LIMITS ON SAUDI ARABIA'S OIL PRICING POLICY: A SHORT-RUN ECONOMETRIC-SIMULATION MODEL

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ABSTRACT

LIMITS ON SAUDI ARABIA'S OIL PRICING POLICY:
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Crude petroleum, despite its presence and usefulness since the 1870s, came to hold an unprecedented importance during the 1970s -- a decade dramatically but erroneously called the "energy crisis decade". Analytically, this study traces the evolution of the international oil industry from privately-owned and dispersed production units to its highly-integrated oligopolistic structure, to its cartel-like phase, and lately its state of devolution into quasi-cartelization with tendencies toward competitive price-setting.

The quasi-cartel phase (1970 to 1980) witnessed OPEC members' inability to maximize joint revenues; nevertheless this was an impressive episode of income transfers to the OPEC members. The absence of a unified OPEC policy is largely attributed to frequent Saudi Arabian pricing/production decisions to influence oil price changes. Such demonstrated ability in the past prompted many to attribute oil price current downward rigidity to Saudi Arabian unwillingness to increase production. Empirically, this study presents a simultaneous equations oil market model in a simulation setting to test the above hypothesis and to predict future oil prices under specific assumptions.

Three supply sources are identified: a) major non-OPEC producers (Britain, Norway and Mexico) assumed to be price-takers; b) the OPES group (OPEC excluding Saudi Arabia) acting as price-maximizers; and c) Saudi Arabia's supply decisions assumed constrained by budgetary requirements. The simulated, non-cooperative assumptions enable this study, based on 1970-1984 statistical data, to predict supply responses by the OPEC group excluding Saudi Arabia to unilateral, sudden and non-transitory Saudi Arabian production variations and the ultimate effect of such actions on oil prices.

The major conclusions of this study are: 1) contrary to popular belief the international oil industry rarely, if ever, operated competitively, 2) the sole association of oil price increases to the embargo of 1973 is an outright distortion of facts, 3) the roots of the so-called energy crisis lie in: a) post-World War II West European reconstruction, b) U.S. industrial adjustments from a war to a consumer-oriented economy, c) the continuously dwindling oil reserves in major industrial countries, and d) the comparative advantage of location and cost-per-unit of the Middle Eastern oil, 4) barring further market institutionalizations, a per barrel price below $15 by the end of 1990 (in constant 1984 prices) is not unlikely, and 5) future Saudi Arabian pricing/production policies to exert downward pressures on prices could lead to price increases, if perceived to be permanent by the OPEC group excluding Saudi Arabia.

DEDICATION

To the memory of my father who always anticipated changing conditions, trusted his instincts, and put forth his views succinctly and straightforwardly. And, to my mother . . . for her love, patience, understanding and encouragement.

"We, in Saudi Arabia, have made a transition from a modest beginning to the microchip era. In many ways, and in more than one avenue of our life we "ticked" faster than a quartz watch . . . I sometimes wished we had a stopwatch instead."

<u>The late Mr. S.M. Bagour (the author's father)</u>

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LIST OF ABBREVIATIONS

AER: American Economic Review

API: American Petroleum Institute (also oil gravity measure)

bbl(s)/d: Barrel(s) a day

bbl(s)/y: Barrel(s) a year

BTD Model: Becker-Telser-Danielsen model

CFP: Compagnie Francaise des Pétroles

COMECON: Council for Mutual Economic Assistance

ECMET: Econometrica

ENJ: The Energy Journal

GAO: (U.S.) Government Accounting Office

JED: Journal of Energy and Development

JEL: Journal of Economic Literature

JPE: Journal of Political Economy

NYT: The New York Times

OGJ: Oil and Gas Journal

RES: The Review of Economics and Statistics

STATOIL: Den Norske Stats Oljeselskap

WSJ: The Wall Street Journal

CHAPTER I. THE SETTING AND THE PROBLEM

1.1 INTRODUCTION

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CHAPTER I. THE SETTING AND THE PROBLEM

1.1 INTRODUCTION

Resource economists as well as economic historians may not resist the robustness and elegance of summarizing the developmental experience of Saudi Arabia with reference to a single natural resource: oil. For the economic and social transformation that Saudi Arabia has undergone since the early 1960s and is still witnessing could not have been attained at its observed scale or pace without the massive infusion of oil revenues.

The developmental experiences of other oil-producing countries in comparison to Saudi Arabia's experience, however, do not vary significantly. From a purely theoretical view, oil-producing countries' development efforts are novel. After World War II, economic development theoreticians took comfort in identifying a set of socio-economic and institutional characteristics to group the world into three neatly-nested categories: developed, developing, and underdeveloped. Low income per capita, reliance on the agricultural sector as a major source of national income, and low human productivity (mainly due to a population growth rate outstripping growth rate of capital stock) were, and to a large extent still are, the major fundamentals upon which international economic progress comparisons are based. The elegance of countries' grouping and the almost universality of economic backwardness characteristics gave students of the field an illusive promise. The two decades, 1950 to 1970, witnessed a rise of development theories that invariably reduced development efforts to identifying and relaxing a set of constraints. The intellectual "mirage" began with the vicious circle theory (low per capita income is responsible for the paucity of personal savings, and thus insufficient domestic capital is the bottleneck); increased demand is the initiating development force (save your profits, spend your wages); the stages of economic growth (an inevitable socio-economic progression for orderly development); the leading sector argument (specialization based upon natural endowments); the big push theory (capital shock to a sleeping economy); the basic needs approach (the anti-climax to distribution via growth); and finally, the supply side growth orientation (a blatant public policy in favor of those who "have" and "can") (Hagen, 1975, pp. 162-194; Meier, 1970, pp. 169-190, 420-479; Yotopoulos and Nugent, 1976, pp. 3-14, 164-182).

A theoretical fallacy to which almost all market development theoreticians committed themselves rested within a premise that could be safely summed up as: "market passive participation." Patterns of demand for the products of developing countries as expressed in world markets would determine their products' price. Developing nations were encouraged to produce efficiently (utilize the unlimited supply of their zero, if not negative, labor marginal productivity à la Lewis' dualism)[1] and engage in foreign trade. In essence, the world market loomed larger to nullify individual efforts of pricing above true marginal costs.

That the effort of a single supplier to charge a price above the competitive market is doomed to fail was, and still is, an indisputable axiom among economists; that the collective efforts by commodity suppliers to render the above assumption invalid were hardly perceived. For _the few_, the _far-sighted_, the _doom-sayers_, even if such a phenomenon should rise, it would be short-lived. This conviction grew out of theoretical modeling and previous unsuccessful efforts toward collective action by primary resources suppliers (Stocking and Watkins, 1946, pp. 3-14). Thus, studies of international resource development and trade enjoyed an era of tranquility, if not dormancy, theoretically initiated and historically supported.

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[1]Lewis, W. Arthur, _Economic Development with Unlimited Supply of Labor_, Manchester School of Economic and Social Studies, May 1954, Vol. XXII.

Oil producers, however, proved to be "mavericks"; be it a divine choice or a foul of nature, they were awakened by the unexpected economic importance of their petroleum. Traders by heritage and education, they needed not look beyond simple arithmetics to realize the role oil played in augmenting the industrial machinery and enhancing the living standards of their wealthier and more prosperous trade partners. And it took them a while, almost 25 years, to realize that the commandment of "passive participation" in world markets was neither necessary nor sufficient to insure economic salvation. Their admiration grew for the market role the oil companies enjoyed over pricing their resource; and as good students, they emulated the then existing intra-companies' coordination strategies to enter the market, a power arena in reality, as active participants.

For one to claim that the then major oil producers' (Venezuela, Saudi Arabia, and Iraq) sole objective for collective action was economic gains is sheer ignorance, if not outright disingenious. The early years of the Organization of Petroleum Exporting Countries (OPEC), 1955-1970, were the cradle of worldly progressive thinking [ask not what your country can do for you; ask what you can do for your country] and the infancy years of OPEC were a true reflection of the character of its "founding brothers" (Duguid, 1970, pp. 195-220). The coordination efforts between Venezuela, Saudi Arabia, and Iraq and the slow emergence of OPEC since the 1950s find their potency in the unique blend of its most famous proponents: the then Saudi Arabian Director-General Mr. Abdullah Al-Tariki and the then Venezuelan Minister of Hydrocarbons, Mr. Alfonso Pérez. Where the first was aflame with enthusiasm and a faithful nationalist, the latter was a quiet and pragmatic diplomat. They at many times differed over the role of foreign oil companies in their respective countries' economic affairs; at times they disagreed over a bargaining strategy; and more than once they struggled over the use of their respective countries' political support to influence an outcome. Yet, they rarely permitted their differences to surface in an official meeting. Oil companies' spokesmen almost unanimously report that one would be discussing an issue with Perez and hearing the views of Tariki, and vice versa. OPEC benefited greatly from the wisdom and paternalistic devotion that both Perez and Tariki generously offered.

OPEC, with particular reference to international resources development and management, is more than an economic phenomenon. The duration of its command over pricing and exploiting its members' petroleum resources is almost unparalleled. Aside from the huge financial revenues, the pace of modernization enjoyed, and the worldly political influence, OPEC had introduced new realities: *first*, that development efforts, contrary to conventional wisdom, cannot realistically be viewed as passive responses to market conditions; *second*, that natural endowments specialization (à la Heckscher-Ohlin mode) have to be recast in coalition settings if it is to have practical relevance; *third*, that resources development and exploitation is subject to economic as well as political objectives; and that economically-motivated "nation-coalitions" may be more of the norm than the exception; and *finally*, that theoretical premises regarding the rise/demise of entrepreneurial cartels may not necessarily hold in the case of sovereign-states cartels.

With the intention to address these issues, this study is undertaken.

1.2 PROBLEM STATEMENT AND STUDY OBJECTIVES

Current OPEC members, given the size of their proven reserves, the relatively low costs of production, and the relative ease with which current production capacities could be augmented could, through various oil-supply policies, influence not only the ultimate world oil market price but the rate at which non-OPEC additional oil investments could be undertaken and the pace at which alternative energy sources could come forth.

Saudi Arabia, a member of OPEC, through manipulating its oil supply, had been able to influence the rate of increases in oil prices. Within the foreseeable future, Saudi Arabia stands alone in its ability to augment its productive capacity, given the size of its proven reserves and the existing petro-infrastructure, to ameliorate sudden supply interruptions/shortages.

For this, and undoubtedly a host of other factors, Saudi Arabia has been subjected to tremendous worldwide pressures.[1] These pressures have taken many forms, ranging from outright "over-pricing" its purchases of physical capital and implementation of public and private development projects to, unfortunately, speculative schemes of direct "takeovers" of its oil fields (Ignotus, Harper, March, 1975). Notwithstanding the hoax of the latter, intermittent Saudi production increases have been induced under the lure of: greater internal stability, cessation of regional turmoil, the overall impact on world economic and political stability, expanded bilateral educational and technical agreements, the establishment of joint commissions on economic cooperation, preferential access to private and public financial assets and, not the least in a list of many, arms sales.

The record of the last decade has shown that many of these promises could have been fulfilled without the "high" price paid for them, i.e., increased Saudi production.

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[1]See: Report to the Congress of the United States (GAO: Washington, D.C., May 12, 1978).

Eroding value of financial assets; subjugation of these assets to political whims; suspected technical feasibility studies and social unacceptability of a number of projects implemented; imposition of contractual clauses that could render some of the equipment purchased inoperative, and increasing tendency toward protecting petro-chemicals' Western markets[1] are, at least, unpleasant indications. At the heart of the above claims is the market price of oil.

The objective of this study is to investigate the assumed economic power assigned to Saudi Arabia in terms of influencing the ultimate world price of oil. Thus, we intend to estimate the ensuing price of oil under assumptions pertinent to the demand for oil, the non-OPEC sources of supply, and OPEC with the exclusion of Saudi Arabia, with a specific modeling of Saudi economic behavior. The analytical frame of the study problem is viewed as:

a) given a set of resource-utilization assumptions pertinent to non-OPEC oil producers,

b) given a set of assumptions pertinent to the economic behavior (objectives) of OPEC producers (excluding Saudi Arabia),

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[1]See: "Saudi Petroleum Buildup," OGJ, February 4, 1985, p. 33.

c) identifying a maximum sustainable production constraint and a minimum expenditure requirement,

d) what, then, could be the world price of oil when Saudi Arabian production levels vary within the identifiable boundary.

Conceptually, this approach differs markedly from previous work (see Chapter VI, Sections 6.1 to 6.4). In contrast, Saudi Arabia is not postulated here to play the role of the residual supplier. A market gap that may ensue between insufficient oil aggregate supply and the quantity of oil demanded at any time (i.e., excess demand) would translate itself into higher prices. In addition, the introduction of a specific welfare function for Saudi Arabia rules out the price-moderation-behavioral assumption that had swamped OPEC modeling-behavior studies. Instead, Saudi Arabia is assumed to exhibit an inward-looking policy.

1.3 IMPORTANCE OF THE TOPIC

There are a number of focal points where one could assess the contribution of this kind of research. At an outer boundary the place of energy resource, its relative costs and uninterrupted availability could hardly be exaggerated whether the perspectives were the technologically advanced countries, developing nations, or even the less developed countries. To an industrial country, the concern may lie in the relative costs of energy and stability of supplies. Granted that the majority of the industrial countries have a ready access to their own petroleum as well as other energy-producing resources (such as coal, hydroelectricity, nuclear, wind or solar) volatile (i.e., non-market oriented) changes in the price of oil could entail massive "retooling costs" which, other things constant, would be reflected in the market price of a country's own goods and services. Nations produce to consume within their own boundaries and to trade with other nations to satisfy the diversity of current, consumptive needs and/or augment current and future production and consumption standards. An unexpected rise in the price of oil would necessitate an accommodating or insulating policy choice (monetary and/or fiscal), the choice of which rests largely with a country's development stage of its energy sector. The policy response would ultimately have its impact on other resources markets, the labor market, and the financial sector. Given a country's relative weight and composition of its foreign trade (to its own domestic economy), industrial countries may have a larger range in either domestically absorbing or shifting a portion of their energy bill to other trade partners.

For a developing nation or an underdeveloped country, the intended effects of manipulating fiscal and/or monetary policy tools might be less predictable. Where the policy emphasis might be on developing financial institutions to retain and augment domestic capital or attract foreign investments, "over-adjusting" the price of a national currency [i.e., devaluation] may lead to a temporary surge in the trade side of the balance-of-payments at the expense of an increased domestic inflation rate. An increase in oil price may require an increase in commodity (indirect) or income (direct) tax rates which, other things constant, could affect personal disposable incomes and national saving-to-income ratios.

To the oil-producing countries, the majority of which depend on obtaining revenues by exporting a small bundle of natural (or semi-processed) natural resources, the situation is less prone to policy manipulation. They have more than an economic incentive to maximize the obtainable market price of a unit of oil. An increase in the price of oil means, in simple arithmetic, an increase in public spendable income. Whereas to most oil-importing governments an increase in the price of oil may mean market adjustments and intensification of efforts to further develop their own energy resources to an oil-producing government, more often than not it translates into political survival. Given that in oil-producing countries petroleum resources are publicly owned and given that public expenditure is the major if not the only stimulating force, then efforts in the fields of economic diversification, investment in human capital, public industry subsidization, and public welfare programs all hinge upon the per-unit oil revenue. In addition, oil revenues are the major source to obtain physical capital, contract for skilled labor and finance private consumptive needs. The concerns of the early 1970s due to large accumulation of financial surpluses accruing to oil producers (due to oil price increases) have been quietly silenced as witnessed by the scope of almost all oil-producing nations' participation in international trade. To close the circle, an increase in the price of oil, *ceteris paribus*, reflects possibly a more than equivalent proportional increase of marketing possibilities for the industrial countries' goods and services.

To Saudi Arabia, the research topic is just as relevant if not truly needed. The three ambitious development plans (1970-1985) upon which Saudi Arabia has embarked could not have been conceived without the associated increase in the price of oil. Not only has Saudi Arabia been able to carry out its major development projects but the sudden wealth status had also enabled it to partake in new regional and worldly diplomatic roles. From a foreign relations historical perspective, it would be safe to hypothesize that the events that led to the rapid development of the oil sector are by themselves crucial parameters impinging upon the direction and scope of Saudi Arabia's diplomatic relations.

Western countries' (and particularly the U.S.) involvement in Saudi Arabian trade and development dates back to the discovery of oil in the 1930s. The Arabian-American Oil Company (ARAMCO), whose assets are now Saudi government-owned, began to develop the kingdom's oil industry and had been a prime mover in designing feasibility studies and implementing major petro-chemical projects (as witnessed by the rapid development of petro-complexes in the towns of Jubail and Yanbu).[1] In June 1974, Saudi Arabia and the U.S. agreed to establish a joint Commission on Economic Cooperation; a reciprocal technical cooperation agreement was signed in February 1975, and permanent U.S. representation to the commission was established in the kingdom's capital (Riyadh). Under commission auspices, cooperation between the two countries has grown in such fields as technical training and education, agriculture, sciences and technology, transportation, government administration, industrialization, and solar energy research (Vielvoye, OGJ, pp. 74-78).

Saudi Arabia is the largest Arab customer for U.S. products and services and the sixth largest market for U.S. products worldwide. In 1982, U.S. exports to Saudi Arabia amounted to $7.9 billion, while imports totaled $3.8 billion; as of 1982, U.S. (21 percent), Japan (19 percent),

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[1]See: NYT, pp. D-1, D-5, October 17, 1979.

West Germany (11 percent), Britain (7 percent), Italy (6 percent) and France (5 percent) were the major sources of Saudi Arabia's imports with almost 70 percent of Saudi Arabia's imports originating in these countries (See: SAMA Annual Report, 1983, p. 60). In 1984, more than 500 U.S. firms maintained offices in the kingdom; many of these firms entered into joint ventures (with Saudi partners) and their services extend into the fields of engineering, construction, health, and consumer and defense services (See: "Gist," U.S. Department of State, Dec., 1984).

Being a member of OPEC with the largest proven oil reserves, financial surpluses, and expansible production capacity, and with the political situation in the Middle East as it stands now (the chronic Arab-Israeli conflict, Soviet occupation of Afghanistan and Soviet military presence in the southern parts of the Arabian peninsula and the African Horn, the political factions war in Lebanon, the Iraq-Iran war, the Gulf Cooperation Council) Saudi Arabia is unavoidably immersed in the grandiose "congeries" of world foreign relations. A Saudi Arabian economic decision hinges upon six interlocking axes:

a) Saudi Arabia's economic and political interests,
b) Saudi Arabia's economic and political initiatives toward Arab unity,
c) Saudi Arabia's membership obligations to the objectives of OPEC,

d) Saudi Arabia's responsibilities as guardians of the holiest Moslem shrines, and the support for Islamic brotherhood,

e) Saudi Arabia's economic, political, and security relations with its western partners, and

f) Saudi Arabia's responsibility as a member of the world community in terms of international economic stability and political calamity.

Increasing petroleum revenues had enabled Saudi Arabia to ameliorate some of the regional political turmoil, extend financial assistance (grants and low-interest loans) to a large number of less developed countries, and partake in a larger aid role through the international organizations. At the domestic level, development and diversification efforts have clearly underlined the need for socio-economic and institutional adaptation. Discussions of this subject remain in the realm of speculation or educated guesses at best due to insufficient studies on the subject. It is the observation of this author, however, that a number of concerns still require some satisfactory answers. Some of these are:

a) Questions regarding the scope of the current development projects with reference to population and its growth rate [the population base has been estimated at 8.5 million endogenous inhabitants at best].[1]

b) The extent to which petro-dollars are substitutable for a well-defined Saudi foreign policy both regionally and worldly, and

c) The extent of Saudi Arabia's fulfillment of its obligation to OPEC's objectives and maintaining an oil price consonant with its price-moderation policy.[2]

In 1983, Saudi Arabian proven oil reserves were estimated at more than 166 billion barrels; these reserves, at the current world oil consumption, should carry the country well into the 21st century. Currently, Saudi Arabia accounts for 10 percent of the non-Communist world crude oil production, and only the U.S. and the U.S.S.R., from a position of declining reserves, produce more. Thus, until the Saudi Arabian economy reaches a stage where more than one resource could significantly contribute to national income, oil pricing policies will be critical to domestic development effort and Saudi foreign policy options.

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[1]See: Saudi Report (Policy Statements by H.E. the Saudi Arabian Minister of Finance and National Economy), Vol. 6, No. 9, April 2, 1984, pp. 1, 6.

[2]See: Saudi Arabia (the Monthly Newsletter of the Royal Embassy of Saudi Arabia, Washington, D.C.). For Policy Statements of H.M. for the fiscal year 1984-1985, Vol. 1, No. 4, May, 1984).

1.4 RELEVANCE OF THE TOPIC TO THE KNOWLEDGE BASE

Synchronized production/price efforts by commodity producers are as old as institutionalized markets. Economic history books and court archives are laden with cases of producers' attempts at collusive behavior (Stocking and Watkins, 1946, pp. 14-519). The earliest recorded case of an international cartel is the salt cartel of 1301. In those days, salt was an indispensable commodity for food preservation - perhaps as important as oil as a source of energy today. Its price had been declining because of competition between the salt mines of King Philip the Fair of France and those belonging to the King of Naples, Charles II. Florentine bankers who leased these mines proposed that competition be eliminated by forming a joint company that would sell joint output at a uniform and higher price, thereby increasing their income as well as the royal incomes. Not only did financial institutions directly intervene in economic activities to serve their interests and those of their clients, but religious institutions also did so effectively. For many years, the Turks had controlled the world production of alum (a key ingredient in cloth dyeing and leather tanning); its marketing in Europe was carried out by wealthy Italian firms who paid royalties to the Turkish sultan. In 1461, however, rich alum deposits were discovered in the Papal State, and Pope Pius II, in collaboration with the Medici, set up a company for their exploitation.[1] In order to eliminate competition, the Pope officially declared Turkish alum as heathen and prohibited Christians from buying it.

Political factors and national interest justifications remain, in many cartelization efforts, the most effective, and the least accessible, to research.[2] The Organization of Petroleum Exporting Countries (OPEC) emerged under similar circumstances. As Chapter IV shows, it was due to inter-industry competition (the "Seven Sisters" and the "independents") that oil prices declined to an unprecedented level, affecting producing countries' revenues and political stability.

By 1978, resource and welfare economists' concerns focused on the eventual price that OPEC may be able to charge for its oil. Briefly, the first group's focus was the long-term implications of the resource management, i.e., the relationship between increased prices and

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[1]Historical efforts at cartelization were not solely restricted to land products. Medieval craft guilds (of which today's labor unions are a modified version) set working hours and output quotas; prohibited members from soliciting each other's customers or finishing the work started by another member, and prevented non-members from practicing their trade (through the apprenticeship system and abolishing tools lending).

[2]During the 1920s, the rubber cartel was initiated by Winston Churchill, then Secretary of State for the British Colonies, who designed the scheme and justified its organization to pay World War I debts to the U.S.

increased supply sources, whereas the latter's concerns were the distributional effects of increased prices within a given country and among nations. At the heart of these interrelated concerns was and still is the eventual price of oil.

That OPEC possessed a market power to influence oil prices became an axiom for empirical work practitioners by early 1977. This, in return, induced interest in modeling OPEC's behavior (to identify situations/conditions that could decrease OPEC's acquired market power) and estimating future price levels (by using econometric and simulation techniques). Sections 6.1 - 6.4 present a detailed evaluation of some of the major empirical work in this area. Suffice it here to identify some of the current models' environmental and behavioral attributes and contrast them with what this research aims to achieve. These are:

a) The perception of OPEC as just another market supplier in the energy market without due attention to its market power in setting prices [e.g., Adelman, 1972-73, 1980; Dunkereley and Jankowski, 1980; Hogan, 1983],

b) The selective choice of a group of OPEC members as "core" producers (usually Saudi Arabia, Abu Dhabi, Kuwait and Libya) and predicting future oil prices under cooperative assumptions among the "core"

members [e.g., Kosobud and Stokes, 1980; Saunders, 1983].

c) Predicting OPEC's behavior in future price setting over a long period of time (e.g., until the year 2010) with division among OPEC members as "savers" and "spenders" (most notable Pindyck, 1979).

In addition, the above cited works as well as others do not account for the market changes that have evolved since 1981. Some of these are:

a) The need to empirically account for the increasing production role of some of the major non-OPEC suppliers. Prominent among this group are Britain, Norway, and Mexico. An important factor explaining the current trend toward declining prices is these countries' abilities (as well as the collective production effect of some other minor suppliers such as Egypt, Oman, Colombia, Zaire, Cameroon, Malaysia, and Brunei)[1] to offer increasing petroleum for sale, thereby acting as "free-riders" and undercutting OPEC's official price.

b) Even within OPEC, the disparity among members in proven crude petroleum reserves, short-run potential for increasing oil supplies, the capacity of

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[1]As of the end of 1984, the combined crude production of these countries was estimated at 2.1/mbd with an aggregate crude petroleum reserves base of 12.4 billion barrels (See: OGJ, December 31, 1984).

existing petro-structures to accompany increased production, foreign exchange development needs, relative ease of liquidating foreign financial holdings, and availability of emergency cash; these and undoubtedly others do affect a country's (or a group's) pricing decisions.

c) Given the price setting influence that OPEC has acquired since 1971 (the phase of governments-companies price bargaining), many econometric studies (using time series data) do not separate this time period from the pre-1971 period. This is a problem of aggregation that could "contaminate" parameters estimates.

d) From the viewpoint of policy guidelines and policy options, there is a need to specify a time span within which model variables are assumed or are expected to exhibit relative stability. Notwithstanding the inevitable element of subjectivity, observations teach us that a projection horizon beyond, say, 10 years may be less relevant for the formulation of decision-making guidelines. The observed adjustment to price increases since 1976 in terms of intensified conservation efforts, improvements in industrial and personal equipment's energy use, increased availability of alternative energy sources (and/or renewed interest in existing energy sources such as coal) and increased petroleum reserves and production worldwide could render some of the guidelines based upon empirical work conducted in the late 1970s as obsolete.[1]

1.5 STUDY RESEARCH METHODS

In order to identify the limits on Saudi Arabia's potential role in influencing world oil prices, an econometric/simulation model is developed. The model presented differs from previous empirical work in terms of its behavioral premises, choice of supply policy constraints, and the length of the analytical period within which the model is assumed operative. Section 6.5 of Chapter VI is devoted to explain the proposed model.

Briefly, non-Communist[2] oil demand function is estimated using regression analysis techniques. The world supply side of the model is segmented into three

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[1]See for example: U.S. Central Intelligence Agency, The World Oil Markets in the Years Ahead (ER79 - 10327U 1979).

[2]The exclusion of the USSR is based upon its intermittent ability to fulfil its energy goals. Periodic excess capacities are either sold to members of the COMECON or disposed of in West European markets in exchange for hard currency. China, on the other hand, is still in the stage of achieving energy self-sufficiency and seems to be more concerned with using its energy resources to accelerate industrialization. Neither country, within the analytical period of this study, is viewed as a steady oil exporter.

identifiable producing groups with relevant behavioral assumptions for each group. Saudi Arabia is identified as an oil producer with a pertinent set of behavioral assumptions. The remaining two groups, namely: OPEC producers (excluding Saudi Arabia) and non-OPEC major oil suppliers complete the supply-side matrix, each with an attached relevant set of assumptions. After estimating model functions, the behavior of the model is simulated, a price range is identified and the model, as estimated, is further subjected to behavioral assumptions sensitivity-analysis to investigate potential changes in prices due to behavioral assumptions variations.

1.6 MAJOR SOURCES OF INFORMATION

The study as presented is a blend of descriptive analysis and quantitative estimates. Furthermore, the descriptive side is influenced by emphasis on quantitative events and variables. The emphasis here has come at the expense of excluding other variables (political, institutional, social, and diplomatic), the majority of which have been assigned footnote status. As such, this study is subject to the same criticisms that almost all social studies encounter, namely the segmentation of a phenomenon into smaller, more manageable yet interdependent and incomprehensive components.

For the descriptive parts, extensive use has been made of many historical references documenting the events that led to OPEC's emergence; published interviews with previous and current OPEC officials; and the U.S. congressional hearings, testimony, and the "extension of remarks" record. Extensive use has also been made of publications pertinent to world political situations (such as: Foreign Policy and International Affairs). Whenever a policy or a formal stance contradiction is encountered, trade journals (such as Oil and Gas Journal, Platt's Oilgram and Petroleum Economist) were used to sort out inconsistencies. Weekly and monthly business magazines (such as Business Week, Forbes and Fortune) and daily newspapers (The New York Times, Wall Street Journal; the Times and the Economist of England; and the Banque of France) were also consulted. U.S. governmental agencies' reports (the GAO) also were of immense help.

For the quantitative part, the end-of-year issue of Oil and Gas Journal, international organizations' statistical reports (the IMF and the U.N. Annual Statistical Reports and Forecasts of World Economy and the OECD), and oil companies' annual reports (U.S. and West Europe) were always cross-referenced for data accuracy and consistency. Only in the case of Saudi Arabia's statistical data was a country's own reporting agencies' statistical information used - this is more of the author's selective perception.

The Saudi Arabian Ministry of Finance and National Economy annual statistical yearbook and the Saudi Arabian Monetary Agency (SAMA) biannual and annual reports were used extensively.

1.7 ORGANIZATION OF THE RESEARCH TOPIC

The study as presented falls into seven chapters. Chapter I covers a larger perspective: introductory remarks, the study problem and its setting, the importance of the study and research methods. Chapter II is a physical/historical blend of petroleum as a natural resource and its pre-OPEC institutional structure. The objective of this chapter is to present an interface between the natural resource idiosyncrasies, its economics, and the evolution of the international oil industry.

Chapter II also serves as a prelude to the theoretics involved in collective resource management as presented in Chapter III. The main objective of Chapter III is to show that collusive (i.e., cartel) economic behavior, its rise and its potential destability are market initiated and embedded events. This conclusion contradicts orthodox wisdom that views cartel behavior as economically abnormal. The chapter ends with a critique of the most frequently used and cited theoretical models pertaining to the world oil market.

Chapter IV deals with a misconception about the emergence of OPEC. The rise of a unified forum for the oil producers is the final episode in a process that lasted almost 20 years. Chapter V is a logical extension of the fourth chapter and includes an evaluation of OPEC members' efforts at negotiating a unified oil price policy. The fifth chapter also shows the intra-OPEC member self-interest strategies and concludes that Saudi Arabia had tried, unsuccessfully at times and contradictory to other members' economic interests at others, to lead and implement what is termed as a price-moderation policy.

Chapter VI subjects the fifth chapter's conclusion to further quantitative inquiry. It presents an answer to a hypothetical question: "By varying its current maximum feasible production capacity, how far can Saudi Arabia impact upon world oil price?" An econometric/simulation model is developed and operationalized, the functions are econometrically estimated and model behavior is simulated. The ensuing world oil price is reported with the results of sensitivity analysis of the main behavioral assumptions.

Chapter VII concludes the study topic with a summary, conclusions, and recommendations for further research and policy.

1.8 LIMITATIONS OF THE STUDY

The proposed model's shortcomings stem from the same reasons researchers resort to modeling, viz. a simplified version of the real world capable of producing useful predictions for policy guidelines. This built-in subjectivity is usually balanced against an efficiency notion -- for the ideal model would include all pertinent variables and simulate the real world. More precisely, the proposed model assumes that all major oil price changes could be captured in the supply and demand functions -- the absence of a specified macro-economic feedback mechanism (i.e., accounting for monetary-fiscal policy intervention and conservation efforts by consuming nations) may impact upon the model's assumed simultaneity response to price changes. Although some of the economic counteractions to price changes would be captured in the lagged-variables, the n-value response may take more than one time period to complete.

At a more precise level, important portions of the data base (i.e., estimates of the magnitude of a petroleum discovery and actual production levels) are always subject to revisions. The proposed model should always be subjected to data base revision and updating.

The model environment would always be a source for results changes. Wars, coups d'état, use of petroleum for political objectives have been ruled out -- to account for the price impact of such interruptions, a supply-shock submodel should be included.

CHAPTER II. THE INSTITUTIONAL STRUCTURE OF THE WORLD PETROLEUM MARKET

2.1 INTRODUCTION

2.2 THE PHYSICAL NATURE OF THE RESOURCE BASE

- 2.2.1 THE DEBATE OVER RESOURCE FORMATION
- 2.2.2 THE RELATIONSHIP BETWEEN THE ORIGIN AND LOCATION
- 2.2.3 RESERVOIRS AND DISSOLVED GAS
- 2.2.4 PETROLEUM MAIN PRODUCTS

2.3 THE INTERNATIONAL OIL INDUSTRY

- 2.3.1 THE INTERNATIONAL CHARACTER OF THE INDUSTRY
- 2.3.2 A MODEL OF AN INTEGRATED OIL COMPANY

2.4 THE EMERGENCE OF AN INTERNATIONAL OIL INDUSTRY

- 2.4.1 THE MAIN INSTITUTIONAL ASPECTS OF THE INTERNATIONAL OIL INDUSTRY
- 2.4.1.1 THE CONCESSION SYSTEM
- 2.4.1.2 THE MARKETING OF CRUDE OIL
- 2.4.1.3 THE PRICING MECHANISM

2.5 THE RELATIVE POSITION OF PETROLEUM AS AN ENERGY RESOURCE

2.6 CONCLUDING REMARKS

11. THE INSTITUTIONAL STRUCTURE OF THE WORLD PETROLEUM MARKET

2.1 INTRODUCTION

The two concepts of "institution" and "market" appearing in the same phrase may seem redundant to some. To an economist, the market as a form of organized exchange is one of the social institutions that undoubtedly marks the progression and complexity of economic life in a given community. In this study, what makes the institutional aspect of particular importance is the variety of forms it took to assure the flow of production and exchange, its malleability to adapt to changing socio-economic and political conditions, and above all, its resilience to retain unchanged some of its basic characteristics. This chapter will embody an investigation of the natural attributes of the resource itself, the nature and emergence of the oil industry, and the basic patterns of global supply and demand.

2.2 THE PHYSICAL NATURE OF THE RESOURCE BASE

The word "petroleum" is used here in consonant with the nomenclature adopted by the American Petroleum Institute (API). As such, it combines "oil" and "gas"; crude oil is petroleum in the liquid stage, as gas is petroleum in the gaseous stage. Not only does this conceptualization accord well with the natural setting in which both oil and gas are commonly found but also, and of no less importance as it will become clear in other parts, the inevitability that the resource's natural characteristics impinge upon exploration methods, preservation strategies, production devices, and differentials in petroleum products' relative prices from one region or country to another. Differences in patterns of refining and transporting within a country or inter-countries could, to a large extent, be explained in the resource's own natural formation.

2.2.1 THE DEBATE OVER RESOURCE FORMATION

The generally accepted theory of the process of oil formation implies the existence and continued presence of a finite quantity of crude petroleum available for mankind's use. Theories of the origin of petroleum, however, could be broadly classified into two categories depending upon the view of the primary source material as organic or as inorganic (Leverson, 1967, Chapter II). Early ideas leaned toward the inorganic sources explanation whereas the dominant view during the twentieth century, with few exceptions, assumes that the primary source material was organic. The change in thinking was brought about by the almost ever present availability of organic substances, particularly hydrogen, in a major portion of petroleum prospecting and drilling. Prominent among the organic proponents are chemists, geologists, engineers and fieldmen; chemists were able to construct laboratory experiments in proof of their views. The absence of volcanic phenomena (an element essential to the inorganic theory) seems to have put the debate to rest. Today the most commonly accepted theory of the origin of the source materials is a hybrid version that stresses both the organic component and the location, technically referred to as the land-plant theory. The term encompasses "the plants growing in swamps or in coastal marshes as well as those of the land proper, and is used mainly to distinguish between those of the continents and those of the deep seas" (Lilley, 1925, p. 3).

2.2.2 THE RELATIONSHIP BETWEEN THE ORIGIN AND LOCATION

The issues involved in the aforementioned debate over the origin directly impinges upon the location -- the trap. Until almost the end of the nineteenth century, man rarely had to search for oil -- in some places it was easy to detect since it drained into pools or glistened on the surface of the stream. During the same period, however, geologists and field workers observed that oil seeps often seemed to originate near upward-folding arches that came to be known as "anticlines." An anticline is one kind of structure indicating a distortion of strata beneath the earth's surface to form a trap. This geological formation is the dream of a geologist and a resource owner. The history of field operations proves this formation the easiest to detect and by far the most promising -- petroleum permeates[1] layers of porous[2] rocks like water in a sponge, and the oil is contained and kept from migrating and dispersing by a layer of impermeable rocks called the "cap rock" (ARAMCO and its World, 1980, p. 176).

The dream talked about above, however, is not always easily realized, for the arches in rock strata do not necessarily reveal themselves upon the surface. Thus the search for oil has to utilize other deductive tools. The basic tool of this search is a knowledge of the earth itself -- the process of the geological formation and structure and potential temporal modifications. The search generally starts with a study of the surface features: the study of the origin, composition, and distribution of rock strata (stratigraphy); the physical and chemical properties

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[1]Permeability is a measure of the resistance to flow through a porous medium under the influence of a pressure gradient.

[2]Porosity: the percentage porosity is defined as the percentage volume of voids per unit total volume. It represents the total possible volume available for accumulation of fluids in a formation.

See: Daniel N. Lapedes, ed., Encyclopedia of Energy, (1976), for further discussion.

of the rocks (mineralogy); and fossilized animals and plants remains from previous geological eras (paleontology) (ARAMCO and its World, 1980, p. 176).

Now we can bring together the physical properties of petroleum: origin, formation, and location and how they affect the search for decision-making. The theory that one adopts has a bearing on the method of exploration that one pursues. If one believes, for example, that petroleum originated and formed *in situ*, then one is persuaded to explore in areas favorable to origin. If, on the other hand, one accepts that petroleum has migrated into traps at some distance from its region of origin, then identification of migration routes, potential traps, and anti-migration barriers are of more importance in the decision to explore. Furthermore, a belief in a marine environment origin would give priority to marine sediments, whereas a belief in the possibility of fresh-water sediments may motivate exploration in areas underlain by fresh water and continental sediments. Accepting migration of petroleum relegates marine or non-marine sedimentation arguments to a position of less significance, for migrating petroleum could concentrate wherever there is a trap within the limits of potential barriers (Leverson, 1967, Chapter II).

2.2.3 RESERVOIRS AND DISSOLVED GAS

The word "reservoir" is relatively new to both the conceptual and technical literature on the subject. In societies where the institution of private property entitles the owner to the right to exploit, not only the surface of his land holding but the subsurface as well, the "reservoir" concept came to signify the presence of a petroleum resource that extends beyond the boundaries of an individual holding. This coincidental physical-legal interfacing had presented numerous problems to field operators who had to gain the consent of more than one owner regarding royalty payments and rate of production. The technical aspect of the concept (i.e., the reservoir) has come to be equated with the simultaneous availability of oil and gas in a trap.[1] Petroleum reservoirs are commonly referred to as pools -- actually a reservoir is composed of sections of porous rock or sand containing oil and gas in their pore space (Zimmermann, 1957, p. 59).

