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THE DETERMINANTS OF
OPEC MARKET SHARE STABILITY

by

FAHED M. AL-AJMI

A dissertation submitted in partial fulfillment of the
requirements for the degree of

DOCTOR OF PHILOSOPHY
in
URBAN STUDIES

Portland State University

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AN ABSTRACT OF THE DISSERTATION of Fahed M. Al-Ajmi for the Doctor of
Philosophy in Urban Studies presented April 17, 1990.

Title: The Determinants of OPEC Market Share Stability.

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Abdul Qayum

The objectives of this dissertation are to explain the production behavior of
OPEC's member countries from 1971 to 1987 and to determine whether there was
any structural shift in OPEC's production behavior after the organization attempted

to assign a quota to each member. This study focused on political and social as well as economic variables, in order to overcome the misspecification of previous models.

In order to achieve the above objectives, the study used the following four models, with modifications: the cartel, competitive, target revenue, and property rights models. The double log multiple linear regression technique was used to operationalize the cartel, competitive, and target revenue models; simple linear regression was used to estimate the property rights model. The cartel model was based not only on economic variables but also on social and political variables. The internal political instability of each OPEC country was measured by the number of armed attacks within the country.

The structural shift in OPEC's production behavior between the 1971-1982 period and the 1983-1987 period was evaluated using the Chow-test. The Chow-test showed no significant difference between these two periods for OPEC overall or for individual members. Thus, the two periods were combined so that the study was performed for the entire 1971-1987 period. Because this period of analysis was relatively short, alternative models were applied to pool the data and thereby increase the reliability of the model estimates. A cross-sectional correlated and time-wise auto-regressive model (CCTA) was selected to pool the data and to estimate OPEC's production coefficients. Then each individual OPEC member's production model was estimated and compared to the pooled model.

The results indicate that OPEC behaved as a cartel, and that a partial market-sharing hypothesis was significant for all 11 OPEC members. These findings indicate that OPEC was a loose cartel, with only partially effective cooperation on production decisions. Political instability was found to be significant (at the 10-percent level) overall, and it negatively affected production. It was also significant at the 5-percent level for the *price-pusher* group (Iran, Venezuela, and Algeria). This group was also the only one pooled using least squares with dummy variables (LSDV), because of its common slope and different intercepts. Overall results suggest that OPEC members were basing their production decisions on crude oil prices, excess production capacity, and each member's share of total OPEC output.

DEDICATION

I dedicate this work to my father, Mohammad Bin-Jomaha, Sheik of the Al-Ajman tribe, and my family.

ACKNOWLEDGEMENTS

I would like to express my gratitude to my advisor and chairman of my dissertation committee, Dr. James G. Strathman , for his guidance and support throughout my program and dissertation process. His understanding of the international student's environment, and his work experience in the Arabian Gulf enabled him to provide useful comments relating the subject matter to the actual environment. His kindness and open communication created a conducive academic environment. My sincere thanks to Dr. Nohad A. Toulan, Dean of the School of Urban and Public Affairs, for his criticism, constructive comments, advice, and confidence in me. I also extend my appreciation to all members of my dissertation committee for their suggestions and comments: Dr. Giles H. Burgess, Jr.; Dr. Kenneth J. Dueker; and Dr. Abdul Qayum, the graduate office representative.

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CHAPTER I

INTRODUCTION/OVERVIEW

The Organization of Petroleum Exporting Countries (OPEC) consists of 13 member countries: Algeria, Ecuador, Gabon, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, United Arab Emirates (U.A.E.), and Venezuela. All of these countries have something in common: oil exports represent approximately 90 percent of their total exports. The OPEC countries experienced economic prosperity throughout the 1971-1980 period. Oil revenues increased as a result of both high real oil prices and high production during the same period. The consequent windfall in revenue was the largest in OPEC history. This phenomenon created a surplus of approximately \$100 billion in their current account balance. The high oil revenue enabled the OPEC countries to pursue and finance their national plans. Social programs were provided, and public satisfaction increased. During the 1980s, with the changing oil market conditions, the surplus in the current account balance was replaced with a deficit. The problem of the deficit was exacerbated by the decline in the oil real price after 1983. As a consequence of decreased oil revenues, each OPEC member government had to rationalize its spending and reevaluate the effectiveness of its development programs. Furthermore, the decline in OPEC's oil revenues resulted

from production cuts and lower oil prices that were intensified by a lower world oil demand and higher non-OPEC production.

These economic effects placed social and political pressures on some OPEC governments to increase oil revenues by increasing their oil production. The internal social and political pressures reflected those societies' dissatisfaction with their governments' production decisions. Therefore, the OPEC governments faced two problems: the competition of non-OPEC producers and the risk of sociopolitical pressures at home. In its production decisions, OPEC had to consider non-economic factors so as not to jeopardize its economic interests (Hedley, 1986). It is because of these factors that OPEC's pricing and production behavior is not well understood by professional, political, and OPEC analysts (Griffin and Teece, 1982). This misunderstanding is believed to arise from the diversity of social, economic, political, and developmental conditions among the member countries. Specifically, the countries have different geographic patterns, petroleum reserve levels, population sizes, political climates, and revenue needs for economic development (Ezzati, 1976). With such diversity among member countries, it is not surprising that OPEC's oil production behavior tends to confound the analysts viewing the situation from within the confines of a single discipline.

The major purpose of this research is to analyze economic, social, and political conditions that might have an impact on OPEC's production behavior. The OPEC literature is full of models investigating this behavior, but most of these

models rely solely on economic variables. Four such models are the cartel, competitive, property rights, and target revenue models. These models are modified in this study to include non-economic factors as well.

PROBLEM STATEMENT

The oil embargo of 1973, the Iranian revolution of 1979, and the Iran-Iraq war of 1980 disrupted the oil supply and raised oil prices. All of these political events testified that political instability existed in this region. This political instability could influence OPEC governments' decisions even in the absence of political crises. Sociopolitical pressure was evident in some of the OPEC countries. For example, in 1985, there was a military coup against the Nigerian government; this coup was caused partially by a decline in the oil revenues (*The Middle East Journal*, 1986). Venezuela faced political and social unrest through the 1980s, and these activities were intensified by the reduction in world oil prices after 1983 (Blank, 1984). Some activities reflecting internal unrest were evident in the Algerian situation in 1979; they increased through the 1980s when oil revenues started to decline.

In another situation, Saudi Arabia abandoned its role as residual supplier during the same period, not only because non-OPEC countries did not cooperate and some OPEC members cheated on their quotas, but because Saudi Arabia found out that it could not meet its society's needs when its production was

declining to a level that was too low to generate enough revenues (*The Middle East*, 1986).

The historical perspective of OPEC's behavior demonstrated the importance of considering non-economic factors as well as economic factors in order to really understand OPEC production behavior. Non-economic factors play an important role in determining OPEC's production behavior and can, at times, overrule economic factors in some OPEC countries (Tahmassebi, 1986). Reduced oil revenue to OPEC members may put social pressure on them to increase output. But political conflict or social instability within a member country or among members can affect oil production negatively; and this, in turn, results in higher oil prices (Curlee et al., 1988).

Moran (1982) argued that political security was significant in explaining Saudi Arabia's production, because the historical events of OPEC showed that Saudi Arabia adjusted its behavior to external and internal political pressure to avoid fomenting conflict within OPEC or with outsiders. Therefore, Saudi Arabia is concerned about its own security as well as that of other OPEC members. The problem here is that the ability of the previously used economic models to analyze OPEC's production behavior is limited by the exclusion of non-economic factors. This study deals with this problem by accounting for the effects of these non-economic factors on OPEC's production decisions.

OBJECTIVES

OPEC's production behavior is a complex issue because it relates to the political, economic, and social conditions of each OPEC member. The objectives of this study are to account for the effects of these factors on OPEC's production, to increase the knowledge and understanding of OPEC's production behavior, and to shed light on the uncertainties surrounding OPEC's future.

The first task of this research is to test four alternative frameworks governing the organization's behavior:

1. That OPEC behaves as a cartel to maximize its wealth, and it has a major influence on world oil prices.
2. That OPEC's members are behaving as competitive producers, and oil production is determined by world oil market forces.
3. That OPEC countries produce according to their investment needs. When these needs are satisfied, they produce less.
4. That the transfer of ownership from the oil companies to the host countries in the 1970s resulted in production cuts and higher prices, reflecting a reduction in the implicit discount rate that accompanied the shift in property rights for oil resources.

To test the above behaviors for each OPEC member, the following associated econometric models were used: cartel, competitive, target revenue, and property rights.

The second task is to apply the above models in analyzing the structural shift in OPEC's oil behavior over two periods: 1971-1982 and 1983-1987. In the first period, OPEC's higher prices were not considered by some economists to be caused by cartel behavior. Also, this period included such events as the oil embargo of 1973, the Iranian revolution of 1979, and the Iran-Iraq war of 1980. The second period witnessed OPEC's first real effort to exercise cartel behavior with its strategy to limit production by assigning quotas to its members in 1983, thereby trying to create and maintain an overall production ceiling.

