative, or greedy may experience the most difficulty in coping with the potential fluctuations in future oil and gas prices. Prudent long-term investors should be able to ride out the storms successfully.

J. Summary

This chapter defines both a lower bound of about \$8 per barrel and an upper bound of about \$20 per barrel for the price of crude oil in the Persian Gulf over the near-term--the next two to three years. The actual price, in 1986 dollars, is likely to fluctuate, probably substantially, between these bounds, because of the many possible developments that could have a strong impact on oil prices.

The lower bound is determined by the price that would be likely to prevail if free market forces were to become dominant

for a few months or more. That price would be low enough to force oil producers around the world to begin shutting in wells that currently produce several million barrels of oil per day. If lower-bound prices persist for a year or more, perhaps 4-5 MBPD would soon have to be shut in within the United States alone, including the Alaskan production of about 2 MBPD.

The upper bound is determined by a price that would sufficiently discourage competitors to prevent any future increases in non-OPEC oil production. That price is now estimated to be in the \$18-\$20 range. By restraining competitors in this way, OPEC producers could expect to pick up all of the worldwide growth in demand for crude oil, which could range between .5 and 1 MBPD annually, as long as oil consumers are not excessively worried about a threat of rapidly rising prices.

The analysis also suggests that several known factors could lead to erratic fluctuations in actual prices between these two bounds. One of them would be the well-known tendency of OPEC producers to sell more oil than their nominal quotas. Another is that, despite expectations to the contrary, non-OPEC production may begin to rise, if prices hover near the upper bound during most of the next few years and are expected to rise in the 1990s. That outcome is less likely to be true of production in the U.S., but it is possible in nearly every other oil-producing area.

A third possibility is that a resolution of the Iraq-Iran war could have a strong impact on oil prices, the direction depending upon the nature of the resolution. The usual scenario is a negotiated settlement, perhaps following the demise of the Ayatollah Khomeini, which leads to a rapid increase of supplies from the two countries and then to a great amount of downward pressure on prices, as OPEC fails to accommodate gracefully to the

expressed needs of those two members. Another scenario visualizes a clear victory for Iran that soon leads to Iranian hegemony over the entire Persian Gulf region. Political changes following the victory give Iran effective control over the production and pricing policies of all of OPEC and lead to an Iranian-preferred price trajectory. That outcome results in oil prices rising quickly to the \$40-\$60 per barrel range or even higher.

The impact of new energy taxes by oil consuming countries is another tactic that could be used to restrain rising international prices, by reducing the demand for petroleum or, in a form such as an oil-import fee, by stimulating indigenous production of oil and natural gas. Other forms of intervention by governments of oil-importing countries could be used to restrain or stabilize oil prices. One would be a policy of adding rapidly to buffer stocks when prices are falling and selling from those stocks when prices rise above stipulated levels.

Several other factors could have an important impact on oil prices, although some of them are unlikely to affect the near-term. One that could become significant during the next few years is Soviet oil export policy. Rising production of oil and, more importantly, of natural gas could lead to a rise in the volume of Soviet oil exports during the next few years, while decline in Soviet oil production may or may not affect those exports. Another factor that would affect the mid-term more than the near-term is the trend of exploration and development within Third World countries. Among such countries, concerns about the possibility of rapidly rising prices during the 1990s could soon lead to a relatively rapid rise in exploration for oil and gas.

In addition, there still remains an enormous technological potential for increasing efficiencies and for finding substitutes for petroleum fuels--for example, through the development of electric vehicles and efficient solar cells. Although the impact

of new technologies is unlikely to have much effect upon near-term demand, their appearance in the marketplace could create strong expectations of reduced future demand for petroleum and thereby affect OPEC policies, as well as those of the other oil producers.

Some of the potentially influential factors could strongly affect near-term prices. One example is an international recession or depression. Such events usually are not or cannot be anticipated, just as the prior oil crises were not. Potential surprises, together with such known but uncertain possibilities as government interventions or the outcome of the Iraq-Iran war, do not provide much comfort to those who prefer more stability in world trade. Still, there may be at least a bit of comfort in the expectation that oil prices are apt to be bounded in the near-term in the \$10 to \$20 range.