The dissolved gas in oil plays a dual role of importance in the production of oil: a) it makes oil more mobile and more fluid by lowering its viscosity; b) the dissolved and usually pressurized gas in the reservoir upon

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[1]This should not be taken to rule out the availability of "gas-reservoirs." In some cases, gas could contain sulfur in amounts that would prevent its commercial use unless the sulfur is removed. Gas, in such cases, in commonly referred to as "sour gas."

pressure releasing -- such as by well-drilling -- often expands, thus providing power to bring oil up to the well bore and, in some cases, even up the bore. The ratio of gas to oil in a given reservoir is essentially a function of the molecular composition of the petroleum, the temperature, and the level of pressure in the reservoir (Zimmerman, 1957, p. 59). When oil is fully saturated with gas it shows, at the prevailing temperature and pressure, a reservoir in equilibrium. If additional gas is present, it usually forms a "gas-cap" above the saturated segment of the reservoir. In this case, some oil is oversaturated -- it does not hold all the available gas in the reservoir -- and after a given production level, field operators would have to resort to secondary recovery methods if further production is desirable.

According to oil-to-gas proportions in a given reservoir, a distinction is made between gas-cap oil drive and dissolved-gas oil drive. In making use of either drive it is essential to regulate the per unit of time production; control over the production rate is thus essential to an efficient magnitude of recovery. Reservoirs differ widely in several significant respects. The most obvious amongst them are the size and quality of the contents. The size factor is dependent upon the depth of the oil-bearing sand and its areal extent.

Reservoirs could contain only oil or gas or an unknown portion of both. Still others yield crude of varying quality. The quality of a reservoir crude primarily depends upon the proportions in which sulfur, carbon and hydrogen are found (Riva, Jr., 1983, pp. 4-5). Organic sulfur compounds are present in all known oils. Generally, higher density petroleum contains the most sulfur. The total sulfur in crude oil varies from below 0.05 percent (by weight) as in some Pennsylvania oils to about 2 percent for average Middle Eastern crude (Hobson, 1973, p. 193). As will be discussed later, there are significant engineering, economic, and environmental relationships between a crude sulfur content and the pace and scope of developing the resource.

2.2.4 PETROLEUM MAIN PRODUCTS

For our purposes, the identification of a set of petroleum products is taken in light of the relatively extensive and stable use of these products for consumptive as well as industrial use, given the current state of technology. As such, the set of products tends to be biased toward consumptive patterns as we observe them in industrial as well as developing communities.

Petroleum ranges from gas to liquid and to heavy sticky dark liquids. Gases are materials whose boiling points are below normal prevailing temperatures and pressures. The following list contains five hydrocarbons arranged in an ascending scale of carbon-hydrogen ratios together with their boiling points.

PRODUCT	CHEMICAL STRUCTURE	BOILING POINT
Methane	CH_4	-258.5°F
Ethane	C_2H_6	-127.5°F
Propane	C_3H_8	-44.0°F
Butane	C_4H_{10}	-31.0°F
Octane	C_8H_{18}	-258.0°F

Methane and ethane are usually sold as natural gas; in some situations they are separated and each is used for particular purposes in chemical manufacture. Propane and butane are sold as liquid petroleum gas (LPG). Heavier materials are separated further by various boiling ranges into such products as gasoline, kerosene, diesel fuel, heating oils, lubricating oils, and residual fuels. Asphalts and waxes are sold as solids or semi-solids.

In general, oil-crudes are classified either by molecular composition (such as paraffinic, naphthenic, or asphaltic) or on the basis of their specific gravity.[1]

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[1]Specific gravity of a crude can be expressed in two ways: a) as a decimal fraction of 1 which represents the specific gravity of water, or b) by degrees on the API scale. On the API scale, the gravity of water is set arbitrarily at (10.00) when expressed as degrees API. The degrees on the API scale increases as specific gravity decreases. The API gravity usually indicates the gasoline and kerosene content of the crude. Thus a given crude could have two scales:

a) for example (.796) with respect to water,
b) (5.25°) on the API scale (see D. N. Lapedes, ed. (1976).

Because of the relative ease with which petroleum can be separated into its constituent parts, the refining industry is as old as the oil exploration activities themselves. The refining phase began as a relatively simple operation of boiling the crude and letting the constituent parts condense into their respective products.[1] In the last few decades, improvements in petroleum refining has resulted in hundreds of valuable and marketable products. Manipulation of the molecule -- thereby extracting a larger yield of a given crude volume of new products, by "cracking" either thermally or catalytically -- practically increases the array of valuable products. Refineries are increasingly taking on the role of research units, adapting the crude to changing market preferences and new demands.

2.3 THE INTERNATIONAL OIL INDUSTRY

A comprehensive treatment of the international oil industry is a task that extends beyond the stated objective of this work. We will be concerned here primarily with identifying the major events and circumstances that

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[1]The amount of sulfur in a crude is relevant in terms of handling the crude within the refinery and the presence of undesirable effects in the products. For instance, sulfurous gasoline has an offensive odor, may corrode the engine and fuel parts, and pollute the environment. High-sulfur crudes require special materials when constructing refinery equipment. Certain refinery processes require desulfurization before use as a feed-stock because of their corrosive veneers and the effect of sulfur bearing compounds on expensive catalysts.

precipitated the rise of an international oil business structure. Furthermore, in an effort to understand the world market for petroleum, an added emphasis will be placed on the institutional structure and the policies adopted by the various participants -- the parameters that entered their decision-making system. It is hoped that this emphasis will bear fruit, in the later chapters, when we begin to closely examine the possible avenues through which supply could be stabilized.

2.3.1 THE INTERNATIONAL CHARACTER OF THE INDUSTRY

If for no other reason, the corporate oil industry[1] should legitimately claim an international status due to the geographical separation of regions of production and consumption; such regions that practically encompass all socio-economic and political systems as a sphere of operations. This notion of an interlocking system of production and consumption should be carefully assessed. In the trade journals and western companies' literature there is a marked delineation between the industry of the "communist nations" and that of the rest of the world. In addition, even within the "centrally-planned" economies

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[1]Until early 1970 the terms: "Seven Sisters," "Seven Majors," or simply the "Majors" were used interchangeably to refer to the joint oil operations of: British Petroleum (BP), Exxon, Gulf, Mobil, Royal Dutch Shell, Socal, and Texaco.

there is the further division between the U.S.S.R. and its European allies on one hand, and China and its satellite states on the other. Notwithstanding the ideological overtones of such a division it remains, nevertheless, a reality when viewed in terms of the degree of cooperation among the respective countries.[1] In the rest of the world there is an apparent division between the oil industry of North America (mainly the U.S.) and that of the remaining of the "non-centrally planned" countries.

The international oil industry is taken here to mean the oil business and its operations -- from exploration to development to the phase of retail sales chains -- in that part of the world that excludes North America and the centrally planned economies. Within this delineation, the

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[1]During the latter years of the 1960s, increased Soviet crude petroleum production was assessed by analysts as an indication of increased Soviet exports to China. Since the early part of the 1970s, a new pattern began to emerge and was characterized by an elimination of Soviet-China petroleum trade. Since then, China has embarked on an ambitious program to increase its own domestic energy supplies aiming to achieve self-sufficiency. As of 1983, China's oil production amounted to 776.9 million barrels, an average of 2.13 million b/d. Currently, the USSR produces about 12.2 mbd (300,000-400,000 less than its 1984 target). As of 1982, it sold an average of 1.4 mbd to its COMECON partners and as of 1983 it sold an average of 1.8 mbd to West Europe countries. The USSR oil trade with West Europe seems to be motivated to obtain foreign exchange.

For further explanation, see "L'organization et le Developpement du Marche Sovietique des Petroles," Henry Peyrot, in Le Pétrole et son Economie, La Libraire technique et économique, Paris 1935, and OGJ, April 9, 1984, p. 46, and WSJ, June 15, 1984, p. 1.

industry cannot be equated with an industry owned or controlled by many nations. Operationally, it is the multi-national operation of a network of oil transactions with a large portion of the decision making still in the hands of a limited number of companies referred to as the "majors."

2.3.2 A MODEL OF AN INTEGRATED OIL COMPANY

In the work of bringing oil to the surface and finally to the market in the form of finished products, four distinct phases of the industry have gradually evolved. The operation of a single company need not extend to all phases but in the complete organization, i.e., the fully integrated, the grouping of operations creates four distinct divisions. These are:

a) The production division.

b) The crude transporting and marketing division.

c) The refining division.

d) The refined-products marketing division.

In application and with respect to the actual dynamics of the industry, it is not uncommon that a particular division may include under its formal heading additional supporting services, the functions of which could be interfaced with other divisions. For instance, the production division would generally encompass activities such as <u>exploration</u>, <u>leasing</u>, <u>drilling</u>, and <u>production</u>

operations. The production operations unit generally deals with the installation of production machinery, the labor force, maintenance, and the handling of wells after they have been completed. An indicator of the dominance of a particular phase over others, in a particular company, can be constructed from the number of subdivisions and the relative position of that particular division in the overall organizational structure.[1]

The second division is of particular interest since within it the physical properties of the resource and the institutional structure of a particular country come into full force and present an institutionally controlled outcome. For example, in the U.S. there is a noticeable degree of separation into crude-purchasing, transporting, and marketing companies. Here, the manner of transporting of crude petroleum includes only three subdivisions: the pipelines, the tank cars, and the marine departments.

The refining divisions have taken on an added importance, particularly in the last two decades. As the products of the refinery must be prepared from different types of crude petroleum, standard operations no longer

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[1]A number of studies that have dealt with the phenomenon of "vertical integration" seem to convey the impression of a company capable of handling all its production/purchases throughout all divisions until the deliverance of the final product to the consumer. This author finds this conceptualization naive and misleading. An examination of the major companies' capital holdings in the various phases of the operations clearly reveal a

yield the same grade of products. And since products sold are composed of other substances besides petroleum, blending and compounding plants are generally located on refinery grounds.

The marketing division handles the sale of the final products. Its organization is more flexible and its operation continuously changes with the product handled. In one aspect, the lot is sold in units of millions of barrels while in others the quantity demanded may be as small as a quart. This phase of the company is generally the most benefited by performance-efficiency improvements, and it is also within this phase that almost all cost increases come to rest (see Figure 2.1).

2.4 THE EMERGENCE OF AN INTERNATIONAL OIL INDUSTRY

The non-American major oil companies had more than a sheer presence in the active exploitation of "non-domestic" oil resources. Overseas exploiting and development of petroleum resources could be attributed to the assistance granted by a handful of individuals as well as to those

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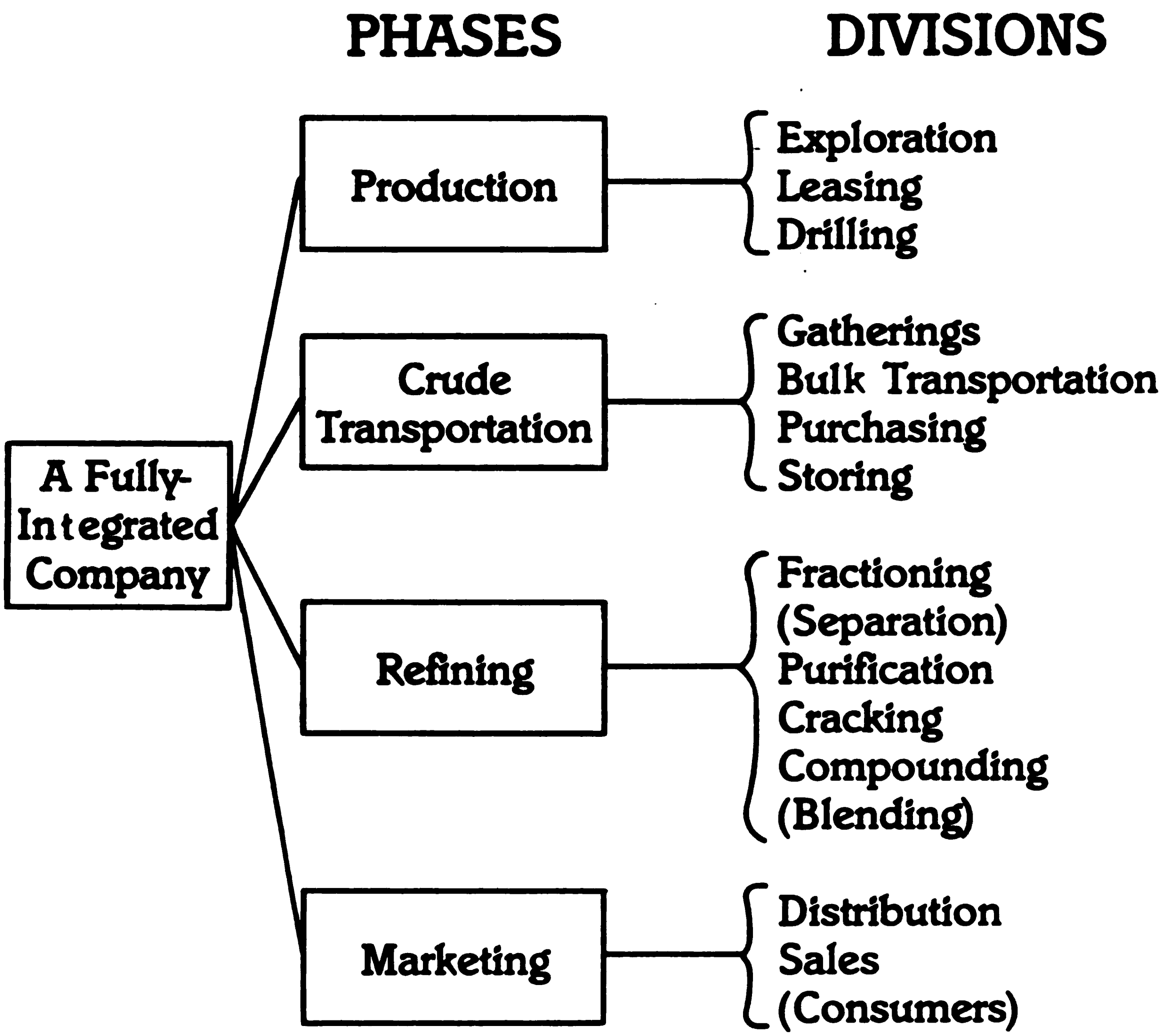
marked degree of "specialization" even within the vertically integrated structure. Furthermore, it will be made clear in later chapters that overseas operations during the 1960s necessitated further specialization which was absent in the vertically integrative structure. A theoretical model for the oil industry has to allow for "specialization" even within a vertically integrated structure.

FIGURE 2.1 MAIN DIVISIONS AND OPERATIONS IN A FULLY-INTEGRATED OIL COMPANY.



individuals' loyalty and personal ambitions to reshape events.[1]

The Anglo-Persian Oil Company was the first oil producing company to be established; it was not until late 1890 that American companies gained entry to the Middle East oil-producing regions. On July 31, 1928, Exxon and Mobil became joint owners of the Iraq Petroleum Company. Later entrants followed: Gulf through concessions in Kuwait, and Standard Oil of California and Texaco through Bahrain and Saudi Arabia. Acquiring the rights to exploit and develop oil resources took place in a manner that could be characterized as mutually beneficial transactions.[2] Most prevalent among the factors that led to the overseas search for petroleum resources were: a) the desire to conserve "own" domestic resources and b) to increase the overall margin of profit to the industry's integrated operations.[2] The activities of the American companies to

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[1]C. S. Gulbenkian, an American, made a study of the oil potential of Mesopotamia. He succeeded in persuading the Turkish sultan Abdulhamid in 1904 to transfer the ownership of immense land holdings from public ownership to his personal account. In Persia an Austrian, William D'Arcy, obtained in 1901 a 60-year concession covering 500,000 square miles, or five-sixths of what is known today as Iran. The direct beneficiaries of the Gulbenkian and D'Arcy discoveries were the British-European firms, British Petroleum (BP) and Royal Dutch Shell (for further details see: Balir, 1978, pp. 29-31).

[2]For further discussion of this aspect of the oil business see, for example: Robert B. Kruger, The United States and International Oil, (New York: Prager Publishers, 1975), pp. 39-69; Joseph A. Yager and Eleanor B. Steinberg, Energy and U.S. Foreign Policy, (Cambridge, Mass.: Ballinger Publishing Co., 1974), pp. 31-50.

secure oil sources outside the U.S. market since the 1950s was motivated by obtaining lower-cost crude petroleum with the intention of shipping back to their home market to increase the profitability of their refining and marketing operations. Prior to World War II and until about 1945, the U.S. was the leading exporter of petroleum and petroleum products to Europe and other parts of the world. The post-war industry's shift to consumer goods and the relative decline in U.S. domestic production precipitated a protective policy against less costly overseas crude sources. To start with, there was no formal U.S. policy regarding oil imports until 1957. U.S. domestic prices, which were artificially maintained high due to production cutbacks, created a favorable market for imported oil. In response, a Voluntary Import Control Program was adopted to insulate the U.S. oil market from increasing oil imports. The voluntary program was instituted on July 1, 1957. Importers then voluntarily agreed to quantity quotas established by the Oil Import Administration. The program, however, contained no restrictions related either to semi-processed or finished oil products. By mid-1958, imports of unfinished petroleum products had risen more than a hundredfold over the first half of 1957, while imports of gasoline and other finished products had increased by 143 percent (Blair, 1978, p. 171).

In 1959 a Mandatory Oil Import Program was adopted with the feature of relating foreign imports to domestic production -- a "floating target." Crude and petroleum products were limited to 12.2 percent of domestic consumption. By the late 1960s the mandatory program seemed to have exhausted its life span; U.S. producers objected to the numerous exceptions granted and consumer groups complained about its increasing administrative costs and inefficient discriminatory applications (Bohi and Russel, 1978, p. 1). Consequently, in the early 1970s a Cabinet task force recommended its abolition in favor of import tariffs. The recommendations coincided with the advent of a new administration concerned with the adoption of restrictive monetary policies to combat inflationary pressures -- the proposed import fees were replaced with a license fee system on April 18, 1973.

This last measure of a U.S. formal oil import policy was short-lived; the events that followed in October 1973 extended interests and concerns beyond a given market. Objectives such as independence, security and conservation replaced market stability and the focus began to shift toward developing domestic sources and maintaining emergency reserves.

2.4.1 THE MAIN INSTITUTIONAL ASPECTS OF THE INTERNATIONAL OIL INDUSTRY

The emergence of the oil companies on the international scene precipitated the appearance of new institutional changes. That such institutional changes are markedly different from a company's home institutional environment will be made clear in this section, and that later changes in the market structure could be traced back to the rigidity of such a system will be made clear in other parts. We will highlight the major institutional aspects of the international oil industry under the following headings: the concession system, the marketing system and the price mechanism.

2.4.1.1 THE CONCESSION SYSTEM

The oil concession system asserted the exclusive rights of the concessionaire to explore, extract, and export petroleum products within the concession area. In its conventional form (i.e., prior to the changes that took place from 1960 to 1973) it obliged the concessionaire to carry out a minimum expenditure for oil search and exploitation. By design, it left to the concessionaire the decision as to the nature of his investments, the choice of exploitation areas, the production level, the auxiliary facilities for transporting and exporting, and the pricing of the product. Such characteristics enabled the oil companies to coordinate among themselves the plans and the size of their investments in the host countries and to assure the growth of supply in consonance with anticipated market demand. The concessions system would not have operated with such efficiency had it not been for another necessary institution called the consortium. Consortia are legal arrangements via which the oil companies assured themselves the security of joint entry into the oil-producing regions for the purpose of joint development of petroleum resources. In terms of the postulated theoretical model (see 2.3.2 above), the concession/consortium arrangements enabled the oil companies to assure joint entry, thus limiting competition among themselves and discouraging, if not effectively prohibiting, new entrants through making crude oil "lifting" accessible only to shareholders;[1] spreading the risk associated with exploration activities among themselves; and gaining their strongest foothold upstream (at the extraction stage), thus enhancing their integrative structures.

2.4.1.2 THE MARKETING OF CRUDE OIL

The report, published by the U.S. Federal Trade Commission in 1952, gave a detailed account of how crude

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[1]Non-share holders were allowed lifting from the consortium area at costs plus a "fee" for administrative expenses: the notorious "one shilling per ton plus cost" principle. The evolution of a crude petroleum pricing system and its relation to government revenues will be dealt with in detail in later chapters.

oil was handled within the club of the "Seven Sisters"; any crude produced by any agency could not be sold to others outside the major oil companies due to imposed barriers to effectuate such a transaction.[1] To assure a greater degree of coordination, another institution evolved in the form of subsidiaries[2] and affiliates. The role of subsidiaries can be illustrated by the following example (Al-Chalabi, 1980, p. 34).

Assume company "A" had two sources of crude petroleum:

a) its share in the consortium operations in proportion to its share holdings at "cost-plus,"

b) any amount that could be bought from surplus consortium partner(s) at the "mid-way" price.[3]

Company "A" can transport all the crude available to it on its tankers which are either directly owned or leased to it under long term chartering arrangements but operated by company B's shipping subsidiaries. Company "A" would then

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[1]This is abundantly clear in the case of the failed attempt at nationalization by the Mossadegh government in Iran in 1952. Blair (1976, p. 79) explains a legal form of retaliation taken by the majors, "The reaction to nationalization . . . took the form of collective boycott on Iranian oil. Prospective buyers were warned of legal action on the grounds that without a compensation agreement the oil was still the property of Anglo-Iranian."

[2]A subsidiary company: a business which is controlled by another, usually by stockholding.

[3]The "mid-way" price is the price paid by the deficit lifter equivalent to the cost of production, plus half the difference between the cost and the posted price.

refine the crude in refineries that are owned and operated by subsidiaries controlled by A's company. Finally, finished products that belong to the same companies are distributed through networks run by other specialized independently operating subsidiaries of company "A" or other companies. ". . . costs for internal oil exchanges between subsidiaries of the same parent company ultimately determine the tax liability of the company's profits at each phase of the oil exchanges. . . ."

2.4.1.3 THE PRICING MECHANISM

The concessions system, by design, assured the absence of a pricing mechanism to determine the price of crude petroleum. Since revenues to host governments were assessed as lump sum payments independent of quantity variations[1] and since the absence of alternative transporting means had been assured via the subsidiary/ affiliate networks, it follows that a market, in the sense of freely adjusting supply and demand quantities, did not exist. Consequently, any price that could have prevailed could not be technically called a market price.

In this regard, the canonical posted price, contrary to what many may believe, was nothing more than a set of

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[1]Payment was set at four shillings per ton lifted. Later the payment was increased to six shillings (in gold) per ton.

company-determined, publicly-announced prices published in specialized press such as Platt's Oilgram. One may think that the companies collectively performed the role of an auctioneer forgetting that an auctioneer, in economic theory, is assumed to be a signal-caller and not a price-setter.

During the period when the U.S. was a net exporter of petroleum, U.S. companies set the price of oil equivalent to the price of oil in the Gulf of Mexico plus the cost of transporting it to the final destination.[1] Until the end of World War I, oil-producing regions outside North America did not account for a significant portion of West Europe's oil imports.

The increase in the quantities of petroleum and petroleum products demanded by the Allies during World War II and the reconstruction requirements after the war, coupled with protective measures to insulate U.S. domestic oil prices, made the Single Basing-Point System of petroleum pricing artificially high.[2]

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[1]This system of pricing was referred to as the "Single Basing-Point System" (or U.S. Gulf plus).

[2]For a buyer in Western Europe, for instance, the posted price of oil (FOB) in a Middle Eastern terminal plus the transportation costs (the equivalent of transportation costs from the Gulf of Mexico), rendered it costlier than U.S.-produced oil. The objective of this system was to protect the price of U.S. oil exported to Europe during a time when the share of oil in West Europe's energy consumption was insignificant due to greater dependence on coal as a source of energy.

In response an alternative pricing system was instituted, namely, the "Dual Basing-Point System." A second basing-point was established in the Arabian-Persian Gulf thus equalizing the FOB price of the Middle Eastern oil to that of the U.S. Given the relative nearness of Middle Eastern terminals to Western Europe, the transportation cost differential was abolished and along with it came an effective reduction in Middle Eastern oil prices.[1]

Furthermore, the international oil industry exhibited its ability to alter the price system not only to maintain a degree of market control but to satisfy a host of other variables.[2]

With particular attention to market control pricing, we observe a number of schemes. In the period that followed World War II and prior to the appearance of OPEC the following changes are of particular interest:

a) The choice of an equalization point assumed a hypothetical competition between Middle East oil and U.S. oil at a certain point in the consuming areas.

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[1]Leeman (1962, p. 92) observes that the price of Middle Eastern oil in the West European market fell from $2.95 after World War II to almost $1.05 per barrel by the mid-1960s.

[2]For further discussion see: OPEC and the International Oil Industry, Al-Chalabi, Fadhl J. (Oxford University Press, 1980, p. 62). The author deals with the role of the oil companies in coordination with the European Cooperation Administration in lowering Middle East oil prices.

This point was initially selected as Naples, Italy. Under this scheme, the price of the Middle East crude petroleum from the Arabian-Persian Gulf plus transportation costs to Naples was set equal to the price of U.S. crude oil in the Gulf of Mexico, plus transportation costs to the Port of Naples. Blair (1978, pp. 113-114) observes that:

> Sales of Middle East oil even to buyers in the Middle East region included the phantom-freight from Texas. The price in an area of lower, falling costs was being determined by the price in an area of higher, rising costs. To compound the problem and the inequity, prices in the U.S. were higher, not merely due to inherent geological differences, but because of restrictions deliberately designed to artificially raise the level of prices.

b) The abolition of the posted-price scheme in favor of a "realized" or "market" price was another route via which the major oil companies asserted their price control. The realized price took the form of discounts from the posted price. It appeared during the late 1950s and early 1960s in response to a number of new changes in the oil market:

   i) New entrants, particularly U.S. independents and a number of European companies offered more attractive concession terms to the host governments (as in the case of some non-Middle Eastern governments) to obtain oil. In response, the major oil companies used their integrated operations and subsidiary/affiliate connections to grant each other price discounts. The new "competitiveness" worked, to the favor of the majors, since now their tax liabilities to the host governments were no longer based on constant posted price.

ii) The new entrants to the oil market, burdened with their heavy financial obligations and costly development expenditures, encountered the problem of securing outlets; for, their refining capacities in Western Europe were limited when compared to those of the majors or to their own available production levels. Faced with this situation, it was in their interest to sell the excess oil at even lower prices than those of the majors'. In addition to disposing of excess capacity, they also were able to reduce their tax liabilities since the latter were assessed on the sale price secured (realized) to a third party.[1]

2.5 THE RELATIVE POSITION OF PETROLEUM AS AN ENERGY RESOURCE

Prior to World War II, international trade in energy occurred primarily in petroleum products; the U.S. was a

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[1]Al-Chalabi (1980, p. 65) observes that the realized-price scheme in Libya has resulted in a very low level of government take. In certain cases [the government take] was brought down to less than 50 U.S. cents per barrel.

net exporter of crude petroleum and petroleum products and West European markets consumed the largest share outside the continental U.S. Transoceanic petroleum trade constituted about one-third of total world trade volume.

After World War II, the amount and value of world energy trade expanded greatly and its composition began to shift toward larger amounts of crude petroleum. This shift is due in large part to the post-war, West European massive reconstruction projects as well as to the U.S. post-war reorientation.

Table 2.1 traces the changes in the relative position of the production of the main sources of energy. In 1955, solids[1] constituted the primary source of energy supply, estimated at 52 percent of total energy production; liquids'[2] contribution was about 35 percent, and gas was placed at 12 percent. This pattern began to change in favor of liquid energy sources; in 1968, the proportion of liquid energy sources in the total energy suppply exceeded that of the solid sources. Such a turnaround of events accords well with the industry's historical record -- most of the overseas oil resources, particularly the Mideastern that were discovered prior to World War II, were brought to

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[1]Solids: hard coal, lignite, brown coal, bagasse, fuelwood, charcoal, coal, coal briquettes and other minor sources.

[2]Liquids: crude petroleum and petroleum products, natural gas liquids.

TABLE 2.1. ENERGY SOURCES' RELATIVE SHARES IN WORLD ENERGY PRODUCTION (THOUSAND METRIC TONS OF OIL EQUIVALENT)

YEAR	TOTAL	SOLIDS	LIQUIDS	GAS	ELECTRICITY
1955	2266774	1162683 (0.5129)	802834 (0.3541)	261427 (0.1153)	39992 (0.0176)
1959	2787630	1344862	1014832	374904	53586
1960	2960757	1400555 (0.4730)	1091912 (0.3687)	410683 (0.1387)	58362 (0.0190)
1962	3136569	1328857	1260685	483216	65046
1966	3934173	1485233 (0.3775)	1699940 (0.4320)	664399 (0.1688)	86478 (0.0219)
1968	4323403	1461006	1993082	777436	93992
1970	4917643	1554568 (0.3161)	2345214 (0.4787)	902409 (0.1835)	106452 (0.0216)
1972	5342695	1564621	2637052	1018991	122230
1973	5652953	1587167	1873602	1064213	128209
1974	5705070	1598692	2882568	1080240	143776
1975	5649268	1668988 (0.2954)	2737803 (0.4846)	1088956 (0.1927)	153797 (0.0272)
1976	5963688	1707144	2965664	1131751	159118
1977	6171176	1767621	3072129	1159466	171930
1978	6289571	1793905	3106305	1198819	190532
1979	6575153	1882707	3227318	1267657	197476
1980	6422286	1825166 (0.2841)	3099013 (0.4825)	1291991 (0.2011)	206116 (0.0320)

LIQUIDS + GAS SHARE: 1974: 0.6946; 1975: 0.6773; 1976: 0.6870; 1977: 0.6857; 1978: 0.6844; 1979: 0.6836; 1980: 0.6837 (computed by the author).

Source: Yearbook of World Energy Statistics, U.N., Selected Years.

production in the early 1950s; the independents' role as oil producers came to impact world energy trade by the 1960s; and it was during the early part of the 1960s that new patterns of energy-resources institutions (such as joint ventures and state-owned companies) began to change the industry's institutional structure.

By 1975, the relative contribution of the liquid energy sources almost equalled that of the solid sources in the total energy supply. However, when we lump together oil and gas under one heading, petroleum's dominance becomes abundantly clear. During the period 1974-80, the relative share of petroleum in total energy supply stayed constant at 68 percent.

On the consumption side, we observe a mirror image. Table 2.2 shows that from 1955 until 1967, the share of solid energy sources to overall energy consumption was about 50 percent. By 1968, the share of liquid sources had increased, at the expense of other energy sources, to about 41 percent. Moreover, gas use as an energy source increased noticeably (from 14 percent throughout the 1960s to almost 23 percent by 1980). Combining both liquids and gas as one source reveals a constant share of 65 percent for the period 1974-80.

World-wide growth in per capita energy consumption during the 1970s averaged 10 percent. Table 2.3 reveals that the highest growth rate had accrued in the centrally

TABLE 2.2 ENERGY SOURCES' RELATIVE SHARES IN WORLD ENERGY CONSUMPTION (THOUSAND METRIC TONS OF OIL EQUIVALENT)

YEAR	TOTAL	SOLIDS	LIQUIDS	GAS	ELECTRICITY
1955	2101626	1168791 (0.5561)	622559 (0.3014)	259520 (0.1234)	39918 (0.0189)
1959	2569462	1324311	820568	371723	53417
1962	2902240	1334766	1023319	480470	64953
1964	3265928	1428509	1201129	566109	72091
1968	3954815	1470033	1618556	774383	93977
1970	4478773	1562445 (0.03488)	1920862 (0.4288)	889591 (0.1986)	106514 (0.0237)
1973	5115111	1593167	2343990	1049622	128331
1974	5138423	1611240	2312432	1070871	143879
1975	5178067	1648518 (0.3183)	2302578 (0.4446)	1073301 (0.2072)	153669 (0.0296)
1976	5453584	1702653	2460596	1131497	158838
1977	5617914	1760698	2539313	1146036	171866
1978	5773512	1796617	2591155	1195183	190557
1979	5987552	1883258	2636811	1269553	197925
1980	5878826	1835398 (0.3122)	2550722 (0.4338)	1286642 (0.2188)	206067 (0.0351)

LIQUIDS + GAS SHARE: 1974: 0.6584; 1975: 0.6519; 1976: 0.6586; 1977: 0.6522; 1978: 0.6558; 1979: 0.6524; 1980: 0.6527 (computed by the author).

Source: Yearbook of World Energy Statistics, U.N., Selected Years.

TABLE 2.3. PER CAPITA CONSUMPTION OF CRUDE PETROLEUM
(IN KILOGRAMS)

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
WORLD	621	642	671	719	699	662	696	717	722	730	684
DEVELOPED MARKET ECONOMY	1962	2024	2134	2302	2197	2070	2195	2270	2267	2329	2079
DEVELOPING MARKET ECONOMY	277	284	285	307	297	265	285	296	301	302	291
CENTRALLY PLANNED ECONOMY	305	330	357	382	409	429	446	462	483	485	497
OPEC ECONOMY	645	636	585	628	605	510	542	567	596	557	519

Source: Yearbook of World Energy Statistics, U.N., Selected Years.

planned economies at 63 percent, both the developed and developing market economies had a 5 percent growth rate, and OPEC countries experienced a decline of almost 2 percent for the same period.

Growth in per capita consumption is closely related to the expansion in refining facilities. Table 2.4 shows a world-wide growth rate of 50 percent over the years 1970-80. The centrally planned economies had a 92 percent growth rate, developed market economies averaged 44 percent, the developing market economies 73 percent, and OPEC countries 20 percent.

Viewing the world in regional terms, Table 2.5 reveals the relative import share for each group of countries in the world petroleum output. The share of the developed market economies throughout the 1970-1980s had persisted around 41 percent, the developing market economies' share had been in the 10 percent range, and the role of the centrally planned economies is almost insignificant as indicated by a value of 2.6 percent. In value terms to total market economy, the developed market economies' value share is around 83.5 percent, with the EEC group and Japan at 16.4 percent and 15.3 percent respectively.

Table 2.6 reveals a relationship between energy imports and the level of economic activity. It should not be surprising that the percentage value of energy imports is higher in the developed than the developing market

TABLE 2.4. GROWTH IN REFINERY DISTILLATION CAPACITY
(THOUSAND METRIC TONS)

	1970	1972	1974	1976	1978	1980
WORLD	2626370	3006404	3444294	3696253	3872721	4125814
DEVELOPED MARKET ECONOMY	1679645	1910324	2166224	2300244	2345619	2412430
DEVELOPING MARKET ECONOMY	555495	641910	736100	804939	888732	962214
CENTRALLY PLANNED ECONOMY	391130	454170	541970	591070	638370	751170
OPEC ECONOMY	183385	205365	218975	237494	272507	197650

Source: Yearbook of World Energy Statistics, U.N., Selected Years.

TABLE 2.5. PERCENTAGE VALUE OF CRUDE PETROLEUM IMPORTS TO TOTAL MARKET ECONOMY IMPORTS

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
DEVELOPED MARKET ECONOMY	84.9	83.6	84.4	83.4	83.4	81.5	81.0	81.2	81.1	86.7	88.3
DEVELOPING MARKET ECONOMY	15.1	16.4	15.6	16.6	16.6	18.5	19.6	18.8	18.9	13.3	11.7
EEC	51.2	50.6	48.6	45.3	40.8	35.3	35.1	33.2	32.6	34.8	35.0
LAFTA	9.2	9.8	9.2	10.5	9.5	10.2	11.0	10.0	9.7	6.8	4.4
JAPAN	13.2	13.4	14.8	15.6	16.9	16.8	14.8	14.9	14.9	16.1	17.7
MIDDLE EAST	0.4	1.1	1.2	1.2	1.4	1.5	1.6	1.9	1.7	--	--

Source: Yearbook of World Energy Statistics, U.N., Selected Years.

TABLE 2.6. WORLD REGIONS' IMPORT SHARE OF WORLD CRUDE PETROLEUM OUTPUT
(IN THOUSAND METRIC TONS)

	1970	1972	1974	1976	1978	1979	1980
DEVELOPED MARKET ECONOMY	896784(0.3941) 2275053	1047411(0.4110) 2547853	1169191(0.4192) 2789031	1204866(0.4195) 2871980	1225381(0.4070) 3007656	1268679(0.4062) 3123256	1201734(0.4021) 2986240
DEVELOPING MARKET ECONOMY	226815(0.09)	271144(0.016)	298661(0.1070)	303708(0.1057)	322284(0.1071)	332186(0.106)	303610(0.101)
CENTRALLY PLANNED ECONOMY	43382(0.019)	62156(0.024)	68049(0.024)	84741(0.029)	98401(0.032)	101326(0.032)	84741(0.028)
OPEC	1475(0.0006)	1965(0.0007)	2124(0.0007)	2169(0.0007)	3492(0.0011)	2320(0.0007)	2169(0.0007)

AVERAGE SHARE OVER THE DECADE: DEVELOPED MARKET ECONOMIES (0.4085); DEVELOPING MARKET ECONOMIES (0.1032); CENTRALLY PLANNED ECONOMIES (0.026); OPEC ECONOMY (0.0007).

NOTE: Figures in brackets are relative shares (computed by the author).

Source: Yearbook of World Energy Statistics, U.N., Selected Years.

economies. The relative paucity of it to the developing economies could be explained in terms of these countries' dependence on a small and constrained set of resources as a source of national income. Given the concentration of their export "bundle" in raw or semi-processed products, developing countries do not yet have a need for petroleum as input for industrial activities. This observation is brought out in Table 2.7 where the share of the developing nations' petroleum exports has been above 90 percent in value terms relative to total market economy exports.

2.6 CONCLUDING REMARKS

Petroleum, as a natural resource, is unique in more than one way. Notwithstanding the debate over its formation, man has yet to come up with a cost-effective, safe, and amicable energy alternative -- most of the technological innovations of the last decade have centered around increasing the throughput ratio, i.e. obtaining more economic products out of a given quantity of crude. Exploration and prospecting activities remain sheer guesses at best -- technological improvements in this phase have greatly reduced the financial risk at the expense of more expensive capital outlays and probably higher output costs. Transporting petroleum remains a hostage of the resource's own setting as witnessed by the continued reliance on tankers and pipelines. The final consumption

TABLE 2.7. PERCENTAGE VALUE OF CRUDE PETROLEUM EXPORTS TO TOTAL MARKET ECONOMY EXPORTS

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
DEVELOPED MARKET ECONOMY	5.4	5.9	6.3	5.7	3.3	3.4	2.9	3.4	4.2	5.6	6.9
DEVELOPING MARKET ECONOMY	94.6	94.1	93.7	94.3	96.7	96.6	97.1	96.6	95.8	94.4	--
SAUDI ARABIA	13.7	17.4	21.8	22.4	37.7	27.6	29.3	31.5	27.4	29.9	--
NIGERIA	4.9	6.9	7.8	7.7	--	7.4	8.1	8.4	6.8	8.4	--
ALGERIA	4.5	3.1	4.5	3.8	4.1	3.7	3.5	4.0	3.9	4.3	--
VENEZUELA	13.5	10.0	7.7	7.4	7.5	5.9	4.6	4.6	4.0	3.6	--
INDONESIA	2.1	2.3	3.6	3.7	5.3	4.9	4.6	5.2	5.0	4.1	--

AVERAGE PERCENTAGE VALUE FOR DEVELOPED MARKET ECONOMIES (4.8181); DEVELOPING MARKET ECONOMIES (95.42) (computed by the author).