SIGNIFICANCE OF THIS RESEARCH

If it can be shown that internal social and political factors, as well as economic factors, have significant effects on members' oil production, analysis of OPEC's production decisions should account for the effects of these variables in the future. OPEC governments can secure their economic interests only if they know about their surrounding environments. Otherwise, the stability of member governments--and therefore the cartel--will be threatened. Greater cartel stability, therefore, will provide OPEC members with a more reasonable environment in which to plan and finance their development programs.

ORGANIZATION OF THIS STUDY

Chapter II gives the historical background of OPEC and a brief discussion of policies that OPEC has experimented with since its establishment. OPEC's

production and price patterns in the 1970s and 1980s are also reviewed. Chapter III begins with a discussion of the alternative theories of OPEC's production behavior--the oligopoly and industrial organization theories--and relates them to OPEC's behavior. Chapter IV discusses the alternative OPEC production models and identifies key determinants. This chapter sets up the frameworks for the conceptual models, model specifications, and operationalization. Chapter V discusses the empirical results of the alternative models. Chapter VI contains implications for OPEC's market share stability, in the short and long terms. Chapter VII includes the conclusions of the study, the limitations of the study, and suggestions for further research.

CHAPTER II

HISTORICAL BACKGROUND

OPEC's objectives and decisions have changed considerably since its establishment; they changed the most during the 1970s and 1980s. These changes have been direct results of non-economic events and competition from non-OPEC oil exporting countries. Also, the reduction in world energy consumption as well as the different interests of OPEC members regarding production and pricing decisions have significantly contributed to the observed changes.

A BRIEF HISTORY OF OPEC

In September 1960, representatives from the governments of Saudi Arabia, Kuwait, Iraq, Iran, and Venezuela met at a Baghdad conference. The final decision that came out of this conference was the creation of the Organization of Petroleum Exporting Countries (OPEC). After the organization was established, new members joined: Qatar in 1961, Libya and Indonesia in 1962, Abu Dhabi in 1967, Algeria in 1969, Nigeria in 1971, Ecuador in 1973, U.A.E. in 1974, and Gabon in 1975. With these additions, OPEC's organization includes a total of 13 members.

Articles 2 through 4 of the OPEC Charter define the organization's objectives as follows:

Article 2

A. The principal aim of the Organization shall be the coordination and unification of the petroleum policies of member countries and the determination of the best means for safeguarding their interests, individually and collectively.

B. The Organization shall devise ways and means of ensuring the stabilization of prices in international oil markets with a view to eliminating harmful and unnecessary fluctuations.

C. Due regard shall be given at all times to the interests of the producing nations and to the necessity of securing a steady income to the producing countries; an efficient, economic and regular supply of petroleum to consuming nations; and a fair return on their capital to those investing in the Petroleum industry.

Article 3

The Organization shall be guided by the principle of the sovereign equality of its member countries. Member countries shall fulfill, in good faith, the obligations assumed by them in accordance with this Statute.

Article 4

If, as a result of the application of any decision of the Organization, sanctions are employed, directly or indirectly, by any interested company or companies against one or more member countries, no other member shall accept any offer of a beneficial treatment, whether in the form of an increase in oil exports or in an improvement in prices, which may be made to it by such interested company or companies with the intention of discouraging the application of the decision of the Organization. (Ghanem, 1986).

The purpose of the creation of OPEC was to increase, or to at least prevent any further decline in, the posted price of oil in 1960. In pursuing the

organization's objectives, despite the oil companies' arguments that oil prices had been stable through the 1950-1956 period, the decline in posted oil prices during the late 1950s was a result of the oil surplus in the world oil market. However, OPEC failed to restore the price of oil to its pre-1960 level through the 1960-1970 period and could not prevent any further decline. OPEC succeeded, however, in increasing its production from less than 8 million barrels a day (MBD) in 1960 to more than 25 MBD in 1971 (Evans, 1986). The OPEC countries attempted again to negotiate with the oil companies to raise their posted oil prices through meetings in September 1970 (the first Tripoli Agreement), February 1971 (the Tehran Agreement), and March 1971 (the second Tripoli Agreement) (Levy, 1982). As a result of these attempts, the posted price of oil increased in 1973. Historical analysis shows that OPEC's objectives were not only economic, but political as well. For example, at the end of 1973, OPEC used its power to cut its oil production in order to demonstrate to the world that it had political as well as economic influence.

As a result of the 1973 embargo, OPEC's oil prices increased sharply and continued to increase through the rest of the 1970s. During the 1970s, OPEC used different economic strategies, such as the flexibility of Saudi Arabia's production as swing producer from 1974 to 1979, to maintain the organization's stability. In the middle of 1975, OPEC faced some disagreements about its oil price structure; these disagreements led to the official price of marker crude oil (Saudi Arabian 34° light oil), instead of posted crude oil prices. In January 1980,

OPEC abandoned marker crude oil; but in June of the same year, it agreed to return to marker crude with a ceiling of \$32 per barrel, and it allowed up to \$5 per barrel above the ceiling to account for oil quality differentiation. At that time, this was flexible marker crude, rather than the one established in 1973, which was fixed at \$7 per barrel (Evans, 1986).

The Iranian revolution of 1979 and the Iran-Iraq war of 1980 disrupted OPEC's supply and subsequently affected OPEC's stability, but the organization did not break down. Instead, those members whose production was not affected by the war produced at maximum capacity to overcome the supply shortage. OPEC did not lose power in the oil market until the beginning of the 1980s; it lost power then because of the increase of non-OPEC supplies and the slow world oil demand that resulted from price shocks of 1973 and 1979. In 1983, OPEC tried again to coordinate the member countries' offers of limiting their production and to assign a quota to each of its members, but cheating by some members was a serious problem. Because some OPEC members were cheating, and non-OPEC countries did not cooperate with OPEC to stabilize the world oil market, Saudi Arabia began flooding the oil market in July 1986. Saudi Arabia's intention was to demonstrate to OPEC and non-OPEC countries that cooperation was beneficial to all of them (Mead, 1986).

The history of OPEC showed that there had always been disagreement among OPEC members, because of the cartel's classical problems of self-interest; but the organization remains viable and is still trying to coordinate its members'

production and to stabilize oil prices. For the reasons specified above, the organization might have been weaker in the 1980s than it was in the 1970s; however, despite the instability, it is still viable, considering the overall benefits of the members' cooperation.

OPEC AND THE OIL MARKET 1971-1987

OPEC's oil supplies were disrupted twice, as a result of political events in 1973 and 1979. In 1973, the real oil price was about \$4 per barrel (in constant 1982 dollars); in 1974, because of the oil embargo which led to a cut in production, the price jumped to almost \$18 per barrel. At the same time, a new event occurred--the nationalization of oil companies in OPEC's host countries--and it was completed by the end of 1974. Ownership was transferred from the oil companies to OPEC's host countries because of concern about the future of their resources. This transfer led to a lower discount rate from the one oil companies had previously charged. The lower discount meant less production, which caused the oil prices to increase (Joheny, 1978).

OPEC's real oil prices were stable at approximately \$18 per barrel through the 1974-1979 period; during this period, production was stable at approximately 30 MBD (only in 1975 did production decrease to 27 MBD, as shown in Figure 1). The stability in OPEC's production could be attributed to the action of Saudi Arabia as the residual supplier. Despite the stability in OPEC's production, its share of the world oil market declined from 68 percent in 1974 to 64 percent in 1979