Finally, the examination of various scenarios makes it hard to avoid the conclusion that inherent uncertainties allow the possibility of great and frequent fluctuations in future petroleum prices, just as they also admit the possibility of a smooth well-behaved, or rational price trajectory. Actual future results probably will depend upon both chance events and deliberate institutional decisions. Despite the possibility of wild fluctuations, it seems likely that oil and gas prices will tend to look relatively reasonable when averaged over one of two "cycles." Thus, while many speculators are likely to be badly burned, prudent long-term investors should be able to survive the stormy weather when it occurs.

A-1

APPENDIX

A-2

The organization, never
as powerful as it looked, may
crumble in the 1980s.

Why OPEC Is Vulnerable

by WILLIAM M. BROWN and HERMAN KAHN

The Organization of Petroleum Exporting Countries is often depicted as one of the most effective cartels in history, able to manipulate oil prices almost at will. Everyone knows, of course, that there are tensions within OPEC, and that different members have different objectives. Nevertheless, the prevailing view is that the 13 member nations have enough interests in common to ensure that they will ultimately stick together and continue to jack up prices. The OPEC meeting in Algiers earlier this month seemed to reinforce this view. Despite some powerful initial resistance from the Saudi delegates, the organization decided once again to raise the ceiling on prices. These prices were about 500% higher in real terms than they had been in mid-1973.

Our view of OPEC differs substantially from the prevailing one. Despite that 500% increase, we do not believe that OPEC has been an effective cartel. The record shows, we believe, that it has been a price follower more than a price leader.

Furthermore, there are reasons to believe that in the 1980s the worldwide supply-demand balance may not be as favorable to OPEC as is often assumed. Indeed, it is likely that in the not too distant future we will be witnessing major oil gluts, tumbling OPEC prices, and sharply reduced OPEC shipments. We estimate that within a year shipments will fall by some four million barrels a day (to around 25 million barrels). And as the decade draws to a close, demand for OPEC oil is still apt to be falling.

Brown is director of energy studies at the Hudson Institute. Kahn, founder of the institute, is now its director of research. This article has been adapted from their forthcoming paper, "An Energy Perspective for the 1980s and 1990s."

OPEC was certainly not a price leader in the five-year period from January 1974 to December 1978. During those years, official OPEC prices *declined* in real terms. In constant dollars the decline was about 25%, in D-marks it was about 40%, in yen about 50%. Moreover, during much of that five-year period, almost every OPEC country offered substantial discounts from the official prices in order to increase its own exports.

The cartel didn't do it

In short, OPEC's real income was slipping badly during 1974-78—hardly what one would expect of an effective cartel. The slippage ended late in 1978, but not because of any action by the cartel. What happened was that purchases by oil-importing countries (to avoid a possible turn-of-the-year price increase) combined with the outbreak of riots in Iran (which cut production sharply) to bring discounting to a sudden end.

Even the renewed price explosion last year was not the result of OPEC policy. The explosion was brought about by the trouble in Iran and magnified by the importing countries, which went on a buying binge and increased their petroleum stockpiles during the year by an estimated 500 million barrels. The binge, intended by its initiators to hedge against the threat of further production delays and consequent higher prices, ended up ensuring that prices would rise. Oil prices on the spot market rose far above the official contract prices negotiated by OPEC members, creating pressure to raise official prices. Most OPEC members, and the Saudis in particular, kept trying to restrain prices last year by underselling the spot market.