Source: Yearbook of World Energy Statistics, U.N., Selected Years.

phase has witnessed marginal improvements, though not unresisted, in energy-using equipments.

The institutional structure that had evolved and remained intact until 1961 reflected the unequal access to information among oil market actors. Prior to World War II, the concession system satisfied the hunger of the oil-producing governments for revenues and fitted well within the international oil industry's scheme of retaining control over the price of oil. This setting gave a price edge for petroleum over other energy sources which aided reconstruction efforts in Western Europe and accommodated the post-World War II surge in consumer demand in the U.S.

That industrial countries are locked in a petroleum-based standard of living; that oil-producing countries are heavily dependent on oil as a prime source of income, are facts beyond dispute. The oil-producing countries need oil revenues to develop their resources whereas the industrialized nations need time and financial support to reorient their industries. What remains in dispute, however, is who shall bear the adjustment costs?

CHAPTER III. THE THEORETICS OF PRICE DETERMINATION AND STABILITY UNDER COLLUSIVE MARKET STRUCTURES

3.1 INTRODUCTION

3.2 PRICE LEADERSHIP MODELS

3.2.1 THE BAROMETRIC FIRM MODEL
3.2.2 THE DOMINANT FIRM MODEL

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3.5 MODELS EXPLAINING COLLUSIVE BEHAVIOR IN THE WORLD OIL MARKET

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3.5.1.1 ADELMAN'S OLIGOPOLY MODEL
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3.6 CONCLUDING REMARKS

CHAPTER III. THE THEORETICS OF PRICE DETERMINATION AND STABILITY UNDER COLLUSIVE MARKET STRUCTURES

3.1 INTRODUCTION

The determination of price and output levels is generally a function of the competitive structure of the respective markets (Baumol, 1972, p. 335). Competitive structure is a phrase that refers to the presence or absence of competitive conditions.

The two polar cases of perfect competition and monopoly serve well as analytical and pedagogical structures for economists in general and resource economists in particular. The desirability for a perfectly competitive market outcome is due in large part to its efficiency and distributional outcomes, namely: resources are said to be allocated in accordance with revealed consumptive preferences and private and public benefits and costs are equalized at the margin in non-discriminatory manner.

In market economies, the desirability for a competitive outcome is approached via unobstructed price movements. Recalling the theoretical premises of perfect competition, we find that a commodity's own price serves as a signal -- a non-discriminatory, allocative device. Price variations with reference to a consumer marginal valuation of an additional unit and a producer's marginal cost to effectively supply the needed units is what intrinsically distinguishes competitive market structures.

This chapter will review the relevant economic literature with particular attention to a commodity's process of price determination and stability. As such, the numbers of suppliers and their actual or potential responses will be given added attention.

3.2 PRICE LEADERSHIP MODELS

The theoretical models presented under this heading represent an ideal situation in collusive price-setting. By their own tenet, they rule out conjectural responses on the part of some of the colluding members. Two variants of the above model are presented here, namely: the Barometric Firm model and the Dominant Firm model.

3.2.1 THE BAROMETRIC FIRM MODEL

At the heart of this model is an operational definition of the term "barometric." The barometric firm is neither the largest in terms of its market share, nor the most powerful.[1] Generally, it is the first firm that initiates price changes that are almost always accepted by other firms in the industry. To them, the barometric firm

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[1]Stigler (p. 431, 1982) reports ". . . for a long period, International Paper was the price leader in newsprint although it produced less than one-seventh of the output. Later, it was succeeded in this role by Great Northern, a smaller firm . . ."

is always perceived as a reasonably accurate interpreter of changes in basic costs or demand conditions in the industry as a whole.

According to Kaplan, Dirlam, and Lanzillotti (Stigler and Boulding, eds., 1982, p. 271), barometric price leadership frequently occurs in response to a relatively long period of abnormal price competition and excess production. The rayon industry has often been cited as an example of barometric price leadership -- American Viscose has generally initiated price changes which have been wholly or in part accepted by other producers with an average time-lag between the initiation of a price change and the response of "associates" of about ten days.

Cohen and Cyert (1975) establish a reason for an industry's barometric behavior. They report:

> The development of price leadership in large-scale industry has roots in the earlier experience of violent price fluctuations and cut-throat competition . . . [by] relating price changes to such formalized bases as changes in direct costs or style and quality changes, the firm attempts to avoid the extreme fluctuations in return on investment. . . . (p. 248).

3.2.2 THE DOMINANT FIRM MODEL

One way to avoid the difficulty of modeling conjectural variations is to set up a model in which one of the firms of an industry is clearly so "powerful" that it is a leader among the remaining firms whose total sum production cannot satisfy market demand.

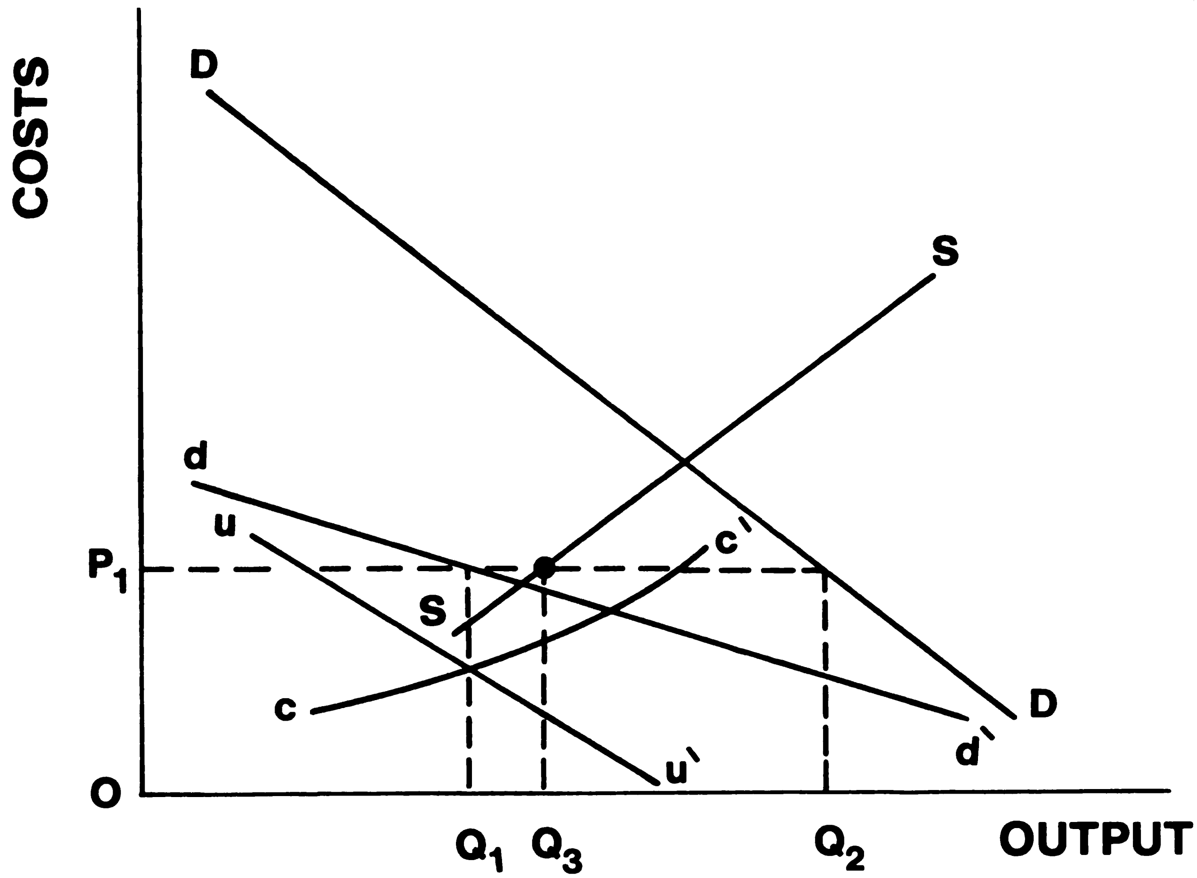
The model assumes that the dominant firm sets the price for the whole industry, but lets the "minor" firms exhaust all their supply capacity at that price -- the remaining amount is assumed to be supplied by the dominant firm. Frequently, steel and cement industries serve as prototypes for this model (Cohen and Cyert, 1975, p. 245).

In Figure 3.1 we derive the price that the dominant firm will set to maximize profits. First, a supply curve for all minor firms is constructed by adding minor firms' marginal cost schedules. The dominant firm demand curve (dd) is equivalent to the difference between total minor firms' supplies and the industry's demand curve (DD). The marginal revenue schedule for the dominant firm ($u\grave{u}$) is derived from its average revenue schedule ($d\grave{d}$). Its optimal output is OQ_1 at price OP_1; at the same price level the minor firms would supply $OQ_2 - OQ_1 = OQ_3$.

3.3 COLLUSION AND CARTELS

In the case of a particular economic activity, i.e. an industry, and in situations when all firms in that industry openly agree to establish prices at levels which are most profitable for the industry as a whole, such a market then is commonly referred to as a cartel. A behavior as such leads to output and price decisions as if the industry were a single-firm monopoly.

FIGURE 3.1 OUTPUT AND PRICES UNDER THE DOMINANT FIRM MODEL.



DD : Market demand curve for the industry's output.
dd\ : Demand curve for the dominant firm's output.
uu\ : Dominant firm marginal revenue curve.
cc\ : Dominant firm marginal costs curve.
SS : Supply curve for minor firms.

Adapted from Mansfield, Edwin, 1975, p. 342.

The presence of an open (i.e. "announced") agreement on a unified price structure and schedule of output is not, however, essential to bestow the cartel designation on a given market structure. Cartels and secret collusive agreements could be the norm more than the exception, particularly where laws and regulations are not explicitly prohibitive.

Notwithstanding, it is of less relevance to our case here to investigate the legality of collusive agreements. We will be concerned, instead, with identifying the conditions necessary to sustain a collusive market structure. Cartels (or collusive agreements) can be regarded as another variant of price leadership models with the notable exception that the agreement among all firms is explicit. Furthermore, the following characteristics tend to distinguish the models presented here from the ones presented above (under 3.2). For collusive agreements to hold for a prolonged period, there has to be some kind of "sanctions" or "punishment" which the colluding members can invoke against a member wishing to pursue an independent pricing course. Since a price reduction below the official collusive price can frequently result in an increased market share for the lower-price firm, there is often an incentive for a member to "chisel" on the collusion. Thus, for the collusion to hold, one or all of the following conditions have to prevail (Cohen and Cyert, 1975, pp. 245-248):

a) The collusion members must be able and willing to impose sanctions -- particularly of the form that would render "chiseling" unprofitable.

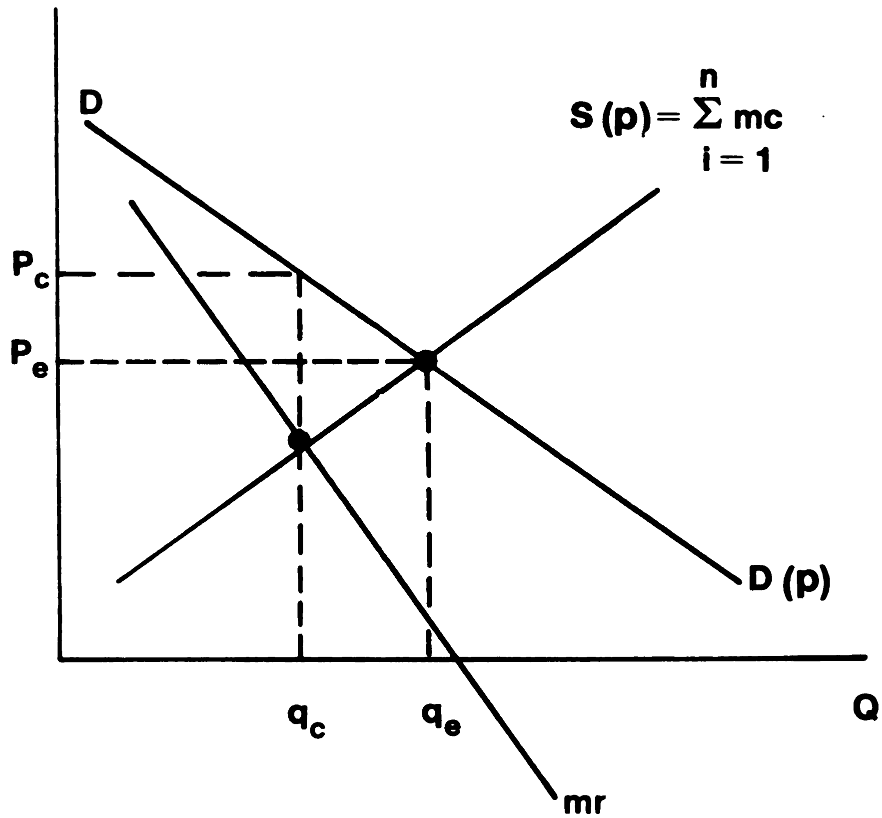
b) All colluding members have to realize that it is in their best interest, particularly from the long-term perspective, to prevent "new entrants," and to adhere to the collusive agreement.

3.3.1 THE ECONOMIC INCENTIVE TO COLLUDE

The ability of a producer or a group of producers to maintain output prices above its marginal costs implies a degree of market control. Two major sources for such a control are: a natural monopoly situation or an agreement among producers to synchronize their activities to maximize joint profits.

In Figure 3.2 we postulate an industry composed of N firms. Assume the market demand for this group of firms is D and the industry's supply curve is S which, for simplicity, we assume to be equivalent to the arithmetic summation of the respective firms' marginal cost curves. Under competitive conditions, market equilibrium is attained at the combination P_e, q_e. This competitive solution, however, does not lead to the maximization of the industry's profits. That is, although MR is equated to

FIGURE 3.2 MARKET EQUILIBRIUM UNDER COMPETITIVE VS. COLLUSIVE CONDITIONS.



(P_e, q_e) perfect competition equilibrium.
(P_c, q_c) Collusive equilibrium.

Adapted from Johany, Ali, 1980, p. 22.

P_C for each firm, the competitive price is greater than MR at every rate of output. The reason is that as every firm expands output to equate its Mc with the constant MR, it effectively reduces revenues for other firms. Agreeing to act together reduces output to q_C and raises the equilibrium cartel-price to P_C.

3.3.2 COLLUSION PROBLEMS

Osborne (1976, pp. 835-844) classifies collusion problems into one external and four internal problems. The external problem is predicting and discouraging production by non-members. The internal problems are:

a) Locating the "contract surface"; that is, the total collusive output that maximizes cartel-revenue;

b) Choosing a point on that surface, that is, agreeing upon relative share to each member;

c) Detecting cheating; and

d) Deterring cheating.

To the problem of deterring cheating, Osborne proposes a "quota rule" that requires each non-chiseling member, upon discovering a chiseler, to increase his output so that, in sum, the overall increase in output would restore prior relative market shares (p. 839).

In dealing with the non-members' output, Osborne argues that:

> variations in the total output of these firms changes the cartel members' profit functions . . . [and] as these variations are likely to depend on the cartel output, the contract surface is not exogenously given (p. 841).

Thus to each level of cartel output, there would be a concomitant level of non-members' output. Furthermore, the external firms are likely to behave as a "Cournot-follower."[1] The cartel then acts as a "Stackelberg-leader," i.e. maximizing its output subject to the reaction functions of the external firms. Under these circumstances, total cartel revenues would be lower.

In discussing the detection problem, Stigler (1964) distinguishes a number of possible situations:

a) A cartel could possibly know the output of each member but with some time-lag. In this case, the proposed quota rule by Osborne is useful to detect chiseling.

b) A cartel could know the total output of its members but not individual shares. Osborne proposes a modified quota rule which requires each member, upon detecting cheating, to increase his output by the difference between his average quota and the additional increase in cartel output.

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[1]In the case of a duopoly, both firms are assumed to maximize profits and, regardless of the other's output level, one firm will hold its output constant at its existing level.

c) A cartel could know the total output of the industry, but not the total output of the cartel.

From a theoretical perspective, a cartel is inherently unstable only if it faces inherently insoluble problems. Of the five problems reported at the beginning of this section, three have been erroneously perceived as insoluble: locating the contract surface, detecting, and deterring cheating. These are primarily a function of an "appropriation quota" and the choice of an appropriate point on the contract surface. If we expand the concept of external supply to include substitutes at a price near marginal costs of the "cartelized product," then would the instability of a cartel come to be a true possibility.

Osborne observes that to recognize that a cartel might collapse because it cannot control external production or detect cheating is quite different from believing that all cartels are necessarily doomed. So much depends on the particular feature of their environments that no general prediction about the durability of cartels is justified.

3.4 OLIGOPOLISTIC BEHAVIOR UNDER THE "THEORY OF GAMES"

3.4.1 INTRODUCTION

Game theory has been an integral part of the economic theory for forty years now; interest was first aroused in 1944 with the publication of the Theory of Games and

Economic Behavior (Von Neumann and Morgenstern, 1947). The fundamental analytical departure stems from perceiving the competitive process as a game of strategy. It was only natural that the first application of the theory was to oligopolistic situations since strategic interdependence and the small number of participants lie at the heart of this behavior. By the late 1950s, the consensus among practioners was slowly emerging: game theory was to be a theory for the small-numbers situations in economics. Such delineation was unfortunate, for the interest among theoreticians then was:

> toward the axiomatic analysis of general equilibrium theory . . . treating all agents as perfect price-taking maximizers tied together by a price-taking auctioneer [whereas] the new game theoretical analysis was Edgeworthian which viewed the price-formation process as the outcome of a large multi-lateral bargaining procedure (Schotter and Schwodianer, 1980, p. 480).

A long discussion ensued in which the unanimity of opinion indicated that as the "groups" studied get larger, both the "Walrasian" and the game theoretical "Edgeworthian" analysis converge to the same solution.

This result, as elegant as it was, spelled the end of interest, for it seemed to convey that game theory which employed strictly cooperative game theoretical concepts was too demanding informationally, and it yielded no new results. Little, if any, was to be gained through its use. The apparent loss in popularity was short-lived for during the 1960s and early 1970s theoreticians, particularly those interested in topics such as bargaining problems, began to focus their attention on a new set of problems. These problems, for which game theory seemed an appropriate modeling tool, were concerned with the design and operation of satisfactory socio-economic institutions; more specifically, with the design and implementation of allocating and voting mechanism. Leonid Hurwicz (1945), an avant garde of this effort, first defined a set of characteristics that any good allocation mechanism should have and then discovered that for sets of quite reasonable characteristics, no mechanism could be found that satisfied them. This startling result paved the way for game theory because, in an informationally decentralized economy, each allocating mechanism can be shown to define an n-person, non-cooperative game. Therefore, by studying the properties of equilibria of these games, we can derive the properties of the allocating mechanism (or institution) that defines them. Thus, the study of strategic behavior and social institutions became synonymous with the analysis of the equilibrium properties of n-person games.

Finally, the social choice literature furnished an added source of interest in game theory. Allan Gibbard (1973) and Mark Satterthwaite (1975) independently asked what may happen when Kenneth Arrow's agents (in Social Choice and Individual Values, 1963) decided to vote strategically or in a manner that is not "isomorphic" to their true preferences -- it is possible that the voting rule they may adopt could generate social choices that are not pareto-optimal.[1] As a result, Gibbard and Satterthwaite searched for a mechanism to motivate voters to reveal their true preferences. What they found was that there does not exist such strategy-proof voting mechanisms that also satisfy a set of "democratic" criteria.

Von Neumann and Morgenstern stress two important points with reference to the role of game theory in designing incentives-compatible voting mechanisms:

a) Social institutions must be seen as the equilibrium outcome of games of strategy whose descriptions are given by the physical capabilities of the participants -- the "empirical background."

b) And, social institutions are the outcome of the theory rather than an input into it -- in other words, enabling the analyst to study the inner (or coercive) creation of social institutions.

The theoretics of game theory holds the promise that economic problems could be analyzed in a more institutionally flexible setting -- beyond the

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[1]If in a situation of n-participants, a state of resource allocation is reached when further re-allocation could not make n better off without making n-1 worse off, then such a state is referred to as pareto-optimal.

neo-classical analysis which is primarily embedded in one institutional framework, namely: competitive markets.

3.4.2 GAMES DESCRIPTION

The description of the game could take many levels, each level involving a degree of details related to the kind of analysis to be undertaken and the results expected. For example, when a detailed description of a situation of strategic interdependence is required, the type of game used is referred to as the extensive form. This "vintage" attributes more attention to the rules and details of the game and focuses on the game's dynamic sequential movements, i.e., each participant's selection of a particular strategy from within the set of strategies available to him at each round of the game. When one is interested only in strategies available to participants and the associated payoff of each strategy, such description is called the normal form of the game. At other times, when we are interested in the payoff (or a set of payoffs) that a single player (or a coalition of players) could procure himself, irrespective of the strategies selected by other participants, then the situation to be modeled is referred to as the coalition form of the game.

In addition to description, the game could be characterized as either cooperative or non-cooperative. Under cooperative assumptions, participants are assumed to communicate with each other and make binding agreements upon themselves to concert their action. The absence of communication and/or binding agreements characterizes non-cooperative games.

Utility payoffs are another way of describing participants' interdependence. If, upon order-preserving linear transformation, a representation of strategies can be formed for which the total sum of the participants' utility payoffs is constant for all strategy combinations, then this situation is referred to as n-person, constant sum game. This constant, however, could be zero -- a situation of n-person, zero-sum game. In the latter case, the utility (or interest) of a participant or a group are totally opposite to the remaining participants' utility.

The importance of a game's description extends into the kind of solution one seeks to obtain in a given application. This theoretical depth should bring to importance Von Neumann and Morgenstern's assertion, namely: social institutions (the _setting_, or _rules of the game_ as commonly referred to) are the outcomes of games of strategy rather than input into it.

3.4.3 OLIGOPOLISTIC BEHAVIOR UNDER THE THEORY OF GAMES

Most analyses of collusive oligopoly à la theory of games assume a game played cooperatively, and proceed to apply various cooperative concepts to quantity-price variations (see for example, Mayberry, Nash, Shubic, 1953). Mamoru Kaneko (1978) studied pricing behavior in an oligopolistic setting where all firms constituting an industry have the same linear cost functions and sell a homogenous product. On the demand side, the buyers are assumed to be utility maximizers acting as price takers. Using these assumptions, a characteristic function is defined for all agents (producers and buyers) which has a "non-empty core" for the case of monopoly and a "non-empty bargaining set" for the case of oligopoly. The bargaining set yields a price tantamount to joint profit maximization in the case of duopoly. The lowest price in the bargaining set approaches the competitive solution when the number of oligopolists increases.

Selton (1973), working with a Cournot model in linear demand and cost functions, progressively models behavior from non-cooperative to cooperative strategies. He allows the firms to form an enforceable output-prorationing cartel. Each firm, however, has to decide a priori whether it wishes to enter the collusive arrangement without prior knowledge of either the number of cartel members or their individual output decisions. If a firm chooses to join, it must present its preferable "quota." The quota system becomes binding if all members present the same proposal.

The conclusion reached by Selton is that, in spite of the restrictive setting, it is still advantageous to form a cartel. If the number of participants increases, then it is more advantageous to stay out. With participants numbering n where n = 2,3,4, the probability that a cartel is formed if an equilibrium point is played (i.e., satisfactory sharing of payoffs) was found to be one and the outcome of the cartel bargaining is joint profit maximization; for n = 5, the probability of forming a cartel is one percent or smaller; and for n > 5, the probability is smaller than 0.0001 making the solution approaching the Cournot equilibrium.

3.5 MODELS EXPLAINING COLLUSIVE BEHAVIOR IN THE WORLD OIL MARKET

3.5.1 INTRODUCTION

The models below represent a sample of a large number of theoretical analyses to explain the rise of cartel-like behavior in the world petroleum market. This author is more concerned with the variety of their orientation toward dealing with the price-setting behavior and stability than strictly adhering to one particular model or another. Their selection should serve to highlight the strength as well as the weaknesses of the selective exercise of relating theory to empirical work.

Adelman's model has had a broader-ranging reputation than the others; Professor Adelman's predictions regarding the world petroleum situation have had a wider circulation and audience. Analytically, his model is an extension of neo-classical oligopolistic theory with more analytical weight to the chiseling factors. He continuously stresses that cartels are inherently unstable, and as such, their price-setting behavior would inevitably lead to their demise due to intra-members' competitive tendencies.

Becker-Telser-Danielsen's model (hereafter referred to as the BTD model) shares the intra-cartel rivalry as a starting point; it reaches more interesting conclusions, however, by ascertaining a degree of autonomy among members. The BTD model views OPEC, for example, as sovereign states and the world market as spheres of influence. With this perspective it markedly differs with Adelman's inevitable collapse of all collusive agreements.

And finally Johany (1979) calls upon the institutional change of property rights to explain price-setting behavior. Johany's model, simple and precise in its theoretics notwithstanding, seems to require a particular "informational" and "decision-making" environment doubtful to have existed then, and improbable to prevail in the near future.

3.5.1.1 ADELMAN'S OLIGOPOLY MODEL

Adelman's analysis is based on a modified version of the theory of oligopoly. This modification stresses competition in crude oil pricing. Adelman reasons that the international oil industry disintegrated (the period of 1960-1970) due to the intense competition that prevailed then between U.S. majors, independents and the European companies. He predicted that OPEC's pricing power would succumb to similar endogenous pressures (1972, p. 8). More recently, however, Adelman had asserted that OPEC will succeed because the consuming countries have a vested interest in high oil prices (1974, pp. 59-60).

Adelman had been mostly concerned with explaining the direction and magnitude of oil prices since 1947. Until after the Tehran-Tripoli agreements of 1971, he held the opinion that prices would decline toward the cost or cost-plus-tax "floor" (1972, pp. 262-275). But by December 1973 he was more uncertain. He thought prices might increase even further than they had in the past. His policy prescription was that "the U.S. take steps to separate itself completely from Arab oil sources . . ." (1974, p. 60).

Adelman's perception is that the oil industry is not a natural monopoly and that competition rather than monopoly will dominate. He reasoned, first, that prices would decline because marginal exploration, development, and extraction costs were $0.10 - $0.20 per barrel and that the world oil price had been substantially higher.[1] The decline in prices during 1957-71 was viewed as a slow working of the competitive market forces and the price increases of 1953 and 1957 were due to American and European protection of domestic oil and coal. The price increases since 1971 are attributed to the passive support from the consuming nations, especially the U.S. (1972, p. 79). Thus, Adelman asserts that:

> the producing nations cannot fix prices without using the multinational companies. . . . The OPEC tax system accomplishes this simply and efficiently. . . . Without the instrument of the multinational companies and the cooperation of the consuming countries OPEC would be an ordinary cartel (1972, p. 87).

In assessing Adelman's model it is worthwhile to note that his conceptualization of the oil companies' role as merely collecting taxes on behalf of the oil producers is erroneous. The taxes imposed on the exported per unit of oil is an element of costs that the oil companies would

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[1]Professor Scott, writing in the Harvard Business Review, observes:

> The premise that pricing oil according to actual costs ignores the very high value oil has in use, ranging beyond $100 per barrel in petrochemicals and as a fuel in automobiles (1981, p. 7).

Adelman, in later work, seems to abandon his position of pricing oil according to production marginal costs. In a hearing before a Senate energy development subcommittee, he stated, "The value of any product is measured by the damage inflicted by not having it" (p. 190). See: "Coping with Supply Insecurity," M.A.Adelman, 98th Congress, 151th Session, June 22, 1983, pp. 184-200.

have to recover to retain their margin of profitability. If oil producers insist upon this tax, then oil transacted in a different manner such as "producer-consumer" or "producer-government" patterns are of little relevance. Oil producers could "inflate" the posted price by the amount of the tax and the situation would remain the same. Interestingly, even during market glut periods when some producers offered volume discounts, these discounts were given against the OPEC posted price while the imposed tax structure remained intact.

Adelman's faith in the role of competitive forces to reduce oil price is spurious. In 1973, the National Iranian Oil Company (NIOC) resorted to sealed bidding to auction off an amount of 82 million barrels of oil. The NIOC was surprised to discover that OPEC's posted price was "undervalued." The following table summarizes the difference between buyers' revealed prices and OPEC's posted price (OGJ, December 17, 1973, p. 28).

CRUDE QUALITY	AUCTION PRICE	OPEC'S PRICE ($)
Iranian light (34°)	$17.40 bbl	$5.40 bbl
GACHSARAN (31°)	16.40 bbl	5.046 bbl
ROSTAM (36°)	16.34 bbl	---
SARSAN (34°)	16.20 bbl	---
DARIUS (33.2°)	16.00 bbl	---

Danielsen (1976, pp. 407-415), in assessing Adelman's model, argues that:

a) The theoretical bases of Adelman's model are deficient. The oligopoly theory, per se, is inadequate because it neglects the possibility that another cartel (either as a new coalition among current producers, or another competing collusion of producers who are not currently members of the existing cartel) may supplant the existing one.

b) Adelman ignores relevant historical processes pertinent to every cartel formation efforts. These endeavors take place in an historic context and require a long period of time to reach maturity.

c) Competitive market forces, present or potential, do not necessarily rule out the rise of a cartel. Differences in demand and cost conditions among a sufficiently large subset of producers could give rise to collusive incentives (see Section 3.5.1.2 below).

3.5.1.2 BECKER-TELSER-DANIELSEN MODEL

Becker, along his analysis of "crime and punishment" (JPE, 1968, pp. 164-207), views that chiselers commit crimes against colluders. The purely monopolistic solution occurs when deterrence is sufficient for violators; whereas quasicompetitive tendencies within a collusive structure are indications of potentially ineffective deterrence measures. Conceptually, Becker's analysis admits a purely competitive outcome, a monopolistic equilibrium, or a solution somewhere between the two extremes.

Telser, expounding on a duopoly model based on premises similar to Becker's and carried out in the cost-benefit tradition, more specifically concludes:

> . . . in oligopoly, a coalition of firms may not necessarily secure the value of their characteristic function by their own efforts. This is why there seems to be no useful theory of imputations for the cartel which derives from the X-core or the B-core.[1] Nor is this all. Since there is no canonical characteristic function to represent oligopoly, there is no agreement on which characteristic function best represents oligopoly (1972, p. 215).

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[1]It is useful to distinguish here between "competitive equilibrium" and the theory of "the shrinking of the core."

Competitive equilibrium presupposes the presence of a price system; participating agents are assumed to act in isolation (i.e., on the bases of one's own preferences); prices are given in an impersonal way (i.e. not subject to bargaining or manipulation). Under these conditions, when the supply and demand for all agents are equal for each commodity, it is said that an equilibrium is realized.

The "core allocation theory" takes a different approach -- it starts with a number of agents, each with his own initial holdings of resources, willing to improve his situation through exchange. With no supposition of a price system, the agents are "free" to form coalitions (defined as a group of participants who, among themselves, agree on a certain reallocation of initial holdings). See p. 23.

The "core theory," on the other hand, gives an answer to the question of whether it is possible to predict the outcome of this exchange process. Starting from an arbitrary "holdings," if there is a possibility to improve upon this "holdings" by any coalition (including degenerate coalitions consisting of a single agent, and the grand coalition embodying all agents) and if an outcome is realized, then such an outcome, or a set of outcomes, is

Furthermore, Telser catalogs the various costs involved in collusive agreements and shows various outcomes under the presence of side payments or their absence. He views "policing" the collusive agreement and preventing new entrants as the most serious threats to a cartel. More significantly, Telser asserts that a cartel's optimum price-quantity combination is likely to be a momentary solution near the collusive profit-maximizing output.

Danielsen (1976), building upon Telser's and Becker's models, includes the important premises that:

a) A cartel (and citing OPEC particularly) is a collection of sovereign enterprises sufficiently separated by geographical, social and political variables to assure for each enterprise a status in its "sphere of influence."

b) The maximum revenue available to a cartel member, as well as to the cartel as a unit, is a function of each member's actions. Each member is assumed

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the "core." An outcome belonging to the core is said to be "stable" in the sense that no other coalition can do better. Recalling "competitive equilibrium," it becomes a matter of analogy to state that a competitive equilibrium belongs to the core. This result is referred to as the shrinking of the core of an exchange economy to the competitive equilibrium when the number of participants increases. See Leif Johansen, "A Calculus Approach to the Theory of the Core of an Exchange Economy", (AER, December 1978, pp. 813-820.)

overtly capable and willing to enter another member's sphere of operations.[1]

In Figure 3.3, a modified graphic representation of Danielsen's work is presented. Using Telser's two-dimensional model, the competitive equilibrium is assumed to accrue at the origin where net revenues for the postulated three groups, V_1, V_2, V_3, are zeros. The loci, MN, MP, and PN, represent maximum feasible net revenues for any set of two cartels. Points J, J', J'' correspond to joint profit maximization for any two cartels whereas J* is the point of maximization for the three combined. The slopes of lines AB, AC, and CB are -1 and the slope of the plane tangent to J* is also -1. Points J, J', J'' represent unstable equilibrium since the excluded firms have an incentive to alter the collusive solution (i.e., the cartel-duopoly solution). J* is not a stable equilibrium as well since it does not dominate all other points.

To apply this model to OPEC's situation (see Figure 3.3), let V_1, V_2, V_3 represent net revenues for American producers, the international oil industry, and OPEC members respectively. World oil prices in 1953 were such that revenues were relatively low for all participants

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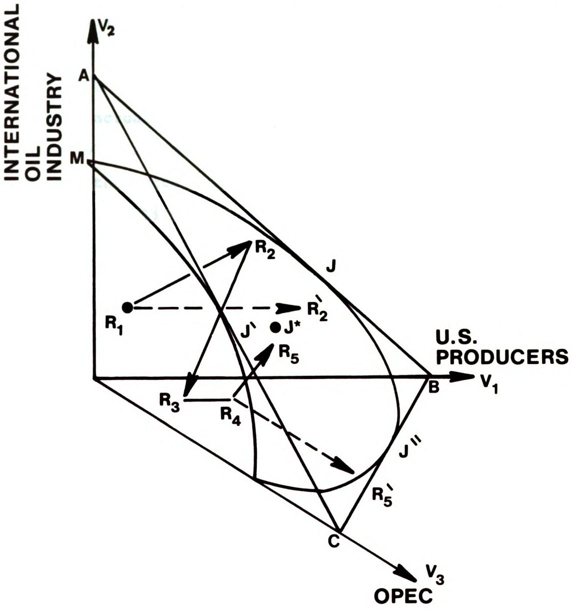
[1]One observes here the beauty of modeling behavior. The two spheres, namely <u>influence</u> and <u>operations</u>, each encompasses a set of distinguishable variables though not mutually exclusive.

FIGURE 3.3 A GRAPHIC REPRESENTATION OF DANIELSEN'S MODEL OF CARTEL MEMBERS INTERDEPENDENCY IN THE OIL MARKET.



Adapted from Danielsen, Albert L., 1976, p. 413.

(R_1). The establishment of the prorationing system -- intending to increase net revenues to American producers and effect the move ($\overrightarrow{R_1R_2}$) -- actually increased net revenues to American and international oil producers. Thus $\overrightarrow{R_1R_2}$ approximates the actual effects of the prorationing system. Profit sharing was intended to benefit OPEC members, so is the representation by $\overrightarrow{R_2R_3}$. The actual effect of the U.S. mandatory import quota in 1959 was to benefit American producers; $\overrightarrow{R_3R_4}$ represents the actual situation until 1971. And finally, the Tehran-Tripoli agreements of 1971 had the initial intent of appropriating all the potential economic rent to OPEC, $\overrightarrow{R_4R_5}$; but the actual effect was to benefit the international corporations and the American producers as well, $\overrightarrow{R_4R_5}$.

3.5.1.3 JOHANY'S PROPERTY RIGHTS MODEL

Analytically, this model views the pricing of crude petroleum as an intertemporal optimization decision. Specifically, a resource owner is assumed to maximize the net discounted value of the output over the physical lifetime of the resource. A point in time is selected at which either the resource is assumed to be exhausted or demand will fall to zero. The decision rule, then, is to select an output time-path to maximize a resource's present value. Johany (1979, pp. 72-80) states a number of observations in support of this model's power to explain the observed rise in crude petroleum prices since 1971. Most important among them are:

a) The assignment of petroleum resources ownership to the producing countries and the associated unilaterality to vary output levels would have sufficed in his judgment to assure a rise in oil prices in 1974, irrespective of the long term supply cost of the resource. This is because the pre-property rights posted price was merely an accounting device through which oil companies determined inter-industry profitability.

b) The posted price under the oil companies' regime did not truly reflect marginal valuation for the additional unit of oil produced due to oil producing countries' disadvantageous bargaining position.

c) The assignment of property rights to producers meant a severance of the relationship between additional recoverable reserves and increased output.

d) Uncertainty over property rights, other things constant, increased the companies' effective discount rate which meant an increase in output.[1]

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[1]Maximize: $R_t = P_t - C_t$

Where: R_t = net revenue per unit of oil at time (t)

P_t = unit price per unit of oil at time (t)

C_t = average cost per unit

r_t = the market interest rate at time (t)

The oil companies will supply oil if:

$$R_{(t+1)} = R_t(1+r) \tag{1}$$

Now let us define q = probability of expropriation, then, oil companies' decision rule will be to supply oil as long as:

$$E(R_{t+1}) = q\ (R_{t+1}) + (1-q)\ 0$$

Or

$$\hat{R}_{t+1} = q(R_{t+1}) \tag{2}$$

Or, in terms of eq. (1):

$$\hat{R}_{t+1} = R_t(1+r) \tag{3}$$

That is, q R_{t+1} (instead of just R_{t+1}) should be equal to $R_t(1+r)$, or

$$R_{t+1} = R_t\frac{(1+r)}{q} \tag{4}$$

The effect of less than 100 percent certainty about oil concessions' duration and rights is to increase the effective discount rate, $\hat{r}$, upon which oil companies' supply decisions are based. For example, when r = 15% and q = 0.80, then

$$\hat{R}_{t+1} = \frac{R_t(1+0.15)}{0.80} = R_t(1+\hat{r})$$

Or

$$1+\hat{r} = \frac{1.15}{0.80} = 1.437$$

That is, the companies' effective discount rate is about 44 percent. An increase in the effective discount rate, *ceteris paribus*, will lead to an increase in oil supply and, consequently, a reduction in the world price of oil.

Thus, Johany proposes that the uncertainty regarding concession rights led the oil companies to overproduce during the 1960s and early 70s in spite of the resulting fall in prices. "The net effect of uncertainty of property rights [was] to increase the companies' discount rate which [led] to an increase in [output] by a greater rate than they otherwise would if there were no risks of expropriations" (p. 76). And, on the other hand, the host governments with no threat to their resource ownership (most oil concessions would have expired during the 1990s) and with a limited set of projects that could be undertaken before the domestic rate of return falls below the market interest rate, have an interest in supplying oil as long as the net value rises at a rate no less than the world interest rate.