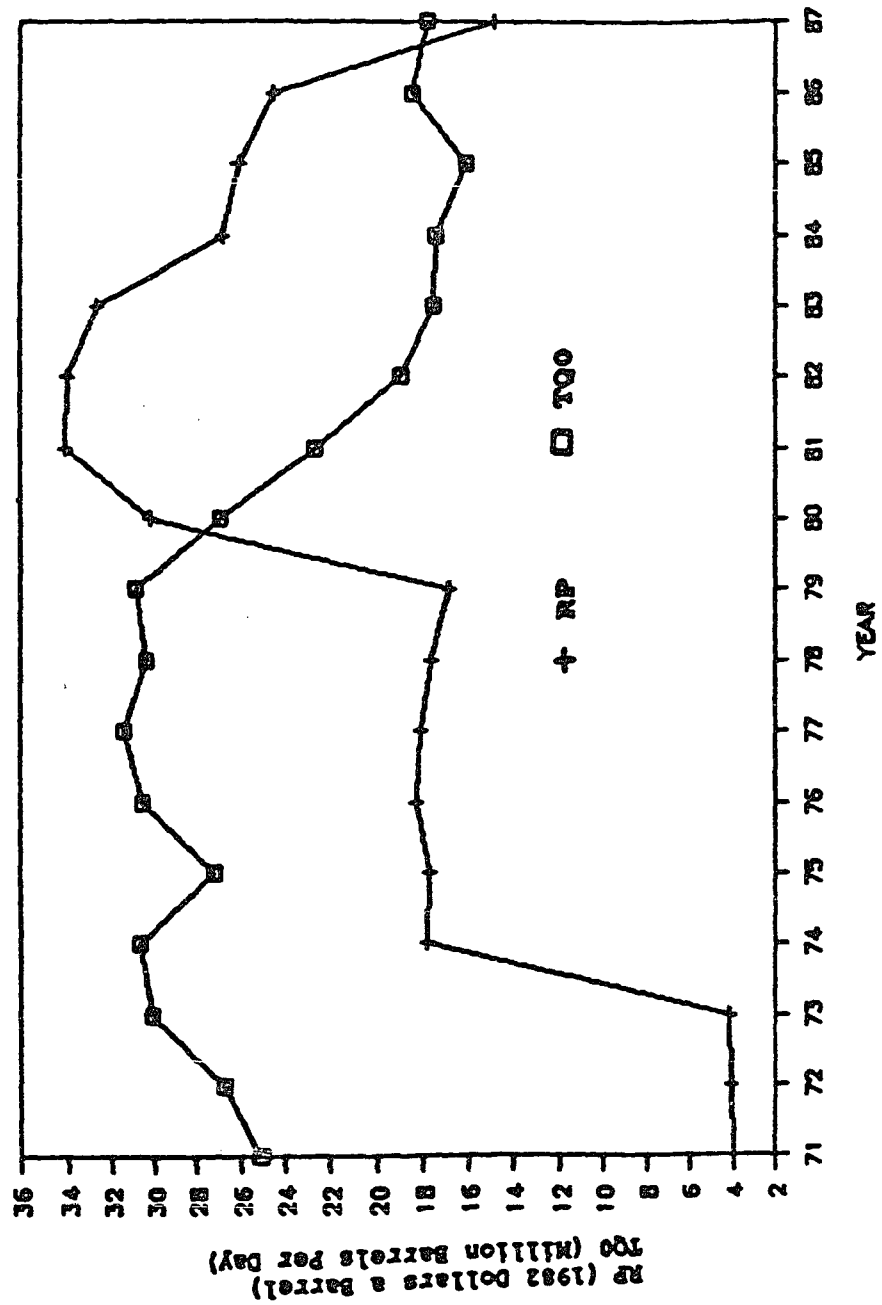


Figure 1. Saudi Arabia real oil price (RP) and total OPEC production (TQO) for 1971-1987.

(Figure 2). The 4-percent loss in OPEC's market share was caused by the change in the world oil market structure after 1975. OPEC's production was affected by non-OPEC oil supplies, which increased from about 14 MBD in 1974 to almost 18 MBD in 1979 (Figure 3). The loss in OPEC's market share was relatively small because the world's consumption was increasing: world consumption increased from 44 MBD in 1975 to 52.2 MBD in 1979 (Figure 4). The second change that occurred in the market conditions between 1979 and 1980 was due to both the Iranian political revolution of 1979 and the Iran-Iraq war of 1980. These events led to a disruption in the oil supplies of Iran and Iraq. Iranian oil production was reduced from 5.21 MBD in 1978 to 1.38 MBD in 1981 (Figure 5). Iraqi production was reduced from 3.5 MBD in 1978 to .92 MBD in 1983 (Figure 6). This disruption in oil supplies caused the price of oil to increase in real value from \$17.73 per barrel in 1975 to \$34 per barrel in 1982. However, OPEC's real oil price started declining in 1984 and then reached its lowest point of \$17.50 per barrel in 1987. The high oil prices of 1973 and 1979 intensified non-OPEC competition. Non-OPEC production increased to almost 23 MBD in 1987. The world's oil consumption did not respond to the oil price shock of 1973, but it did respond to the second shock of 1979. Thus, world oil consumption decreased from its highest point of 52.2 MBD in 1979 to 45.3 MBD in 1983. At the end of 1983, the world's oil consumption started to recover, and it reached 48.9 MBD in 1987. Lower oil consumption, the non-OPEC supply increase, and high oil prices all

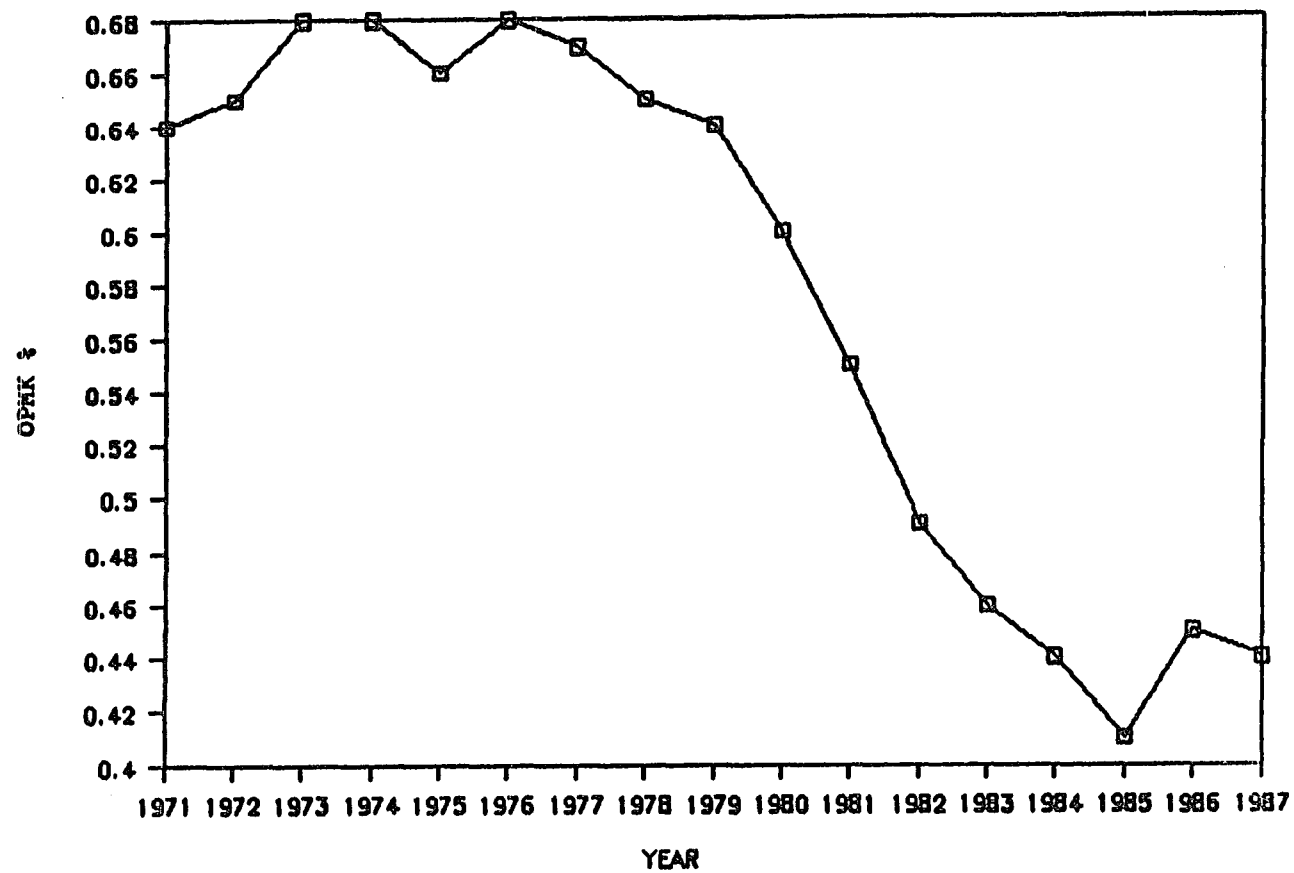


Figure 2. OPEC market share (OPHK) as percentage of total non-communist world production for 1971-1987.