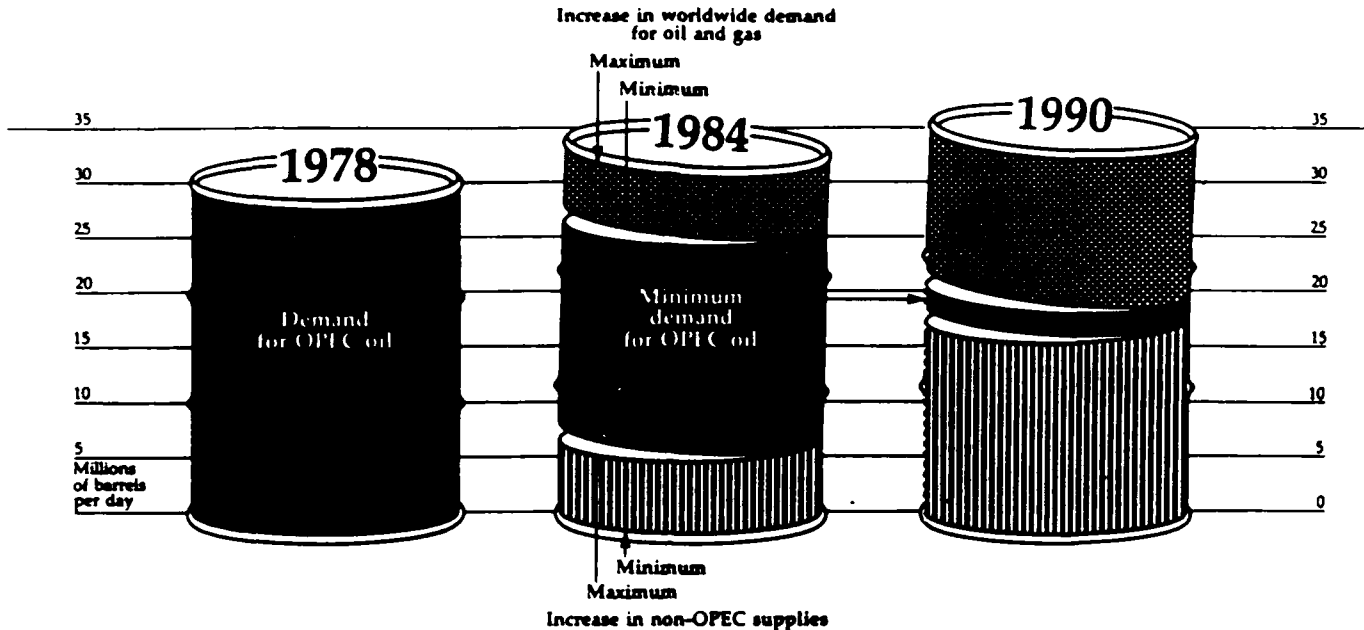
So the price explosion of the past year was not a triumph of OPEC planning but an unanticipated and in some measure unwelcome event that the organization was slow to comprehend, slow to come to grips with, and unable to deal with on a unified basis. Indeed, a somewhat similar analysis might be made of the original fourfold price increases of 1973-74. Then, too, OPEC was generally given credit for forcing the rest of the world to swallow huge increases. But in retrospect it is clear that in 1973-74, as in 1979-80, supplies were never reduced below the level of normal demand. In both periods, a surge of panicky buying by consumers—and a few speculators—created an extra demand.

In both periods, the official price hikes were triggered by the behavior of spot prices, which kept racing ahead of contract prices, conveying a powerful message to OPEC members about the real value of their oil. The persistence with which spot price exceeded the "cartel price" in both periods is a dead giveaway that swaring demand, not the cartel's muscle, has been the prime mover of prices.

In search of stability

In our view, OPEC is a loosely organized group of countries in which Saudi Arabia, with occasional assistance from Kuwait and the Emirates, attempts to furnish price leadership. When the market is strong, the price leaders tend to raise production in an effort to restrain prices; when the market is weak, the Saudis tend to cut production rather than give discounts. To oversimplify somewhat, the Saudis have not cast themselves as adversaries of market forces but as managers whose own interests lie with secure markets and long-term price stability.

Why OPEC's Prices Should Fall



The message of those barrels is that OPEC oil revenues can't grow very much during the 1980s and might shrink sensationally. As that shrinking middle layer indicates, at present prices OPEC oil shipments could be close to vanishing by 1990. This "minimum shipments" situation is one in which (a) worldwide demand for oil and gas holds at the modest 2% growth rate of recent years—which seems likely; (b) non-OPEC sup-

plies grow at a 7% rate—which is entirely possible; and (c) real prices don't drop. If demand for OPEC oil was really falling that fast, of course, prices would come down too. OPEC's maximum shipments are indicated by the heights of the barrels. For the organization to hit those maximums, worldwide demand for oil and gas would unexpectedly have to rise at a 3% rate and non-OPEC supplies grow only at a 5% rate.

Right now there is a widespread belief that the years of Saudi leadership are coming to an end—that OPEC will come to be dominated by its "hawks." We believe that the opposite will be happening—that the Saudis will reassert their leadership. The reason is the coming oil glut. In a period when most OPEC members will be hungry for cash, and desperate to sell all the oil they can, any producer with surplus cash and an ability to cut output has tremendous bargaining power. The Saudis are clearly the only major producer with such leverage.

But even if OPEC did come to be dominated by the hawks, it would have trouble functioning as an effective cartel. Any new leadership would still have to deal with the problem that OPEC's members are sovereign governments with widely differing political needs. These needs will always take priority over those of the organization. No OPEC leadership will be able to dictate price and production schedules to individual members.