3.6 CONCLUDING REMARKS

For someone concerned with neat and precise results, the current state of the theory of collusive behavior represents a muddy ground when compared with the "neatness" of perfect competition and monopoly. A part of such uneasiness that one encounters rests with the difficulty of modeling conjectural behavior. In its current state, the theory of oligopoly, however, puts in vogue a better understanding of the forces that could give rise to collusive behavior; its indeterminism is enlightening par excellence for, on one hand it implies that collusive behavior is a market-embedded phenomenon in its evolution, and on the other it guards against overzealousness of solely relying on the same market forces to destabilize cartels.

Judgments as to the stability and duration of a cartel beyond the potential impact of the increase of the number of suppliers and the appearance of substitutes to the cartelized product have to rely on educated speculations, the scope of which may not be supported by the existing theory of oligopoly.

CHAPTER IV. THE ORGANIZATION OF PETROLEUM EXPORTING COUNTRIES

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CHAPTER IV. THE ORGANIZATION OF PETROLEUM EXPORTING COUNTRIES (OPEC)

4.1 INTRODUCTION

The decade that has just ended witnessed some fundamental changes in the institutional structure of the international oil industry. Changes have ranged from the rise of a petroleum organization (institution) primarily concerned with the interest of oil producers to a so-called oil embargo, during which the world observed intermittent rounds of changes in oil prices. More importantly, the industrialized world became aware of the role of petroleum in the sustenance of its energy-intensive industries; the power arena remained the same, namely, the world oil market, but the number of participants and their mutual coercive leverages drastically changed. It is the belief of this author that a significant portion of current world energy inconsistencies could be traced back to this era; it is also the hope that, through understanding its forces, conflict resolutions could be argued and evaluated.

4.2 HISTORICAL FORCES IN PLAY

Informal contacts between the governments of oil producing countries began as early as 1947 in Washington (USA) between the Venezuelan and the Iranian diplomatic missions (Sampson, 1976, p. 189). The timing of these contacts was not the result of chance; the Iranian government, then, was negotiating with its concessionaires, the Anglo-Iranian Oil Company (AIOC) the potential of increasing production and revenues. The Venezuelan government, in return, was concerned with the rapid growth in concessions and growth of sales from the Middle Eastern oil extracted at tax-paid costs lower than in Venezuela. Of immediate concern to the Venezuelan government also were the apparent differences between the fiscal charges imposed on Middle Eastern concessionaires and the companies operating in Venezuela. The Middle East oil tax structure differed from their counterparts in Venezuela primarily in two aspects:

a) The Middle East governments, then, did not receive "added" royalty payments over and above income tax payments (as was the case in Venezuela),

b) The Middle East governments had unilaterally abdicated the right to alter the fiscal terms of a concession.

Thus, under the Middle Eastern concessions system, the 50 percent rate of income tax was held constant, irrespective of later tax changes. In Venezuela, in contrast, and as is the case in most developed countries in

Western Europe and North America, concession agreements did not fix the income tax rate.[1]

A conventional Middle Eastern concession clearly positioned the state as the owner of a nation's natural resources. Furthermore, it entrusted a company with the right to search for, develop, and export certain natural resources (here hydrocarbons) over a long period of time in return for certain financial payments and other benefits. For example, the first concession granted was in Iran in 1901 and had a lifetime of 93 years; in Saudi Arabia, the original concession was granted to Standard Oil of California for 66 years. Changes in concession terms were made contingent upon mutual acceptance, and disputes over prices, investment outlays and determination of the output level (in excess of a certain minimum stipulated in the

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[1]Peter Odell (1975, p. 16) observes a marked difference toward nationalism between Latin American and Middle Eastern countries. He states that "the larger Latin American nations restrained [the oil companies] freedom of action to operate within their territories, refused permission to expand their activities beyond a certain date; obliged [them] to integrate their operations into a framework established by state control and direction . . . to intensify these measures the Latin American countries often created their own state-owned oil entities . . ."

On the other hand, Lilley (1925, p. 85) in an opinion contrary to Odell's, cautions that "the governments granting such concessions are usually influenced by political conditions and the desire to start development in an area where their chances of success are limited [due to a country's lack of] sufficient capital, technical know-how, or skilled human resources . . ."

concession) were to be arbitrated in international tribunals.

The Iranian confrontation with members of its concessions holders reached an impasse and presented the first effort in the industry's history when a government used its political sovereignty. On May 1, 1951, the Mossadegh government in Iran nationalized the concession of the Anglo-Iranian Oil Company (British Petroleum) and established the National Iranian Oil Company (NIOC).[1]

The Iranian political action brought to vogue two important facets of the international oil industry:

a) A realization of the actual institutional limitations imposed upon oil producing countries' ability to alter concessions terms.

b) The need for an alternate pattern of government-company relationship; the pattern that quickly gained acceptance was the consortium pattern.

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[1]An effective boycott of the Iranian oil was organized by the oil companies and was adhered to from May 1951 to October 1954 until an agreement was reached in 1954. Iran retained oil ownership with a stipulation that it would only be sold to the consortium members (BP share, formerly 100 percent, dropped to 40 percent, Royal Dutch/Shell had 14 percent, Exxon, Gulf, Mobil, Socal and Texaco 8 percent each and CFP had 6 percent.) Boycotting the purchase of Iranian oil was made effective through companies' collaboration to change their "off-take" in countries where oil was still available under more favorable terms.

4.3 THE IRAQI-SAUDI AGREEMENT OF 1953

A fortunate outcome of the unsuccessful Iranian nationalization attempt was the emergence of cooperation among other oil producing countries. The first formal agreement of cooperation among oil producers was signed between Iraq and Saudi Arabia on June 29, 1953 and called for holding periodic consultations about petroleum policies and the exchange of oil information. The agreement was signed in the aftermath of the abortive Iranian nationalization attempt. Iranian oil exports were brought almost to a standstill from 1951 to October 1954, and other oil companies with sufficient market outlets feared potential legal action for they were aware that the ownership of the oil was in dispute. Against this background the Iraqi-Saudi agreement emerged; the agreement's main objective was to seek cooperation with a view to improving their bargaining position vis-à-vis the oil companies.

The Iraqi-Saudi agreement was to be a first step of mutual assistance in obtaining the best terms (clauses) from their concessionaires. A common feature of these clauses is that a host government can call on a concessionaire to discuss possible revisions of agreements if neighboring countries obtain better terms. Thus, beginning in 1955, the Iraqi government, in accordance with a precedent set by Saudi Arabia in 1954, obtained a reduction in the so-called "selling expenses allowable." The allowable expense (similar to a salesman's commission) was meant to be a commutation of actual costs incurred by the concessionaire for oil marketing (Sampson, 1976, p. 189). The fallacy of such a claim became apparent when it was found that most of the Middle Eastern oil moved through integrated channels (affiliates and subsidiaries owned by the oil companies) and as such it did not represent an actual out-of-pocket expense.[1]

Furthermore, in coordination with a Saudi initiative in 1955, Iraq refused to allow volume discounts on posted prices for income tax liabilities. These discounts represented reductions in tax liabilities and were originally intended as an incentive to increase exports.[2]

4.4 THE PRICING MECHANISM: A FIRST LOOK (1947-1960)

The Saudi Director-General, Mr. A. Al-Tariqi (in 1961, and later the Minister of Petroleum and Mineral Resources)

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[1]Mikdashi (1972, p. 25) estimated that the one percent reduction in the selling expenses allowable led in 1956 and 1957 to a one million pounds annual increase.

[2]"Volume discounts in Saudi Arabia prior to 1955 averaged 18 percent of posted price; in Iraq during 1956-57, they amounted to 5 percent of prices for the first million ton exported beyond the agreed minimum of 30 million tons [annually]; a 7.5 percent discount rate for the next 8 million tons, and a 10 percent discount for all additional exports. . . . The elimination of these exports for income tax purposes increased the Iraqi government revenues per unit of exports in 1958 to about 7 percent" (Mikdashi, 1972, p. 25).

commented on the price discounts as follows:

> When we made the 50-50 agreement* [in 1950], a year after or so we discovered that Aramco was putting $1.42 in their books for Saudi income tax purposes . . . they said this was a 18.5 percent discount for the parent companies to build marketing facilities . . . We did not sign that agreement, in effect the 50-50 was only 32-68 (Mikdashi, 1972, p. 25).

The producing countries' attempts to make favorable use of the concession terms were often met with staunch resistance, if not outright neglect. A pivotal area in which the oil companies showed strong resilience was the pricing schemes. Understandably so, since changes in the posted price structure meant changes in their tax liabilities and consequently their profit margins.[1] The oil-producing countries based their demands to halt companies' unilateral discretion to reductions in posted prices on two grounds:

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*As a result of Venezuelan initiatives to explain the advantages of the regime of profit sharing on a 50-50 basis, Saudi Arabia, at the end of 1950, signed an agreement with Aramco. Reduced to its essential feature, this regime meant that sales proceeds less the cost of operations are divided equally between the host government and the concessionaire.

Oppenheim (1976-77, p. 26) writes that the companies' resistance to changing the posted price structure should be attributed to the favorable tax system which allowed tax payments to the oil producers to be credited against U.S. and a company's home country taxes.

[1]Sampson (1976, p. 187) correctly observes the basic flaw in the "50-50" agreement; . . . "They were like plans to give factory workers a shareholding in a company -- fine when profits are booming, explosive when they were slumping."

a) That income tax receipts to host governments are based on posted prices. Thus, the companies are in a position to affect governments' tax revenues through price reductions.

b) That uneven reductions in posted prices among the companies did not follow a consistent pattern. Instead, they seemed to oscillate, favoring one country at one point and another at a different time.[1]

To claim that there has been a single logical tie between prices in the U.S. domestic oil market and prices abroad did not stand the test of market realities. Mikdashi (1972, p. 31) observes that prior to World War II, Texas was the world's largest oil-exporting region. This made the Gulf of Mexico a basing point for most oil prices in international trade.[2] By 1943, the Persian Gulf region was growing as a major exporting area, and the adoption of

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[1]As an example: The Venezuelan government protested, to the British ambassador in February 1959, against the excessive reductions in the Middle East posted prices (about 8 percent and averaging 18 cents a barrel) initiated by British Petroleum. A month later, another unilateral round of reductions in posted prices were initiated by U.S.-based companies and Venezuelan crude oil prices had to be reduced further (see Platt's Oil Price Handbook, 1959, pp. 227-9).

[2]"A price at one point is called a basing point price if it is based on [calculated] directly from the price charged at another point [the base] for an otherwise identical product." Haddock, David, "Basing Point Pricings: Competitive vs Collusive Pricing," AER, June 1982, pp. 289-304.

a dual basing-point pricing system was seen not sufficient by the producing countries to lessen the unilateral authority the companies retained over pricing.

The fundamental objection to the dual basing-point pricing system was that it embodied an "imposed" effect to cause Mideast oil prices to move in a direction opposite to changes in oil demand as reflected in shipping costs. For, when markets are depressed (and freight rates are relatively low) then Mideastern prices had to be increased to maintain the hypothetical price equalization between U.S. Gulf and Arabian-Persian Gulf delivery prices. Similarly, an increase in the quantities of oil demanded which, ceteris paribus, would increase freight rates, meant a reduction in Mideastern prices. The link between U.S. and Mideastern posted prices was fairly well maintained throughout the period 1949 until about 1954 (Leeman, 1962, p. 946). Aramco, the holder of the Saudi concession, was the first to raise its price for the period December 1946 to March 1947 from $1.05 to $1.17-$1.23 per barrel depending on crude quality. Upward adjustments were then made during 1953-1957 with Mideastern price stabilized at about $1.70. The next major increase followed the Suez crisis in 1957 raising the price to $2.08 per barrel.

But as will be discussed later, the pressures on reducing posted prices were already set in motion. In February 1959, the Mideastern price was reduced to just below $2.00 and on August 1960, the price was further reduced to $1.89. It was these last two rounds of unconsulted price reductions that gave rise to an oil producing countries organization.

The first Arab Oil Congress (to which Iran and Venezuela were invited) met in April, 1959 in Cairo. Its significance extended beyond the minimal familiarization and exchange of information; it presented a forum for the oil-exporting countries to express their dissatisfaction over unilateral price reductions. The fact that Arab oil exports at that time did not exceed 30 percent of total world oil demand may have led Arab policy-makers to look beyond their own boundaries for an effective international cooperation. The first such attempt at multi-national cooperation came on the heels of the first round of price reductions in Middle Eastern oil in 1959; it took the form of an oil consultation commission -- a forerunner of OPEC. The convening members in Cairo[1] declared their unified position that there should be no further reductions in the posted prices without prior consultation with the producing countries.

4.5 THE EMERGENCE OF OPEC

As previously noted, during the second round of price reductions in August 1960, the oil companies reduced posted

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[1]Iran, Venezuela; and the Arab oil producing countries [then: Iraq, Kuwait, and Saudi Arabia].

prices by eight to ten cents a barrel (approximately six percent of its previous level). The cuts in Middle Eastern oil were made by concessions holders due to sizeable sales below posted prices by major suppliers[1] (OGJ, August 15, 1960, p. 15). Following this reduction, representatives of the governments of Iran, Iraq, Kuwait, Saudi Arabia, and Venezuela conferred in Baghdad from September 10-14, 1960, and agreed upon creating a permanent organization for oil producing countries (OPEC) with a view of coordinating and unifying members' policies.

OPEC's emergence had been influenced by four major characteristics of the oil industry (Mikdashi, 1972, p. 34):

a) The oligopolistic structure of the oil industry,

b) Vertical integration of the oil companies operating on multinational bases,

c) Certain features of the Mideastern oil concessions system,

d) The arbitrary and unilateral authority that the companies had over oil pricing.

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[1]Blair (1972, p. 213) attributes such price reductions to the independents who obtained newer Venezuelan concessions, or the Soviet Union who was increasing its sales in world markets to obtain foreign exchange, or even the majors themselves. These price reductions took place when the world economy was still recovering from the 1958 recession and the U.S. 1959 imposition of import quotas.

4.6 THE LIBYAN INITIATIVE AND ITS EFFECTS ON OPEC

4.6.1 INTRODUCTION

Since its early years as an oil producer, a large portion of the Libyan oil was produced by non-major oil companies. This was a deliberate policy decision on the part of King Idris' government; the King was later dethroned in a coup d'état by Colonel Qadaffi in September 1969.

The "majors" were not without ambivalence to the activities of the "independents" -- for, on one hand, the productivity of the Libyan oil fields, the low sulfur crude, and proximity to Western Europe markets continuously undermined a unified price structure to their European consumers. Moreover, due to the insufficiency of the independent's network of transporting and refining capacities they, more than often, sold their excess production to the majors or their affiliates. Inasmuch as such discounted sales increased the major's profit margins, they also were concerned with their concessions in other Mideastern countries which yielded twentyfold their Libyan operations.

The majors have always perceived their Libyan oil operations as a last resort -- the relatively small share they had coupled with their "floor production" obligations to Saudi Arabia and Iran meant, at the very least, temporary output reductions in the Arabian-Persian Gulf region. Would the Saudis and the Iranians tolerate loss of revenue and would not their established relationships as well as their traditional concessions be in jeopardy? These were some of the questions that the majors had to answer for themselves.

4.6.2 LIBYA'S INITIATIVE IN PRICE-SETTING

Less than four months after the successful coup d'état, the Libyan government demanded an increase of 40 cents in the posted price of its oil. The Libyan argument for an increase rested upon: a) an underpricing of its crude relative to its costs, b) its superior quality, and c) the short-haul to Western Europe's markets. The operating companies, including the majors, counteroffered a 5 cent increase per barrel.[1] In response, Libya targeted its largest concession holder, Occidental, with an output reduction order from an average daily production of 800,000 b/d to 440,000 b/d. Occidental's efforts to secure crude were not successful.[2] And in September 1970, four

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[1]Interestingly, James A. Akins, an undersecretary of the U.S. State Department then, stated that he found that the difference between what Libya was receiving from its concessions holders and what it could fetch in terms of "comparable products" price to be "higher than 40 cents." (See: Hearing on Multinational Corporations, reprinted in "Hearings on Multinational Corporations", 93rd Congress, 2nd Session, 1974, Part 4, p. 4.

[2]Exxon refused to sell crude to Occidental at less than the market price citing an OPEC resolution prohibiting concession holders to sell to other companies at less than the posted price (See Kaufman, 1978, p. 106).

months after the Libyan output reduction order, Occidental agreed to an immediate price increase of 30 cents, escalating over a five year period to 40 cents. All operating companies thereafter agreed to similar terms including an income tax rate hike from 50 to 55 percent.

The Libyan price initiative had set in motion a process almost all companies had feared; namely, a "leap-frogging" in prices between the Libyan negotiated prices and the posted prices for Arabian-Persian Gulf producers. And it was only a matter of time before those fears became reality. Convening in Caracas (Venezuela) during December 1970, OPEC[1] informed the companies operating in its territory of an upcoming round of prices and productions negotiations to be held in Tehran (Iran) sometime in 1971. The targeting style à la Libya would not have been an appropriate strategy, for most of the oil produced was shared and controlled by the majors. In anticipation, the companies solidified their position towards targeting in a communique[2] which came to be known as the "Libyan Producers' Agreement." In summary, the communiqué stated that the companies would supply oil at cost to any company

[1]For details regarding the importance of this meeting, see an interview with the then Minister of Petroleum and Hydrocarbons, Dr. Hugo Perez in <u>OGJ</u> (Dec. 3, 1973, pp. 20-21).

[2]The communiqué requested and was granted a clearance from the U.S. Antitrust Division which came to be known as the "Antitrust Exemption." See "Hearings on Multinational Corporations," Part 5, p. 113.

cut off in a reprisal action; the provisions also included the independents in what came to be known later as the "Safety Net Agreement."[1]

The real impact of the petro-corporate union was more psychological than economic -- a bargaining hoax, as the events of February 14, 1971 showed. In Tehran, OPEC and their concessionaire agreed to:

a) An immediate increase of $0.30 a barrel, escalating to $0.50 a barrel by the termination of the agreement in December, 1975. The price of the Saudi light crude (OPEC's marker) was increased by 70 percent during the years 1970-73,

b) A stipulation that none of the Arabian-Persian Gulf countries would seek reciprocity for benefits obtained from other producing countries.[2]

But the Libyans were not about to be deprived of their price-leader status; with the close of the Suez Canal due to the Arab-Israeli war of 1967 and the continuous rise in

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[1]According to George Schuler of Bunker Hunt, ". . . the genesis of this solidarity movement was Shell. Shell [had] some very forward-thinking people in an office that followed OPEC affairs . . ." See "Hearings . . .," Part 5, p. 80.

[2]Kaufman (1978, pp. 99-101) hypothesizes that the oil companies were more concerned with price stability than with absolute increases in the crude price. He further states that even before the agreement was concluded, the Saudi Minister of Oil and Mineral Resources, Mr. Yamani, had asserted that world scarcity of oil would lead to new price demands.

freight rates, they requested that market changed conditions be reflected in their crude pricing. Although the dual basing point pricing system was no longer operative, the Libyans relied heavily on it to assert their demands. And again, to ascertain their leadership, they refused joint bargaining with the companies. The terms of the Tripoli agreement signed on April 1971 guaranteed an immediate per-unit increase from $2.55 to $3.55. In addition, the Tripoli agreement raised the tax rate to 55 percent for all companies except Occidental which had to pay 60 percent tax rate because of a provision in its contract to commit 5 percent of its before-tax profit to Libya's agricultural development (OGJ, April 12, 1971, pp. 32-33).

4.6.3 LIBYA'S NATIONALIZATION EXPERIENCE

During OPEC's Beirut (Lebanon) meeting in September 1971, it was agreed that each member-state would separately seek equity participation with its concessionaires.[1] Libya was the first member to effectuate OPEC's resolution. It will suffice for our purpose to highlight the nationalization attempt with particular reference to

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[1]This decision was more of a reaffirmation. The genesis of the equity participation proposal was discussed and agreed upon during OPEC's meeting in Caracas, December 1970. See OGJ (1970, p. 34).

its impact on Libya's operating companies' oil supply:[1]

a) By the end of 1973, all companies with holdings of up to 33 percent of Libya's proven reserves were entirely nationalized.

b) Libya entered as a partner with Occidental, Oasis and its affiliates (Continental, Marathon, Amerada).

c) Mobil and Exxon were exempted on the grounds that their production records showed good balance between production and marketing operations.

d) BP (with 48 percent of its shares held by the British Government) was nationalized on the grounds of an unsympathetic political stance toward Libya.

The economic impact of Libya's nationalization was to reduce the overall market oil supply by an estimated amount of 3 to 3.75 mbd. In addition, the prolonged closure of the Suez Canal and the growing awareness of energy conservation among oil-producing countries were crucial parameters in the unanticipated price increases of 1973.

4.7 THE OSCILLATION BETWEEN NATIONALIZATION AND PARTICIPATION

4.7.1 INTRODUCTION

The environment of rising prices that began by late 1973 followed a decade during which the option of

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[1]For further discussion see Blair (1978, pp. 227-234).

nationalization drew closer but never materialized. The option had been quietly discussed along the shores of the Arabian-Persian Gulf since 1968. Blair (1976), Kaufman (1978), and Quandt (1981) seem to agree that many OPEC members expected Saudi Arabia to take the initiative. It seemed that the traits of moderation and quiet diplomacy that the Saudi negotiators had acquired led many to believe that the issue was best left handled by them. With oil demand growing rapidly against a short-run supply capacity, coupled with the feelings on the part of some OPEC members that their resources were "over-exploited," an environment was created different from the one that prevailed during the unsuccessful Iranian attempt of 1951.[1] The slogan that the Saudi negotiators had opted for was "equity participation" in lieu of "nationalization."

4.7.2 THE SAUDI MODEL: GRADUAL OWNERSHIP

In 1972, Saudi Arabia, Kuwait, and Qatar jointly entered equity participation negotiations with their

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[1]Professor Chandler (1977, pp. 53-54), analyzing the aftermath of the Iranian nationalization attempt, wrote:

> Throughout the 1960s, the Mossadeq episode in Iran was remembered as indicating an ability on the part of the companies to frustrate the effective exercise of nationalization . . . Both the British and U.S. governments played a role, but more potent than this was the ability of the companies to increase the production of the oil discovered elsewhere to compensate for the loss of the Iranian crude.

concessionaires. The proposal put forth suggested:

a) To own 25 percent of the operating companies as of the first of January, 1973; ownership included concession rights of oil produced and facilities,

b) To raise the ownership share by the end of 1982 to 51 percent, on a five percent annual basis, and,

c) To return the right to dispose of crude petroleum in a manner consonant with the development of the host government's domestic and international markets.

There were additional provisions for the disposal of government's shares in crude petroleum. Generally, they fell between: a) the equivocal right of the government to dispose of oil in any manner deemed appropriate, b) the allowance of first claim to the foreign partner at preferential prices, and c) the establishment of state-owned companies to market and develop petrochemical industries (as in the case of Saudi Arabia). The companies almost unanimously agreed to the proposed provisions for the refusal meant nationalization à la Libya. The general agreement was short-lived, however. The events of the 1973 war and the associated price increases led to unilateral decisions of either partial or full nationalization. Briefly, Algeria began by nationalizing all non-French oil interests through its state-owned company, Sonatrach.[1]

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[1]For further details, see Ian M. Torrens (1980, pp. 9-19).

The companies that were fully nationalized retained the right to purchase oil in accordance with their historical production record and at more favorable terms. For Iraq, the successive unsuccessful negotiations between Iraq Petroleum Company (IPC) since the 1950s culminated in the 1972 nationalization of all IPC holdings (except the Basrah Petroleum affiliate). Full ownership was finally achieved in 1976 with the companies retaining access to crude in accordance with established quotas and negotiable prices. For the remaining Arabian-Persian Gulf countries (Kuwait, Qatar, and Abu Dhabi) there was not a noticeable variation in their terms from the ones proposed by Saudi Arabia. Kuwait, for example, in January 1974 took 60 percent participation in the concession controlled by the Kuwait Oil Company (KOC). Both Kuwait and Qatar completed their participation takeover in 1976 and 1977 respectively. Abu Dhabi decided against full ownership; it cited its need for exploration and development of its off-shore resources; thus needing the assistance and expertise of the international industry in a capacity larger than service-contractor. And, in Saudi Arabia, the 60 percent participation was achieved with the understanding that it was a prelude to full ownership. Saudi Arabia acquired full ownership by the end of 1979.

4.7.3 THE IRANIAN MODEL: SERVICE-CONTRACTOR AND PURCHASER

The energy demands from France, on one hand, and the desire of the Iranian government to pursue more concessions patterns to develop additional energy resources led to a formulation of an interesting pattern in internation oil agreements. France is an important consumer of petroleum products; its energy balance sheet for the year 1966 showed that of the 67 million tons of crude oil processed in France, of which 57.4 million tons were for domestic consumption, only 2.93 million tons came from French resources (Rouhani, 1971, p. 63). It was natural then that France would pursue an energy policy that was not subject to the whims of the international oil industry.

The National Iranian Oil Company (NIOC), empowered by the Petroleum Act of 1957 to conclude with qualified persons agreements for the exploitation of petroleum resources, signed with the Enterprise de Recherches et d'Activites Petrolieres (ERAP) in August, 1960 an agreement that was "accord nouveau." We will highlight here some of the main clauses of the agreement to show the changing pattern of relationships between resources ownership and the desire to affect production rate, investment expenditures, and price determination. Some of these clauses stated:[1]

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[1]For detailed examination, see Rouhani, Fouad, <u>A History of OPEC</u>, (Prager Publishers, Inc., U.S.A.), 1971.

a) ERAP undertakes, as a contract for services, to carry out operations of prospecting and exploration corresponding to a minimum annual expense obligation, during a period of six years . . . on areas that are reduced by stages. If at the end of the period of exploration no commercial field has been discovered, then the contract shall be deemed to have terminated and funds supplied by ERAP shall be lost . . . if one or more commercial fields are discovered, then only the exploitation areas shall remain at the disposal of the general contractor.

b) For the financing of exploration operations, ERAP supplies the funds as loans without interest -- when the exploration operations lead to discovery of a field capable of commercial production, ERAP supplies the funds necessary for the operations, as loans carrying interest payable over a period of five years from the beginning of production.

c) NIOC is the owner of all the oil produced and the assets created or used during the operations course -- it undertakes to sell ERAP between 35-45 percent of the production at a price equal to the cost of exploration and exploitation plus two percent -- 50 percent between this sum and the realized price is payable as income tax.

d) When it is established that the fields discovered allow the repayment to ERAP the costs of exploration, then 50 percent of the recoverable resources discovered will be set aside as national reserves with NIOC free to exploit them without any obligation to ERAP.

e) In the case of discovery of a field of natural gas, the general contractor can choose between giving up its rights over such discovery, or exercising its rights to develop the gas in which case a different agreement has to be concluded concerning the exploitation of the gas field.

At the beginning of 1965, more than several year later, ERAP concluded a similar agreement with the Iraqi government. This agreement was more advantageous to the Iraqis in terms of a shorter period of exploration and exploitation, the portion of the oil sold to ERAP, and the terms of calculating the sale price. The latter advantages to the Iraqi government had been attributed to more favorable geographical and geological conditions.

The French formula of a service contractor and purchaser also was found appropriate to the Venezuelan government. Accordingly, in February 1968, the state-owned Corporacion Venezolana del Petroleo (CVP), soliciting offers to develop oil reserves in the southern part of Lake Maracaibo, announced that all offers should be in the service-contract form. The variations between the Iranian, Iraqi, and Venezuelan contracts were in terms of the concession areas, length of exploration/exploitation periods, the number of national participation in operations phases, and managerial supervision, but essentially differences of magnitude. The Venezuelan contracts, however, markedly differed in the areas of governmental tax laws and settlement of disputes in which a contractor is held to abide by pertinent fiscal legislation and the sole jurisdiction of Venezuelan courts to settle contract disputes.

4.7.4 THE INDONESIAN MODEL: PRODUCTION-SHARING

Among all OPEC members, Indonesia has the longest established record in oil operations; the first discovery of petroleum dates back to 1855. The Dutch East Indies was the first field of activity of the Royal Dutch Company, founded in 1883, and commercial production started with 2,000 bbls/d in 1983 (Rouhani, 1971, p. 85).

In 1960, the government, relying on a constitutional clause that only the state had the right to exploit petroleum resources, abrogated the concessions system and substituted it with a contractorship to the state agency; thus, all petroleum activities were included under the government control. The Indonesian pattern of resource-ownership reflects a unique character of the

Indonesian petroleum natural setting. By contrast to the relatively low costs, particularly in exploration and transportation, and ease of accessibility that characterize almost all Middle Eastern oil fields, petroleum deposits in Indonesia's archipelago are contained in small and widely scattered deposits. Consequently, exploration and recovery methods are relatively costly. The Indonesian government recognized the need for financial incentives if oil companies are to continue their high-risk operations -- the return per barrel has historically been higher in Indonesia than in the Middle East.

Currently, the largest operator in Indonesia is CALTEX (a joint ownership of Socal and Texaco), operating under a "work contract" via which it provides for capital and technical expertise in return for a share in oil profits with the state-owned oil company (PERTAMINA).

Another type of contract in Indonesia is that of production sharing which includes PERTAMINA and about 30 foreign companies (Torrens, 1980, pp. 11-12). The distinctive features of this arrangement are:

a) Managerial control is retained by the state-owned company regarding developmental expenditures, level and rate of production, and sale prices.
b) Operational losses are borne by the foreign operators with the understanding that remunerations for fixed assets is subject to negotiations.

c) Net profits are divided between PERTAMINA and the foreign operators. The ratio is set variable and, historically, has varied between (85:15) and (89:11) with the largest share going to PERTAMINA.

4.8 THE PRICING MECHANISM, A SECOND LOOK (1960-73)

4.8.1 INTRODUCTION

Table 4.1 reveals some of the economic reasons that led to price volatility during the decade 1962-72. The dependence of the industrialized nations on Mideastern oil sources are summarized. Rising from 2 mbd in 1962 to almost 5 mbd (an annual growth rate of 8.5 percent), the import share in U.S. oil consumption has risen from 20 to 30 percent and was estimated to be 35 percent before the 1973 war (Darmstadter and Landsberg, 1975, p. 22). Yet as a share in total energy consumption, American oil imports stood low when compared to the imports of other industrialized nations. In western Europe, oil imports rose from 37 percent of total energy consumption in 1962 to nearly 60 percent in 1972; in Japan from 44 to 73 percent. For western Europe and Japan, the dominance of the Middle Eastern oil sources, coupled with the importance of oil to their resources base enabled the Middle Eastern countries to play a crucial role in the total energy position of the consuming areas:

TABLE 4.1. ENERGY CONSUMPTION, OIL CONSUMPTION, AND OIL IMPORTS: UNITED STATES, WESTERN EUROPE, AND JAPAN (1962-1972)

	1962			1972		
	U.S.	Western Europe	Japan	U.S.	Western Europe	Japan
Energy Consumption (Oil equivalent)	23.27	13.96	2.25	35.05	23.84	6.58
Oil Consumption	10.23	5.24	0.96	15.98	14.20	4.80
Oil Imports	2.12	5.19	0.98	4.74	14.06	4.78
Oil Imports from the Middle East	0.34	3.80	0.72	0.70	11.30	3.78
As Percentage in Total Energy Consumption						
Oil Consumption	44.0	37.5	42.7	45.6	59.6	73.0
Oil Imports	9.1	37.2	43.6	13.5	59.0	72.6
Oil Imports from the Middle East	1.5	27.2	32.0	2.0	47.4	57.4
As Percentage of Oil Consumption						
Oil Imports	20.7	99.0	102.1	29.7	99.0	99.6
Oil Imports from the Middle East	3.3	72.5	75.0	4.4	79.5	78.6

Source: Darmstadter and Landsberg, 1975, p. 21.

Note: All figures are 10^6 barrels per day.

47 percent for western Europe and 57 percent for Japan in 1972. Such energy dependence explains the "invasion" of the European independents to obtain Mideastern concessions which in return solidified the countries' bargaining position more thoroughly.

There is no single factor that could explain price increases between 1960-73; we will explain here the major economic as well as political factors that led to them. It is not unreasonable to assume that the major oil companies were aware in one variant or another of the overall situation as summarized in Table 4.1. But if we have to pinpoint a particular event, then one cannot overlook the 28 oil concessions granted by Libya in 1968. Whether that surge was due to a realized unexploited differential between the "price-plus-tax" and net return (by the independents) or a realization of structural energy-rigidities in the industrialized countries would remain an empirical question. Nevertheless, given a) the suffocating contract terms of the conventional concessions system, b) the rate of growth of additions to proven reserves in almost all Mideastern countries, and c) the unilaterality with which the majors changed the posted price, all these factors and possibly others undoubtedly created a seller's market.

Yet, when we review the absolute increases in prices obtained during 1961-1973, one begins to suspect that price increases, per se, could not have been the primary objective. For example, in the case of Saudi Arabia, the posted price (for Arabian light, 34' gravity, FOB Ras Tanura) was about $1.80 and the government take of royalties and tax revenues was $0.83; by January 1973, both the price and government revenue per barrel were increased to $2.59 and $1.52, respectively. A relatively meager increase when compared to the prices that prevailed after 1973. This brings us to the consideration of some relevant political factors.

During the decade of 1950-60, most of the oil producing countries gained their political independence. Some of them had been either colonies or protectorates, or had experienced a prolonged external interference. For the young governments, ascertaining their economic sovereignty became synonymous with political independence, notwithstanding market conditions. The new wave of non-alignment in which almost all the oil producers were either active members or tacit supporters created the aura of resource-ownership as a manifestation of non-alliance.

Due to the above-mentioned economic and political factors, and undoubtedly others, there emerged a new pricing mechanism essentially characterized by state intervention and administration. Instead of price locational parity, a host of variables were adopted by the oil-producing governments as determinants, such as:

instability of exchange rates, inflationary pressures and prices of imported manufactured goods -- to rationalize and legitimize price increases.[1] The new state-administered system brought along some new rigidities:

a) For the first time in the world oil market, there appeared a division in the conventional functions of a price, as known to economists -- the states retained the price-setting phase, leaving to the oil companies the task of allocating output among consumers.

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[1]Some authors, notably Adelman (1972-73), Oppenheim (1976-77), Chandler (1977), and Church (1977), seem to inadvertently convey to the reader an image of an organization careless and ruthless in pursuing its economic objectives and negotiations settings short of "gun duels." It is refreshing, however, to encounter statements and views that unravel biases and restrain agitations. Among the latter is Mr. G. Henry S. Schuller, the director of energy programs (Center for Strategic and International Studies) who, in a congressional statement (World Petroleum Outlook 1983, 98th Congress, 1st Session, February 21, 1983, p. 383) stated:

> . . . [in] my experience in negotiating with OPEC in the early 1970s . . . the argument constantly encountered, and particularly from the Shah, was that why should the producer states [get] $2 a barrel for their oil when the consumer in Europe was ultimately willing to pay $15 or $16 at the pump because of the taxes that the consuming government puts on? And unfortunately, that was an argument that none of us could ever really counter because in fact [we] were making money on oil that was a wasting asset of the producing states . . . We could never counter [this argument] and it helped to destroy the will and the ability to resist [price increase] demands. .

b) This mechanism created a "ratchet effect," i.e., a noticeable rigidity toward future downward pressure on price, if any.

c) On the consumption side, new government agencies emerged with objectives such as: energy-use efficiencies, and stockpiling and managing strategic reserves; on the production side, many governments established public companies to diversify sources of national income, and develop petrochemical oil-related industries.

d) The volume of petroleum traded on government-to-government basis or bartership increased.[1]

4.9 CONCLUDING REMARKS

"Changing conditions" or "force majeure" are terms with which one can safely argue and legitimize the changes in the institutional structure of energy-resources ownership. Political sovereignty during the last part of the 1960s and early 1970s came to be equated with not only the availability of a resource within defined and internationally acknowledged political boundaries and the right of a host government to grant concessions but also

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[1]Recent reports have indicated an increasing willingness on the part of U.S. and French firms to exchange industrial products for oil. For example, see: WSJ, July 31, p.2 and Oct. 1, p. 33, 1984.

the ability to direct utilization, control and vary output levels, and influence prices.

Peter Odell (1975, p. 18) views OPEC as a bargaining unit that prevented the oil companies from manipulating production-investment decisions and playing one country against another. Kaufman (1978, p. 104) seems to remain convinced that ". . . the Libyan oil settlements of 1970, by playing the independents off against majors . . . [had] established a pattern to be followed later." Christopher Rand (1978, pp. 303-306) hypothesizes that the companies agreed to participation settlements because they were more interested in an uninterrupted flow of oil than the concessions, per se.

The above analytical views and many others are not without merit. To this author, it seems that the participation/ownership settlements were well-calculated strategies by the oil companies to shift the burden of <u>rationalization</u> and <u>stabilization</u> of the world petroleum trade and prices to the producers. The international industry held, and still holds, an advantage, if not a near monopoly position, over geological and reserve data; it may be true that equity participation had resulted in high buy-back prices (i.e. the price paid by a company for a government's oil share) but even so, the companies seem to have had little difficulty in passing the additional costs on to consumers. When all is said and done, one has to remember that price stability had been a primary objective of the "old" Seven Sisters' structure and, given the increasing competitiveness that the world market had witnessed during the 1960s, the oil companies would have gladly created an "OPEC" and placed it in the middle of the chaos.

CHAPTER V. OPEC'S PRICING POLICY AND THE ROLE OF SAUDI ARABIA

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CHAPTER V. OPEC'S PRICING POLICY AND THE ROLE OF SAUDI ARABIA

5.1 INTRODUCTION

The period 1973-84 is an era of particular significance in the history of OPEC. It marks a time span during which OPEC members,[1] collectively but not necessarily united,

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[1]Membership: the statutes of OPEC provide for three categories of membership: founder, new, and associate (the term "new" was dropped out of the revised statutes of 1965--it was replaced by the phrase, "those countries whose application for membership has been accepted by the conference"). The founding members are the countries that convened in Baghdad (Iraq) on September 14, 1960. They were: Iran, Iraq, Kuwait, Saudi Arabia, and Venezuela.

A country applying for membership should show that it is a net exporter of crude oil in substantial quantity, and that its petroleum interests are fundamentally similar to those of the founding members. At the first conference (in Baghdad), it was agreed upon that a new member's admission should depend on the unanimous acceptance of the five founding members (under this rule, at the time, three new members were admitted: Qatar in January, 1961, and Libya and Indonesia in June, 1962). This rule was modified in 1965 to provide that admission of new members would require three-fourths of "full members," including the unanimous-consent vote of each and all the founding members (the members that were admitted under the modified rule were: Abu Dhabi in November, 1967, and Algeria in July, 1969). Both Gabon and Ecuador were admitted in 1973. OPEC headquarters are in Vienna (Austria).

Since 1970, the "founding members" and "new members" have been referred to as the "full members" to distinguish them from "associate members." The latter could be any country admitted by a majority vote of three-fourths (including the concurrent votes of the founding members) irrespective of its oil-export balance as long as it is believed that the associate member shares the interests and aims of the organization. An associate member is invited became the price determiners of the petroleum market. More importantly, it is also within this period that one comes face to face with the unpleasant reality of the superficiality of separation between resource ownership and the economic ability to influence prices. This latter phrase would not hold had the resource owners, as participants, been able to synchronize their production decisions and achieve maximum joint revenues. OPEC is a collection of sovereign states, more of a trade organization than an effective cartel, with differing political ideologies, differing regional socio-economic and political problems, and differing paces toward socioeconomic development.