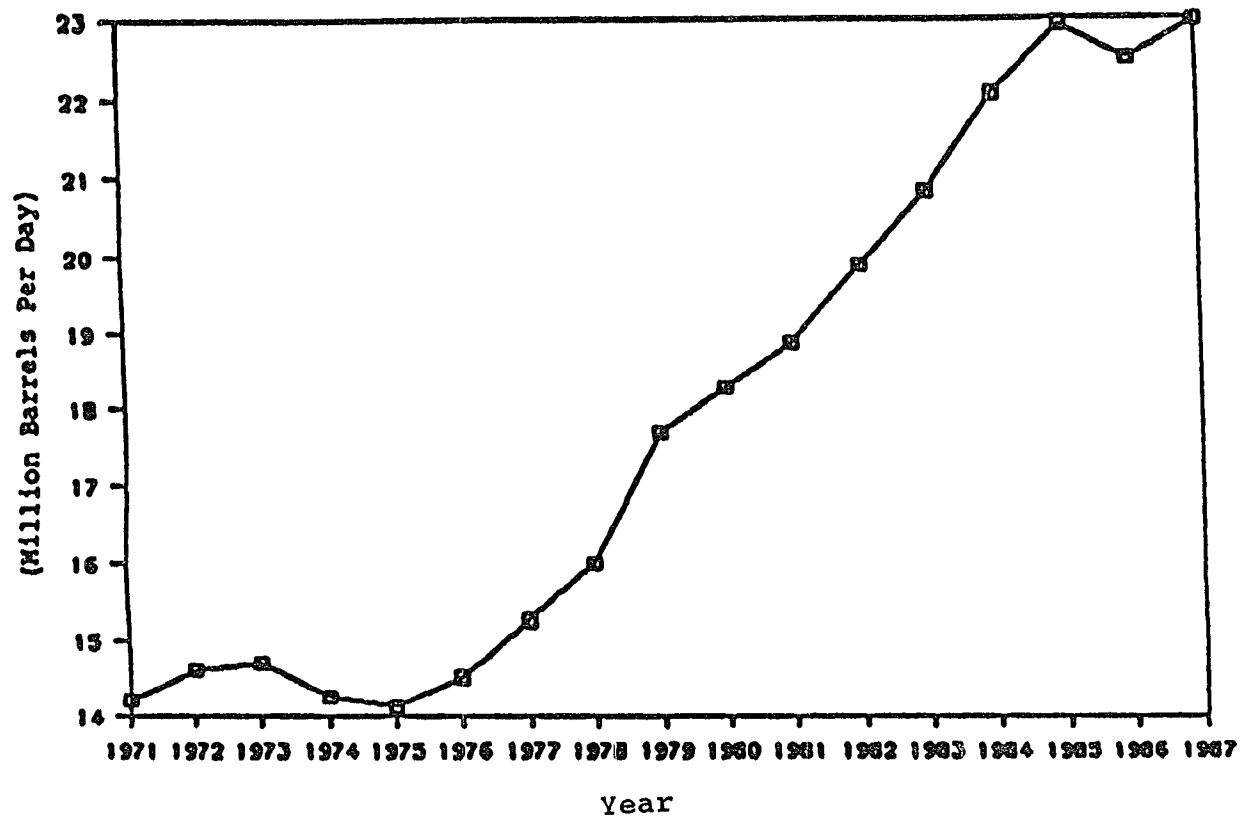


Figure 3. Total non-OPEC production (NON-OPQ) excluding communist production for 1971-1987.

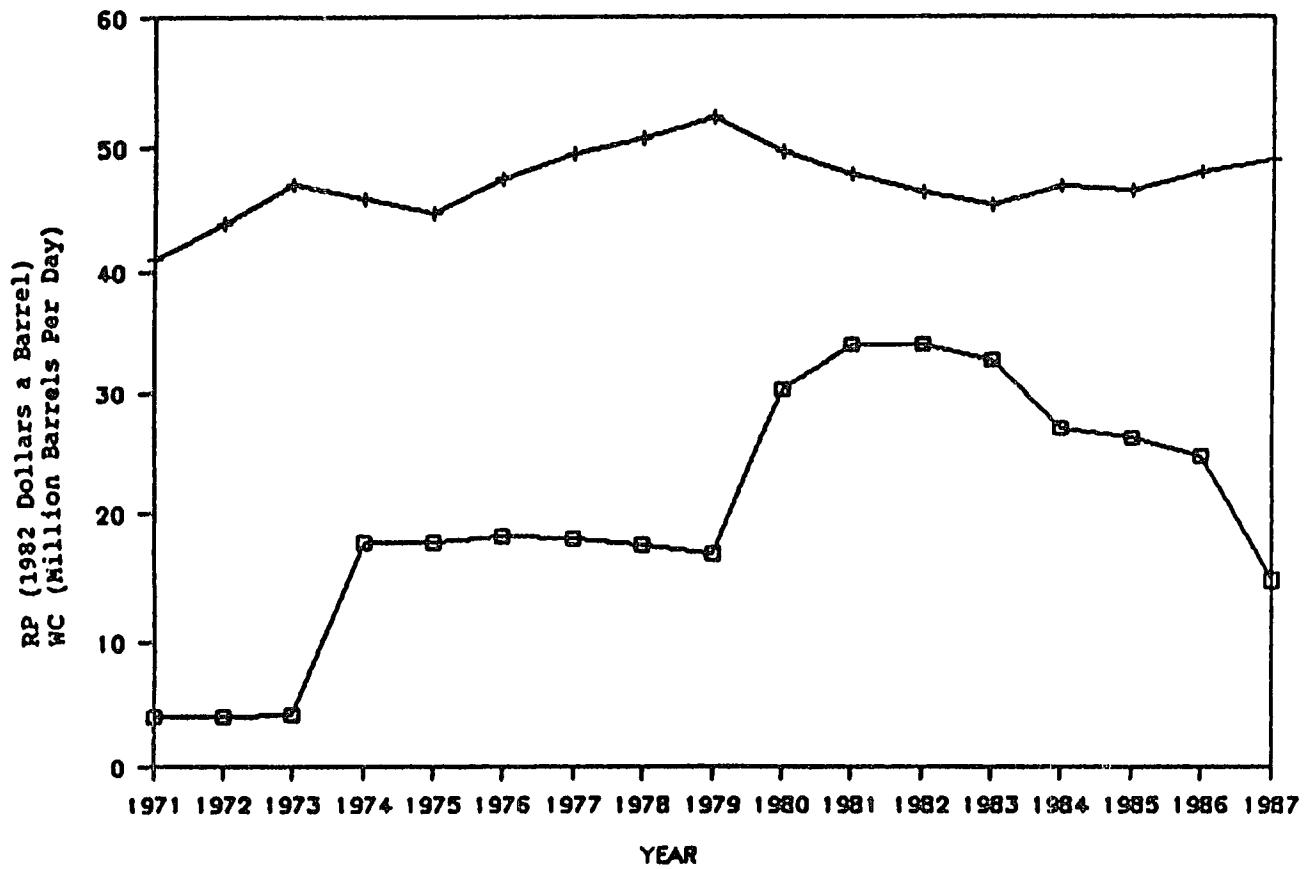


Figure 4. Saudi real oil price (RP) and total non-communist world consumption (WC) for 1971-1987.

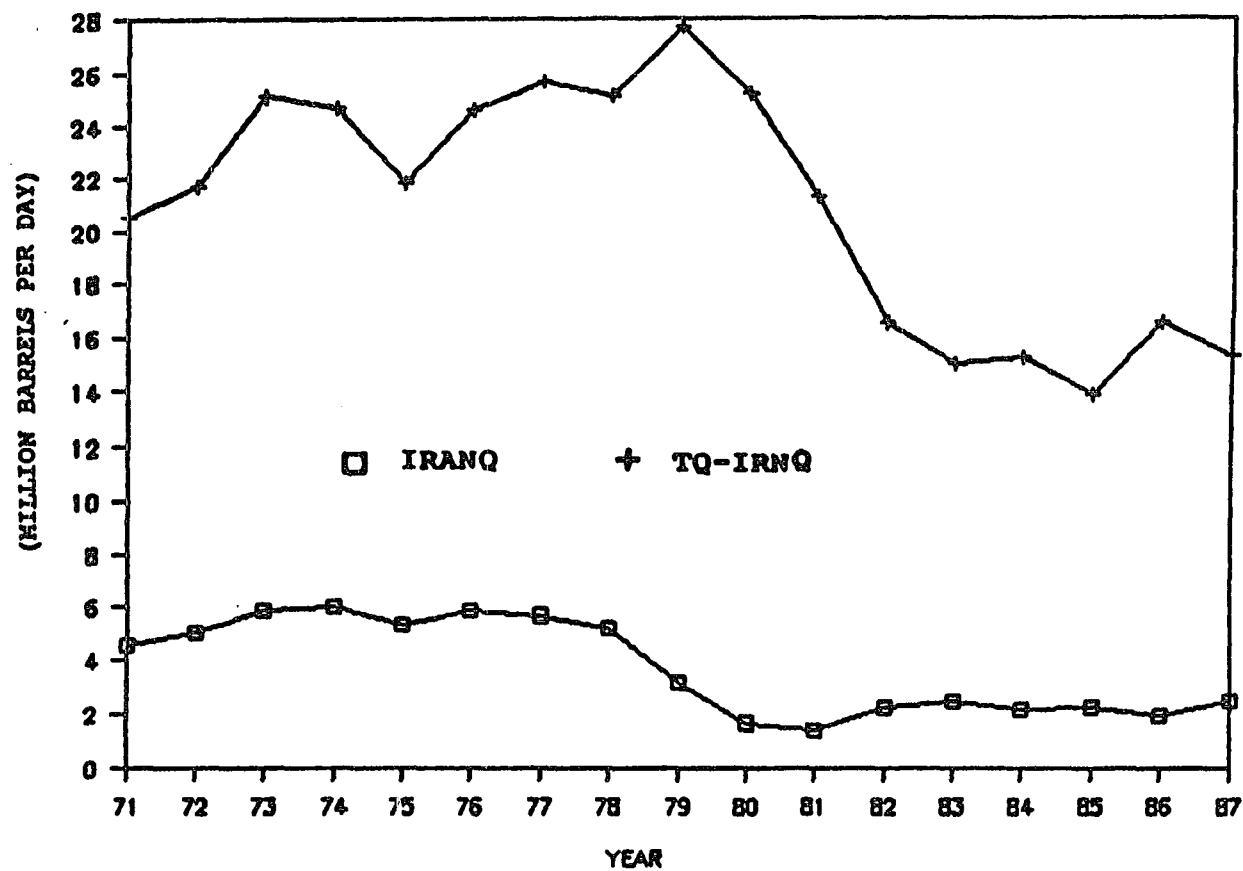


Figure 5. Iran production (IRANQ) and total OPEC production (TQ-IRNQ) excluding Iran production for 1971-1987.