A guardedly optimistic view about fu-

ture oil supplies and prices seems at least as rational as a guardedly pessimistic one. Forecasts of long-term oil supplies have been wildly wrong for a century. There has been a chronic tendency to see "short-falls" that didn't materialize.

The U.S. government has been pessimistic about the prospects for finding oil in this country. In 1885, the U.S. Geological Survey said that there was little or no chance of finding oil in California; in 1891, comparable statements were made about Kansas and Texas. In 1939, the Interior Department said we had only enough oil to last another 13 years. In 1949, Interior said that the end of the U.S. oil supply was almost in sight.

Moving down at Exxon

In more recent years, the oil companies' forecasts of demand have also tended to overstate shortfalls—by overestimating demand. A 1973 Exxon projection put the non-Communist world's energy demand for 1985 at the equivalent of 163 million barrels a day of oil. Two years later, that

was reduced to 130 million barrels. In 1977, and again last year, the forecast was further reduced, to 118 million barrels.

Many present forecasts, including our own, may turn out to need as much revision; serious difficulties are inherent in all such projections of supply and demand. Nevertheless, the information now available does not appear to justify the widespread gloom about our ability to deal with OPEC. Barring wars, insurrections, or replays of the Iranian debacle in other countries, there is no reason to expect endless increases in oil prices.

In developing a forecast of the supply-demand balance, we focus on prospects for natural gas as well as oil. Gas and oil can be substituted for each other to a large degree in heating, electric power, and industrial boilers, so we find it useful to combine the two when dealing with energy issues.

In the U.S., gas suitable for use as a fuel will be obtained from several different sources. Conventional sources, including onshore deposits, are generally

expected to produce about another 1,000 tcf (trillion cubic feet)—enough to last about 50 years at current rates of consumption, but not enough for substantial increases in production. Based on the historical tendency to underestimate future discoveries, however, there is a significant possibility that available gas will turn out to be two or three times as great as anticipated in the standard forecast. If so, natural-gas production in the U.S. will be increasing for decades.

Natural gas is also being sought in a variety of unconventional places, where it is known to be available in huge quantities but is hard to extract. Some gas is now being produced from the difficult "tight sand" formations of the Rocky Mountains and elsewhere. Enormous amounts come frozen in a loose association with ice in crystalline forms; these crystals, or clathrates, are found at moderate depths below the ocean floor in colder regions. Widely dispersed and at low pressures, a lot of gas is available in shale and coal deposits. The potential for these unconventional sources is huge, ranging from a few hundred tcf for gas from coal deposits to millions of tcf for the clathrates. Some of these processes still require a fair amount of development before commercial production is possible. On the other hand, there are now substantial commercial prospects for non-natural gas manufactured from coal and various organic materials.

From conventional sources alone, we believe, it is conservative to project a worldwide growth of natural-gas production of some 4% or 5%—about the rate that prevailed during the 1970s. This implies that by 1990 world supplies of gas will be the equivalent of more than 40 trillion barrels per day of oil (vs. around 28 million barrels today). During this century, gas supplies will probably provide the largest single alternative to OPEC oil.

In focusing on future price prospects, two other sources of supply must be considered: oil produced by the Communist countries and non-OPEC oil from the rest of the world. Our best estimate of Com-

munist production during the 1980s is for annual growth of 2% to 4%. We assume that Soviet production will be essentially flat but that the Chinese, now making a major expansion effort, will have growth at a 10% rate.

Oil from other non-OPEC countries will play a somewhat larger role in reducing OPEC shipments during the 1980s. The annual production increases for the first half of the decade can be estimated fairly closely, since in this period we are essentially talking about planned development of fields already discovered. Mexico should increase production by a minimum of 250,000 barrels a day and a maximum of some 400,000 barrels. In the United Kingdom, the range is 350,000 to 450,000 barrels. For the non-OPEC free world as a whole, estimated growth ranges from a shade over one million barrels a day to 1.85 million barrels. These figures represent growth of 5% to 7% a year.

The records are being broken

What about the second half of the decade? For this period, we can no longer rely on the development of known oil fields. We must project the amount of producible oil that will be discovered during the next few years. However, there are some solid reasons for making the projections optimistic.

The main reason is that the 1979-80 rise in oil prices has already given major impetus to the search for new supplies. The exploration budgets of the major oil companies are at all-time highs. The number of active seismic crews is growing rapidly; in the U.S., it reached a 22-year high in 1979 and is still rising. The number of active drilling rigs is expected to set a new record each year.