As has been noted before, the international oil industry had successfully shifted the burden of price stability to the producing governments. This era, furthermore, witnesses the announcement of an embargo by some members; the appearance of a new price-leader; the

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to attend the meetings of the conference, of the board of governors, or of a consultative meeting with the right to participate but not to vote. A non-member country may be invited to send a representative to the conference as an observer (either at its request or at the initiative of the organization) if the board of governors considers it desirable.

It is worthwhile to note that the two statutory conditions regarding the admission of new members are still a source of some ambiguity: <u>the meaning of "substantial quantity of net export</u>" and the "<u>assumed fundamental interests</u>" that a new member is expected to share with the organization.

outbreak of war between two OPEC members; the formal, although ineffective, production allocation among members; the impact of increasing revenue needs by members as translated into "price-shading" and tacit violations of production quotas; and the emerging role of "non-OPEC" oil producers as a new threat to a group of sovereigns. It is primarily and probably more frequently this perception of sovereignty by which OPEC could determine its economic vitality or marshal its demise. OPEC, beginning in early 1980, amply showed its inability to adhere to its commitments.

5.2 THE ECONOMICS OF PRICING AN EXHAUSTIBLE RESOURCE

Petroleum, as an exhaustible resource, differs in its pricing from other economic goods; the latter, it is commonly agreed that its price should be equal to the cost of production in the long run when allowing for increase in the number of participants to assure absence of above-competitive profits. El Serafy (1979, pp. 273-74) extends the analysis of equilibrium in the assets market to note that the price of oil, or other exhaustible resources for that matter, would be expected to rise over time to allow for the scarcity rent to vary with variations in the market interest rate.

The price of a unit of petroleum will attain equilibrium when producers are indifferent to the option of not producing an additional barrel of oil, or producing it and investing sales revenues at the going interest rate. Expectations of rising future oil prices, _ceteris paribus_, would ration the quantity supplied and keep it in line with existing demand. Differentials in the going interest rate and producers' time preference lead to different results. If the market rate happens to be higher than producers' expected return rate then, _ceteris paribus_, oil supply would be expected to increase and resources would be depleted faster.

The above analysis brings to vogue the long-term forces of supply and demand that influence oil prices. The prices of alternative goods, upon which the current level of scarcity rent is determined, are influenced by their long-term cost prices which in return are a function of the current prices of, among other things, oil. Even within the past ten years and in spite of increases in oil prices, the presence of alternatives and the pace at which they have been introduced to the market may indicate the current price of oil may not be high enough to warrant their forthcoming supply. Relatively moderate prices now would, other things remaining constant, delay the development of substitutes and therefore contribute to higher substitute prices in the future.

Technological changes and their future directions are primarily dealt with on conjectural bases. With greater certainty toward technological changes, the long-term prices of substitutes would be set within assured confidence intervals to allow for scarcity rent to vary with the going market rate. "Instead we have the current state of affairs . . . producers claim prices are too low and consumers, or at least some of them, insist they are too high . . ." (El Serafy, 1979, p. 275).

This approach to exhaustible resources pricing leads to a conclusion: the 1950s and the 1960s were the prelude and possibly the necessary conditions for the higher prices that have prevailed since 1973-74. If this conclusion holds, then it is safe to state that market forces were not operating freely at that time to allow prices to ration rising demand. In this regard, the Saudi Arabian Minister of Finance and National Economy stated:[1]

> The economic range within which the price should be set is a very wide one, with the lower limit defined by the cost of production and the upper limit defined by the cost of producing alternatives to oil . . . until 1970 the price was closer to the lower limit . . . considering the particular characteristics of oil it should have been at or near the upper limit. The 1973-74 price corrections therefore had to be somewhat of drastic character, being the first decisive attempt by the oil exporting countries to set things in the right direction (p. 520).

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[1]For a review of the evolution of oil prices see: H.E. Mr. Mohammed Aba Al-Khail, the Saudi Arabian Minister of Finance and National Economy, "The Oil Price in Perspective," International Affairs, Vol. 55, No. 4, October 1979.

5.3 THE CRUDE OIL SPOT MARKET: AN ADJUSTMENT MECHANISM

Crude petroleum transactions between oil companies and governments of the oil-producing countries fall under contract agreements. These contracts establish commitments to buy and sell specified amounts of petroleum over a long period of time; usually an annual contract on a monthly basis of delivery under stipulated terms of transaction. Since these contracts are signed well in advance, the relative stability of the crude market depends largely upon how successful companies are in estimating demand growth and profiting from their locational monopolies.[1]

While such contracts provide an element of relative stability for the supply and price of petroleum (and derived products), the availability of a mechanism for "momentary adjustment" was clearly absent. Thus, the spot market is perceived by many as a corollary instrument for "fine tuning."

The crude oil spot market is a process by which cargoes of crude petroleum change owners on a daily basis and at times even on shorter notice. It is an informal institution via which buyers and sellers -- a worldwide network of personal and professional contacts -- exchange

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[1]The British National Oil Corporation (BNOC) prefers to export 50 percent of its production [at spot prices] to Germany, Scandinavia, and the U.S. while covering that portion of British needs by importing oil at OPEC prices (Road Transportation and Oil, International Road Transportation Union, Geneva, July 1979, pp. 10-11).

information on spot transactions and price quotations. The U.S. General Accounting Office (GAO) observes that:

> participants can be anywhere in the world, as can be the oil that is traded. Participants may be oil producers, refiners, brokers or traders. Spot market prices are set for each transaction by the parties involved, and deals are almost always made by telephone or telex . . . a single cargo may change hands several times before it reaches its destination (p. 2).

During 1979, the term "spot market" came to embody a set of transactions not previously known to the petroleum market. Among these are:

a) "entry fee" sale representing the purchase by a company of a single cargo or a number of cargoes to obtain a contract with a producing country. This is to say, some of the participants in the spot market are agencies or individuals selling on behalf of their respective countries for varied reasons,

b) "spot tie" situation in which a single unit transaction of spot crude is made conditional to reception of spot crude contracts.

However, a common characteristic is that crude is transacted in the spot market at prices above the price of contract oil during tight market conditions.[1] Trade

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[1]According to an Opec Bulletin (May, 1980) the differential between official and spot prices from April, 1979 to February, 1980 exceeded $5 a barrel for every category of OPEC crude oil. However, due to the glut and drop in demand during 1983-84, officials at the 21-members International Energy Agency estimated that spot prices are used in 33-40 percent of oil trading and that spot prices are more than a dollar below official OPEC price (NYT, July 3, 1984, p. D5).

publications such as Platt's Oilgram Price Report and Petroleum Intelligence follow the spot market weekly, but they do not report specific transactions or final prices. A typical spot participant knows the origin of the cargo he buys or sells; he generally does not know, or is even not interested in knowing who owned it or what price had been paid for it.

5.3.1 FACTORS AFFECTING THE SPOT MARKET OPERATIONS

A major factor affecting the functioning of the market is refiners' expectations of future prices, particularly independent refiners. Since refineries are capital-intensive operations requiring uninterrupted plant utilization, many refiners, therefore, have an interest in securing a steady supply of oil.

The relatively small size of the market affects its price stability to even small increases in overall demand. If 30 mb of oil are traded daily and if 5 percent of it (1.5 mb) is traded on the spot market and if overall demand is expected to increase by 2 percent (.60 mb), the marginal increase in demand on the spot market would be 40 percent. The differences among OPEC members over a unified price structure, largely between those members with small proven oil reserves and a substantial need for high revenues and those with large reserves and more of a "financial cushion," led some OPEC members (e.g. Ecuador) to test the market about the potential price for its crude such as the reported sale of June, 1979 (GAO Report, 1980, p. 17).

Restrictive actions by producing countries is an additional source for spot volatility. In January 1979, Saudi Arabia reduced its production from 10.5 to 9.5 mbd and to 8.5 mbd from April to June of the same year. Although production was increased later to 9.5 mbd for the last half of 1979, Saudi Arabia was reported to have taken 500,000 barrels a day previously allocated to ARAMCO and began marketing that portion itself. Libya claimed *force majeure* to reduce its contract sales by 10 percent for the second quarter of 1979.

But perhaps more important is the effect of political events on the behavior of the market. With the fall of the Shah in January 1979, the petroleum trade lost about 5 mbd. Over the 11 months that followed, the reduction in Iranian oil exports to about 2.5 mbd and the cancellation of some contracts with major oil companies, the DOE data (GAO, August 12, 1980, p. 12) showed that more than 21 percent of U.S. crude oil from Iran was purchased at spot prices.[1]

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[1]The British National Oil Corporation was the first to surpass OPEC ceiling price of $23.50 in 1979--adding $2 per barrel premium on contract sales for "greater security" of British oil and the high spot prices (Road Transportation and Oil, July 1979, pp. 10-11).

It is also worthwhile to note that political crises always result in hoarding to be dumped later, thus depressing prices. (See the WSJ, March 6, 1984, p. D5, and the NYT, April 8, 1983, pp. D1 and D5.)

5.4 OPEC'S OIL PRICING EXPERIENCE

5.4.1 INTRODUCTION

Until early 1970, the oil companies sought to expand sales by fixing a low price for oil. Primarily, two factors led to this policy: a) the need to substitute oil for coal as a prime source of energy, and, b) the huge amounts of proven petroleum reserves whose production potential extended beyond the oil companies' concessions termination dates. Since a major portion of their crude came from Mideastern sources and, given the relatively minute costs of oil production in the Middle East, it was invariably true that the price per barrel for new competitors could not fall below the costs of successful discovery efforts from marginal sources plus a return to entrepreneurship commensurate with risks involved.

A chief executive of a major oil company had asserted that the oil industry's pricing policy did not reflect the scarcity value of oil and led to an excessive expansion of demand:

> If you really want to condemn the oil industry, then I think you condemn it for the simple fact that we have produced very cheap energy. Now that cheap energy made possible the tremendous growth of this country [the U.S.] particularly since the end of World War II.[1]

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[1]Rawleight, Warner Jr., Chairman of Mobil Oil Corporation, "Oil Strategies Bad and Good," (Financier, N.Y., Sept. 1979, p. 32).

A positive outcome of oil price increases, grace à OPEC, enabled the industrialized countries to "weed out" inefficient industries without serious political ramifications to governments as well as to make investments in alternative energy industries a worthwhile endeavor. As a French official succinctly stated:

> . . . in fact they [the price increases] were the consequence of a rapid depletion of lower-cost oil deposits. The price increases paved the way for opening up [or further development] of higher-cost sources of energy: natural oil deposits in Alaska and the North Sea, nuclear power, coal and synthetic crude . . ."[1]

OPEC members had consulted with each other about output and pricing policy prior to 1973; but the characterization of OPEC as a cartel did not appear until the price increase of 1973-74. Until 1980, there was no formal allocation of quotas among the members. Saudi Arabia played the role of adjusting its production so that the declared oil prices would prevail; but, also, there were periods when Saudi Arabia operated almost independently of the other members and even contrary to what market conditions and maximization of joint revenues would have required.

5.4.2 FIRST ROUND PRICE ADJUSTMENT: 1973-74

During 1972 and 1973, world demand for oil was increasing rapidly, exerting an upward pressure on prices.

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[1]Monsieur R. Marjolin, Le Développement Économique de L'Europe: La rupture de 1974 et ses prolongements dans l'avenir (Banque, Paris, Feb., 1981, p. 135).

Saudi Arabian production increased rapidly during this period to meet demand.

The Arab-Israeli war broke out on October 6, 1973. At a scheduled OPEC meeting in Kuwait on October 16, Saudi Arabia agreed with other OPEC members on a call for increased prices.[1] The Arab oil ministers, in addition, announced a 5 percent production cut. But on October 19, and as a response to President Nixon's request to Congress for $2.2 billion in aid for Israel, Saudi Arabia along with other Arab members of OPEC reacted by declaring an embargo on shipments of oil to the U.S. and the Netherlands.[2]

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[1]Oppenheim (1976-77, p. 50) sees that the U.S. State Department pursued a policy of tolerating or even encouraging higher oil prices. He writes: "James Akins [former U.S. Ambassador to Saudi Arabia who was unexpectedly removed during the summer of 1975], one of the men who forsaw--and perhaps helped bring about--the higher prices of OPEC oil, now believes that it was calculated that the effect of the oil price increase would be of competitive advantage to the U.S. because the economic damage would be greater to Europe and Japan." Oppenheim quotes Akins as stating: "OPEC was a tool of U.S mercantalism."

[2]The 1973 oil embargo was not the first attempt by Arab governments to use oil for economic as well as political objectives. Because of the Arab-Israeli war of 1967, there was an enunciation of an oil "shut-down." By the second day of the June 6, 1967 war, Libya was the only Arab country that brought to a halt its oil export operations. Abu Dhabi, Bahrain, Kuwait, Qatar, and Saudi Arabia continued oil exports but excluded the U.S. and Britain as final destinations of their oil exports; Algeria's exports to France stayed on schedule and Iran accelerated its daily production.

In 1956, when another war episode took place, the Suez Canal was nationalized; Britain, France, and Israel retaliated by an orchestrated three nations' military

More important, though, than the political proclamation of an embargo[1] were the announcements in October and early November of the same year by Arab members of OPEC to reduce production below September 1973 levels by a fixed percentage each month until a permanent resolution of the Arab-Israeli conflict is reached.[2]

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invasion to capture and re-open the canal. The closure of the canal that followed brought a response by the Foreign Petroleum Supply Committee (FPSC)--a consortium of 21 U.S. major oil companies--in the form of an allocation and transporting plan mobilizing a tanker fleet to transport oil around the Cape of Good Hope. See: Nixon (1980, pp. 73-86), Warner (1979, pp. 226-239), and OGJ (June 12, pp. 43-48; June 19, pp. 76-78; June 26, pp. 38-41, 1967.)

[1]El Sarafy (1979, p. 286) observes that it was a strange cartel whose members behaved discordantly: the non-Arab members in fact expanded production to take advantage of the (expected) reduction in supply, and some of the Arab members themselves disagreed with the embargo idea.

Professor Paul MacAvoy writing in the MIT Technological Review ascribes gasoline shortages in the U.S. to: a) the maintenance of price control by the federal government over U.S. domestic oil, and b) federal directives to refiners to produce more fuel oil and less gasoline for health and safety reasons.

Professor F. Singer (Winter 1972-73, p. 58) observes that U.S. gasoline lines "provided an effective, albeit inefficient rationing system. U.S. reserve stocks around the embargo time were hardly depleted, and in fact were greater at the end of the embargo announcement than during January 1974. . . . the international oil companies managed to blunt the embargo by simply swapping their shipments . . . Arab oil went to Europe while the U.S. received oil from other sources. . . ."

[2]Johany (1979, pp. 43-49) reports Saudi Arabian production figures as: September 1973, 8.5 mbd; October 1973, 7.8 mbd; November 1973, 6.3 mbd; December 1973, 6.6 mbd.

By February 1974 when oil shipping restrictions were formally removed, posted prices had increased four-fold, almost up to $10 per barrel.

5.4.3 THE SECOND ROUND PRICE ADJUSTMENT: 1974-78

Since 1974, the real price of oil has fallen steadily, and at the beginning of 1978, it stood a little over three times its level of the early 1960s (Penrose, 1979, p. 22). There were inter-OPEC pressures on Saudi Arabia to announce a price increase. At the Doha meeting in late 1976, Saudi Arabia and the United Arab Emirates[1] disagreed with the remaining OPEC members. Instead of the proposed 10 percent, they agreed only to a 5 percent increase. To assert its economic stance, Saudi Arabia raised and maintained a production level above 9 mbd throughout 1977.[2]

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[1]Note that Abu Dhabi and other Arabian-Persian Gulf emirates severed their political ties to England as "protectorates" and joined in a political confederacy on December 1, 1971 that came to be known as the United Arab Emirates. They are Abu Dhabi, Ajman, Dubai, Fujairah, Ras-al-Khaimah, Sharjah, and Umm Al-Qawain. Among the member states constituting the United Arab Emirates, only Abu Dhabi is a net exporter of oil and thus a member of OPEC. This should explain the ambiguity in some of the international statistical reports where use is made of the name Abu Dhabi at times and United Arab Emirates at others as a member of OPEC.

[2]Church (1977, pp. 42-44) observed ". . . the Saudis first lifted their 8.5 mbd production limitation knowing full well that all the incremental volume that could be made quickly would have to be in the medium to heavy-grades crudes [that] directly competed with those produced by Iran, Iraq, and Kuwait. The Saudis then opted for a 3.6

But by mid-1977, OPEC met again and Saudi Arabia agreed to increase its price by 5 percent in return for no further price increases by OPEC members.[1] The posted price of the Arabian light was maintained at $12.70 throughout the second half of 1977 and most of 1978. But by late 1978, political turmoil in Iran which resulted in work strikes in the oil fields sharply reduced Iran's exports. From October to November 1978, crude prices on the spot market increased from about $13 to nearly $19 a barrel, an increase of 68 percent. Saudi Arabia, expecting that prices might increase even further, began to increase its production that reached an average 10 mbd for November and December, 1978 (Quandt, 1982, p. 15).

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percent hike for these crudes, as compared to OPEC's 10.2 percent to exacerbate the situation and create as much demand as possible. . . .The Saudi Government ordered the four ARAMCO International marketers [Exxon, Mobil, Texaco, and Standard Oil Company of California] to pass on the government lower prices directly to importers in consuming countries, without intermediaries and with no extra profits to themselves. To further increase the pressure on the other OPEC members to bring their prices into line with Saudi prices, Saudi Arabia designated four large European international oil companies [Shell, BP, CFP, and ENI] as the first new customers to whom ARAMCO will sell its additional Saudi production . . ."

[1]The Saudi Arabian Minister of Petroleum and Mineral Resources, H. E. Mr. Ahmad Z. Yamani, reflecting on this decision later, stated: "As a result of the price freeze imposed by Saudi Arabia, oil prices have doubled since the end of 1978. If the Western countries had been realistic and had accepted regular annual increases in the price of oil, there would not have been a sharp and sudden increase in prices, with the ensuing impact on their economies. I wish we had not frozen the price of oil in the past." (In Mikdashi, p. 408).

OPEC's meeting in Abu Dhabi in December 1978 led to an agreement of a gradual increase in prices through quarterly price-adjusting formulae to increase the price of the the Arabian light -- OPEC's marker -- to $14.55 per barrel for the first months of 1979.[1] This agreement was short lived due to the Shah's departure from Iran in January, 1979. (The historical-statistical record shows no significant Iranian exports for the first quarter of 1979.)

Expectations of increased oil prices due to unknown Iranian oil plans led to consuming nations' increased stockpiling plans and additional rounds of speculative purchases on the spot market.

Saudi Arabia's responses to these events came through announcements (in mid-January, 1979) to reduce production and the adoption of a ceiling of 9.5 mbd. Between January and February 1979, spot prices for the Arabian light rose from about $18 to over $22.

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[1]The Saudi Arabian Minister of Finance and National Economy, H.E. Mr. Mohammed Aba Al Khail, stated: "In the four years following 1974, the OPEC countries exercised considerable restraint in their pricing policy, even at the cost of their own interests in order to afford the consuming countries the time necessary for the required adjustment. Between 1973 and the end of 1977, the price of oil barely kept up with other prices, the real value of oil remaining steady or falling somewhat. In 1978, its real value fell sharply as the dollar price of oil remained relatively stable in the face of world inflation and the falling value of American currency . . . as a consequence of the adjustment in June 1979 for the first time since 1974 the oil price has risen relative to the increase in other prices over the same period" (1979, p. 521).

5.4.4 THE THIRD ROUND PRICE ADJUSTMENT: 1978-80

By late March 1979, Iran began to sell its oil on both contract bases and immediate spot-type sales. Saudi Arabia made another production decision to allow for a price increase. In early April 1979, Saudi Arabia announced a further reduction in oil production to 8.5 mbd for the second and third quarter of 1979. In response, spot prices reached $29 in May and $35 in June, 1979.

OPEC's meeting in March 1979 accelerated the price increase (of December, 1978), setting $14.55 for the Saudi Arabian light. Four months later, Saudi Arabia announced an $18 posted price, while other members were charging an average of $24 for comparable grades of oil. For the third quarter of the same year, Saudi Arabia raised production to 9.8 mbd.

5.4.5 THE FOURTH ROUND PRICE ADJUSTMENT: 1980-82

For the years 1980-82, Saudi production was kept near maximum capacity, averaging between 9-10 mbd. Even with this high production level, prices during 1980 rose from $26 to $32 and remained within this range until the December, 1981 decision to increase posted prices to $34.

During 1980-82, Saudi Arabia argued with other members for the need to return to a price strategy (similar to the one adopted in December, 1979) which rests upon small quarterly increases in prices adjusted to the inflation rate and the value of the U.S. dollar. Saudi Arabia, to ensure acceptance of its price strategy, raised the posted price of its oil gradually through 1980. Overall demand was declining, yet Saudi Arabia's production remained high. Equally significant is Saudi Arabia's share of OPEC market that went from 32 percent in late 1979 to 44 percent in October 1980, and to 50 percent in August, 1981.[1]

Prior to the outbreak of war between Iraq and Iran in September 1980, spot market prices hovered around $30 for the Arabian light. The outbreak of the war affected oil exports of both countries. Saudi Arabia's policy response was an increase in production to an unprecedented high level of 10 mbd, and this high level of production was maintained from October, 1980 until September, 1981.[2] Spot market prices initially rose to over $40, then slowly began to decline, so by mid-1981 spot and contract were almost equalized at $32 a barrel. Gradually, Saudi Arabia

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[1]Penrose (1979, p. 23) observes that the mechanism for setting the price of crude oil does not require that OPEC act as a cartel. No member of OPEC has oil reserves large enough to enable it to sustain a volume of sales at lower prices which would so affect Saudi Arabia's exports as to induce it to lower the marker's price. So long as [Saudi Arabia] is willing to accept reductions in its own exports in order to accommodate the exports desired by other countries, there is little difficulty in maintaining the general level of oil prices.

[2]Quandt (1981, p. 132) observes that "by the time of the Iraq-Iran war, worldwide stocks of oil were about 400 million barrels above normal, almost exactly the amount of oil accounted for by the Saudi Arabian additions since mid-1979 . . ."

began to cut production to 9.2 mbd in September, 1981, then to 8.6 mbd in November of the same year. At the December, 1981 meeting, OPEC agreed to set $34 as the posted price for the Saudi Arabian light with allowance for small price variations to compensate for quality differentials among members. But by February, 1982, the spot price fell to almost $30 and Saudi Arabia, in response, reduced production to defend the $34 per barrel.

An emergency OPEC meeting was called for in Vienna during early 1982. And for the first time, the organization adopted a quota rule to ensure that total output would not exceed a ceiling of 17.5 mbd. Saudi Arabia agreed to sustain a 7 mbd production level to support the official $34 prices.

5.4.6 THE FIFTH ROUND PRICE ADJUSTMENT: 1982-84

This period is characterized by a non-adherence to production quotas and underselling the official price through discounts and various forms of easing contract provisions.[1] But these were more of the symptoms than causes -- OPEC revenues reached a peak in 1981 at $250 billion, but sluggish demand and increasing non-OPEC oil

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[1]Such as: a) granting extended credit terms, b) adjusting price paid for oil to the realization of prices on derived products, c) selling crude oil combined with petroleum products far below market prices, and d) eliminating the requirement to ship crude on producing governments or national oil companies tankers (see <u>OGJ</u>, Feb. 21, 1983, pp. 60-61).

sources (Britain, Mexico, Norway) drove down revenues to $150 billion in 1983 (WSJ, March 6, 1984).

OPEC was estimated to be 1.5-2.0 mbd above the total sum of "member's quotas" with spot prices $3-4 below OPEC's official price. Ironically, the first worldwide price reduction was initiated by Britain which announced a $3/bbl reduction for its North Sea crude; Nigeria followed with a $5.50/bbl reduction. During an urgent meeting for OPEC in London in March, 1983, an agreement was reached to reduce the official price to $29 from $34/bbl, place an OPEC production ceiling of 17.5 mbd, and raise Nigeria's share of 1.3 mbd by 100,000 b/d in August and 150,000 b/d in September, 1984 (NYT, July 12, 1984, p. 27).

The pressure on the spot market continued with increasing amounts transacted at spot prices. During the second week of November, 1984, Statoil (of Norway) announced a reduction of $1.75/bbl on its North Sea crude and another "dominoes" effect was set in motion. Britain a week later reduced the price of its premium crude from $30 to $28.50/bbl and Nigeria, to whom Britain's Brent crude is a competitor to its Bonny light, reciprocated by a $2/bbl reduction below OPEC's market of $29.

During its last meeting in Geneva, late October, 1984, OPEC had two problems to address: a) reduce OPEC's production ceiling to accommodate increasing non-OPEC supplies and combat its own members' appetite for extra revenues and, b) realign its pricing formula to allow for larger differential between OPEC's marker (the Saudi light) and regional competition for its members (such as Nigeria, Venezuela, and Indonesia). The conference agreed only to reduce OPEC's ceiling to 16 mbd and support the official price of $29/bbl.[1]

5.4.7 THE SIXTH ROUND PRICE ADJUSTMENT: DECEMBER 1984

As of September, 1984 production stood in excess of one million barrels per day above the agreed-upon quota of March, 1983. The month of December 1984 is notable in the history of OPEC ministerial meetings; OPEC held two urgent meetings within eight days to deal with a long-overdue pricing problem: inter-OPEC price differentials under glut

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[1]Here we report the pre-October, 1984 Geneva meeting members' quotas, the proposed quotas, and the amount of output reduction (in thousand barrels daily). Assigned to each member, respectively: (NYT, Nov. 1, 1984, p. D19).

Algeria [725/663/62], Ecuador [200/183/17], Gabon [150/137/13], Indonesia [1,300/1,189/111], Iran [2,400/2,300/100], Iraq [1,200/1,200/0], Kuwait [1,050/900/150], Libya [1,100/990/110], Nigeria [1,300/1,300/0], Qatar [300/280/20], Saudi Arabia [5,000/4,353/647], United Arab Emirates (Abu Dhabi) [1,100/950/150], Venezuela [1,675/1,555/120].

market conditions.[1] The conflict would not have arisen had not it been for increased North Sea production (particularly by Britain, which was reported to be producing 2.6/mbd as of November, 1984 as compared to almost 2.0/mbd at the end of 1983) and the quality of that oil, which put it in direct competition with the African OPEC members' crudes (particularly Algeria and Nigeria).

A number of proposals were advanced: a) halting OPEC production for three days (the Iranian representative), b) direct intervention in the oil futures market to support OPEC's official price (the Arabian-Persian Gulf states), and c) to decrease the price differential between OPEC's light and heavy crude markers (Algeria and Nigeria).

Increased demand for heavy crudes, mainly due to recent refining improvements, induced OPEC to reduce the price differential. Thus, OPEC lowered the price of its light marker by $.25 and raised the prices of its medium

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[1]Reports show that some OPEC members tried to short-circuit the process of disposing of their above-quotas production in numerous ways. For instance, Iraq entered into an agreement to barter crude oil with Brazil for VW cars. Saudi Arabia was reported dumping as much as 400,000 bbls/d of oil products at reduced prices, thereby effectively selling Saudi crude at $3 to 4 below OPEC's official price (See: WSJ, December 19, 1984; p. 8). Saudi Arabia's oil-for-ten [747 jetliners] deal with Boeing is estimated to have added 36 million barrels of oil to the market during the second half of 1984 (See: WSJ, January 11, 1985, p. 1).

and heavy crudes by $.25 and $.50 respectively.[1] In addition, OPEC agreed to establish a five-member price and production auditing committee (Indonesia, Nigeria, the UAE, Venezuela, chaired by Saudi Arabia). The committee was authorized to appoint observers inside OPEC countries to inspect ports and loading facilities (56 ports in 13 countries), and monitor oil contracts.[2]

5.4.8 THE SEVENTH ROUND PRICE ADJUSTMENT

Another price reduction in OPEC's marker of $1/barrel was announced during the Geneva meeting of February 4, 1985. This last reduction placed the Saudi light at $27.75/bbl; enough to satisfy Nigeria's demand for a competitive edge vis-a-vis the North Sea producers.

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[1]The agreement was seen as an insufficient response to glut market conditions for the following reasons: a) the new price agreement reduced the $3 premium between the Arabian light and heavy to $2.50. For the months of September and October, 1984, British crude spot price was below the new OPEC's official light price of $28.65; b) Algeria and Nigeria were reported to have asked for a $1.50 increase in the heavy crude price. The Algerian-Nigerian proposal underscores the conflict between those OPEC members who have a limited range in the light, high quality crude and those with larger crude quality flexibilities. Heavy crudes on the spot were the only grades for which OPEC's official price was in line with the spot. The new price accord still made the heavy crudes attractive to buy; c) Saudi Arabia is reported to have rejected the $1.50 increase in the heavy crude price, and Algeria and Nigeria refused to accept the new price accord (See WSJ, December 19, 20, 31, 1984 and January 14, 1985).

[2]Algeria and Nigeria refused to endorse the auditing system (for further details see: WSJ, December 31, 1984).

Three OPEC members refused to endorse the new price (Algeria, Iran, and Libya) with Gabon abstaining. The refusal was meant as a preference for re-structuring OPEC pricing around a hypothethical composite crude -- that is to say, crude price differentials should be a calculation based upon quality and location in reference to a "representative" crude.

It would not be difficult to see why the latter proposal did not command unanimity. Notional crudes are not traded on the spot; it might be better to have a marker that is widely available and generates a true market value. Furthermore, it could be a mistake for OPEC to fit the North Sea oil into the differential system. In practice, North Sea oil is not a widely-traded oil; it is a short-haul crude supplying northwest Europe.

5.5 AN ASSESSMENT OF THE SAUDI ARABIAN OIL PRICING POLICY

5.5.1 INTRODUCTION

Under this heading we will evaluate the Saudi Arabian pricing policy on theoretical as well as on production record grounds. Such division is illuminating for the theoretical side would bring forth some interesting features (e.g. some of the tacit premises regarding socio-economic and political changes as they are accounted for in the texts and applications of the already completed three developmental plans) which may be of particular interest to students of resource development; the production record focus would enable us to better assess Saudi Arabia's role as a member of OPEC. Beyond the pedagogics of the dichotomy the policy assessment will be carried out with reference to both sides.

5.5.2 A THEORETICAL POLICY ASSESSMENT

A number of authors have set out to explain Saudi Arabia's oil pricing policy.[1] One observes a degree of unanimity regarding the conclusion that Saudi Arabia's oil pricing policy had been motivated and influenced by a host of economic gains and "myths" of political victories. That is to say that the oil policy does not represent a consistent, equi-proportional blend of economic and political objectives.

The equi-proportional policy input requirement is always easier proposed than executed. Political events have the undesirable idiosyncrasy of surprise and caprice -- a matter that, in the minds of many would necessitate different responses to varying events. But it is to the economic component of the pricing policy, the consistency of it or, more precisely, the absence thereof, that more attention is given here in an attempt to explain how and why this prevailed.

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[1]Prominent among them for originality of contributions are: Kanovsky (1980, pp. 313-59), Kelly (1980, pp. 263-64), Long (Winter, 1979), Moran (1976-77), Pindyck (Spring, 1978), Quandt (1981, pp. 123-135).

One could put forth two schools of thought to explain the Saudi Arabian oil price policy. At one end, one could argue that the financial requirements of development necessitated a given level of production to obtain revenues. As such, looking at this revenue as a constraint, given the span and pace of development as represented in the last three development plans, and viewing the magnitude of Saudi Arabia's oil proven reserves vis-a-vis other OPEC members, then a policy of price moderation is a rational behavior. This view explains Saudi Arabia's interest to produce substantial quantities of oil at relatively lower prices. The second view argues for producing less oil and relying on a short-run price inelasticity for petroleum to obtain the required revenues. The associated rise in price could ensure the financing of Saudi Arabia's development needs; minimize the "hoarding" of depreciating foreign exchange, avoid future political entanglements associated with investing huge national assets in foreign governments' securities,[1] and

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[1]During the period 1973-80, Saudi Arabia was caught in a vicious financial circle: oil dependence by the U.S. (and other industrial consuming countries) meant that an increase in the price of oil would immediately worsen the U.S. balance of payments. Throughout 1970-1980, the U.S. monetary authorities adopted a monetary policy that accommodated increases in the general level of prices by increasing the rate of growth of money supply. This policy decreased the value of the U.S. dollar and consequently reduced the value of the Saudi holdings. Saudi Arabia could not (and possibly cannot as long as a large portion of these assets are denominated in the U.S. dollar) raise

minimize the role of Saudi Arabia as a lender to various international agencies.[1]

Either view is not without merit, particularly to their assessment of the energy markets and normative premises about the development process. The first position views development programs and projects as "needs," primarily constrained by insufficient revenues. Thus, the "price-moderately-and-sell-now" policy is an adoption of a relatively low discount rate -- a bias in favor of present income. Furthermore, essential to this policy is the

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the price of oil because the circular process simply would repeat itself.

Commenting on this situation, the Saudi Arabian Oil Minister has stated: "It is in our interest not to take any action that may cause a further fall in the dollar rate. This explains the attitude of Saudi Arabia that you hear about regarding the question of the dollar. It is a sound attitude despite the great loss and despite the fact that it contradicts the attitude of the oil-producing countries. But it is an attitude that stems from Saudi interest." Peter Osmos and David Ottaway quoted the Saudi Oil Minister saying that "[Saudi Arabia] was losing money by producing so much oil to meet western needs instead of leaving it in the ground where its value appreciates much faster than any dollar investment." Referring to the loss which is due to such high production paid for mostly in dollars, the Saudi Oil Minister said: "It is on the whole not a pleasant thing to do." See: U.S. Congressional Record, Extension of Remarks, May 4, 1978, p. E2342 and P:E2344, respectively.

[1]The WSJ (April 25, 1984, p. 32) reported that: "Saudi Arabia, which already has a net creditor position of about $10 billion with the IMF as a result of its earlier loans to the international agency, will provide $3.15 billion of a new credit package. West European countries, Japan and other countries will provide the other $3.15 billion . . ."

objective of income diversification -- employing underutilized resources, supposedly hampered by insufficient capital or unavailable skilled labor, with the long-term result of more balanced, multi-sector growth contribution. Additional technical premises that add to this approach's appeal is an assumed different sectoral response to technological diffusion and by-passing institutional (i.e., tribal, attitudinal) rigidities.

The second view is essentially conservationist in heart and soul:

> Our sons and daughters are receiving the educations we never had. We would deserve the worst they could think of us if, when they come of age with the intellectual equipment to build our economies, they find we have frittered away our own one resource.[1]

This view seeks to optimize an inter-temporal, intergenerational resource allocation -- to its advocates, it seems to accept a gradual and holistic amelioration of developmental bottle-necks; its major argument seems to refute current market registering of consumptive and investment preferences to be a fixed costs to future preferences.

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[1]Mr. Suliman S. Olayan, Chairman of the Olayan Group of Companies (a Saudi Arabian commercial, contracting, insurance, and investment group); currently a member of the International Council of Morgan Guaranty Trust Company (see Fortune, Aug. 13, 1979, pp. 217-222).

5.5.3 THE PRODUCTION RECORD ASSESSMENT

From Section 5.5.2, one could conclude that either view could have been a sound theoretical foundation had the Saudi Arabian pricing policy adhered to one or the other. Instead, we observe that during 1974-75, a period during which the real price of oil was declining, Saudi Arabia maintained a production level that further eroded the real price of oil.[1] A policy with an objective of retaining constant real income would have necessitated a downward adjustment of production.

During the Doha meeting in December, 1976 when OPEC disagreed on a unified price structure, Saudi Arabia, to assert its position of only a 5 percent increase in the posted price, practically flooded the market with a steady 9 mbd production level throughout 1977.

In response to the political situation in Iran, the price per barrel went up from $13 to $19. Again, revenue requirements or maintenance of a postulated real income, other things constant, would have required a reduction in production. Instead, Saudi Arabia raised production to one of its highest

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[1]See: H.E. the Minister of Petroleum and Mineral Resources and H.E. the Minister of Finance and National Economy Statements on P(146 and P(147) respectively.

historical levels, 11 mbd for the months of November and December, 1978.

The policy of gradual price increases proved out of line with market conditions. This gradual approach to pricing put the Saudi Arabian light at $14.55 during the Abu Dhabi meeting in December, 1978. This price did not last, however, for Saudi Arabia found out how underpriced its oil was when the spot market was charging $40 per barrel. It was by late December, 1979, a policy lag of one year, that Saudi Arabia adjusted its posted price to $24/bbl -- $16 below arm's length prices.

Some economists, notably Pindyck (1978), have argued that Saudi Arabia sought to maintain a price-path to maximize long-run return. The argument rests upon an analytical distinction between two groups of OPEC, namely "Savers" and "Spenders." A spender would generally choose higher prices preferring large revenues in the short run even if it means smaller revenues later, whereas a saver would generally have an opposite policy. He further asserts:

> The price freeze [of December, 1976] was clearly in the economic interest of Saudi Arabia[1] . . . and as long as Saudi Arabia was determined to pursue its economic interests the outcome was assured (p. 40).

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[1]Pindyck's assertion is erroneous in light of previous statements by the Minister of Oil and the Minister of Finance. See Section 5.4.3.

Pindyck's assertion that Saudi Arabia maintained a price path to maximize long-run return is unwarranted. Statements by both the Saudi Ministers of Oil and Finance reveal that Saudi Arabian policy led to a decline in the real price of oil. It makes no sense to argue in nominal terms in light of the high rates of inflation and currency fluctuations that prevailed during 1970-1981 in the economies of almost all OPEC trading partners.[1] Thus, recasting Pindyck's assertions in real terms, he seems to be saying that the interest of Saudi Arabia lies in a declining long-run real rate of return!

When we look at the period 1973-84, we observe the emergence of two not unrelated pricing policies. The first lasted from 1974-82 during which the Saudi Arabian rate of production set the tone for OPEC. There was no formal allocation of production among OPEC; Saudi Arabia built up its foreign reserves and carried out ambitious development expenditure programs. During this era, there was a massive redistribution of revenues at the expense of limited production and development expenditures by OPEC

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[1]Dailami (1979, pp. 336-43) in his study of the effects of inflation and dollar depreciation on OPEC's purchasing power concludes that over the period 1971-77, "the fluctuations in the dollar value had led to a decline by about 16.24 percent, and inflation had led to a decline by about 63.2 percent in OPEC's terms of trade."

members. The second policy ensued between 1982-84; although production quotas were assigned, the price differential between OPEC's marker and other members' crude (such as Nigeria and Indonesia) retained a favorable price advantage to Saudi Arabia. In spite of the "overproduction" (above assigned quotas) that the majority of OPEC members practiced during 1982-84, Saudi Arabia assured itself the exhaustion of its quota through the differential factor.[1]

The above analysis seems to support the conclusion that Saudi Arabia acted as a price leader for OPEC (the price leadership within OPEC was exercised first by Libya as Chapter IV shows, and later Iran took over the role between

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[1]Penrose (1979, p. 23) observes that as long as the Saudi crude is made available at the announced price, then the price of the remaining, 130-odd varieties of crude should fall in line with it after making allowance for quality differences which affect refining costs and yields . . . different crudes are, at a cost and a given time, substitutible in the refining process.