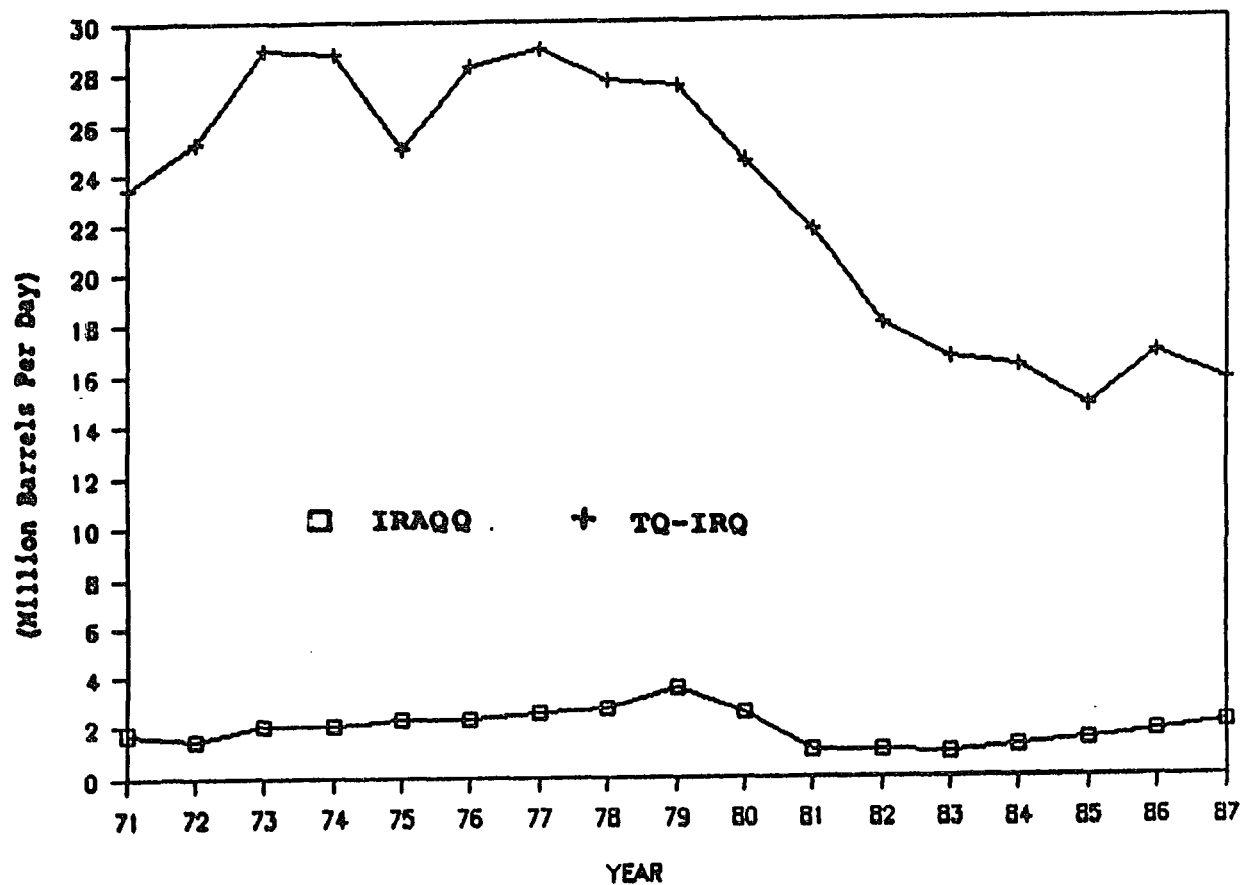


Figure 6. Iraq production (IRAQQ) and total OPEC production (TQ-IRQ) excluding Iraq production for 1971-1987.

contributed to a sharp decline in OPEC's market share from 65 percent in 1978 to 41 percent in 1985.

OPEC's market share stability was affected by the increase in the reserves-to-production ratio increased from 16.17 in 1980 to 29.55 in 1985, while its production declined from 26.94 MBD in 1980 to 16.12 MBD in 1985. In 1986, OPEC's reserves-to-production ratio declined, and during the same period OPEC's production increased by 2.42 MBD; this increase was furthered by an increase in the world's energy consumption as the real oil prices declined by \$1.67 per barrel. But in 1987, OPEC's production declined to 17.76 MBD; this decline caused an increase of 1.29 in the reserves-to-production ratio (Figure 7). The real OPEC price did not increase that year, but instead it declined to \$14.85 per barrel.

OPEC had changed its behavior since 1981. It cut its production from 27 MBD in 1980 to 17.8 MBD in 1987, by assigning quotas to its members from 1983 to 1987 to increase its real oil price. In 1987, however, the price declined sharply to \$14.85 per barrel, and the cheating on quotas by some members might have contributed to this price decline (Table I). OPEC realized that its market share was declining in the early 1980s, so it made a decision to abandon its official selling price in 1985. Saudi Arabia, the biggest OPEC producer, adopted a netback pricing policy as a strategy to expand its market share, but this mechanism caused instability in the world energy market. In 1987, OPEC decided to return to its official selling price in order to stabilize the world oil market (Evans, 1986).

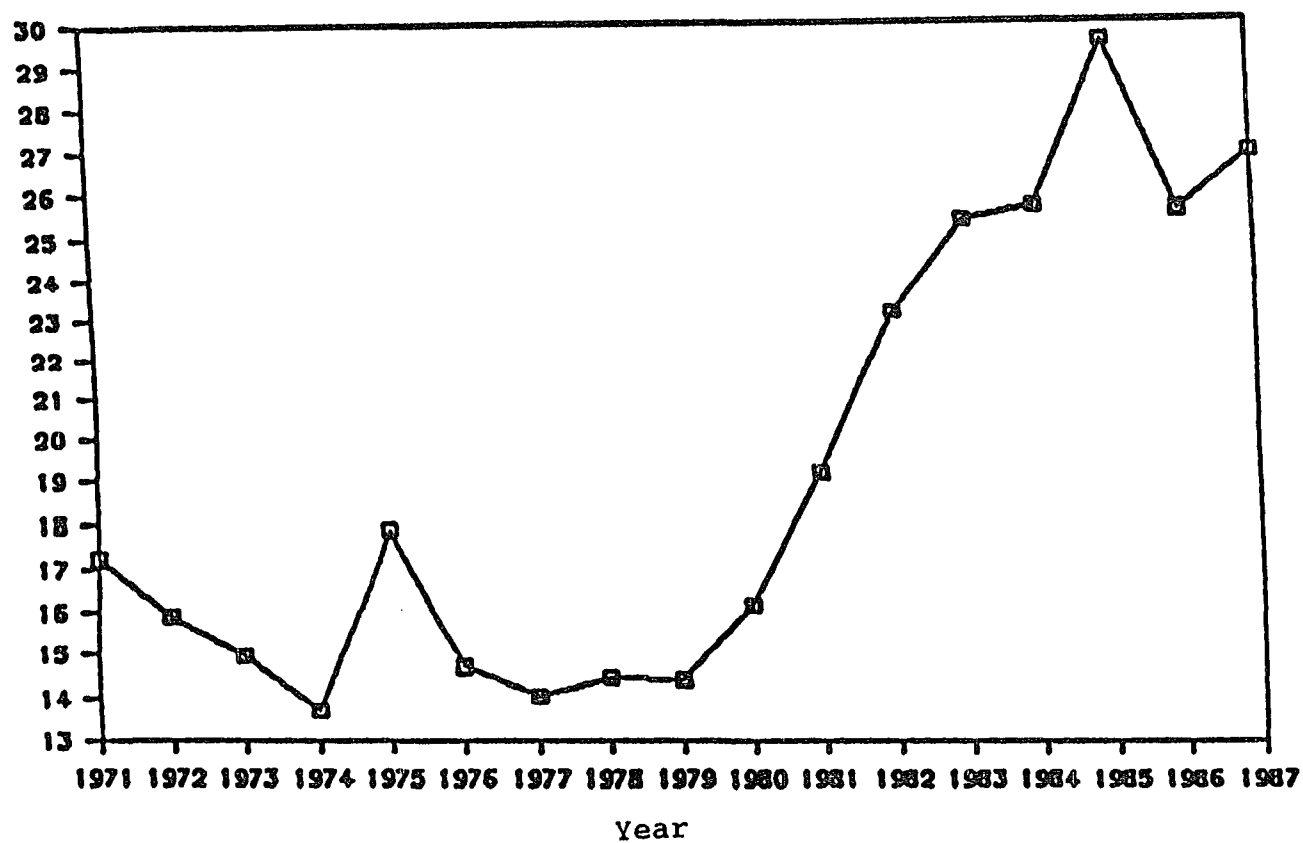


Figure 7. The ratio of OPEC reserves to production (R/Q) for 1971-1987.