The technology available to searchers for oil has recently undergone major improvements, the most significant resulting from the application of high-speed computers to the processing of seismic data. This technology has apparently made possible several exciting new discoveries, including the Overthrust Belt in the U.S. Exploration will be further aided by such

advances as self-contained seismic instruments that can be dropped from helicopters into relatively inaccessible areas, with the required data then transmitted by telemetry.

Against this background, it seems reasonable enough to assume that present price levels would leave non-OPEC free-world oil production in the late 1980s growing at the same 5% to 7% rate that is foreseen for the earlier part of the decade. This would imply a growth of such production to a level of 30 million or even 40 million barrels a day by 1990, compared with about 20 million at present.

Combining this figure with our projections for Communist oil supplies and worldwide gas supplies gives us total non-OPEC supplies that are the equivalent of around 100 million barrels a day by 1990, compared with around 60 million barrels now. These projections imply major problems for OPEC in the years ahead. If worldwide demand for oil and gas continues to grow at the 2% average annual rate that has prevailed since 1973, OPEC shipments will decline steadily. Even if supplies grow only at the lower end of our projected ranges, the organization's exports would shrink each year by about 3% (a million barrels a day).

A time to cut prices

And if supplies grow at our maximum rates, there would be virtually no demand for OPEC oil by 1990—at least, there would be no demand at present prices. In reality, of course, OPEC would be cutting prices in this situation. OPEC as an organization would plainly come under severe strains, and it seems possible that these could reduce cohesiveness and discipline still further.

We believe that the U.S. should be furthering this process—and hedging against the possibility that demand for imported oil will be stronger than expected—by implementing energy policies designed to encourage conservation and foster production. But even without such policies, the illusion of a strong OPEC cartel is apt to be crumbling in the years ahead. ☐

A-6

FOLLOW-UP

Can OPEC Survive the Glut?

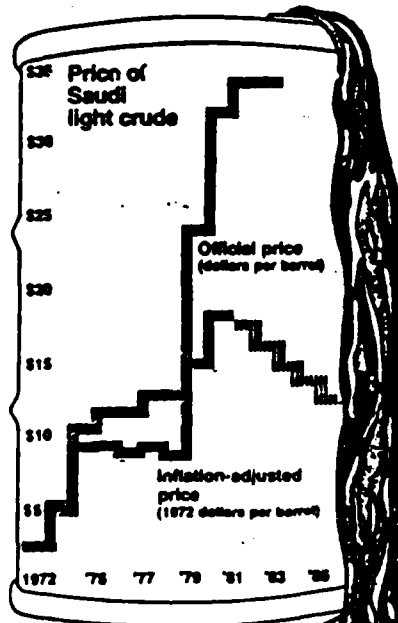
by WILLIAM M. BROWN

In *FORTUNE* last year, William M. Brown and Herman Kahn of the Hudson Institute presented a seemingly far-out analysis of the future of OPEC and oil prices ("Why OPEC Is Vulnerable," July 14, 1980). OPEC's oil exports, they argued, would shrink during the 1980s and oil prices would decline, not keep rising as almost everybody then believed. Rosy though they seemed, the Brown-Kahn predictions derived from careful analysis, and they soon began coming true. In the following article, Brown, a physicist and director of energy studies at Hudson, takes an updated look at OPEC's prospects. His analysis suggests that they've grown even bleaker.

Despite the much-noted oil glut, Americans generally still appear to believe that oil prices will continue moving up in the years just ahead—that, after all, is what experts have been telling them. According to my analysis of the oil outlook, this picture of the future is quite mistaken. We are in for lower, not higher, oil prices. It is pretty safe to predict that world oil prices in 1985 will be lower in real terms than the unified official price of \$34 a barrel agreed upon at the OPEC meeting in Geneva in late October. The official price in 1985 may be higher than \$34, but inflation and discounts will probably bring real selling prices considerably below \$34 in 1981 dollars.

The glut has already reduced OPEC's oil exports from a 1979 rate of over 28 million barrels per day (mbpd) to less than 21 mbpd currently, and there is no reason to expect exports to get much higher than

that for at least a few years. Consequently, competition for market shares within OPEC is likely to increase and to result in further price declines in real terms. After two or three years, a downward price spiral resulting from these economic pressures could even bring an end to a pervasive illusion of the 1970s—that OPEC is a powerful cartel that can impose its will on the marketplace.