1970-74). This role, however, on occasions failed to account for other OPEC members' development needs.[1]

Now, it is worthwhile to investigate the resource bases upon which Saudi Arabia's price leadership role rested. This investigation would be carried in a comparative frame among OPEC members. Table 5.1 shows the resource position of OPEC and Saudi Arabia. Over the period 1970-1983, OPEC's share of world proven oil reserves has averaged 69 percent; almost one-quarter of the world's and OPEC's reserves lie within Saudi Arabia. This variable by itself shows the relative command that Saudi Arabia could have in the near future regarding OPEC price policy. OPEC holds even greater command when we compare its natural gas resource base to the rest of the world. Table 5.2 shows that almost one-third of the world's known and recoverable

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[1]Mr. G. Henry M. Schuler, Director of Energy Programs (Center for Strategic and International Studies), in a congressional testimony stated:

> If one looks at the Saudi decisions with respect to price, none of the economic models will support the views that they are economically driven by supply and demand or revenue optimization, or anything of that sort, and in fact they have been driven by political considerations, whether political in order to resist regional pressures or obtain international support or to defuse domestic political developments that would be against stability.

See: World Petroleum Outlook - 1983, hearings before the Committee on Energy and Natural Resources, U.S. 98th Congress, 1st Session, February 21, 1983, p. 388.

TABLE 5.1. SAUDI ARABIA AND OPEC'S SHARE OF WORLD PROVEN OIL RESERVES (1,000 BBL.)

	1970	1974	1978	1980	1983	1984
World	611,397,458	615,697,189	641,607,825	648,524,712	669,302,600	698,667,400
OPEC	407,650,000	503,615,000	437,140,000	425,485,000	440,785,600	469,005,000
Saudi Arabia	128,500,000	164,500,000	165,700,000	165,000,000	166,000,000	169,000,000
$\frac{\text{OPEC}}{\text{World}}$	0.66	0.82	0.68	0.66	0.66	0.70
$\frac{\text{Saudi Arabia}}{\text{World}}$	0.21	0.27	0.26	0.25	0.25	0.20
$\frac{\text{Saudi Arabia}}{\text{OPEC}}$	0.32	0.27	0.26	0.25	0.25	0.40

Source: Oil and Gas Journal, Selected Years (ratios computed by the author).

TABLE 5.2. OPEC AND SAUDI ARABIA'S SHARE OF WORLD NATURAL GAS RESERVES (10^9 CUBIC FEET)

	1970	1973	1976	1979	1983	1984
World	1,588,390	2,033,372	2,303,777	2,573,241	3,199,950	3,402,025
OPEC	556,000	637,345	774,000	901,600	994,600	956,114
Saudi Arabia	49,000	50,900	63,000	85,000	121,000	123,270
$\frac{\text{OPEC}}{\text{World}}$	0.35	0.31	0.34	0.35	0.31	.30
$\frac{\text{Saudi Arabia}}{\text{OPEC}}$	0.08	0.08	0.08	0.09	0.12	.10

SOURCE: <u>Oil and Gas Journal</u>, Selected Years (ratios computed by the author).

natural gas lies within OPEC, with Saudi Arabia retaining more than one-tenth of OPEC's natural gas reserves.

Table 5.3 compares OPEC's proven oil reserves to world regions' proven reserves. As of 1981, only the centrally planned economies hold a reasonably significant oil reserve compared to OPEC's (20 percent) with Africa (13 percent), the U.S. (6 percent), West Europe (5 percent), and Asia-Pacific (4 percent) in a descending order of importance.

Saudi Arabia's ability to vary production is demonstrated in Table 5.4. Saudi Arabia's production share in OPEC's total has grown from 15 percent in 1970 to 45 percent in 1981. During the last ten years, production has settled to around 25 percent of OPEC production capacity. It is essentially this built-in variability in capacity, particularly the production and loading facilities, that enables it to influence OPEC's posted price, at least in the short run.

But to discuss production and reserves potential is but one aspect of the pricing influence that Saudi Arabia could command. Being able to sustain relatively moderate price changes in the face of a given development expenditures constraint brings us to investigate the position of Saudi Arabia's financial situation. Looking at international reserves (excluding gold) as a "cushion" against price variations and expected loss of revenues, Table 5.5 ranks

TABLE 5.3. REGIONAL RATIOS OF PROVEN OIL RESERVES TO OPEC'S TOTAL (1,000 BBL).

	1973	1975	1978	1981	1984
Asia Pacific	15,634,040(0.03) 435,315,000	21,234,230(0.04) 440,770,000	20,007,200(0.04) 437,140,000	19,150,800(0.04) 427,824,000	18,529,900(0.03) 469,005,000
Africa	67,303,750(0.15)	65,085,220(0.14)	57,892,125(0.13)	56,171,630(0.13)	55,540,550(0.11)
United States	34,700,249(0.07)	33,000,000(0.07)	28,500,000(0.06)	29,785,000(0.06)	27,300,000(0.05)
Centrally Planned Economicies	130,000,000(0.24)	103,000,000(0.23)	94,000,000(0.21)	85,845,000(0.20)	84,100,000(0.17)
West Europe	15,990,500(0.03)	25,487,700(0.05)	23,966,000(0.05)	26,634,500(0.05)	24,425,500(0.05)

Source: Oil and Gas Journal, Selected Years (ratios computed by the author).

TABLE 5.4. SAUDI ARABIA'S SHARE OF OPEC'S TOTAL OIL PRODUCTION (1,000 BBL/D)

Year	Total OPEC	Total Saudi Arabia	OPEC Growth Rate	Saudi Arabia Growth Rate	Saudi Arabia/OPEC
1970	22477.3	3437.5	1970-76=31%	1970-76=140%	15%
1972	25357.4	5255.0			21%
1974	31573.9	8400.0			27%
1976	29475.0	8570.0	1976-80= -12%	1976-80=12%	29%
1978	28660.0	7800.0			27%
1980	25725.0	9620.0	1980-83= -35%	1980-83= -49%	37%
1981	21617.0	9642.0			45%
1982	17905.0	6484.0			36%
1983	16657.5	4872.0			29%
1984	16580.0	4545.0			30%

SOURCE: Oil and Gas Journal, Selected Years (ratios computed by the author).

TABLE 5.5. INTERNATIONAL RESERVES[1] (EXCLUDING GOLD) AMONG OPEC MEMBERS AS OF JUNE, 1983 (MILLION $)

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Indonesia	1490	584	1497	2509	2626	4062	5392	5014	3144	2793
Iran	8223	8744	8681	12106	11977	15210	--	--	--	--
Iraq	3098	2559	4434	6820	--	--	--	--	--	--
Kuwait	1249	1492	1702	2383	2500	2870	3929	4068	5913	4702
Qatar	64	97	129	162	211	288	343	366	387	--
Saudi Arabia	14153	23193	26900	29903	19200	19273	23437	32236	29549	33619
Algeria	1454	1128	1765	1684	1981	2659	3773	3695	2422	1893
Gabon	103	146	116	10	23	20	108	199	312	--
Libya	3511	2095	3106	4786	4105	6344	13091	9003	7060	6337
Nigeria	5602	5586	5180	4232	1887	5548	10235	3895	1613	1070
Ecuador	319	253	477	623	636	722	1013	632	304	294
Venezuela	6034	8403	8124	7735	6035	7320	6604	8164	6579	6011

Source: Statistical Yearbook, United Nations, Selected Years.

[1]International Reserves=Special Drawing Rights+Reserve Position in IMF+Foreign Exchange

Saudi Arabia first among OPEC members. As of June, 1983, Saudi Arabia's holdings of international reserves (excluding gold) was estimated at $33619 million. The growth rate over the period 1974-1983 is estimated to be 137 percent.

Libya is the second highest reserve-holding member; with an estimated $6337 million, it amounts to less than one-fifth those of Saudi Arabia. Saudi Arabia's holdings of gold over the period 1970-83 (Table 5.6) have grown at the rate of 35 percent, placing Saudi Arabia's holdings of 4.6 million ounces as third to Venezuela and Algeria, respectively.

A surplus in the balance of trade for a single country is a desirable economic indicator -- it reflects an economy's ability to sell more of its domestic products to its trading partners than it imports from them, although a persistent surplus is not a desirable goal from the viewpoint of international liquidity. The surplus, nevertheless, enables a country to finance future trade rounds, through diversifying its imports and thus enhancing its comparative advantage in terms of gains through capital transfers. Over the period 1975-1981, all OPEC members have shown surpluses in their respective balances of trade. Table 5.7 shows Saudi Arabia with an average surplus of $38629 million over the period 1975-1981, more than four times the second highest surplus member, Kuwait.

TABLE 5.6. GOLD RESERVES AMONG OPEC MEMBERS AS OF JUNE, 1983
(MILLIONS OF FINE TROY OUNCES)

	1970	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Indonesia	0.11	0.06	0.06	0.06	0.06	0.17	0.22	0.28	2.39	3.10	3.10	3.10
Abu Dhabi	--	--	--	--	--	--	--	--	--	--	--	--
Iran	3.74	3.74	3.74	3.74	3.74	3.78	3.82	3.90	--	--	--	--
Iraq	4.10	4.10	4.10	4.10	4.10	4.14	--	--	--	--	--	--
Kuwait	2.46	2.85	3.50	3.99	5.58	2.51	2.52	2.54	2.54	2.54	2.54	2.54
Qatar	0.18	0.19	0.19	0.19	0.19	0.18	0.25	0.27	0.47	0.71	0.90	--
Saudi Arabia	3.40	3.09	3.08	3.08	3.08	3.08	4.54	4.57	4.57	4.57	4.60	4.60
Algeria	5.47	5.47	5.47	5.47	5.47	5.50	5.53	5.58	5.58	5.58	5.58	5.58
Gabon	--	--	--	--	0.00	0.01	0.01	0.01	0.01	0.01	0.01	--
Libya	2.44	2.44	2.44	2.44	2.44	2.45	2.45	2.46	3.08	3.58	3.58	3.58
Nigeria	0.57	0.57	0.57	0.57	0.57	0.63	0.63	0.69	0.69	0.69	0.69	0.69
Ecuador	0.55	0.39	0.39	0.39	0.39	0.40	0.41	0.41	0.41	0.41	0.41	0.41
Venezuela	10.97	11.17	11.18	11.18	11.18	11.32	11.39	11.46	11.46	11.46	11.46	11.46

Source: <u>Statistical Yearbook</u>, United Nations (New York), Selected Years.

TABLE 5.7. OPEC MEMBERS' TRADE BALANCE (MILLION DOLLARS)

		1975	1977	1980	1981		
Indonesia	Exp.	6888	10763	21757.0	23410	6820	(as of June 1984)
	Imp.	5469	7478	12603.0	16590	10885	
	Bal.	+1419	+3285	+9154.0	+6820	+4065	
Iran	Exp.	20432	24356	--	--	11539	(as of end of 1982)
	Imp.	12898	15842	--	--	16453	
	Bal.	+7534	+8514	--	--	+4914	
Iraq	Exp.	8301	10838	--	--		
	Imp.	4162	5267	--	--		
	Bal.	+4139	+4971	--	--		
Kuwait	Exp.	8485	9561	21062	15682	8283	(as of end of 1982)
	Imp.	2400	4735	6756	7036	10867	
	Bal.	+6085	+4862	+14306	+8626	+2584	
Saudi Arabia	Exp.	27249	40351	100717	100683	29795	(as of Sept. 1983)
	Imp.	6004	14698	28238	34010	32728	
	Bal.	+21290	+25653	+72479	+76673	+2933	
Algeria	Exp.	4501	6009	13652	--	10754	(as of end of 1982)
	Imp.	5452	6198	9596	--	13182	
	Bal.	-951	-189	+4056	--	+2428	
Gabon	Exp.	1149.2	1300.4	2087.2	--		
	Imp.	599.1	694.0	686	--		
	Bal.	+550.1	+606.4	+1401.2	--		
Libya	Exp.	6418	10406	21919	14943		
	Imp.	4424	5458	10550	13323		
	Bal.	+1994	+4948	+11369	+1620		
Nigeria	Exp.	8329	12431	25324	17055		
	Imp.	5484	9723	15830	17409		
	Bal.	+2845	+2708	+9494	-354		
Ecuador	Exp.	1012.8	1400.8	2544.2	2544.2	868	(as of June 1984)
	Imp.	1006.3	1360.5	2241.8	2361.5	1239	
	Bal.	+6.5	+40.3	+302.4	+182.7	+370	
Venezuela	Exp.	8853	9545	19051	19860	1663	(as of March 1984)
	Imp.	5462	10194	10877	12378	3727	
	Bal.	+3391	-649	+8174	+7482	2063	

Source: Statistical Yearbook, United Nations (New York), Selected Years.

And finally, Table 5.8 shows the relative stability of the exchange rates of OPEC members in terms of the American dollar. Over the period 1970-1983, the Saudi Arabian "riyal" has gained a 24 percent increase in its exchange against the dollar.

5.6 CONCLUDING REMARKS

One could see many similarities between OPEC's efforts toward collective behavior and that of the "tragedy of the commons" -- better yet of the "nouveaux riches." OPEC's share in world energy supplies had fallen sharply from 31 mbd in 1979 to less than 16 mbd in 1984. Slow economic recovery worldwide and the associated sluggish demand for energy and the growth of non-OPEC energy supply sources seem to be the major reason for this drop. For the time being, OPEC is gradually approaching the role of "swing producer" -- a market situation OPEC may not be happy to accept.

Two characteristics have dominated OPEC's behavior in the last four years: a) a tendency toward polarization, and b) a drift toward price regionalization. For instance, Mexico's pricing policy has almost immediate effect in the western hemisphere, and particularly upon Venezuela; Britain's and Norway's price cuts would almost always precipitate reciprocity, if not underselling, by Nigeria. Furthermore, Nigeria has persistently complained about

TABLE 5.8. EXCHANGE RATE OF OPEC MEMBERS' NATIONAL CURRENCIES WITH RESPECT TO U.S. DOLLAR (AS OF JUNE, 1983)

	1970	1975	1977	1978	1979	1980	1981	1982	1983
Indonesia	378.000	415.000	415.000	625.000	627.000	626.750	644.000	692.500	974.000
Abu Dhabi	--	--	--	--	--	--	--	--	--
Iran	76.380	69.275	70.475	70.475	70.475	72.316	79.450	83.433	86.337
Iraq	0.359	0.295	0.295	0.295	0.295	0.259	0.295	0.311	0.311
Kuwait	0.357	0.294	0.280	0.272	0.273	0.271	0.281	0.289	0.293
Qatar	4.762	3.987	3.960	3.838	3.705	3.640	3.640	3.640	3.640
Saudi Arabia	4.500	3.530	3.505	3.315	3.365	3.325	3.415	3.435	3.445
Algeria	4.937	4.125	4.035	3.834	3.755	3.971	4.378	4.635	4.791
Gabon	276.000	224.270	235.250	209.000	201.111	225.800	287.400	336.250	381.880
Libya	0.357	0.296	0.296	0.296	0.296	0.296	0.296	0.296	0.296
Nigeria	0.714	0.627	0.651	6.648	0.561	0.544	0.637	0.670	0.741
Ecuador	25.00	25.00	25.00	25.00	25.00	25.00	25.00	33.150	44.900
Venezuela	4.450	4.285	4.929	4.292	4.292	4.292	4.292	4.292	4.300

Source: Statistical Yearbook, United Nations (New York), Selected Years.

price differentials -- the difference in pricing OPEC's marker to other members' crudes does not seem to permit Nigeria the necessary competitive edge in West European markets.[1] Indonesia sees its immediate interest in aligning itself with high population countries such as Algeria, Iran, Nigeria, and Venezuela -- to each one of these countries persistent loss of sales could precipitate political crises. Indonesia's immediate concern is the Asian market, whereas Iran's concern is any market that maintains a steady cash flow to finance its war against Iraq. And the Arab group of OPEC, with relatively small populations and high financial and petroleum reserves have a long-term interest, if not fixation, in moderate price increases.

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[1]Light crude accounts for about 60 percent of all oil sold. Buyers pay a higher price for it because of the highly demanded (price inelastic) products such as gasoline and jet fuels that are less costly extracted from it. Later newer developments in refining, however, have made it possible to extract almost equal amounts (of the highly-demanded products) from both crudes. The spot market price differential between light and heavy crudes is about \$1 to \$1.25. As of October, 1984, heavy crude on the spot is sold at \$0.50 above OPEC's official market (the Saudi heavy crude at \$26 bbl), whereas spot prices for the light crude are \$1 to \$1.50 below OPEC's marker (the Saudi light at \$29 bbl). OPEC, by retaining a \$3 bbl official price differential between light and heavy crudes makes it difficult to market the Nigerian crude at OPEC's official price.

OPEC members seem to be outgrowing OPEC and oil pricing is their dividing issue. In an ironic way, history is repeating itself, for it was not long ago when pricing oil was the force that deinstitutionalized the international oil industry.

CHAPTER VI. EFFECTIVE LIMITS ON SAUDI ARABIA'S OIL PRICING POLICY

6.1 INTRODUCTION

6.2 MODELING OPEC'S BEHAVIOR AS A DOMINANT PRODUCER

6.3 MODELING OPEC'S BEHAVIOR AS "REVENUE-TARGETING"

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6.6 MODEL RESULTS

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6.6.2.1 A NOTE ON THE SIMULATION RESULTS

CHAPTER VI. EFFECTIVE LIMITS ON SAUDI ARABIA'S OIL PRICING POLICY

6.1 INTRODUCTION

Many authors have modeled OPEC behavior under various assumptions. The scope of this research has varied widely. Some authors have taken a macro-perspective of the world energy situation and introduced OPEC (without particular behavioral assumptions) as another market participant. Others have "regionalized" the world market, and whereas they assigned to OPEC a larger role in influencing the price level they, nevertheless, limited its potential for varying prices to a set of identifiable markets (primarily the West European industrial market and Japan). Still others tried to deal with OPEC from a purely monopolistic perspective (all OPEC members were assumed net revenue maximizers) and limited themselves to the overall impact on future energy prices and supplies.

Of particular significance to this part of the study are the behavioral assumptions that the authors have adopted to model OPEC's behavior -- these assumptions reflect an author's perceptions of OPEC and how it is assumed to interact with other components of the energy market. We will focus here on categorizing some of the major theoretical and empirical work. Although this categorization is essentially selective it is, nevertheless, helpful in understanding the postulated theoretical relationships within OPEC and the potential economic role oil producers may have in energy markets. These categories are:

a) The dominant producer model to explain OPEC's economic behavior in setting oil prices,

b) The target revenue model to show intra-OPEC, economic behavior and the issues involved in selecting a unified pricing policy,

c) The political model to rationalize and explain OPEC's leverage over oil prices.

6.2 MODELING OPEC'S BEHAVIOR AS A DOMINANT PRODUCER

One explanation of OPEC's behavior is to conceive of it as a single producer that sets the price and allows other producers to sell all they can. The dominant producer is, in essence, assumed to act as a "swing supplier" -- absorbing demand and supply deviations to maintain an a priori selected price.

Empirically, this modeling approach has encountered two problems that affect the stability of the selected price.

a) There is the continuous need to monitor supply and demand at the monopoly price, lest it may result in insufficient revenues for the dominant producer objectives. Empirically, some authors have assumed that the dominant producer is able to predict its future revenue needs and thus set its price subject to its needs.

b) There is the probability that the collusive price is set too high and thus may induce new entrants. Empirically, some authors have limited themselves to short-run projection horizons to rule out the probability of new entrants or alternatively, they explicitly account for new entrants' potential supply in the overall supply of oil.

For modeling purposes, many authors have grouped current OPEC members to identify those who could act as dominant suppliers. One popular variant, attributed to Pindyck, is to define what came to be known as the "cartel core" (Saudi Arabia, the United Arab Emirates, Kuwait, Qatar, and Libya) assuming that these countries could "collude" to maintain an a priori price. This modeling approach approximates the theoretics of the dominant producer but it remains, in reality, deficient in a number of respects:

a) The proposed variant requires a great deal of cooperative behavior among the "core" members for collusion purposes -- the theoretics of the dominant producer, however, do not require collusion for revenue maximization.

b) The inclusion of Libya among the "core" group is observationally contradictory to what seems to be Libya's pronounced emphasis on conservation. Within OPEC, Libya has always maintained a position of higher prices contrary to the perceived moderation of the Saudi pricing policy.

c) The inclusion of the UAE, Kuwait, and Qatar is redundant. These countries, among others, have aligned themselves in a larger regional cooperative organization known as the "Gulf Cooperation Council" which has shown emphasis on policy coordination. Furthermore, given Kuwait's adoption of a production ceiling (roughly 1.5 mbd since 1978) and the relative meagerness of the UAE petroleum base, one would expect less ability and willingness on these countries' parts to counteract a Saudi price decision for a prolonged period.

Jacoby and Paddock (1983, pp. 31-46) whose work is an excellent representation of modeling OPEC à la "dominant-producer," clearly stated at the outset this approach's conceptual ambiguity: "hypotheses about OPEC's behavior vary according to one's view of the relations among the members of the core and the objectives of these countries." To operationalize their model, they assumed that "the other members of the core (i.e., excluding Saudi Arabia) will not cut back to less than 60 percent of capacity in order to support the price" and that "the Saudis will want to sustain development plans as they existed in mid-1981 . . ."

Jacoby and Paddock are more concerned with identifying situations within OPEC that may destabilize the market and could lead to negative impact (higher prices) on the industrialized countries' rates of potential economic growth. Their work leads them to identify a range of prices between $25 (in 1982 dollars) and $45 in 1990 as compatible with a set of assumed growth rates in industrialized countries. Equally interesting is their conclusion which seems to reflect less faith in modeling OPEC a la dominant producer:

> . . . we argue against the use of reference cases and central or most likely forecasts. Many analyses and perhaps many decisions, would be improved, if they more reflected the wide range of future oil prices . . . (p. 46).

Daly, Griffin, and Steele (1981, pp. 45-77), using the theoretics of the dominant-producer and relegating OPEC as a whole to the role of "residual supplier," reach a different conclusion. They assert:

> the 1978-79 OPEC price hikes may well have defined the limits of OPEC's monopoly power. A long-run real price path significantly greater than $32 per barrel seems likely to bring forth large supplies of conventional fuels, coupled with conservation efforts . . . (p. 76).

Reza (1981, pp. 77-93) in a theoretical model depicting a self-motivated oil producer and theoretically including some of the ignored factors that affect an oil exporter's supply (such as: the relative physical size of the proven reserves, the choice of a discount rate, market costs of oil substitutes, etc.) concludes that oil market stability [moderate real increases in oil prices] "with the expected costs of oil substitutes (such as shale oil in the $40 range) the market price of oil should be expected to be in that neighborhood too -- even in a competitive oil market" (p. 89).

Pindyck, in his empirical work on the long-term exhaustible resources future price trajectories (RES, 1978), and the application of his work to OPEC's case (JED, 1979) where he assumes all OPEC members act as a monopoly, reports a price (in 1975 dollars) that ranges from $13.24 to $20.29 by the year 2010. Pindyck is aware that his price range is relatively lower than others' estimates; his reasoning rests in a larger set of a monopolist's long-term assumed behavior:

> This price pattern is a characteristic result of incorporating adjustment lags in the model--it was optimal for OPEC to charge a higher price initially, taking advantage of the fact that net demand can adjust only slowly. Of course, these results are dependent on the particular model and parameter values described . . . (p. 265).

And finally, Kosobud and Stokes (1980, pp. 50-84) assume that each OPEC member is concerned with maintaining his current market share while maximizing the overall OPEC revenues. Focusing on long-term OPEC's stability (demise) in terms of future oil prices, they conclude:

> The world economy [would achieve] a most rational use of energy resources by using [OPEC] oil reserves until rising prices brought about the transition to the next major energy resource, 30 years or so in the future . . . this would imply consuming more OPEC oil [now], not less . . . (p. 82).

Kosobud and Stokes' conclusion could be taken to imply: a) OPEC's current oil pricing retards the needed acceleration to develop alternative energy resources, and/or b) the world economy may already have the most economical energy resource notwithstanding the last decade's price increases.

6.3 MODELING OPEC'S BEHAVIOR AS "REVENUE-TARGETING"

Generally, this approach assumes that oil production decisions are made with reference to national budget requirements. Budgetary needs are in return a function of an economy's absorptive capacity. At the early stage of socio-economic and institutional development, an economy's capacity is relatively restricted (as was the case of Saudi Arabia in the late 1960s or early 1970) or during the development process where the in-place infrastructure is insufficient to support injection of investment funds and efforts to improve living standards (as it is currently in the case of Gabon and Abu Dhabi).

Analytically, oil revenues are viewed as the major source of financing planned investment projects. This conceptualization is depicted in Figure 6.1 where proposed

FIGURE 6.1 A MARGINAL EFFICIENCY OF INVESTMENT FUNCTION (MEI).

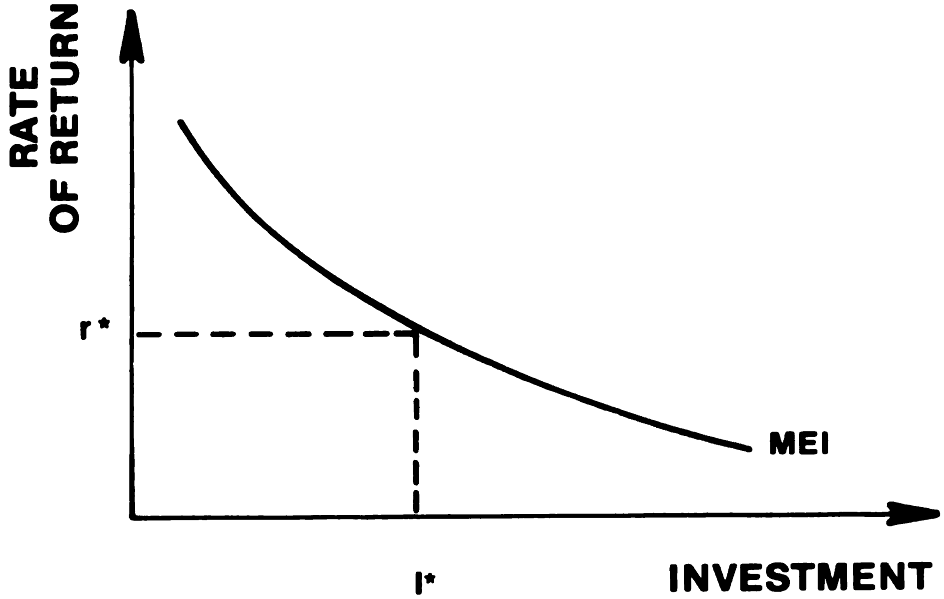
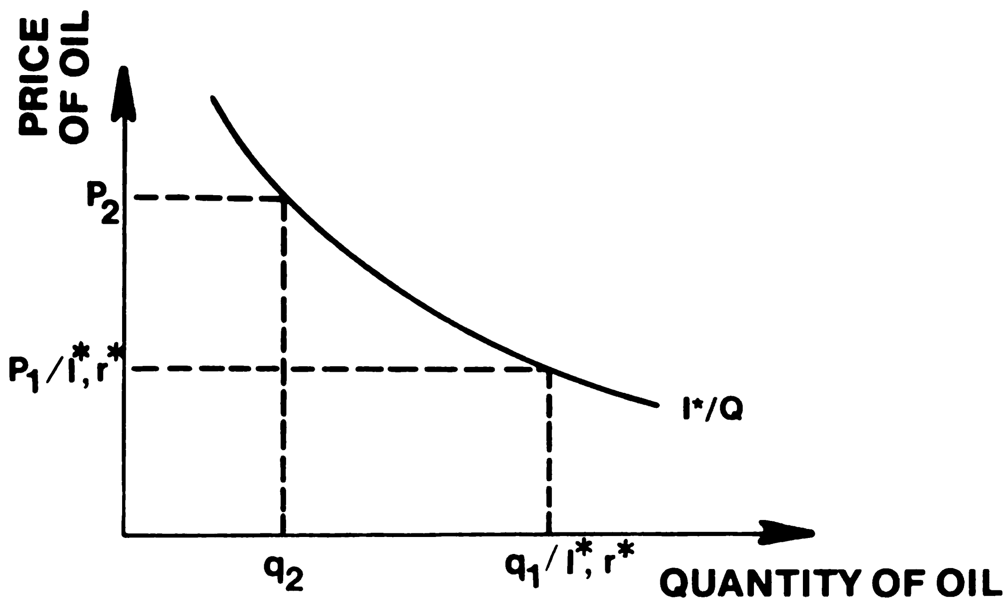


FIGURE 6.2 AN ISOREVENUE — OIL SUPPLY CURVE.



Figures 6.1 and 6.2 adap[redacted] from: Griffin, M. and David Teece, 1982, pp. 88-9.

projects are ranked along a representative marginal efficiency-of-investment schedule. If a country's social time preference is taken to be r*, then investment needs that match this r* are limited to I*. In Figure 6.2, when oil production decisions are made to exhaust investment opportunities depicted in I*, then increases in world oil prices, other things constant, say from P_1 to P_2 could result in a reduced level of production, say, from q_1 to q_2 and still satisfy financial development needs. This approach analytically allows the oil supply schedule to be backward-bending over the relevant range. Observationally, a backward-bending supply curve is a theoretical possibility, for development processes are, in one respect, an actual current expansion for future investment opportunities, thereby necessitating continuous revision of a previously adopted revenue target. The development experiences of most oil producing countries have quickly quieted concerns that arose in the early 1970s over potential accumulation of funds viewed then as a threat to international liquidity. Currently, almost all OPEC members have demonstrated an "appétit" to augment their domestic private and public capital stock and an observed trend toward better living standards. As a matter of fact, with the possible exception of Saudi Arabia, Libya, UAE and Algeria, the remaining OPEC members are either experiencing current balance-of-payment deficits or encountering stricter conditions when acquiring international loans.

Another assumption in the revenue target modeling is that foreign investments are not a viable alternative to domestic investment. The assumption is valid because of diminished real rate of return (due to relatively high inflation rates as prevailed in the industrial countries during the 1970-80 period and a capricious dollar value with respect to other major currencies). The analytical exclusion of foreign investment opportunities, however, seems to rest with the political risks associated with them.[1]

A number of authors have modeled OPEC behavior according to the revenue-targeting approach: De Vries and Gebelein (1976), MacAvoy (1982), Belgrave (1982), and Aperjis (1982). Professor Teece's study (1982, pp. 64-87) is the most comprehensive; Teece is more concerned with oil supply non-interruptions and future level of price and less with projecting a range for future prices. He concludes that: "The conceptual [model] advanced here indicates that competitive output expansion is possible if real prices can remain constant long enough to permit expenditures to press up against revenue constraints . . ." and ". . . a modest

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[1]The most obvious cases are: a) regulatory measures attributed to the-then prime minister of England, Mr. Harold Wilson, the leader of the Labor Party in 1974, over increased concerns with Arab real estate buying, and b) the case of freezing Iranian assets in the U.S. during the U.S. Embassy hostage crisis in Teheran (Iran) in 1979.

output expansion by OPEC will suffice to keep real prices constant through the 1980s and perhaps to the year 2000, in the absence of serious oil supply disruptions."

Professor Teece's prediction is consistent with most OPEC members' currently observed over-production to obtain more revenues. This increased tendency toward competitiveness has, other things constant, led to a slow but constant decline in oil prices. Teece, however, did not account for non-OPEC supply sources which also contribute to increased competitiveness and lower prices.

6.4 MODELING OPEC'S BEHAVIOR IN POLITICAL TERMS

Professor Moran's work (1982, pp. 94-130) is essentially an explanation and a rationalization of OPEC's economic behavior as a response to a larger and less flexible political environment. Although he accounts for the economic factors affecting OPEC's decisions he, nevertheless, views the organization's pricing policies as greatly influenced by political considerations.

A political scientist, he rejects economists' intellectual monopoly to model and forecast OPEC's behavior. Rightfully, he asserts:

> While useful in sketching a general path of aggregate self-interest, the rational monopolist approach suffers from representing the OPEC cartel as if the members motivated to behave overtime as a single unified actor. In reality, the individual governments of OPEC have differing national economic interests depending upon domestic social pressures, revenue needs, alternative sources of

> fiscal earnings and fiscal income, hard currency, financial assets, and geological reserves. Hence, they have different discount rates for present versus future earnings and different strains or pains associated with holding spare capacity or not developing additional capacity. Ultimately, the members of OPEC have different preferred prices and production paths in the exploitation of their petroleum resources (p. 97).

Having specified the modeling difficulties on the market supply side, Moran furthermore, includes the market demand side. Retaining his perspective of organizations and governments as a collection of individuals subject to similar home and abroad pressures he writes:

> . . . the major industrial countries, especially the United States have been (and may again be) likely to react to higher oil prices in a perverse way, that is, through price controls that mask the impact of OPEC decisions or through an entitlements program that subsidizes the importation of foreign oil . . . (p. 101-102).

Moran analytically accepts the economic dichotomous approach to OPEC (e.g. Pindyck's "savers" vs "spenders" or Teece's "core" vs "non-core") but recasts his analysis in a context overridden by political constraints. He postulates Saudi Arabia's decisions and reactions to a regionally and worldly political environment as affecting the overall OPEC pricing policy. He writes:

> Saudi Arabia [by assuming to be observing] an operational code of advancing Saudi political priorities, while minimizing hostile external and internal pressures . . . [this] explains Saudi behavior better than the economic optimizing model does . . .

To support his thesis, Moran enumerates six "political episodes": a) the phantom oil auction of 1974, b) the stand-off increase of 1975, c) the Doha meeting price split of 1976-77, d) the aborted price confrontation of 1977-78, e) the production crisis of 1979, and f) the oil glut of 1981. Moran goes into a lengthy discussion (carried in an: "If . . . then; else . . . " analytical frame) to show that Saudi Arabia's response to each event greatly influenced possible courses of actions that were different and available to OPEC.

Moran is quite persuasive in developing and advancing his political paradigm. His identification of some of the crucial political parameters is illuminating to an educated understanding of the political side of the world energy situation. To an economist, however, his analysis suffers two weaknesses:

a) The assumption of separating a response to a given event as "political" and "economic" may have a larger audience in the domain of academics. In reality, it remains judgmental, in a response to a given "historical episode," when an action exhausts its "political" lifetime and takes on an "economic" reincarnation.
b) The assumption of Saudi Arabia's dominance within OPEC as advocated by Moran has to be realistically assessed within a larger context of an on-going

"bargaining process." In their empirical work of modeling OPEC's behavior in a "game theoretic" setting and with focus on potential pay-offs and counter-strategies, Hynilicza and Pindyck (1976) conclude:

> When output shares are open for policy discussion, OPEC members will have a lot to argue about, and any resulting optimal policy will depend considerably on the relative bargaining power of the two groups of countries (pp. 152-153).

While accepting Moran's arguments, one may conclude that Saudi Arabia's influence over OPEC's pricing policy could not have been a "free ride" as Moran wants us to believe. OPEC's records on intra-members' financial assistance are not accessible to this author. Nevertheless, it is worthwhile to recall that unilateral political stances also have costs associated with them, and allowing for sufficient lag effect, they inevitably have to translate themselves in the market place.[1]

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[1]For useful observations see: "Peace in the Middle East," an address at Georgetown University by H.R.H. the Saudi Arabian Ambassador to the U.S., the Royal Embassy of Saudi Arabia, The Information Office, Nov. 22, 1983; Johany, A., "OPEC and the Price of Oil," WSJ, Dec. 15, 1980; and Olayan, S.S., The Burden of Moderation, 1983 (private copy).

6.5 AN ALTERNATIVE MODEL

6.5.1 INTRODUCTION

The empirical work presented in Sections 6.2 to 6.4 represent the state-of-the-art in modeling OPEC's behavior for predicting future price changes. For the objectives of this study, an alternative model is developed with particular attention to world oil supply and the potential role of Saudi Arabia.

6.5.2 MODEL ASSUMPTIONS

The alternative model shares common structural features with some of the empirical work cited in this chapter. Along Pindyck's (1979) and MacAvoy's (1982) work it exhibits a free-world (i.e., non-Communist) supply and demand model for oil. It estimates an aggregate demand function on the market demand side and a more detailed aggregate supply function. Model parameters estimates are restricted to the period 1970-1984 (where data is available). The restriction of the statistical analysis to this period is historically induced, for it was early in 1970 that OPEC began to influence oil prices. (The notion of a free market oil price prior to OPEC's emergence is naive, at best. In Chapters III and IV we have shown that the world oil market rarely was allowed to operate competitively.)

The segmentation of the aggregate supply function and its related behavior assumptions are unique to our model. As has been stated frequently by numerous authors behavioral assumptions, though bounded by actual observations and practical relevancy, nevertheless remain a matter of selective perceptions. Specifically, our model does not require cooperative assumptions between the various "supply groups." Thus, Kosobud and Stokes' (1980) assumption of maintaining a market share while maximizing the overall OPEC revenues is incompatible with the problem statement (Sec. 1.2). The "core" supply segmentation of Daly, Griffin, and Steele (1981) and Pindyck (1979) is also contradictory to this study's objectives.

Situations of excess supply have been ruled out in a number of ways:

a) The average length of time required to develop a commercially-proven oil field ranges from 5 to 8 years. Therefore, limiting the projection period to five years seems sufficient to rule out potential excess supply during the analysis period.

b) Major short-term sources of potential increased production are Britain, Norway, and Mexico. Let us deal with the North Sea oil suppliers first. At the outset one observes that the amount of investments poured into developing North Sea oil discoveries and the pace at which operations were carried out is unparalleled. One is left with the conclusion that they were a response to political signals more than market-oriented signals. Secondly, the current technically-feasible production levels of both Britain and Norway are practically insignificant, assuming a conflict setting, to affect a long-term price war with the intention of reducing oil prices. Thirdly, given the relatively high costs of developing off-shore oil resources and the desire to obtain a satisfactory rate of return compatible with the associated risks, it would be plausible to hypothesize that in a continuously declining price situation, both Britain and Norway could be closer to a shut-off decision than an OPEC member. Therefore, for the purpose of this research, the current price undercutting of OPEC's official prices is taken to be temporary measures to dispose of oil during glut market conditions.

c. Mexico is a different case when one studies non-Opec major oil suppliers. Mexican oil discoveries are the most promising short-term supply increase source. Examining policy statements made by Mexican officials reveals an intention to utilize oil resources, the relatively less costly labor, and locational advantages to large markets for more industrialization (Philip, 1980, pp.474-483, and OJG, December 31, 1979, pp. 40-41). In addition, Mexico has already made production expansion conditional upon the attainment of other objectives. In 1979, Mexico used increased oil development as a bargaining advantage to obtain international debt refinancing and to support the "peso" exchange rate. Mexico's behavior during 1980-83 clearly associated production future expansion to revenue targets. Mexico, though declining an invitation to join OPEC in 1982, seems politically committed not to undercut OPEC's official prices.