TABLE I
HOW OPEC MEMBERS OBSERVED OR IGNORED PRODUCTION QUOTAS

Production	Quotas				Production
	1986	1987			1987
	Dec.	First half	Second half	year	Fir.9 months
Saudi	4353	4133	4343	4238	4169
Kuwait	999	948	996	972	1331
Iran	2317	2255	2369	2312	2346
Iraq	1780	1466	1540	1503	2021
U.A.E.	950	902	948	925	1350
Qatâr	300	285	299	292	276
Indonesia	1193	1133	1190	1160	1182
Nigeria	1304	1238	1301	1270	1226
Venezuela	1574	1495	1571	1533	1582
Libya	999	948	996	972	1046
Ecuador	221	210	221	216	128
Gabon	160	152	159	156	155

Source: International Petroleum Encyclopedia, 1988.

Despite high real oil prices during the 1980-1986 period, OPEC's financial situation was weaker until 1985; its current account balance reached its all-time peak of \$100.21 billion in 1980, then declined sharply reaching a deficit of \$7.31 billion in 1982 and a larger deficit of \$19.72 billion in 1983. The OPEC account balance deficit was \$3.68 billion in 1984; but a sudden turnaround occurred, and by 1985 there was a \$6.5 billion surplus. The biggest deficits in OPEC's current account balance in recent years were about \$20 billion in 1986 and about \$7 billion in 1987 (Figure 8). These deficits were caused by the declining OPEC market share and increases in financial needs driven by ambitious development programs and lower oil prices.

OPEC BEHAVIOR

The argument that OPEC was a cartel and that it had the power to set the price of oil is not supported by the history of events prior to 1973. During the first decade of OPEC, oil companies actually determined oil prices. Between 1971 and 1973, oil prices were driven by the outcome of the Tehran Agreement. An empirical test of OPEC's behavior showed that OPEC did not adjust its prices to the change in economic conditions from 1974 to 1979; rather, OPEC increased its real price of oil by \$12 per barrel in 1979, and this price increase was not related to production constraints. In 1984, OPEC attempted to constrain its production and maintain its production ceiling (Lowinger, et al., 1985).

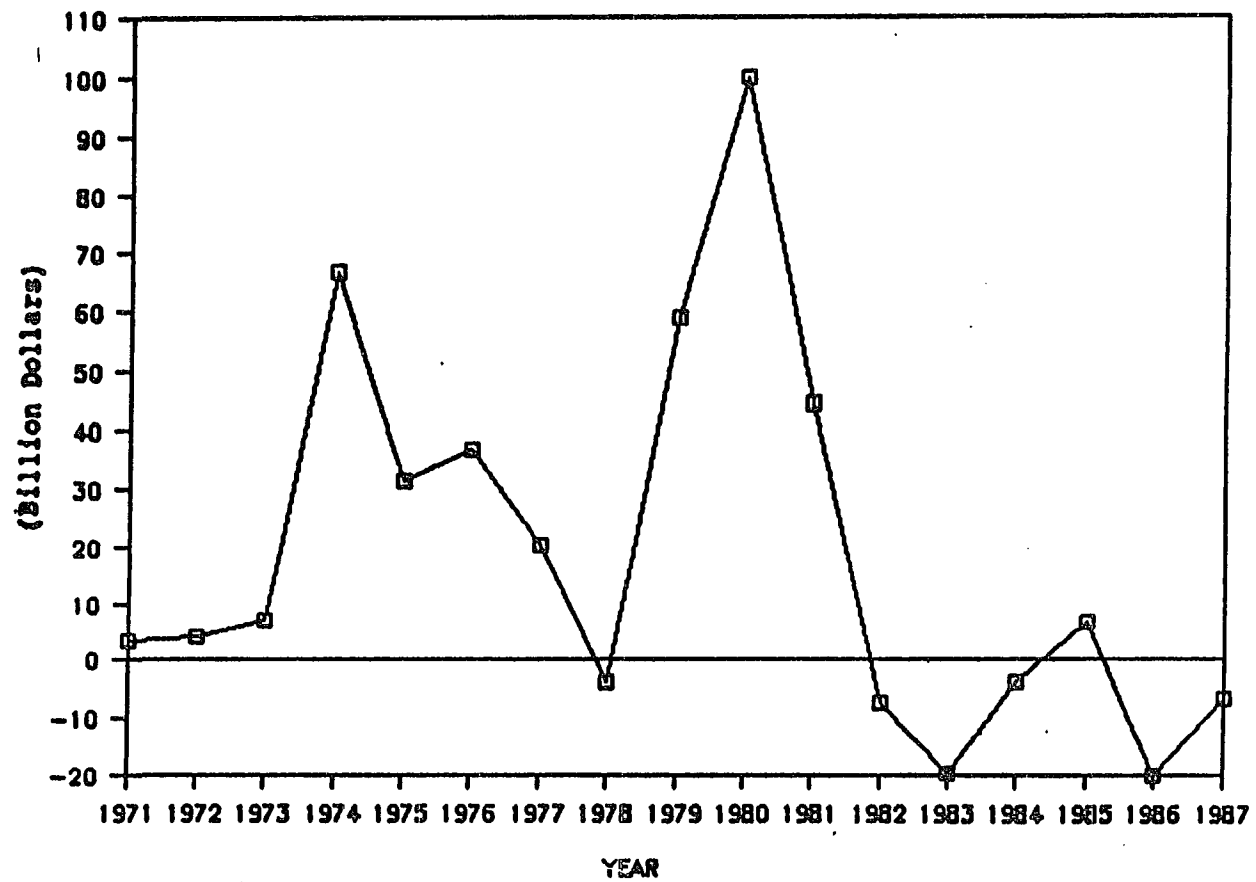


Figure 8. Total OPEC current account balance (TCAB) for 1971-1987.

As the real price of crude oil fell from approximately \$34 per barrel in 1981 to \$32.60 in 1983, OPEC responded with typical cartel behavior (i.e., setting production quotas) in an attempt to stabilize oil prices. Production cuts were allocated among the dominant OPEC producers. Excluding the output of the dominant producers and Iran and Iraq, OPEC output remained constant during this period; and this finding suggested the independent behavior of these countries. Consequently, Mead (1982; 1986) rejected the claims of OPEC's unity and its effectiveness as a cartel.

The diversity of economic interests among OPEC members led some economists to divide the OPEC cartel into subgroups. Hnyilicza and Pindyck (1976) used a Cournot-Nash cooperative solution to analyze OPEC's pricing structure. They divided OPEC into *spender countries* (Iran, Venezuela, Indonesia, Algeria, Nigeria, and Ecuador) and *saver countries* (Saudi Arabia, Libya, Iraq, U.A.E., Kuwait, and Qatar). They suggested that the two groups viewed price and production policies differently. Specifically, they noted that saver countries had less of a need for cash flow, and that their implicit discount rate on their oil resources was lower than that of spender nations. When the output was unconstrained, the cartel consisting of subgroups adopted a pricing policy that approximated a monopolistic price level. On the other hand, when output was controlled, the optimal price policy would be decided by the bargaining power between the saver and spender groups, so that a cooperative agreement could be reached (Hnyilicza and Pindyck, 1976).

Eckbo (1979) divided OPEC into three categories: the *core* countries (Saudi Arabia, Kuwait, U.A.E., Qatar, and Libya), which could sell their petroleum at lower prices than the other two groups; the *price-pusher* countries (Iran, Venezuela, Algeria, and Gabon), which had very limited resources and greater needs for current income; and the *expansionist* fringe countries (Indonesia, Nigeria, Iraq, and Ecuador), which had strong needs for current income but smaller reserves than the core countries, and which produced at slower rates of depletion than the price-pusher countries. Also, this group wanted a higher market share.

The OPEC member countries were classified into dominant and fringe groups by economists using cluster analysis (Mohammad, 1984). The dominant group consisted of Saudi Arabia, U.A.E., and Qatar. These group members had the ability to alter their output levels; they could produce at lower prices than members of the fringe group (Iran, Nigeria, and Indonesia), and they could influence the prices set by other participants in the oil market. Dominant group behavior was evident from 1974 to 1979. The fringe group's ability to make output changes was limited, and they demanded higher prices. Libya, Algeria, Venezuela, Ecuador, and Gabon were considered part of the fringe group, even though they could alter output levels. Kuwait was considered a saver country, because it could adjust its output but it demanded a higher price. In general, the OPEC member countries' goals were to maximize the current value of their resources. These

findings demonstrated that an economic incentive could create conflict among OPEC members.