Some observers describe the current glut as a short breathing space that will end soon when OPEC gets its act together. OPEC did get its act together to some extent at Geneva, and afterward Sheikh Ahmed Zaki Yamani, the Saudi oil minister, announced that Saudi Arabia would cut its output to 8.5 mbpd to support the new \$34 price—a cut of about a million barrels a day. That, he predicted, will bring the glut to an end. Nonetheless, I expect that the glut will grow larger. There are at least seven reasons to think so:

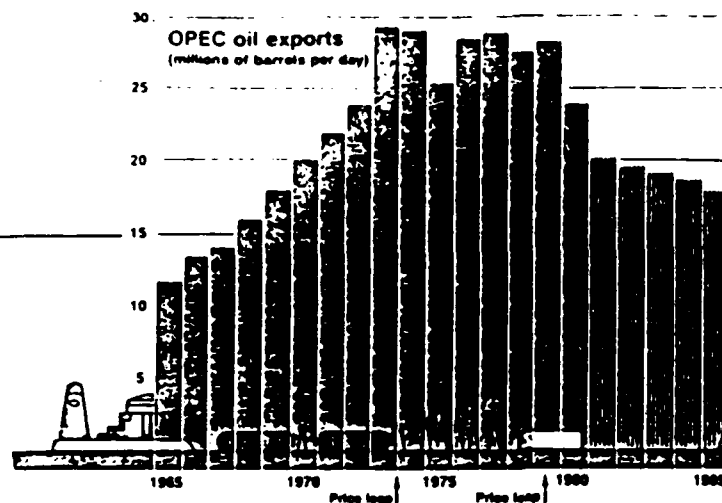
■ **Energy conservation.** Since the Arab oil embargo, the impact of energy conservation in the major industrialized countries has been impressive. Energy efficiency should continue to improve at least through the remainder of this century. Technological improvements already scheduled point to efficiency gains of 30% to 50% in motor vehicles and in energy-intensive industrial processes.

■ **Switching to alternative fuels.** For the next 20 years, significant growth is likely in the worldwide consumption of energy from sources other than oil—coal, natural gas, nuclear power, hydroelectric power. As a rough estimate, over the next two decades switching to alternative fuels may be equivalent to discovering each year a new giant oil field that would produce between 0.5 and 1.0 mbpd.

continued

Downhill from Here

Between the surges of 1973-74 and 1979-80, oil prices declined somewhat in real, inflation-adjusted terms. Now they're headed downward again. The chart shows year-end prices, so the official price for 1981 is \$34, the figure OPEC announced in October, adding that it would hold through 1982. Continuation of this price post 1982 is assumed in the projections of the inflation-adjusted price. These projections by author William Brown are based upon an average inflation rate of about 9%.



OPEC Pays a Price

During the Sixties, OPEC's export volume grew 10% a year, but growth stopped after the price leap of 1973-74. Exports never regained the 1973 high. After oil prices more than doubled in 1979-80, export volume went into what threatens to be an extended decline. In short, demand has responded to prices—just as basic economics says it should.

■ **Slowed economic growth.** For the industrialized countries as a whole, the OECD expects economic growth in 1981 to be a little more than 1%, about one-third of "normal." A return to the vigorous growth rates of the Sixties and early Seventies appears at least a few years off.

■ **Inventory reduction.** Early this year, stocks of petroleum in importing countries were close to their all-time peaks. The above-normal amounts held by governments, oil companies, and consumers might add up to as much as 1.2 billion barrels. Both oil companies and consumers can be expected to reduce inventories toward normal during a prolonged glut.

■ **Non-OPEC production.** Since soon after the Arab oil embargo of 1973-74, non-OPEC oil production has been climbing fairly steadily by 5% to 6% a year. Based on existing oil discoveries and investments in oil-field development, this growth appears sustainable over at least the next few years. Even beyond the next four or five years, there appears to be a reasonable chance of maintaining a 5% growth rate for a while, because of the current unprecedented level of effort in the worldwide search for new oil and gas fields.

■ **Production from Iraq and Iran.** As a result of the stalemated war between Iraq and Iran, oil production in those countries together is running about 4 mbpd below their 1973 output. In two or three years, if not earlier, it is quite possible that Iraq and Iran will find some face-saving exit from their conflict and that most of the war damage will be repaired. Any rise in their production would, of course, put additional

pressure on the other members of OPEC.