The oil supply by major non-OPEC producers (Britain, Norway, and Mexico) is modeled here subject to additional constraints:

a) That production in any given year must be equal to or less than a given fraction (Z_M) of the previous year's reserves estimates. The (Z_M) parameter could be an engineering constraint or a policy decision that places a ceiling on production. Thus, for a non-OPEC major producer, the level of production in any year is assumed either technically or institutionally bound.

b) A major non-OPEC oil supplier is further assumed to be an active oil developer. Therefore, net additions to reserves at any given period is assumed to be a function of the last two period's real prices.

For current OPEC producers (excluding Saudi Arabia), their economic behavior is assumed to be affected by three factors:

a) <u>They are assumed to be price maximizers</u>. This assumption may not be practical for all OPEC producers. With the exception of Saudi Arabia and some of the Arabian-Persian Gulf members of OPEC, almost all the remaining OPEC members are experiencing difficult economic conditions (difficulty in refinancing international debts, and relatively meagre contribution by other economic sectors to national income) as well as a relatively small or non-growing oil reserves (largely due to insufficient funds to undertake oil prospecting and development). With these conditions in mind, and given the relatively short horizon of our analysis (six years), price maximization per unit produced seems a plausible assumption.

b) <u>They are assumed to pay attention to their respective reserves-to-production ratio</u>. The reasoning given under the first assumption [related to OPEC members (excluding Saudi Arabia)] is also applicable here as well as the fact that a major portion of their incomes is derived from oil.

Economic diversification is viewed as costly and time-consuming; hence, it seems appropriate that they would be concerned with prolonging the economic life of their resources.

c) <u>They are assumed to be concerned with their respective market shares</u>. In Chapter III (Section 3.5.1.2) we presented the BTD model. An important contribution by Danielson is his perception of the OPEC cartel as sovereign states and the division of the market into "spheres of influence." Here, we take the market share variable as a proxy to the sphere of influence notion. The interest in this notion, however, extends beyond operationalizing an economic concept. In reality, a given country's total revenues are the product of what is produced and the price per unit. In Chapter V (Section 5.3), we showed that petroleum transactions in the spot market are more of temporary, tight-conditions alleviating measures. In contrast, long-term contracts embody more than an oil sale; they are synonymous with establishing diplomatic offices, and as such they are the last thing to tamper with. The record on country-company transactions reveals more than the immediate attainment of economic gains. Maintaining a market share (i.e., a given volume of sales at a previously agreed-upon price) may not be profitable when prices are rising or a revenue target has been adopted, but it could prove valuable in glut market conditions when buyers call the shots.[1]

Saudi Arabia's supply decisions are assumed governed by maximizing net oil revenues subject to three constraints:

a) That oil revenues are sufficient to cover the operational budget,

b) That oil revenues are sufficient to satisfy development needs, and

c) That oil revenues are sufficient to maintain a given financial cushion.

Saudi Arabia, contrary to a large number of empirical works, is not assumed to be a swing-supplier. Pindyck's (1979) and Daly, Griffin, and Steele's (1981) notions of "core" suppliers are viewed as incompatible with the study objectives. Furthermore, in contrast to restrictions on "excess supply" market conditions, the appearance of "excess demand" conditions are assumed here to be cleared through higher prices.

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[1]See: Petroleum Intelligence Weekly, January 17, 1977.

6.5.3 MODEL SPECIFICATIONS

The alternative model is presented here. Let us first start with the demand side. Equation (1) represents the aggregate demand for oil:

$$D_{(t)} = y^{f}_{(t)} \times P^{e}_{(t)} \times d^{g}_{(t-1)} \times k^{h}_{(t-1)} \qquad (1)$$

Where, in year (t):

$D_{(t)}$: aggregate demand for oil,

$P_{(t)}$: real price of oil,

$Y_{(t)}$: an index of the level of economic activity,

$d_{(t-1)}$: lagged demand (last period demand), and

$k^{h}_{(t-1)}$: lagged changes in private oil stocks.

For statistical estimation, equation (1) may be expressed in natural log form as:

$$\ln D_{(t)} = f \ln Y_{(t)} + e \ln P_{(t)} + g \ln D_{(t-1)} + h \ln K_{(t-1)} \qquad (1\text{-}b)$$

Thus equation (1-b), in natural logarithms, gives a solution to world oil demand where:

e: the price elasticity of demand,

f: the income elasticity of demand,

g: elasticity of adjustment from short to long run, and

h: private oil stocks adjustment elasticity.

Now, let us deal with the supply side of the model. The aggregate oil supply function is written as:

$$\mathfrak{S} = S_{MNO(t)} + S_{OPES(t)} + S_{SA(t)} \qquad (2)$$

Equation (2) reads that the aggregate supply of oil is divided into three sources:

$S_{MNO(t)}$: supply by major non-OPEC countries (Britain, Norway, and Mexico),

$S_{OPES(t)}$: supply by OPEC excluding Saudi Arabia,

$S_{SA(t)}$: supply by Saudi Arabia.

Now, supply by major non-OPEC countries [S_{MNO}] is assumed to be subject to:

1) Production in a given period must be equal to or less than a given fraction [Z_M] of previous year's reserves. Note that:
   a) [Z_M] may reflect engineering standards of maintaining a certain pressure level in a field, i.e., what could be termed: maximum sustainable production,
   b) [Z_M] may reflect the capacity of auxiliary facilities, such as: storage tanks, pipelines, seaports, etc.
   c) [Z_M], furthermore, may reflect a policy decision to impose a ceiling on production allowable.

Thus, relating [Z_M] to the previous level of reserves, we write the constraint as:

$$S_{MNO} \leq Z_M \, R_{MNO(t-1)} \qquad (3)$$

That is, the current level of production of a major non-OPEC supplier is bound by an institutional/technical constraint [Z_M].

2) We want to account for the effect of changes in the real price on net additions to reserves. The variable: net additions to reserves [NAR_t] at any time is treated as a function of last period's real oil prices. This is to account for a country's decision to vary exploratory/development activities in response to market conditions. Thus:

$$NAR_{MNO(t)} = F\left[P_{(t-1)},\ P_{(t-2)}\right] \tag{4}$$

3) We want to bring in an inventory mechanism relating: current reserves [R], net additions to reserves [NAR], and the production level. The adopted mechanism is:

$$R_{MNO(t)} = R_{MNO(t-1)} + NAR_{(t)} - Q_{MNO(t)} \tag{5}$$

Equation (5) reads that the reserve level of any major non-OPEC producer at the beginning of any production period is equal to the sum of reserves level at the end of last period (t-1) and net additions to reserves minus current production level.

Thus, supply by major non-OPEC producer takes the form:

$$S_{MNO(t)} = F\ \left[P_{(t)},\ Z_M\ R_{MNO(t-1)}\right]$$

Subject to:

$$R_{MNO(t)} = R_{MNO(t-1)} + NAR\ f\left(P_{(t-1)},\ P_{(t-2)}\right) - Q_{MNO(t)}$$

Now for OPEC members (excluding Saudi Arabia), their supply production is the difference between aggregate demand minus the quantity supplied by major non-OPEC producers minus <u>Saudi Arabia's</u> production. From the market clearing condition:

$$D_t = \mathfrak{S}_{(t)}$$

$$= S_{MNO(t)} + S_{OPES(t)} + S_{SA(t)}$$

$$S_{OPES(t)} = D_{(t)} - S_{MNO(t)} - S_{SA(t)} \tag{6}$$

Equation (6) shows the supply of oil by OPEC members (excluding Saudi Arabia). For OPES group, the following assumptions hold relevant to their supply decisions (these assumptions have been elaborated upon under Section 6.5.2):

a) They are price maximizers,

b) They observe a given reserve-to-production ratio,

c) They are concerned with their market shares.

The OPEC group excluding Saudi Arabia (OPES), is assumed to have a supply function of the form:

$$S_{OPES(t)} = F\left[P_t,\ Z_N\ R_{OPES(t-1)},\ MS_{(t)}\right] \tag{7}$$

Where: Z_N Technical/institutional constraint pertinent to OPES group. Note $(Z_M \neq Z_N)$,

$R_{OPES(t-1)}$: Last period reserves level,

$MS_{(t)}$: Current market share;[1] $(MS_{OPES(t)} < 1)$

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[1]It is worthwhile to note that the market share variable (MS) in eq. (7) is computed from historical data. An alternative variable is the total sum of OPES' production quotas as established by OPEC's Geneva meeting of October, 1984 (see footnote, page 152). We opted not to choose the latter variable for: a) restricting OPES supply to an a priori level violates the non-cooperative assumption in our model, and b) it is impractical since no OPEC member is currently adhering to its quota (either

Equation (7) is subject to a price reaction function of the form:

$$\%\Delta P_{[(t-1),t]} = a + b\left[\frac{1}{1 - \Delta MS_{OPES}}\right] + \Delta S_{SA} \qquad (8)$$

and

$$P_{(t)} = P_{(t-1)} \times \left[1 + \%\Delta P_{[(t-1),\ t]}\right] \qquad (9)$$

Equation (8) establishes a relationship between percentage changes in OPES market share, Saudi Arabia's production variations, and the rate of change in oil prices. If market share falls below a target level, OPES group would reduce the price to encourage an increase in demand. Conversely, when OPES market share rises above the target level, OPES would raise the price to reduce demand. Equation (9) shows how the current price is computed using previous period oil price.

Again, reinvoking the market equilibrium condition equation (2), the supply (production) of Saudi Arabia is given by:

$$S_{SA(t)} = D_{(t)} - S_{MNO(t)} - S_{OPES(t)} \qquad (10)$$

Equation (10) shows that Saudi Arabia is the ultimate residual supplier. It is worthwhile to note that equation (10) is an accounting identity; it does not presuppose, from a behavioral point of view, that Saudi Arabia will either "fill" the gap or allow it to persist indefinitely. Saudi Arabia, in contrast with the previous two groups of

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through above-quota production or, indirectly, through barter deals and/or disposing of their petrochemical products cheaply).

suppliers, is assumed concerned with maximizing a utility function of the form:

$$\text{Max } W = \sum_{t=1}^{6} \frac{1}{(1+r)}^{t} \left[P_t \, S_{SA(t)} - c_t \, S_{SA(t)} \right] \qquad (11)$$

Equation (11) reads that Saudi oil supply decision is based upon maximizing net oil revenues, where:

r_t = interest rate (indicative of long-term return rates.

c_t = an estimate of market cost oil substitutes,

$S_{SA(t)}$ = Saudi Arabia's oil production level.

The maximization in equation (11) is subject to two constraints:

$$4{,}353{,}000 \text{ bd } \leq S_{SA(t)} \leq 10{,}000{,}000 \text{ bd} \qquad (12)$$

and,

$$S_{SA(t)} \times P_t \geq \sum (a_1 \, B_c + a_2 \, B_d + a_3 \text{ IMP.}) \qquad (13)$$

The inequality in equation (12) states that Saudi Arabia's production should be greater than or equal to its quota share but less than or equal to its maximum feasible production. And equation (13) shows that oil revenues should at least be sufficient to cover operational plus development funds requirements and Saudi Arabia's foreign trade bill.

6.5.4 ALGORITHMIC NOTES

The equations of the model are as follows:

1) $\ln D_{(t)} = f \ln Y_{(t)} + e \ln P_{(t)} + g \ln D_{(t-1)}$

$$+ h \ln K_{(t-1)} \qquad (6.6.1)$$

2) $S_{(t)} = S_{MNO(t)} + S_{OPES(t)} + S_{SA(t)} = D_{(t)}$ (6.6.2)

3) $S_{MNO(t)} = F\left[P_{(t)}, Z_M\ R_{MNO(t-1)}\right]$ (6.6.3)

Subject to:

4) $R_{MNO(t)} = R_{MNO(t-1)} + NAR\ f\left(P_{(t-1)}, P_{(t-2)}\right) - Q_{MNO(t)}$ (6.6.4)

5) $S_{OPES} = F\left[P_{(t)}, Z_N\ R_{OPES(t-1)}, MS_{(t)}\right]$ (6.6.5)

6) $\%\Delta P_{[(t-1),t]} = a + b\left[\frac{1}{1-\Delta MS_{OPES(t)}}\right]$ (6.6.6)

7) $P_{(t)} = P_{(t-1)} \times \left[1 + \%\Delta P_{[(t-1),t]}\right]$ (6.6.7)

8) MAX. $W = \sum_{t=1}^{6} \frac{1}{(1+r)}t \left[P_{(t)}\ S_{SA(t)} - cS_{SA(t)}\right]$ (6.6.8)

Subject to:

$4{,}353{,}000 \text{ bd} \leq S_{SA(t)} \leq 10{,}000{,}000 \text{ bd}$ (6.6.9)

And

$S_{SA(t)} \times P_t \geq \Sigma\left(a_1\ B_c + a_2\ B_d + a_3\ IMP.\right)$ (6.6.10)

We should note that for the value of $[Z_M]$ in equation (6.6.3), we were not able to obtain reliable data to measure it (i.e., as an institutional/technical/production constraint). Therefore, in the case of the non-OPEC major suppliers, as well as OPES, $[Z_M]$ and $[Z_N]$ have been estimated as time-series reserves to production ratios. And, in equation (6.6.8), for the value of [c] (i.e., market costs for oil substitutes) the results of engineering-economic studies widely differed. This is not surprising since most of these studies were conducted in the late 1970s before non-OPEC oil sources began to enter the world oil market. There is, however, a noticeable unanimity over a price range: $20 to $35/bbl. Therefore, we have opted to use three values for [c] (i.e., [c] = $20, $25, $30), estimate equation (6.6.8) under [c] = $20 as an initializing value, and subject the model's results to sensitivity analysis with respect to each of the remaining [c] values. The upper range of the observed values of [c] (i.e., c = $35) was discarded in light of the stable flow of oil supplies at a price currently far below it.

All variables in the proposed model are real variables -- the nominal price of oil (FOB Saudi light) has been deflated by the OECD consumer price index, and the interest rate adopted is a real simple average of the U.S. and British government bond yields.

OPEC members' (including Saudi Arabia) production levels were taken equivalent to quantities supplied. The difference between production and export supply (i.e., quantities retained for domestic consumption) are relatively small and stable. As discussed in Chapters II and V, this is an indicator of the relative smallness of OPEC countries' industrial base and the importance of oil revenues as a source of foreign exchange. In the case of non-OPEC major producers (Britain, Norway, and Mexico) the distinction between production and exports has been garde bien for functional estimates.

6.6 MODEL RESULTS

This section consists of two parts: functional estimates and simulation results. Ordinary least squares methods were used to obtain the fitted functions[1]-- of the nine equations in the model only five need to be estimated. These are: <u>the oil demand function</u>, <u>two aggregate supply functions</u> (major non-OPEC and OPES), <u>the price-reaction function</u>, and <u>Saudi Arabia's demand for foreign exchange</u>.

6.6.1 FUNCTIONAL ESTIMATES

Over the period 1970-84, the estimated oil demand function is (all numbers are rounded to two digits after the decimal):

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[1]The regression phase was carried out on a Cyber 750 system using (SPSS)/"New Regression" Package. With this package, the variables we wanted to model were entered as dependent variables, and the variables that we felt (because of prior knowledge) to act upon the dependent variable were entered as independent variables. Major variables (e.g., demand, supply, price, Saudi Arabia's revenues) were predicted in terms of other variables while the minor variables (e.g., interest rate, changes in private oil stockpiling) were calculated as a function of time only.

$$\ln D_{(t)} = -2.70 + 1.13 \ln D_{(t-1)} + 0.04 \ln K_{(t)} + 0.11 \ln Y_{(t)} - 0.03 \ln P_{(t)}$$

S.E: (6.01) (0.35) (0.03) (0.06) (0.03)

t: (-0.45) (3.17) (1.59) (1.86) (-1.04)

$R^2 = 0.65$ Multiple R = 0.81 d.f = 10

d/w = 1.55 $F_{(4,10)} = 4.63$

Critical t (10; 5%)=2.228 Critical F [(4, 10); 5%]=5.96

The algebraic signs of the price and income variables are consistent with economic theory predictions. Holding all variables constant, a one percent increase in income would lead to (0.11) percent increase in oil quantity demanded; and quantity demanded is expected to decrease by (0.03) percent in response to a one percent increase in the price. The explanatory variables included explain 65 percent of the total variation in current period quantity of oil demanded. The double-log linear specification seems to fit the data rather well. At 5 percent significance level (two-tail test); all variables, with the exception of the lagged variable of the quantity demanded $D_{(t-1)}$ are statistically insignificant (i.e., not significantly different from zero). The F-test at 5% significance level leads us temporarily to accept the null hypothesis that the true population values of the relevant coefficients are zero.

One way to improve the statistical fit is to include additional explanatory variables. Retaining the double-log linear specification we obtained:

$$\ln D_{(t)} = -1.10 + 0.02 \ln K_{(t-1)} + 0.04 \ln K_{(t)} + 1.02 \ln D_{(t-1)} + 0.05 \ln Y_{(t-1)} + 0.12 \ln Y_{(t)} - 0.002 \ln P_{(t-1)}$$

S.E: (8.02) (0.03) (0.03) (0.47) (0.07) (0.07) (0.03) (0.05)

t: (-0.14) (0.49) (1.18) (2.15) (0.67) (1.63) (-0.07) (-0.39)

$R^2 = 0.68$ Multiple R = 0.82 d.f = 7

d/w = 1.47 $F(7, 7) = 2.10$

Critical t (7;5%) = 2.365 Critical F [(7, 7); 5%] = 3.79

The inclusion of additional explanatory variables: $P_{(t-1)}$, $K_{(t-1)}$, $Y_{(t-1)}$ did not noticeably increase the overall explained variation (+.03), and none of the added variables proved to be statistically significant. Among the added lagged-variables, the relationship between the quantity of oil demanded in the current year and that of the previous year is the most promising. Termed as the speed of adjustment demand coefficient it shows that it takes (1.02) years to eliminate the discrepancy between actual and desired quantity-demanded levels.[1] Adding up the coefficients of adjustments in private oil stockpiling

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[1]Comparing this result with Professor MacAvoy's work (1982, pp. 24-25), he estimated the adjustment periods for the U.S. world, and LDCs as 1.6, 2.7, and 1.9 years, respectively. It should be noted, however, that Professor

reveals that an observed discrepancy between actual and desired stockpiling levels is expected to be eliminated within .05 years (or less than three weeks). The presence of two (or more) demand adjustment coefficients should not be surprising since private oil stockpiling, as discussed in Chapter V, Section 5.3, is a contingency demand.

We have also experimented with two other functional forms to estimate the oil demand function. These are: a) a non-logarithmic specification and, b) a semilog on the explanatory variables. In both cases we obtained inconsistent coefficient signs (with respect to the price and income variables) without an increase in the overall causality coefficient or the number of the statistically significant parameters. The multiple coefficient of determination remained within the range (0.64 - 0.68) and the coefficient of multiple correlation has decreased in both cases. These results lead us to believe that the double-log specification, given the data base, does present the best statistical fit.

In estimating the supply function for the major non-OPEC producers (S_{MNO}) we followed a different

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MacAvoy's time series data base does not explicitly account for OPEC's role in setting prices. The difference in the estimated demand adjustment coefficients could be attributed to the magnitude and frequency of price changes since 1973. Expectation of rising prices, on the consumption side tend to enhance the effectiveness of conservation measures.

approach. We first estimated S_{MNO} with all relevant variables (from the literature, prior empirical studies and other plausible factors) included. Then, to account for the presence of multicollinearity, we deleted one variable at a time observing the overall change in the causality coefficient (R^2) and the value of F-test. This approach seemed to work rather well; thus, the first function we obtained is:

$$\ln S_{MNO(t)} = -5.0 - 0.01 \ln P_{(t)} + 1.04 \ln S_{MNO(t-1)} + 0.40 \ln MS_{(t)} + 0.13 \ln Z_M + 0.03 \ln P_{(t-1)} + 0.12 \ln \underline{CONSTR.}$$

S.E: (1.75) (0.03) (0.03) (0.22) (0.04) (0.03) (0.06)

t: (-2.85) (-0.40) (40.44) (1.83) (2.97) (0.97) (2.07)

$R^2 = 0.99$ Multiple R = 0.99 d.f = 8

d/w = 1.92 F (6, 8) = 986.79

Critical t (8; 5%) = 2.306 Critical F [(6, 8); 5%] = 4.15

The CONSTR. variable above is the linear equality restriction imposed on the supply behavior of the major non-OPEC producers (see Sect. 6.5.4, equation [6.6.4]). Of the explanatory variables included, the reserves/production ratio (a measure of the physical lifetime of the resource) and the lagged own supply, $S_{MNO(t-1)}$, were found to be statistically significant (i.e., significantly different from zero). Just as the $D_{(t-1)}$ coefficient represents the demand speed-of-adjustment coefficient when regressed on $D_{(t)}$, the regression $S_{MNO(t-1)}$ on $S_{MNO(t)}$ represents the supply speed-of-adjustment coefficient with reference to the major non-OPEC producers. It shows that $S_{MNO(t-1)}$ could adjust to its desired level, $S_{MNO(t)}$, within a little over one year.[1]

The supply price elasticity obtained was negative (-0.01), a rather abnormal result both theoretically and empirically; but the price elasticity of supply coefficient is positive (+0.03) with respect to the lagged price variable, $P_{(t-1)}$. All remaining variables have the expected positive sign, indicating a positive effect on current period supply level. The most significant contribution to current period major non-OPEC producers' supply level is the previous period supply level (or market share). This result enforces our previous speculation (see Sect. 6.5.2, pp. 197-8) that retaining a permanent contractual relationship, even under rising prices market conditions could prove valuable during glut market conditions. To a lesser degree (depending on the value of the partial coefficient of determination) current supply level by major non-OPEC producers is positively influenced

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[1]A word of caution is due here when interpreting the direction of adjustment -- it seems plausible to assume that the proposed adjustment coefficient is pertinent to market situations of rising prices. It is possible, also, specifically in situations of "contracted sales" which typically extend over a period of 2-3 years, that the coefficient refers to reduced volume of operations. This latter interpretation should hold, ceteris paribus, had the algebraic sign been negative.

by: the reserves-to-production ratio, OPES current market share, and the production constraint (the CONSTR. variable).[1]

The high value of the coefficient of multiple determination ($R^2 = 0.99$) is generally indicative of the presence of multicollinearity in the data; and since the value of the F-test enable us to reject the null hypothesis that all partial coefficients are simultaneously zero we tried deleting the variables that potentially are not linearily independent. The new $S_{MNO(t)}$ function is:

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[1]In Section 6.5.3, eq. (5), we postulated a quantity constraint on non-OPEC major producers' supply behavior as a linear equality restriction. A component of this quantity restriction was the variable: net additions to reserves (NAR). There is a possibility that this variable (NAR) could be dependent upon price changes; so we regressed, NAR, on a two periods lagged-price variables.

The obtained regression is:

$$NAR = 0.96E - 07 + 278997.04\, P_{(t-1)} - 0.65E - 06\, P_{(t-2)}$$

S.E:	(0.45E + 07)	(0.52E + 06)	(0.56E + 06)
t	(2.17)	(0.54)	(-1.2)

The coefficient of net additions to reserves, (NAR), as a proxy indicative of the intensity of oil exploratory and/or development efforts obtained were statistically insignificant. This conclusion, in a limited sense, could be taken in support of our previous speculation that the pace at which North Sea oil resources have been developed was not a direct response to market realities (see Sect. 6.5.2, pp. 193-4).

$$\ln S_{MNO(t)} = 21.39 + 0.20 \ln P_{(t-1)} - 1.14 \ln Z_M - 0.04 \ln P_t - 0.27 \ln CONSTR$$

S.E: (15.90)(0.35)(0.46)(0.50)(0.97)

t: (1.35)(0.56)(-2.50)(-0.083)(-0.28)

$R^2 = 0.54$ Multiple R = 0.73 d.f = 10

d/w = 1.39 F (4,10) = 2.87

Critical t (10; 5%)=2.228 Critical F [(4, 10); 5%]=2.88

The deletion of the variables: $S_{MNO(t-1)}$ and $MS_{(t)}$, reduced the overall explanatory coefficient of the original function by (0.55) percent. This loss in the overall causality came at the expense of gaining Z_M, the reserves/production ratio as a statistically significant variable. The F-test still leads us to reject the null hypothesis with respect to the value of partial coefficients; but, even this latter manipulation did not produce a statistically significant current period price coefficient.[1]

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[1]Only when we used simple regression specification did we obtain a statistically significant price coefficient. The fitted function is:
$S_{MNO(t)} = 121263.64 + 38244.1\, P_{(t)} - 0.65E - 04$ CONSTR.

S.E: (92034.0) (6109.9) (0.26E - 04)
t: (1.32) (6.26) (-2.54)
$R^2 = 0.85$ Multiple R = 0.92 d.f = 12
Critical t (12, 5%) = 2.18

Although this specification is not directly helpful in obtaining elasticity coefficients estimates it, nevertheless, shows that a $1 increase in oil price, other things constant, would lead to 38,244,100 bbls annual increase in supply by the major non-OPEC producers.

The fitted supply function for the OPES group (i.e., OPEC excluding Saudi Arabia) is:

$$\ln S_{OPES(t)} = 11.72 + 0.30 \ln S_{SA(t)} - 0.02 \ln S_{MNO(t-1)} - 0.06 \ln P_{(t)} - 0.03 \ln S_{MNO(t)} + 0.51 \ln MS_{(t-1)} - 0.45 \ln Z_N - 0.05 \ln P_{(t-1)}$$

S.E: (4.21)(0.18)(0.41)(0.05)(0.04)(0.45)(0.18)

t: (2.8)(-0.47)(-1.3)(-0.82)(1.13)(-2.48)(-0.75)(2.78)

$R^2 = 0.92$ Multiple R = 0.96 d.f = 7

d/w = 2.70 F (7, 7) = 12.51

Critical t (7; 5%) = 2.365 Critical F [(7, 7); 5%] = 3.79

The variables included explain almost all the variation in S_{OPES}; and the value of multiple R show a high degree of linear association between the variables. Only two variables are statistically significant: the lagged-price variable, $P_{(t-1)}$, and the lagged OPES group market share $MS_{(t-1)}$. The F-test enables us to reject the null hypothesis that all partial coefficients are simultaneously zero.[1] The most significant variables to influence the

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[1]When we regressed the variables: (Z_N) and (P_t) on (S_{OPES}) we were able to obtain statistically significant coefficients. The obtained function is:

$$S_{OPES(t)} = 0.10E + 08 + 17729.2\ MS_{(t)} - 0.32E\text{-}03\ Z_N - 71631.8 P_{(t)}$$

S.E: (0.2E + 07) (29404.2)(0.5E + 04) (20380.16)
t: (5.0) (0.60) (-6.27) (-3.51)
$R^2 = 0.72$ Multiple R = 0.85 d.f = 11
d/w = 1.42
Critical t(11, 5%)=2.201 F = 8.76
Critical F((3, 11); 5%)=27.1

The result of the F-test leads us to reject the null hypothesis that all partial coefficients are simultaneously zero.

supply of the OPES group are the lagged-price and the group's own last period market share.[1] This result accords well with current calls within OPEC to re-design the quota system according to each member's population base, and/or the availability of other resources significantly contributing to own member's national income.

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[1]Interestingly, we wanted to obtain the speed of supply adjustment coefficient of the OPES group of producers. We regressed current Saudi Arabia's supply, the lagged supply by the OPES group, last period supply by major non-OPEC producers, and the lagged price of oil on current period supply by the OPES group. The function we obtained is:

$$\ln S_{OPES(t)} = 15.75 + 0.003 \ln S_{SA(t)} + 0.006 \ln S_{OPES(t-1)} + 0.02 \ln S_{MNO(t-1)} - 0.18 \ln P_{(t-1)}$$

The supply adjustment coefficient gives us almost an instantaneous response (2.2 days). It is worthwhile to stress here that our model is not designed to measure time adjustment coefficients. It is the belief of this author there is a serious error in models that derive adjustment coefficients in this manner. (See: Oil Market Simulation Model, The Energy Information Administration, 1983, pp. 35-44). It seems that the source of error stems from the assumption of equating "an actual increase in supply" with "actual availability of crude on the market." Looking at a standard chain of oil operations (See Ch. II, Figure 2.1), we observe that it is a relatively easy task to operate a pumping station, a refinery complex, or a loading terminal an additional "shift" to satisfy an unexpected demand increase. It is essential, however, that tankers should be available for transportation, an excess storage capacity is accessible at the receiving end, spare refining capacity exists and so on, for the increased supply (production) to manifest itself on the consumption side of the market. It is the belief of this author that unless a model is specifically designed to measure adjustment coefficients (e.g., modeling each variable on sub-system basis as a function of time and the quantitative influence of other variables, in simultaneous equations regression, with bi-weekly or quarterly data base), invariably, all adjustment coefficients are "by-products" and should be expressed with reservation.

The best obtained fit for the price-reaction function is:

$$\ln P_{(t)} = 0.69 - .006 \ln S_{MNO(t)} - 0.18 \ln MS_{(t)} + 0.99 \ln P_{(t-1)}$$

S.E: (12.45)(0.21)(0.24)(2.56)

t: (0.06)(-0.03)(4.04)(-0.07)

$R^2 = 0.72$ Multiple R = 0.85 d.f = 11

d/w = 2.0 F = 9.64

Critical t(11; 5%)=2.201 Critical F [(3, 11); 5%]=8.76

As expected, only the lagged-price variable is statistically significant; the critical F-value enables us to reject the null hypothesis that all partial coefficients are simultaneously zero. Experimenting with additional explanatory variables did not contribute to either the overall causality coefficient of the function or increase the number of the statistically significant variables. The latter exercise, however, was beneficial in showing additional variables that tend to exert upward pressures on the rate of change in the price. These are: Saudi Arabia lagged supply, $S_{SA(t-1)}$, and the lagged market share of the OPES group, $MS_{(t-1)}$.

And finally, Saudi Arabia's demand for foreign exchange, over the period 1970-1984, is estimated as:

$$\ln R_{(t)} = 5.33 + 1.12 \ln B_{(t)} - 0.16 \ln E_{(t)} + 0.68 FN_{(t)}$$

S.E: (3.62)(0.12)(0.17)(0.38)

t: (1.47)(9.02)(-0.91)(-1.78)

$R^2 = 0.89$ Multiple R = 0.94 d.f = 11

d/w = 2.39 $F_{(3, 11)} = 30.30$

Critical t(11; 5%)=2.201 Critical F [(3, 11); 5%]=8.76

Saudi Arabia's demand for foreign exchange is positively related to budgetary needs, (both the operational and the capital budget), the ratio of imports to oil revenues, and the need to maintain emergency financial reserves. With more than 80 percent of public expenditure dependent upon the revenues of a single resource the obtained results are not surprising.

6.6.1.2 A NOTE ON REGRESSION RESULTS

The common practice of estimating supply/demand, income/price, elasticities lies in the analytical insights gained and the policy implications the elasticity estimators provide. For instance, a high price elasticity for energy demand implies a long-term ability of an economy to absorb the impact of rising energy prices; by contrast, a low price elasticity implies weak response to increasing energy costs and, other things constant, potential adverse effects on output and inflation.

The "elasticity," both as an analytical concept and an estimator, is not without caveats. In a recent study by Energy Modeling Forum (1980), 16 models were surveyed and used to obtain an insight into the question of the aggregate elasticity of energy demand. The main conclusion was:

> Contrary to popular conception, the energy demand elasticity cannot even be defined consistently without explicit specification of several factors. The point of measurement, method of aggregation, price change composition, time frame, and taxes and regulations assumed can significantly affect the calculated value of the aggregate elasticity.[1]

Table 6.1 compares the results of some of the often-cited studies with the ones obtained here. Without going into the technical underpinnings of each study, it is worthwhile to note the following:

1) This study had solely focused on the period within which oil pricing changed hands from the oil companies' control to OPEC's influence. This difference in time frames and its effect on data base observation points alone could give rise to different elasticity estimates.

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[1] For further details and results of empirical work see: "Aggregate Elasticity of Energy Demand," Energy Modeling Forum, Stanford University, Report No. 4, Vol. 1, (in ENJ, Vol. 2, No. 2, 1981) and "Energy Demand Elasticities in Industrialized Countries: A Survey," George Kouris, ENJ, Vol. 4, No. 3, pp. 73-92, 1983.

TABLE 6.1. ESTIMATES OF WORLD SUPPLY AND DEMAND ELASTICITIES

	Energy Information Administration	Central Intelligence Agency (Model - 1)	Central Intelligence Agency (Model - 2)	Gately, Kyle, and and Fischer	Calculated By the Author
Demand					
1. Price Elasticity					
Short Run	-0.1	-0.06 to -0.15	-0.1	-0.01 to -0.06	-0.03
Long Run	-0.5	-0.17 to -0.28	-0.3	-0.10 to -0.2	
2. Income Elasticity					
Short Run	0.10 to 0.17	0.5	0.35	--	+0.11
Long Run	0.5 to 0.85	0.95 to 1.10	1.00	--	
3. Implied Adjustment (Years)		2 - 3	3		1.02
Supply					
1. Price Elasticity					
Short Run	0.04	--	0.2	--	+0.03 to +0.99
Long Run	0.80	--	--	0.33	
2. Implied Adjustment					
(Years)	20	--	--	--	0.006 to 1.04

2) The period within which this study deals is characterized by non-uniform increases in the rate of change in oil price (in nominal terms), a slowdown in major consuming countries growth rates, and the introduction of energy conservation measures. Therefore, our elasticities estimates are a reflection of transitional market conditions . . . a middle ground between the price unresponsiveness of the immediate run and the full adjustment demand elasticity estimates.
3) The various "groupings" of oil producers, and the segmentation of the world oil market give rise to different supply/demand elasticity estimates. For instance, the Energy Information Administration model is heavily influenced by Professors Pindyck and Teece's empirical works (a salient feature of which is supply/demand "groupings" that emphasize mitigating supply shocks and/or the largest "energy savings"), where, on the other hand, the CIA models tend to avoid the "pigeonholing" approach, and emphasize as many scenarios as possible.
4) With reference to our study, we have retained rather as simple a model as possible. Here remain critical questions about the appropriateness of the linear specifications -- some variables (such as price and income) retained then theoretically

expected algebraic signs only after altering the mathematical "fit." Regression analysis works best the larger the observation points; in our case, coefficient estimates of some of the variables (such as $S_{MNO(t)}$) are based upon less than ten observations.

5) Time-series regression estimates almost invariably suffer two ailments: multicollinearity and first-order auto-correlation. As a rule of thumb, the closer the value of the Durbin-Watson test (d/w) to 2, the more it is indicative of absence of first-order auto-correlation, and the closer the value of d/w to 4 the more is the suspicion of negative serial correlation. The results of our d/w tests show absence of serial correlation in the data base.[1] Multicollinearity, on the other hand, is a sampling problem -- even if the explanatory variables are not linearily related in the population, they may, nevertheless, be related in the sample. To remove data multicollinearity we resorted to the common practice of: a) estimating the overall regression with all explanatory variables included, b) if collinearity is suspected (the value of R^2 close to one), one or more

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[1]Note that the d/w test is not applicable to models where the dependent variable is used as an additional explanatory variable.

explanatory variables are deleted, observing the change in the value of R^2, and c) once the value of R^2 is stable around some percentage we took the "purged" function as the "best fit." From there on, the addition of explanatory variables (assuming non-relatedness) to the "purged" function was based on each variable's relative contribution to the total variation in the dependent variable, notwithstanding their statistical significance.

6.6.2 SIMULATION RESULTS

The following functions constitute the simulation side of the model.[1] We opted to simulate the functions in their non-log regression form due to observed divergent and explosive behavior of some of the variables when simulated logarithmically. The functions are:

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[1]A Pascal simulation program was written and run on 150 Zenith computer using Turbo Pascal. We first took the 1970 - 1984 data, and through the regression equations, obtained end of 1984 values for the variables. The model was run for the years we wished to project. This approach allowed us to insert specific values anytime during the projection periods, test the model sensitivity, and see the effect on other variables. The program goes through one major cycle for each year; the variables solely dependent on time are calculated first within their respective cycle; all variables are then calculated recursively.

*We will also report the future price trajectory according to the price-reaction formula adopted by the Energy Information Administration. The function is:

$$\%\Delta P = -0.357 - 0.071 \text{ INV. } \Delta MS_{(t)}$$

See: Oil Market Simulation Model Documentation Report, June 1983, pp. 25-28.

$$D_t = -0.20E+07 + 710847.52\ y_t + 349927.14\ y_{t-1}$$
$$+0.68\ D_{(t-1)} + 48850.62\ P(t-1) + 3.38\ K_t$$

$$S_{MNO(t)} = S_{MNO(t-1)} + 0.01\ S_{MNO(t-1)}$$

$$S_{OPES(t)} = 0.24E+07 + 0.40\ SSA(t-1) + 24926.74\ MS_t$$
$$-68926.67\ P_{(t-1)} - 2.17\ S_{MNO(t-1)}$$
$$+\ 47040.09\ MS_{(t-1)}$$

$$S_{SA(t)} = -0.69E+06 - 0.06\ S_{MNO(t-1)} - 3.84\ IMP_{(t-1)}$$
$$+15050.89\ P_{(t-1)} + 35.32\ B_{d(t-1)}$$
$$-32.97\ B_{c(t-1)} + 0.42\ S_{OPES(t-1)}$$

$$\%\Delta P^* = 1.17 - 1.89\ INV.\Delta MS_t + 0.22E-05\ S_{SA(t)}$$
$$P_t = P_{(t-1)} \times \left[1 + \%\ P(t,\ t-1)\right]$$
$$W = \sum_{t=1}^{6} \frac{1}{(1+r)^t} \left[P_t \cdot S_{SA(t)} - C_t \cdot S_{SA(t)}\right]$$

Subject to:

$$4{,}353{,}000\ bd \leq S_{SA(t)} \geq 10{,}000{,}000\ bd$$
$$P_t \cdot S_{SA(t)} \geq \sum \left(35.3\ B_{d(t-1)} - 33.0\ B_{c(t-1)} - 3.8\ IMP_{(t-1)}\right)$$

Table 6.2 shows the unrestricted values of the model's variables. With the assumption that world economic activity grows annually at 3 percent, both price predictors show a trend toward declining oil prices. Starting with $27.50 as a base price, the Energy Information Administration formula (hereafter EIA price predictor) gives a price of $24.50/bbl by the end of 1990, whereas our model predicts a much lower price ($12.38/bbl). Two reasons could be advanced for this price projection disparity: a) the EIA aggregates all OPEC members as one producing unit, and b) the EIA formula is derived from data bases that include pre-1970 observations. Oil supply by major non-OPEC producers exhibits a uniform behavior over time and shows an annual 10 percent increase irrespective of the price determining mechanism (this is in part due to our assumption that the major non-OPEC producers would sell all they can at the going price, and our assumption of maintaining the historical pattern of reserves/production ratios as exhibited in the data). Oil supply by the OPES group, however, shows greater response to price changes under both formulas -- it shows a sharp drop by the end of 1986 (almost 34.1 percent from its estimated level by the end of 1985) and fluctuates thereafter. For the remainder of the projection period, the supply by the OPES group shows an average upward adjustment of +5.85 percent and a downward adjustment of -3.95 percent. Within these

TABLE 6.2. UNRESTRICTED SIMULATION RESULTS

Variable	1985	1986	1987	1988	1989	1990
D_t	20,263,549.7	20,535,511.6	20,677,939.8	20,907,248.8	20,645,235.3	20,499,450.5
K_t	218,150.1	227,690.2	237,230.4	246,770.5	256,310.6	265,850.7
D_t+K_t	20,481,699.8	20,763,201.8	20,915,170.2	21,154,019.3	20,901,545.9	20,765.301.2
S_{MNO}	1,025,650.0	1,035,907.0	1,046,266.0	1,056,728.0	1,067,296.0	1,077.968.0
$\%\Delta S_{MNO}$	----	----	----	----	----	----
S_{OPES}	4,130,928.9	2,719,977.2	2,802,668.0	2,691,854.1	2,839,466.4	2,953,338.0
$\%\Delta S_{OPES}$	----	-34.15%	+3.03%	-3.95%	+5.84%	+4.01%
S_{SA}	1,559,891.5	1,389,966.5	1,742,690.5	734,208.3	642,962.9	662,233.8
%ΔSA	----	-10.8%	+25.4%	-57.8%	-12.42%	+2.99%
S_4	13,765,229.4	15,617,351.1	15,323,547.5	15,323,605.7	16,351,820.6	16,071,761.4
P_t	$24.98	$22.46	$19.94	$17.42	$14.90	$12.38
P_t(EIA)	$27.00	$26.50	$26.00	$25.50	$25.01	$24.51
Saudi Arabia Revenues	38,950.0	31,216.8	14,807.8	12,787.9	9,577.9	8,195.8
Saudi Arabia's Expenditures						
B_c	28,420.0	28,420.0	28,420.0	28,420.0	28,420.0	28,420.0
B_d	29,580.0	29,580.0	29,580.0	29,580.0	29,580.0	29,580.0
Saudi Arabia's Budget	-$19,035.0	-$26,783.2	$-43,192.2	-$45,212.1	-$48,422.1	-$49,804.2

NOTES: (Tables 6.2 through 6.5)

1) All physical variables are in 1,000/bbls yearly.