Cartel stability stems from agreement among members on price, and production policies; but the pursuit of diverse interests among OPEC member countries continues to be a serious problem. A country with small oil reserves and a large need for foreign exchange has different needs from those of a country with large reserves and less of a need for foreign exchange. These differences have created problems regarding formulation of output and price policies that best serve the overall interests of OPEC. As suggested by Blitzer et al. (1975), conflicts may be ultimately resolved if a group of countries acts as a price leader in reducing its price to the level of the price taker. Therefore, excess capacity is important in assisting the position of the price leader to implement such a policy. Market-sharing agreements can provide the means for the cartel to coordinate its decisions and enhance its stability.

Ezzati (1976) argued that OPEC could resolve these conflicts by assigning production quotas to members. Countries with lower oil revenue absorptive capacity should decrease production, while countries with higher oil revenue absorptive capacity should increase production. This action stabilizes the price of oil, because the ability of each OPEC member's economy to absorb oil revenues influences the stability of the cartel. Also, the real oil price and the reserve rate can alter OPEC's market share. Therefore, we can conclude that the future OPEC oil supply depends on three factors: the production capacity of each OPEC

member country, the internal demand for its oil, and the absorptive capacity of its countries' economies for oil revenues.

Furthermore, OPEC price-setting behavior depends on the elasticity of oil supply and demand; but in the long run, interest rates and reserve levels will have a significant influence on the optimal price level (Reza, 1984). Furthermore, the exchange rate, as a reflection of the change in the real value of the dollar in relation to foreign currencies, can figure into OPEC production and price activity, because oil is traded in dollars in the world market. The activity of non-OPEC members, whether they are acting as output or price maximizers, affects the market shares of OPEC members. Furthermore, OPEC core-member behavior has a significant impact on the stability of OPEC's market share. As the market share of the cartel core increases, and its reserves-to-production ratio decreases, market share stability occurs and eliminates undesired excess capacity (Daly et al., 1982).

Market share stability serves as an effective strategy for narrowing the gap between production level and excess capacity. Excess capacity levels were evident in the mid-1980s. Rapidly declining oil prices in 1982 and 1983 were responsible for OPEC's market share instability. It was extremely difficult for OPEC to cut production significantly in order to maintain a high price level. But in a situation where the price is low, OPEC does not have to reduce its output, because a lower price will increase the demand for OPEC oil in the future, thereby reducing excess capacity (*International Petroleum Encyclopedia*, 1988).

In general, one part of the OPEC literature indicated that the increase in prices in 1970s was not related to OPEC's behavior as a cartel, whereas the other part indicated that the stability of OPEC during the 1974-1979 period was related to the dominant producer's behavior. But there was agreement that OPEC acted as a cartel in 1983, by restricting its output and maintaining its production ceiling in order to increase or at least stabilize the oil prices. Also, this literature clearly revealed that OPEC has diversified economic and political interests that could lead to the cartel's instability. Overall, market share stability would best serve OPEC's interests.

CHAPTER III

MARKET STRUCTURE THEORIES

OLIGOPOLY THEORY

A cartel is an organizational structure in which the producers all agree on the price structure and production limit, with mutually agreeable market shares. The cartel can maximize its profit by dividing the production among its producers so that marginal production costs are all identical. The level at which the profit-maximizing cartel would produce is determined by restricting output to such an extent that the common marginal production costs are equal to the marginal revenue for the group. But the oligopolists typically do not maximize their joint profit, because their different interests regarding output and price make the coordination a difficult task (Griffin and Teece, 1982).

Oligopoly theory focuses on the study of market concentration. A tight oligopoly entails a high level of concentration, and a loose oligopoly entails a low level of concentration, in a particular market (Kaysen and Turner, 1959). Market concentration exists in a market when a few sellers have control over the price and output of a particular product in the same industry. An oligopoly formulation represents an interaction or interdependence among a few sellers in an industry (Friedman, 1983). The interdependence can be realized by oligopolistic firms

when the concentration ratio reaches a certain level. The concentration ratio level can vary from 25 percent for the largest two firms to 70 percent for the largest eight firms in the market (Nicholson, 1985).

Under an oligopolistic structure, effective collusion and coordination among firms enable them to charge higher prices for their goods than they could as independents, thereby maximizing their profits. The collusion is possible if the benefits exceed the overall costs and risks associated with this type of collusion, because the benefits of collusion are negatively related to the level of demand elasticity and positively related to the elasticity of the industry's marginal cost (Joheny, 1978). Agreement among members on the level of output and price structure is more likely when the number of producers is not large enough to create a conflict among members. This is because the market demand is divided among many producers, and this division has an impact on the profit level. Also, cheating can be a serious problem, because it is very difficult to detect the cheater and enforce the agreement. However, other studies suggest that tacit collusion is possible even with a large number of firms, but that it is more likely with just a few firms (Dulbear et al., 1968).

Oligopolistic models range from classical models (such as Cournot and Bertrand) to modern models (such as the Stackelberg and conjectural variation models which are based on the game theory). These models analyze the reactions of the competitive producers and the new entrants to the market. They have different assumptions about the behavior of other producers. When a

number of firms sell a homogeneous product in such a market, and their objective is to maximize their profits but they expect that the output of other firms will stay the same and the market will determine the price, these firms are facing the Cournot equilibrium. Sometimes these firms have knowledge about the reactions of other firms in the same market, so they can choose an optimal strategy that maximizes their profits, as Stackelberg explained. Bertrand explained that oligopolists can set their own prices, under the assumption that the other producers will keep their prices constant. But if the product is differentiated, the producer can obtain a degree of monopolistic power over its product brands (Clarke, 1985). Furthermore, Cournot explains that producers with large market shares will have more power to dictate the market; but under Bertrand's model, there is no relationship between more market concentration and the market power of a homogeneous product. Recently, some economists have developed models based on the game theory to analyze the interaction among oligopolists. The conjectural variation model is one of these models. It analyzes the interdependence among firms, the way the variation of one firm's output can affect the market price, and the way the output of other firms may affect the market price indirectly. These models are criticized because of Cournot's assumption of other firms' constant output; Stackelberg has a disequilibrium problem in determining which firm is the leader and which is the follower; Bertrand is erroneous in his assumption that other firms' price reactions will be constant (Nicholson, 1985).

INDUSTRIAL ORGANIZATION THEORY

Oligopolistic models do not account for all factors that may have effects on market behavior, but the industrial organization models offer more explanations for all these factors and their effects on market behavior (Nicholson, 1985). Burgess (1990) asserted that the industrial organization theory explains the relationship among certain attributes that are related to a particular industry. This theory explains the relationship among demand, supply, and market characteristics, all of which he called basic conditions. These basic elements are the ones that define the industry's structure.

In general, the industrial organization theory studies the market structure, and the way the firm conducts its business in order to enhance its performance. Most industrial organization economists divide the field into three categories: (a) market structure, which is the result of basic conditions such as cost, demand, and technology; (b) firm conduct; and (c) economic performance. Market structure describes the supply side of the market--specifically, the industry as a whole, the number and size of each firm, product differentiation, economies of scale, and barriers to entry. Based on these factors, the firm's conduct is established. Firm conduct encompasses firm price structure, product differentiation, advertising, investment, research and development, and other factors that might affect the firm's behavior, such as rival actions and the outcomes of market structure. Economic performance includes market efficiency, equity, the industry's expansion over time, and new product innovation (Clarke, 1985).

BARRIERS TO ENTRY AND MARKET CONCENTRATION

Substantial concentration can deter entry and make collusion more effective. Bain (1956) classified the barriers to entry into three categories: absolute cost, product differentiation, and economies-of-scale advantages of the established firms. Also, he sub-classified the entry conditions and their influences on the firm's profit into three levels. A *very high* barrier level occurs when the established firm price is about 10 percent or more above its minimal costs, a *substantial* barrier level when the price is about 7 percent above minimal costs, and a *moderate-to-low* barrier level when the price is 4 percent or less above minimal costs. Basically, this differentiation explains the relationship between concentration and profit level. The biggest firms in the industry with very high barriers to entry will have more profits than the biggest firms with either substantial or moderate-to-low entry barriers. High levels of concentration in any industry lead to more profit, but this can be more effective among firms with substantial entry barriers. Therefore, concentration has a positive effect on the collusion level, and this effect leads to higher profits for the largest firms with substantial levels of entry barriers.

The demand price elasticities for oligopolistic firms determine their behavior if they are trying to prevent entry in the way Bain (1956) explained, to maximize their profits or economies of scale. Inelastic demand means the firm wants to deter entry and not make a profit at scale maximization (Koutsoyiannis, 1984).

Gort (1963) stated that barriers to entry do indeed contribute to the relationship between concentration and market share stability, since barriers to entry encourage concentration. Hence, it is possible to have a positive relationship between concentration and stability of market share. However, it is important to note that stability may be negatively related to excess profits, because a higher-than-normal profit draws new entrants into the market, and new entrants in turn destabilize the market share. Highly concentrated industries have more stable prices than do those with low concentration, while the group facing medium barriers to entry has more stable prices than those industries with higher or lower barriers (Qualls, 1975). Rice (1979) criticized the contention of price stability in more highly concentrated industries, and he suggested that there is no significant relationship between concentration and price stability.