■ **Falling oil prices.** If oil prices are flat or declining in real terms over the next few years, as I expect, some OPEC countries will probably attempt to increase their export volumes as a way of keeping their income up. The dilemma facing each member is that the only effective way of accomplishing this is likely to be through price reductions. Each such action, however disguised, could then spur other OPEC countries to cut their prices (or increase discounts). A downward price spiral could follow, the bottom of which can only be conjectured.

One way for OPEC to counteract the impact of these seven factors would be to establish a system of production quotas. However, the outlook for effective agreements of this type in OPEC is dim.

A double burning

Without either quotas to hold down supply or a sharp drop in prices to lift demand, the only factor that could significantly ease the current oil glut would be an outbreak of serious disturbances involving oil-exporting countries. Thus, one can easily imagine a renewed escalation of fighting between Iraq and Iran or the eruption of mass riots, revolutions, or wars in other OPEC countries, or even a new war between Israel and some Arab country. But such events are not likely to alleviate the current glut enough to stabilize or increase prices for any extended period, as long as nothing comes along to close down Saudi production.

Declining prices in the early 1980s

would increase demand for oil, but by how much? I expect oil demand to be less responsive to declining prices than other commodities would be. After all, consumers and businesses in oil-importing countries were burned twice, by price surges in 1973-74 and 1979-80. Those experiences will linger in our minds for decades.

Lower oil prices over a few years are likely to be interpreted as a trap into which no alert nation, or business, should fall. Declining oil prices might induce government intervention—for instance, tariffs—to keep the domestic price of oil artificially high and ensure that dependence upon oil imports will not increase. Governments would be glad to get the additional revenue too, of course.

Gradual price erosion, then, is unlikely to reverse the declining trend in demand for OPEC oil anytime soon. With the already wide gap between OPEC production capacity and OPEC exports growing wider still, a Saudi production cut to about 5 mbpd might be required, even before the end of 1982, to maintain the \$34 price. Moreover, an additional cut of perhaps 2 mbpd might be needed by the end of 1983. Economic analysts believe that if Saudi exports should fall below about 6 mbpd, the government would probably have to cut back the country's economic-development budget—unless the Saudis are confident enough about the future to draw down their cash reserves.

If the Saudis choose to reduce their output to 5 mbpd during 1982 to defend the \$34 price, they could find themselves looking at 1983 and beyond with trepidation.

continued

tion. My estimate for total OPEC exports for 1985 is 18 mbpd (see chart page 90). That level could be perhaps 12 or 13 mbpd below OPEC's maximum sustainable export capacity. Also, a constant \$34 price in nominal dollars for another four years implies roughly a 30% decline in real income even for OPEC members that maintain their export volumes. Unfortunately for OPEC, attempts to gain greater market shares for individual members would also tend to make oil prices fall more rapidly for them all. The situation suggests that oil prices have already reached their peak for the early 1980s, if not for much longer.

Trial by glut

Although OPEC is generally referred to as a cartel, it has never behaved like one. Any producers' association may appear to be in relatively strong control of pricing and production arrangements during a rising market. The crucial test of effectiveness, however, occurs when the organization is faced with a declining market—a glut, not a shortage.

On the record, OPEC was not successful from 1974 through 1978. During that span the inflation-adjusted price of petroleum actually declined, as the chart on page 89 indicates. OPEC was temporarily "saved" in 1979, not by its wisdom, but by the prolonged oil-buying panic that followed the revolution in Iran. After the market began to soften again in mid-1980, a new rescuer appeared in the form of the Iraq-Iran war. Now OPEC is facing the beginning of another major test—one that could threaten not only its income, but its existence.

A strategy of deliberately moving oil prices lower might help to save OPEC, if anything can. In the absence of an OPEC agreement on production quotas, the Saudis alone cannot be expected to cut their output enough to keep real oil prices from falling. To support the official price might require the Saudis to surrender their entire export market by 1985, an obviously unacceptable outcome.

What we can expect over the next few years, then, is gradual erosion in real oil prices, probably with official OPEC prices

remaining stable or going up very little. A faster price retreat, with actual cuts in official prices, would make sense on economic grounds, but that would stir up internal political troubles. Arabs tend to look upon their oil reserves as a precious national heritage; price-cutting can easily be interpreted as an outrageous act—like selling the family jewels to a pawnbroker.

In view of all this, the Saudis—indeed all OPEC members—may soon become enmeshed in a Catch-22 situation. To follow an intelligent long-range plan, deliberately lowering prices, may invite political ruin. But if the Saudis don't take that course, economic forces may make a shambles of the international oil market within a few years. After that, no one could confidently foresee how low prices might fall or what the political consequences would be.