2) Prices are in U.S. dollars at constant 1984 price level.

3) Saudi Arabia's revenues, expenditures and budget are in U.S. $billion.

boundaries average daily production by the OPES group for the period 1985 to 1990 is projected to be 8.3 mbd.[1]

Supply (= production) by Saudi Arabia shows a steady decline over time; from an estimated 4.3 mbd (corresponding to its assigned quota as of October 1984) by the end of 1985 to almost 1.8 mbd by the end of 1990. Retaining the assumption that Saudi Arabia will maintain the proposed expenditure level of the 1985/86 budget throughout and given the historical budgetary division between operational and capital expenditure (derived from data), Saudi Arabia is projected to witness budgetary deficits estimated to grow from \$19B at the end of 1985 to almost \$50B by the end of 1990.[2]

The assumption of an annual 3 percent growth in world economic activity has little effect on aggregate demand for oil. The model predicts a rather modest increase, demand for oil is expected to show an increase of 1.15 percent

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[1]When comparing this result with the OPES group quota of October 1984 (estimated at 11.6 mbd) we observe the tremendous pressures on OPEC members to reduce the collusive output to maintain the price.

[2]During the fiscal year 1983/84 it was reported that Saudi Arabia withdrew \$10B from previously accumulated budget surpluses to cover anticipated deficits; and for the fiscal year 1984/85 the deficit was estimated to be more than \$10B (see: <u>WSJ</u>, January 8, 1985, pp. 1, 19). His Majesty's speech on the budget for the fiscal year 1985/86 gave an estimated expenditure of \$58B (at an exchange rate of \$1 = 3.5 S.R.). (See: <u>Al-Mubtaath</u>, "The Budget Royal Speech," Vol. 7, No. 77, April 1985, pp. 16-18). We have taken the \$58B expenditure level to be reoccurring each year until the end of the projection period.

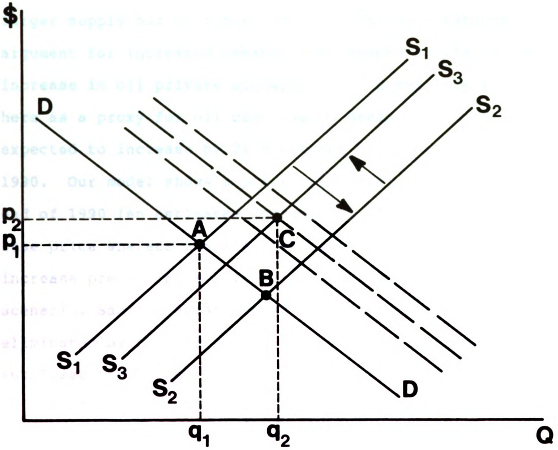
TABLE 6.3. SIMULATION RESULTS WITH 50% OF MAXIMUM SAUDI ARABIAN OIL PRODUCTION

Variable	1985	1986	1987	1988	1989	1990
D_t	20,263,549.7	20,733,510.1	21,243,787.8	21,788,651.4	22,363,184.2	22,963,168.3
K_t	218,150.1	227,690.2	237,230.4	246,770.5	256,310.6	265,880.7
D_t+K_t	20,481,699.8	20,961,200.3	21,481,018.2	22,035,421.9	22,619,494.8	23,229,049.0
S_{MNO}	1,025,650.0	1,035,907.0	1,046,266.0	1,056,728.0	1,067,296.0	1,077.968.0
$\%\Delta S_{MNO}$	----	----	----	----	----	----
S_{OPES}	4,130,928.9	2,547,952.4	2,420,076.7	2,291,979.7	2,163,659.2	2,035,108.8
$\%\Delta S_{OPES}$	----	-38.3%	-5.01%	-5.29%	-5.59%	-5.94%
S_{SA}	1,825,000	1,825,000	1,825,000	1,825,000	1,825,000	1,825,000.8
$\%\Delta SA$	----	----	----	----	----	----
S_4	13,500,120.9	15,552,340.9	16,189,175.5	16,861,714.2	17,563,539.6	18,290,972.2
P_t	29.03	30.56	32.10	33.63	35.16	36.69
P_t(EIA)	31.05	34.61	38.16	41.72	45.27	48.82
Saudi Arabia Revenues	52,984.5	55,781.0	58,577.8	61,374.5	64,171.3	66,968.1
Saudi Arabia's Expenditures						
B_c	28,420.0	28,420.0	28,420.0	28,420.0	28,420.0	28,420.0
B_d	29,580.0	29,580.0	29,580.0	29,580.0	29,580.0	29,580.0
Saudi Arabia's Budget	-5,015.7	-2,218.9	+577.7	+3,374.5	6,171.3	+8,986.1

over the study period at an average daily consumption of 56.3 mbd. Private oil stockpiling (modeled as a function of aggregate demand, current, and lagged oil prices) is expected to show an increase of 21.8 percent over the years 1985 to 1990.

In Table 6.3 we introduced the assumption that Saudi Arabia will produce at 50 percent of its maximum feasible production (estimated at 10 mbd) and will hold this production level throughout. This approach to sensitivity analysis enables us to control model variables values and investigate changes in projected values. Although supply by major non-OPEC producers remained unaffected, there is a supply reduction effect by the OPES group. In reaction, the OPES group are projected to reduce their production level throughout at an annual average of 12.03 percent. More interestingly, is that the hypothesized sudden increase in the Saudi Arabian supply would lead to an increase in the price of oil according to both price predictors. Figure 6.3 shows how this situation could arise. Starting from an initial equilibrium at point A the assumed Saudi supply increase, other things constant, would cause an increase in the aggregate oil supply and a fall in price. Point B, however, does not represent an equilibrium point because expectations of falling prices would cause gradual shifts in oil aggregate demand curve. The broken segments demand curves each of which represent a demand

FIGURE 6.3 SUPPLY REDUCTION EFFECT BY OPES GROUP.



NOTES:

$S_1 = S_{SA_1} + S_{OPES_1} + S_{MNO_1}$

$S_2 = S_{SA_2} + S_{OPES_1} + S_{MNO_1}$

$S_3 = S_{SA_2} + S_{OPES_2} + S_{MNO_1}$

$S_{SA_2} > S_{SA_1}$

$S_{OPES_2} < S_{OPES_1}$

level associated with higher expectations of falling prices. The OPES group supply reduction represents an upward shift in oil aggregate supply curve, from S_2 to S_3, leading to a market equilibrium at point C, with larger supply but at higher prices. The expectations argument for increased demand is evidenced by the projected increase in oil private stockpiling -- a variable taken here as a proxy for oil contingency demand -- which is expected to increase by 21.8 percent over the years 1985 to 1990. Our model shows a price per barrel of $36.69 by the end of 1990 (an estimated increase of 26.3 percent over the base price whereas the EIA formula shows a 57.2 percent increase predicting a price of $48.82/bbl. Under this scenario, Saudi Arabian budget deficits are expected to be eliminated by the end of 1986 and will begin to show surpluses thereafter of an average of $4.8B annually.

In Table 6.4 we extended the hypothetical increase in the Saudi Arabian supply to its maximum feasible limit. Retaining the previous assumptions regarding growth in world economic activity and the Saudi Arabian budgetary limit and division, the price of oil is expected to go up even higher than under the previous case. The OPES group supply reduction would gradually offset the Saudi supply increases by an average reduction of 24.41 percent from its 1985 level. The Saudi Arabian budget is projected to show surplus by the end of 1987 estimated to an average of

TABLE 6.4. SIMULATION RESULTS WITH MAXIMUM SAUDI ARABIAN FEASIBLE OIL PRODUCTION

Variable	1985	1986	1987	1988	1989	1990
D_t	20,263,549.7	20,931.508.6	21,809,635.9	22,868,054.2	24,081,133.1	20,645,235.3
K_t	218,150.1	227,690.2	237,230.4	246,770.5	256,310.1	265,850.7
D_t+K_t	20,481,699.8	21,159.198.8	22,046,866.3	23,114,824.7	24,337,443.2	25,692.736.9
S_{MNO}	1,025,650.0	1,035,907.0	1,046,266.0	1,056,728.0	1,067,296.0	1,077.968.0
$\%\Delta S_{MNO}$	----	----	----	----	----	----
S_{OPES}	4,130,928.9	3,007,527.7	2,600,284.8	2,192,820.6	1,785,133.0	1,377,215.5
$\%\Delta S_{OPES}$	----	-27.01%	-13.54%	-15.66%	-18.59%	-22.85%
S_{SA}	3,650,000.0	3,650,000.0	3,650,000.0	3,650,000.0	3,650.000.0	3,650,000.0
$\%\Delta SA$	----	----	----	----	----	----
S_4	11,675,120.9	13,465,764.2	14,749,809.5	16,215,276.1	17,835,014.2	19,587,553.4
P_t($)	33.09	38.67	44.62	49.84	55.43	61.01
P_t(EIA)($)	35.11	42.71	50.32	57.93	65.54	73.14
Saudi Arabia Revenues($)	120,762.5	31,216.8	14,807.8	12,787.9	9,577.9	8,195.8
Saudi Arabia's Expenditures						
B_c	28,420.0	28,420.0	28,420.0	28,420.0	28,420.	28,420.0
B_d	29,580.0	29,580.0	29,580.0	29,580.0	29,580.0	29,580.0
Saudi Arabia's Budget ($)	-5,015.7	-2,218.9	+577.7	+3,374.5	+6,171.3	

$3.4B. And finally, Table 6.5 shows the results of maximum feasible production by the OPES group[1] assuming the Saudi oil supply to hold at present quota level. The price increase is expected to be more moderate; estimated to be 17.7 percent above the base price according to our model, and 49.6 percent according to the EIA price predictor. This latter case would cause a permanent Saudi budget deficit throughout, although declining over time, estimated to be $8.78B annually.

6.6.2.1 A NOTE ON THE SIMULATION RESULTS

It is worthwhile to note the following remarks related to this study's projections:

1) By design, we imposed on the model market-clearing conditions at the end of every projection period. Alternatively, a model that allows for disequilibria situations (either at the end of each projection period or forward cumulative disequilibria) would project different timepaths and values of variables. It is our belief that, given current glut market conditions, a disequilibrium model is a worthwhile exercise.

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[1]To approximate this production level, we have taken the highest historical supply (= production) level by the OPES group. This benchmark was attained by the end of 1973 and is estimated to be 8,315,941,000 bbls/y. See: OGJ, The End of the Year Issue, 1973.

TABLE 6.5. SIMULATION RESULTS WITH MAXIMUM S_{OPES} OIL PRODUCTION

Variable	1985	1986	1987	1988	1989	1990
D_t	20,263,549.7	20,707,889.1	21,170,565.1	21,648,976.7	22,140,881.6	22,644,363.2
K_t	218,150.1	227,690.2	237,230.4	246,770.5	256,310.6	265,850.7
D_t+K_t	20,481,699.8	20,935,379.3	21,407,797.5	21,895,747.2	22,397,192.2	22,910,213.9
S_{MNO}	1,025,650.0	1,035,907.0	1,046,266.0	1,056,728.0	1,067,296.0	1,077.968.0
$\%\Delta S_{MNO}$	----	----	----	----	----	----
S_{OPES}	8,315,941.0	8,315,941.0	8,315,941.0	8,315,941.0	8,315,941.0	8,315,941.0
$\%\Delta S_{OPES}$	----	----	----	----	----	----
S_{SA}	1,588,845.0	1,588,845.0	1,588,845.0	1,588,845.0	1,588,845.0	1,588,845.0
$\%\Delta SA$	----	----	----	----	----	----
S_4	9,551,263.8	9,994,886.3	10,456,745.5	10,934,233.2	11,425,110.2	11,927,459.9
P_t($)	28.51	29.52	30.52	31.53	32.54	33.55
P_t(EIA)($)	30.53	33.56	36.59	39.62	42.65	45.68
Saudi Arabia Revenues($)	45,294.8	46,896.3	48,497.9	50,099.4	51,700.9	53,302.5
Saudi Arabia's Expenditures						
B_c	28,420.0	28,420.0	28,420.0	28,420.0	28,420.	28,420.0
B_d	29,580.0	29,580.0	29,580.0	29,580.0	29,580.0	29,580.0
Saudi Arabia's Budget($)	-12,705.2	-11,103.7	-9,502.1	-7,900.6	-6,299.1	-4,697.5

2) In deriving the price-reaction function, we looked at the period 1970 to 1984 and selected periods during which percentage increases in the price of oil were inversely related to voluntary reductions in the OPES group supply share. Similarly and during the same period, we isolated periods during which percentage reductions in oil prices could be attributed to an additional Saudi supply increase (from an a priori production level consonant with maintaining a one-year's oil income in budgetary surpluses). This procedure gave us two sets of observations; the price-reaction function was derived by regressing the obtained observations as independent variables on percentage changes in the price of oil (as a dependent variable).

3) We assumed a zero inflation rate prevailing throughout the projection period. As such, projected prices are in constant 1984 prices. A better pricing mechanism should either account for inflationary periods or correlate the price of oil to changes in the terms-of-trade.

4) In reporting the Saudi budget deficits, we excluded the goods and services portion of total imports that are privately financed. This assumption was adopted in light of recent Saudi public policy statements to assign a larger role for the private

sector since most of the development infrastructure has been laid out.[1] Thus, projected Saudi budget positions are solely public sector surpluses and/or deficits.

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[1]See His Majesty's speech on the fiscal year 1985/86 in Al-Mubtaath, Vol. 7, No. 77, April 1985, pp. 16-18.

CHAPTER VII. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

7.1 SUMMARY

7.2 CONCLUSIONS

7.3 STUDY RECOMMENDATIONS

7.3.1 THEORETICAL/EMPIRICAL RECOMMENDATIONS
7.3.2 POLICY RECOMMENDATIONS

CHAPTER VII. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

7.1 SUMMARY

Crude petroleum, despite its useful presence as a source of energy since the 1870s, gained unparalleled importance during the decade of the 1970s. This study, from a historical perspective, has traced the major turning points in the oil industry emergence: from disperse national operating units to a multinational industry. Two major circumstances aided the oil industry in acquiring this status: a) the traditional concession system with its asymmetrical distribution of rights and obligations, and b) consequently, oil companies' control of a large portion of the then known oil fields and the surreptitious price coordinating schemes and rules adopted to reduce intraindustry competition.

Oil producers' reaction to the oil companies' control over exploration, production, and pricing came in the form of an organization (OPEC) primarily concerned with preserving oil producers' economic interests. Resource ownership (be it nationalization, gradual ownership, or production sharing) was not the primary objective of OPEC; oil producers were more concerned with a representation in production and pricing decision making -- a right the oil companies were not about to abide themselves by.

This study has shown that a better understanding of the world energy situation should begin prior to the oil embargo. As a matter of fact, the 1973 oil embargo and the events that followed bear no direct relationship to the price (cost) of oil. The true roots of the energy problem lie in: a) post-World War II West European reconstruction programs and the U.S. industrial reorientation from war economy to consumer products; b) the dependence of Western economies on relatively less costly and easily accessible sources of energy, and c) the costs associated with re-discovering additional oil resources outside the Middle Eastern belt, or the cost of developing energy substitutes.

Energy producers, be it the oil companies or OPEC, invariably had, and still have, an incentive to alter market distribution patterns of gains when a contemplated new order seems to promise to be beneficial. In this regard and contrary to popular misconceptions, incentives for collusive behavior are inseparably imbedded market phenomena. Colluders, unavoidably, have to choose between <u>controlling the overall production level</u> of the cartelized product or <u>assigning a "minimum" per unit price for it</u> (although, by definition, controlling one or the other is sufficient to alter the pre-collusion gains distribution). Economic history has shown us that collusive resources management efforts are short-lived, better yet, transitory. Aside from the formidable task of enforcing a collusive agreement (the needed information to establish data bases and the choice of efficient criteria for enforcement, particularly in the case of sovereign states' collusions) a collusive agreement has to deal with two major sources of market instability: a) the potential of developing supply sources unbounded by the collusive agreement where the new entrants may opt to be free riders, and b) the potential of developing substitute products, both on the production and consumption sides of the market that could effectively compete with the cartelized product. These two potential sources of collusion instability lead us to stress, as witnessed by the behavior of the world oil market since 1980, that collusive agreements instability is also a market-embedded phenomenon.

A finding of this study is that OPEC did not fully exploit its market power (i.e., the absence of coordinated production/pricing policies) to maximize members' joint revenues. OPEC members, however, successfully utilized their resource ownership in the early 1970s to create an environment conducive to expectations of higher prices. The oil companies continued to play the role of the "middle man," and with the remainder of the oil operations virtually under their control (i.e., the exploration and development, transporting, refining, and distribution) resources ownership proved to be purely "cosmetic."

OPEC's inability or unwillingness to establish a coordinated pricing policy was first reflected in Libya's successful efforts (in 1969) to break the Seven Sisters' stranglehold on the oil market by granting a one-time 28 concessions at more favorable revenues and development terms to it; in Iran's instrumental role (in 1971) in nullifying oil companies' pricing unilateralities and establishing producers-concessionaires negotiated price-setting, and finally, in Saudi Arabia's role in maintaining what came to be known as a policy of price moderation.

Prior to OPEC's enactment of a production ceiling, in early 1982, the historical record reveals intermittent periods of underpricing by all members, at different times. OPEC's members seem to have entered into an agreement to allow a member to exceed his production quota or offer a price discount if his domestic socio-economic and political situations seem to warrant. The two policies differed in their effect on the market price of oil. An above quota production, _ceteris paribus_, tends to reduce the sale price to all members, particularly in situations where the sold quantities were large and happened to find their way to the spot market. A price discount, on the other hand, is usually a "seller-made," one-shot large quantity extending over several months and transacted with the understanding that the sold quantities will not be resold on the spot market. An example of the latter is a government-to-government sale through publicly-owned oil marketing agencies.

The characterization of the Saudi Arabian oil pricing policy as "moderate" is a misnomer, at best. This study has shown situations during which Saudi Arabia, through unilaterally pricing its crude oil and/or varying its production levels has had an impact that was not consonant with other members' economic interest or the market conditions as then prevailed.

By the early 1980s, non-OPEC oil supply sources began to influence the market. OPEC's response was a series of reductions in its overall production level and a system of quota assignment. Almost every member, however, at one time or another, continued to violate its quota assignment or offered substantial discounts below the official price. Oil bartered for commodities became a new device used by some members to disguise intra-OPEC price reductions. By the time OPEC became a true cartel (limiting overall production, quota assignment, and establishing an information and data base system to detect violators) it was too late because the share of non-OPEC supply sources began to have an undermining effect on OPEC's official sale price.

Demand for oil (by consumers) is a derived demand for the activities that oil could be put to; and demand for foreign exchange (by producers) is a derived demand for the benefits accruing from investing oil revenues. An oil producer would have an incentive to sell below the collusive price as long as his assessment of the current rate of return (both private and social) exceeds his expectations of higher returns if oil is withheld. OPEC members have different needs for foreign exchange; a collusive pricing agreement that overlooks members' varying foreign exchange demand elasticities is not expected to command adherence unless demands for foreign exchange are satisfied through means other than unilateral oil sales.

Throughout 1976 - 1982, Saudi Arabia played a pivotal role in maintaining oil price changes within a range perceived to be in its best interest. This policy induced a belief that Saudi Arabia, through varying its production levels, could cause oil prices to drop even further. To investigate the validity of this hypothesis this study presented a simulated, simultaneous equations model for the world demand and supply for oil. Three groups of suppliers have been identified, viz., the major non-OPEC producers, the OPEC group excluding Saudi Arabia (the OPES group), and Saudi Arabia. Major non-OPEC producers were assumed to act as price-takers (i.e., sell all they could at the going price), the OPES group was assumed to be price-maximizers (able and willing to alter their market share to hold price declines), and Saudi oil decisions were assumed dependent upon current and capital budgetary requirements.

A finding of this study is that among the three identifiable supply sources the burden of adjustment, i.e., the maintenance of a given percentage price change, would be carried by the OPES group and Saudi Arabia. Through the simulated values of the model, it was found that the trend toward declining oil prices would continue at least until the end of this decade (end of the projection period). Furthermore, this study finds a potential for intra-cartel (i.e., intra-OPEC) rivalry for price leadership -- the OPES group could counteract unilateral oil production decisions by Saudi Arabia. Sensitivity analysis highlights an interesting finding: sudden, unilateral, and non-transitory increases in Saudi oil production with the intention to reduce the price of oil could be effectively nullified by the OPES group by reducing their market share. Given the current trend of Saudi public expenditure requirements, the OPES group could reduce their market share to practically realize a price rise, instead. With particular reference to Saudi Arabia, this study finds that variations in non-domestic rates of return and the cost of oil substitutes are of secondary importance to Saudi oil decision -- Saudi Arabia's budgetary obligations are more binding.

7.2 CONCLUSIONS

The study of collusive behavior, outside national boundaries, is both interesting and risky. It is interesting in many ways -- it broadens the practitioner's international resources development perspectives beyond the compact world of his/her tools kit, it demands continuous evaluation and clarification of one's values, and it requires a head-on encounter with the normative judgments of programs and policies. The risky side is related to future actions predictability -- leaders and nations are transformed into economic actors, nations' strengths and susceptibilities grow clearer, and effective communications become a matter of capsulizing grievances, hopes and aspirations into slogans and workable policies. All this in an environment characterized by actions and counteractions where the stability and optimality of outcomes are temporary, at best.

Based upon the findings of this study, we feel justified in concluding:

1) The circumstances that gave rise to the traditional concession system as known in the international oil industry are the results of unequally situated partners with respect to access to information, and needs for additional resources. The rigidity of these concessions with respect to what constitutes "property" under changing conditions is the major reason that led to the emergence of OPEC.

2) OPEC emerged in an environment when assertion of political sovereignty became synonymous with ownership of natural resources. OPEC members were later disappointed in finding that the legalities of ownership, at least in the oil industry, did not directly translate into controlling output and changing product prices.

3) The percentage of then proven oil reserves held under the concession system by the oil companies and the well-orchestrated schemes to stabilize prices and output effectively nullify claims of a competitive world oil market prior to OPEC.

4) Rising demand for Middle Eastern oil as a prime source of energy, given its proximity to major consuming areas, its favorable cost differentials per unit, and the increasing demand for development rights by independent companies are the major reasons that enabled OPEC to exercise greater influence over prices.

5) The association of the 1970s price increases to the oil embargo of 1973 is an unfounded conclusion. In light of the pre-1970 demand for oil and the prices prevailing then, it is beyond dispute that the prices (both as a measure of the value of oil in use and/or with respect to the cost of energy "substitutes") were too low to be sustained even if

OPEC did not successfully manipulate rising prices expectations. On the other hand, OPEC prices that prevailed by late 1979 seem now to be too high to have lasted throughout the 1980s.

6) There is a continuous dispute about the significance of OPEC and what has happened in the last decade. In our view, OPEC has succeeded in manipulating the energy environment (i.e., the magnitude and the timing of the rate of increase in prices); on the other hand, OPEC members have failed in maintaining a pricing policy consonant with maximizing their joint economic interests.

7) OPEC members have tacitly allowed a member to exceed his production share or offer price discounts if his economic conditions warrant so; this policy seem to have worked well for all members during intermittent periods of revenue shortages.

8) There are a number of crucial questions about the production levels and/or pricing decisions unilaterally taken by Saudi Arabia. Given the vast amounts of foreign exchange accumulated during the 1970s and the development plans upon which Saudi Arabia has embarked, there are numerous periods when Saudi Arabia's decisions ran contrary to the joint interest of other OPEC members.

9) The oil price boom of the 1970s has shown the need to upgrade the Saudi Arabian foreign policy decision making process. The current process is often characterized as slow, secretive, and petrodollar-oriented. An effective oil diplomacy should operate in a world characterized by arms races, allies and spheres of influence, the Arab-Israeli clashes, and superpower rivalry.

10) By allowing for political factors to enter our analysis, this study concludes that Saudi Arabia has been, and is still, motivated to take an active role in maintaining a pre-determined rate of increase in oil prices, supposedly at economic as well as non-economic gains to itself. This so-called price moderation policy has come at the expense of OPEC's economic vitality.

11) Given current market conditions, this study projects a declining price trajectory for oil. With increasing competition from non-OPEC supply sources and barring further market institutionalization to hold the price decline, a price for oil below $15 per barrel by the end of this decade is not improbable.

12) This study shows a potential for a new leadership within OPEC. The remaining OPEC members, excluding Saudi Arabia, could prevent further price

reductions and may effectively cause the price to rise. The ability of the OPES group to counteract the assumed Saudi Arabian price reducing policies also has to be assessed in terms of the OPES group revenue needs and the political desirability of such policy. With the ensuing price rise due to the OPES reduction in market share, it is probable that the current average OPES public expenditure level could be maintained.

13) Until the end of this decade, Saudi oil production decisions would be constrained by budgetary requirements. Assuming the persistence of the oil price decline and the maintenance of the Saudi level of public expenditure (estimated to be $58B for the fiscal year 1985/86), Saudi budget deficits are projected to persist.

14) Saudi Arabian revenue policy seems destined to operate within: a) continuously declining public expenditure levels, b) draw down previous budgetary surpluses (the majority of which is held in short-term bank deposits and medium-term loans), and/or c) utilize additional schemes for revenue generation (such increased tariff rates on imported goods and/or charge higher prices for public services).

7.3 STUDY RECOMMENDATIONS

The study's recommendations are divided into two parts: theoretical/empirical and policy recommendations.

7.3.1 THEORETICAL/EMPIRICAL RECOMMENDATIONS

Studying the phenomenon of collusive agreement by producers, and particularly when the agreement involves sovereign states, it remains an open question how best to design a behavioral model to predict future courses of action. Viewing OPEC as largely a political phenomenon, an approach helpful in and of itself, it becomes apparent that a "better" model should incorporate the non-economic variables impinging upon the "economic" decision. But leaving the argument at this level does not truly add much to what we already know. Thus, we put forth the following recommendations:

1) In our view, an essential starting point to predict the behavior of a sovereign-states collusive agreement is to discard the assumption that collusive members are "equal," i.e., equally situated in terms of actual and anticipated gains or equal in terms of the coercion each is capable of exercising upon other members. The theory of games approach, notwithstanding its numerous assumptions and the immense data base required, seems more promising than the current state of

modeling. With respect to our conclusion that Saudi Arabia was motivated and it saw it in its best interest to dampen the rate of increase in the price of oil, it becomes crucial (from the viewpoint of an assumed joint decision making) to ask: <u>what if the incentives offered to Saudi Arabia fell below its expectations</u>, <u>what if the remaining OPEC members countered with a "better" offer, or better yet, could Saudi Arabia have maintained the same policy had the other members collectively used coercion (expel Saudi Arabia from OPEC</u>)? The point expressed here is that collusive agreement "internal stability points" (i.e., inter-members' payoffs; the presence (or the lure) or inter-members' joint ventures, . . . etc.) are as relevant as demand/supply elasticities or maximum feasible production. We believe a "better" model should account for such interaction.

2) Of greater importance to the nature and magnitudes of the energy demand in the short run is energy demand responsiveness to macroeconomic policies. The energy demand/energy price transaction can be altered by aggregate demand policies, and in particular the monetary authorities. It is of less relevance to policy decisions to state that a price path could be altered by varying assumptions about

money supply growth rate. A more appropriate model should explicitly include a monetary/financial sub-system (a feedback mechanism) from changes in oil price to expected growth rates, and vice versa.

3) Along the above point, econometricians, when estimating the various statistical "fits" for a relationship, should include in their reports parameter estimates for all of the specifications attempted (or an expanded range) and relevant test statistics rather than reporting the "ideal" fit. This would immensely help users as well as students of the field better evaluate the robustness (i.e., significance levels, types of error, . . . etc.) of the relevant parameters.

4) There is an urgent need to "standardize" the energy data; model comparisons are made difficult, if not practically useless, by the diversity of inventory conventions adopted by government agencies, international organizations, energy research private firms, trade journals, and universities. Granted that each agency reports data (disaggregated and processed) for its own objectives, somewhere in this chain there has to be a unit which would take upon itself such a task. The gains reaped from standardized data are invaluable; and in our judgment, universities

through private/public funds might be the ideal place to design and evaluate attempts to standardize data.

5) There is much emphasis on deriving and estimating demand/supply, price/income, elasticities. Notwithstanding the policy implications of these estimates, it seems that we need to emphasize not only by how much an estimate differs from an a priori value but also what are the relevant factors behind estimate differences. It is of less comfort to state data problems while factors such as price expectations, consumptive habits formation, and technological change remain unsatisfactorily measured. But even at a more manageable level, the choice of the analysis period is of itself crucial. The pre-1970 period is analytically interesting for historical reasons but the least relevant for econometric work. And it is only when the full impact of the price increases of the 1970-1979 period is included in the sample observations could the computed price/income elasticities be thought of as representative.

6) More theoretical and empirical work is needed on both the energy demand and supply sides. On the demand side: the theoretical/statistical form of the lag structure and the formation of price

expectations are important and warrant further investigation; and on the supply side: estimates of the geological resource base of the conventional energy sources (oil, gas, coal) and an assessment of the near-term costs and capacities of these resources are crucial uncertainties that remain a source of disagreement among modelers and professionals.

7.3.2 POLICY RECOMMENDATIONS

Within this study's projection period and barring major disruptions to the production capacity in the Arabian-Persian Gulf group, we do not see a return to the price pattern that prevailed during the 1970-1979 era. The basic reason for this belief is that the rate at which non-OPEC energy sources are developed is sufficient to offset individual OPEC members' efforts to shore up prices. Add to this the fact that major consuming nations have stockpiled sufficient oil to endure an average of three to four weeks partial slowdown in OPEC's production given modest estimates of near-term economic growth. But even within the overly optimistic scenario that future economic recovery would increase the demand for oil, thus putting upward pressures on prices, it is highly unlikely that major consuming nations would permit a return to the 1950-1970 era when OPEC's oil constituted the major energy source. In addition to these factors there is OPEC's internal weakness: the absence of members' resilience which could be attributed to economic and political reasons. The economic bind stems from all members' dependence on oil earnings as an economic stimulus for public expenditure; the political reasons rest with the susceptibility of some major OPEC members to political "tickling" and "teasing." Without major institutional adaptation (i.e., restructuring OPEC's quota system in light of each members' vital needs such as population base, stage of development, foreign debt, . . . etc.) or the creation of an OPEC emergency fund to ameliorate members' temporal funds needs, OPEC's role as an energy supplier is increasingly relegated to the position of a residual supplier.

In the above statements we presented an extreme scenario, a rather gloomy picture of OPEC's ability to influence prices. This position should not be confused with OPEC's future potential for supply tightening -- OPEC's members still collectively hold over 25 percent of the world's proven oil reserves. Given current environmental concerns regarding the use of coal, safety problems with nuclear energy production and disposal of nuclear waste, the exotic but yet unproven marketability of solar and wind energy sources, let alone the massive investment costs, this potential should grow larger depending upon the underlying price responsiveness of demand and future expansion in non-OPEC supply sources.

Preventing long-term price decline potential could be augmented through the following steps:

Step 1 - To start with, all OPEC members have to scale down their current development plans to a more realistic scope. All OPEC members have lavishly spent oil revenues on projects, some of which are of dubious feasibility, uncertain social acceptability, or sheer showcasing. A major portion of OPEC members' expenditure is for so-called "defense." Although we do not claim to have a better knowledge of a member's defense needs, we question the seemingly unstoppable trend toward stockpiling advanced arms. There have to be more suitable and less costly ways to defend one's territory, especially in light of the potential of a spare-parts delivery slowdown or outright embargo (the Gulf Cooperation Council members have already taken steps to design policies to mitigate the effects of such actions). A more careful examination of this category should reduce the demand for foreign exchange and/or release public funds to more productive avenues.

Step 2 - OPEC members have to properly assess and prioritize their participation in international trade. Although we do not rule out situations threatening to national interests and therefore the legitimate use of economic measures, oil as an economic good should not be solely relied upon to achieve political goals. We urge as well the study of the application of selective trade barriers to OPEC's vast foreign trade sector.

Step 3 - OPEC members have to critically examine their ambitious industrial plans in terms of the energy price charged to their home industries. Economically speaking, it is outright folly to sell energy to home industries at below world market price (which translates into an outright subsidy to foreign consumers) when a major portion of the output is sold abroad. If the objective is to encourage home industries and given the relative small size of home markets, it might be wise to start on a smaller scale with an eye on one's own market.

Step 4 - OPEC members should investigate the economic feasibility of altering their product mix, i.e., less emphasis on exporting oil and gas in their crude states. Saudi Arabia has already begun what seems to be a long-term program to produce and export more refined petroleum products. Current profit margins on these products alone are sufficient to make it a worthwhile task. We view a higher stage of product specialization where OPEC gradually leaves the export of crude petroleum to new entrants.

The above steps should be viewed as long-term proposals aiming at aligning development efforts to more realistic market conditions.

To the short run price decline we argue that it might not be in OPEC's interest to participate in energy price stabilization. This translates into a policy that advertently aims at creating market price uncertainties, (assuming cost differentials between OPEC's per unit price and the profitable selling price of the new energy sources), to render the introduction of current or additional energy sources (and/or energy "substitutes") a less profitable and more risky endeavor. Two institutions that could be used are already in place: <u>the spot market</u> and the increasing growth of <u>future markets</u>. Since 1981 there has been a steady decline in the percentage of oil sold contractually. Surprisingly, OPEC has stood bewildered and impotent regarding North Sea producers' decision to dissolve their respective national producing/ marketing companies and sell on the spot. Viewing the historical record of developing North Sea oil, this author has not yet come across a policy decision (by either Britain or Norway) pointing to a status of "permanent producer," i.e., to continue large government involvement in the form of state oil companies. We view the current joint ventures of state and private companies in North Sea oil development as essentially a transitory risk-sharing plan; and once the economic worthiness of these projects is assured, the decision to dissolve the state share should not be unexpected.

North Sea producers and for that matter all the "newcomers" would happily let OPEC set the official price and they would sell all they could at a fraction below.

OPEC could minimize this trend by using members' respective marketing agencies to actively buy and sell on the spot as well as future markets. These activities should be of the "fine tuning" nature aligning short-term price fluctuations to OPEC's preferable price.

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APPENDICES

APPENDIX A

A NOTE ON THE 1973 OIL EMBARGO

Notwithstanding the advantage of hindsight of the author, the 1973 embargo failed for two reasons that neglected some characteristics of oil production and distribution and a natural idiosyncrasy of the resource itself. The first reason is:

a) Production cutbacks under the 1973 embargo were uniformly applied to each member's pre-embargo production level. An alternative formula composed of two parts could work better however:

   i) "A floor cutback" applied indiscriminately to all member's pre-embargo production levels,

   ii) "A rising percentage cutback" applied to each member's pre-embargo market share.

The advantages of the proposed formula lie in its rendering ineffective the oil companies' ability to play one country against another and its emphasis on a dynamic equitable distribution of lost revenues. Furthermore, variations in the rising percentage cutback could be linked to progress achieved toward political objectives.

The second reason:

b) The 1973 embargo plan grossly ignored oil fungability and the absence of producing countries' control over market allocations and transporting. The companies and the independent carriers did and probably still hold an advantage in the allocation/transporting phase. This advantage could be partially offset (in the short run) thanks to advancement in communication and data-processing equipments. Given the fondness of almost all bureaucracies for publishing output statistics (some of them useful), the post-embargo production levels and tankers' routes could be easily monitored. Violating companies and/or carriers could be subjected to loss of current contracts and/or the imposition of future less-favorable contractual terms.

As noted throughout, a prolonged production shut-off is not feasible due to the huge number of market as well as non-market variables involved. Furthermore, a short-run, limited-objective, gradual production cutback would require an emergency fund to ensure cash flows to members. In this endeavor, a cash fund is just as essential to embargoing oil producers as crude stockpiling is to oil consumers.

APPENDIX B

A NOTE ON THE TREND TOWARD OIL MERGENCE

Attempts by large U.S. (and West European) oil companies to buy smaller companies (e.g., takeovers of middle-sized majors such as: Conoco, Inc.; Marathon Oil Co.; and Cities Service Co. during March/April 1984) and inter-competition among the major ones (e.g., Texaco's offer of $10.1 billion to acquire Getty Oil Co., and Standard Oil of California's offer of $13.3 billion to buy Gulf Corp.) have been explained as indicators that it is less costly to buy known proven reserves (at current market prices, or even higher assuming future prices increases) than to explore for them. If this hypothesis is validated, then we would expect, other things constant, the combined company, for at least several years, to spend less on exploration than the separate companies would have spent. This hypothesis gains strength (against an alternative hypothesis that mergence would increase the new company's margin of financial risk) in light of diminished future capital and credit availability when cash is drawn to pay down the debt incurred in effecting the merger. Merging companies' spinoffs in the form of refineries, transporting facilities, and chains of gas stations which have to be sold to gain the approval of the Federal Trade Commission (antitrust laws) could become available to new buyers.

OPEC's interest in downstream operations in the consuming countries, coupled with tendencies toward mergence and downsizing, gave rise to an interesting, though speculative as of yet, hypothesis that some takeovers and mergence deals are one of many ways to enable oil-producing countries to obtain access to the downstream activities in the oil industry. (See: "OPEC Benefits From Oil Company Mergers," WSJ, March 7, 1984, p. 4; and "Big Mergers in U.S. Industry . . .," OGJ, April 2, 1984, pp. 49-53.)