The spot market is likely to remain soft for a long time. Within the next few months, some member countries will probably be offering oil at discounts from the \$34 "official" price, perhaps \$1 to \$3 per barrel. By 1985, and possibly much sooner, the official OPEC prices could completely unravel. The struggle for market shares may by then have caused prices to decline substantially—perhaps to less than \$20 per barrel in 1981 dollars. Indeed, they might even sink below \$15.

A road to de-escalation

Economists and businessmen generally agree that the prospects for long-term economic stability and prosperity worldwide become better if prices of important commodities vary gradually—in "small doses," as Sheikh Yamani put it—within a reasonable and predictable range. Saudi Arabia appears to be the only OPEC country that both understands this point and, for its own reasons, cares about it. The ideal Saudi strategy would help bring oil prices into such a range and keep them there over the long term—not out of altruism, but because the Saudis are convinced that it would be best for them.

Let us assume the Saudis conclude that their long-term economic and political in-

terests would be much better served by oil prices somewhat lower than \$34 per barrel (in 1981 dollars), perhaps \$25 per barrel. In the oil-importing countries, expectations of a stable real price equivalent to \$25 in 1981 dollars would probably cause the delay or cancellation of many of the high-cost energy projects now contemplated. For example, synthetic fuels from coal or oil shale are usually justifiable only at prices between \$30 and \$60 per barrel. And exploration for conventional oil and gas in many frontier regions could become only marginally interesting at the \$25 price. Lower oil prices would probably discourage the Alaskan natural-gas pipeline, postpone development of tar-sands projects, reduce the desirability of switching to coal, postpone some investments in conservation, and increase current appetites for petroleum fuels. Lower oil prices also would mean stronger economic growth in oil-importing countries, and that would help buoy demand for OPEC oil.

Preparing for the shock

If the Saudis undertake to bring oil prices down, how might they proceed? In early 1982, discounts and sinking spot-market prices may well push the effective price two dollars or more below the \$34 official price. The Saudis will then find that some of their market is about to slip away to OPEC competitors. A plausible scenario of what comes next might run as follows: In the spring of 1982 the Saudis—for political reasons—announce a small cut in output, 0.5 mbpd, and play it up as a move to support prices, even though they want the decline to continue. An OPEC meeting in May, let's say, fails to change the official price or to reach a production agreement. By August the Saudis have prepared their populace for the shock: they announce that widespread discounting and predatory practices of some exporting countries have forced the government to reduce the official price of Saudi light crude back to \$32. Again for political reasons, they also promise another 0.5-mbpd production cut late in the year. The Saudi cutbacks, however, barely match the decline in total

continued

OPEC exports. The formal Saudi price reduction dismays some members of OPEC, but those unwilling to face further shrinkage of their export volume have to match the new \$32 price, either openly or through discounts.

The Saudis repeat this process, letting market forces erode official prices through inflation and discounts, then lowering their official price to meet the competition and at the same time announcing a small production cut. Their goal is to establish by mid-1983 if not sooner a stable market for OPEC exports at stable real prices. This market, at, say, \$30 a barrel in 1983 dollars (about \$25 in 1981 dollars), should absorb about 21 mbpd of OPEC supplies, with the Saudis furnishing about 7 mbpd. At that point, OPEC, now clearly under Saudi leadership, meets and announces that future prices will be increased regularly to keep up with inflation—perhaps a little bit more. Presumably OPEC has learned the lessons necessary to maintain a reasonably stable long-term market.

The no-win prospect

While the numbers in this scenario are unavoidably somewhat arbitrary, they indicate how this phase of the Saudi strategy might be brought to a successful conclusion with minimum trauma to themselves and other OPEC members. If everything works out well for Saudi Arabia, OPEC's 21-mbpd export level would not decline any further during the 1980s, and should rise slowly during the following decade.

This ideal Saudi strategy, even if attempted, would not necessarily lead to a stable market. The Saudis would need luck as well as skill. A collapse of prices, and possibly of OPEC, seems a more likely outcome. However, it is just that kind of outcome the Saudis—and the oil-importing countries too—should want to prevent. The political turbulence following a price collapse might turn into chaos. And neither the OPEC countries nor the oil-importing countries are likely to profit from the unpredictable large swings in oil prices that could well follow. Over time we might all be losers. [E]

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