EXCESS CAPACITY AND MARKET SHARE STABILITY

Some elements of market structure, such as excess capacity of production, that are available to the oligopolists can make the collusion more effective. In the short term, oligopolists produce until the price becomes lower than the average variable cost. But large excess capacity makes the firm's fixed cost greater than the average marginal cost, which gives the firm more of an incentive to produce at a low price level. Consequently, this act can lead to instability of the oligopolistic firms (Nicholson, 1985).

One producer (or group of producers) that has a large excess output can

act as a dominant producer to influence the market price. A dominant producer is different from a monopolistic producer, because the dominant producer recognizes that an increase in its price may lead to output expansion by the competitive fringe, a possibility that the monopolist may not consider. Also, the dominant producer's decision is influenced by the rate of the fringe competition's expansion, the profit's maximum level, and the level of the discount rate. All of these factors can change the dominant producer's behavior so that it may reduce its price to prevent the fringe competition from expanding and increasing their market share. On the other hand, it can sustain its price by cutting its production and losing part of its market share to the fringe competitors in the long term (Martin, 1988).

MARKET STRUCTURE AND OPEC'S MARKET SHARE STABILITY

Crude oil can be differentiated according to the level of quality: light crude oil (low-sulfur), or heavy crude oil (high-sulfur). This difference in quality is the reason light oil is more expensive than heavy oil. When the price gap between light and heavy oil was widening during the 1970s, some refineries started to modify their equipment to process heavy oil, which was less expensive than light oil; this change led to a higher demand for heavy oil than for light oil. This was one reason OPEC had problems with the price differentiation and therefore narrowed the price gap between light oil and heavy oil. Because the price

differential between light and heavy oil is reduced, crude oil can be considered a homogeneous product (Martin, 1988).

Another factor this study cannot ignore is that crude oil is an exhaustible resource. Crude oil production depends on the ratio of reserves to production; the smaller the ratio, the less oil there will be in the future, and vice versa. Crude oil is a non-renewable resource, which is available in a fixed supply determined by geological factors. To distinguish between renewable resources and non-renewable resources is to consider that the structure of the crude oil price is not set by only its marginal cost of production, as is the case with renewable products, because the decision to produce a barrel of oil today may not be replaced in the future. Instead, the crude oil price is set by its marginal production cost plus (MC^p_t) the user cost (opportunity cost) (U_t). The decision to produce oil today depends on the future discount rate. The higher the discount, the less oil will be left; the lower the discount, the more oil will be left. With non-renewable resources, the marginal costs today (MC^p_t) should include the user cost (U_t) at the same time; this cost is different from the conventional marginal cost (MC_t) for a private firm. In other words:

$$MC_t = MC^p_t + U_t$$

The theory of exhaustible resources assumes that all producers are wealth maximizers, that they produce to maximize their present value before their resources are exhausted. The user cost (U_t) is the difference between the

marginal production cost (MC_t^p) and the marginal revenue (MR_t) (Griffin and Teece, 1982):

$$U_t = MR_t - MC_t^p.$$

Hotelling (1931) analyzed the market of exhaustible resources both under a perfect competition and under a monopoly. He applied his models to Persian Gulf oil and assumed that the marginal production cost of oil in the Gulf equaled zero. In a competitive market, the price of oil equals the user costs only, and the price of oil rises at the discount rate. Hotelling indicated that under a competitive market, the oil price should rise at the annual interest rate, assuming that the social discount equals the interest rate. Under a monopolistic market, the marginal revenue of the monopolist rises at the interest rate over time.

The inherent critical relationships between production and reserves in OPEC's cartel behavior make the oligopoly theory ideally suitable to the study of OPEC's pricing and production activity. The level of concentration in reserves is more relevant to organizational structure than the level of concentration in production is, because reserves are seen as an indicator of potential production (Markham et al., 1977). OPEC controls a significant proportion of the world's proven crude oil reserves. Thus, in 1973, OPEC's high level of concentration in production, OPEC's reserves, and the high cost of oil extraction and the low production capacity of non-OPEC producers gave OPEC the leading edge in setting oil prices (Dasgupta and Heal, 1979). Despite all the arguments that OPEC's structure differs from that of a conventional oligopoly, whereas the main

objective of a private firm is to maximize its profit, the aim of government is political, social, and economic development. The profit motive can still influence the government oligopoly, while at other times political and social influences may be more important. In a private oligopoly, political and social factors are less important than profit maximization (Al-Nasrawi, 1985).

Large excess capacity is concentrated in the hands of OPEC producers, especially the core producing members. This can give the core producers the power to maintain the cartel's stability. Excess capacity can be used as a measure to discipline any member who is cheating. It is evident that Saudi Arabia used its excess capacity to discipline OPEC and non-OPEC countries in 1986, in order to force internal agreement and to gain non-OPEC cooperation. But, excess capacity cannot be taken for granted as a stabilizing factor, because excess capacity can encourage those members with high capacity to cheat in order to avoid the cost structure and maximize their market shares (Martin, 1988).

Agreement among members (i.e., collusion) to set quotas and prices enhances the position of the OPEC oligopoly, which in turn may provoke the rival action of non-OPEC producers. A rival's reaction serves to weaken the level of collusion. Johnson (1983) explained that cartel stability can be maintained when production demand with a large part of the market share is inelastic and the supply of non-OPEC producing countries has low elasticity. According to the market-sharing cartel model, oligopolists tend to share the market based on their output and price decisions. In the short term, a change in the cartel's market

share that has not resulted from fundamental determinants of wealth-maximizing behavior (such as reserve size) is caused by political and social factors. But the market share is not the only factor leading to market share stability, because the market share itself can be affected by reserve levels and other factors. In other words, if the reserve level of one of the cartel members is declining, it should not be seen as a threat to the cartel's stability (Daly et al., 1982). Because the interest of the oligopolists is profit maximization, a fixed market share is the most efficient method for preventing any secret price cutting within the organization. There is some evidence suggesting that higher concentration may help to deter cheating (Stigler, 1964). Also, the level of collusive prices depends upon the conditions of entry into the industry, as well as the elasticity of demand.

Market structure influences the oligopolist's behavior. Heggstad and Rhoades (1976) supported the hypothesis that market structure determines the market share and that the greater the concentration, the greater the stability of the market share. Havrilesky and Barth (1969) confirmed what microeconomic theory had long predicted: that highly concentrated industries and product-differentiated industries have stable market shares. McGuckin (1972) indicated that the relationship between market share and entry is a negative one, and that it has a significant impact on the concentration ratio. Concentration alone cannot deter entry, and entry can lead to a reduction in market share.

The dominant model could be applied to Saudi Arabia, which has the biggest oil reserve and production capacity within OPEC. Saudi Arabia could

establish the cartel price and give the other members opportunities to expand their production; then Saudi Arabia supplies the residual demand. Nobody denies that Saudi Arabia influences the world oil market, but there is disagreement among economists about the dominant behavior of Saudi Arabia. Griffin and Teece (1982) rejected the dominant-producer model for Saudi Arabia, because the Saudi production share was a much larger percentage of the total OPEC production in 1980 than in 1973. Also, Griffin (1985) found that Saudi Arabia does not vary its production inversely to the production of other OPEC countries, and therefore the leadership of Saudi Arabia is rejected.

Moran (1982) argued that Saudi Arabia understood its leadership very well and that it approached the issue in an intelligent way. The sensitivity of its position should be considered--economically, socially, and politically--within OPEC and among outsiders. External and internal political pressures on Saudi Arabia make its leadership different from the leadership of big firms that are less sensitive to political pressures. OPEC is both an economic and a political organization. In consideration of this fact, Griffin's specification should be modified to allow for political variables in the dominant-producer model, because the leadership of the Saudi government does not have the same motives that the private sector has. Moran insisted that the economic and political stability of Saudi Arabia explained its behavior as a dominant producer.

CHAPTER IV

ALTERNATIVE MODELS OF OPEC PRODUCTION

CARTEL MODEL

Quite an array of models has been used to analyze OPEC's production and pricing behavior. Gately and Kyle (1977) used two dynamic simulation models. The first analyzed OPEC's output and profit based on a fixed price path; the second analyzed different price paths, based on simple rule-of-thumb pricing strategies, to evaluate different market conditions. The models assumed that OPEC acted monolithically. The study compared many OPEC price strategies and concluded that the best one charged a highly discounted present value and was the most cautious about the consequences of high prices.

Another application was based on the assumption that OPEC was monopolistic and shared the oil market with a competitive fringe. The study concluded that the price increase at the time was indeed related to OPEC's cartel behavior (Cremer and Weitzman, 1976). Kalymon (1975) employed two economic models. The first, a long-term optimization model of oil resource utilization, analyzed the influence of reserve size, demand elasticity, and time preference on price equilibrium. The second was a simulation model of market sharing used to

evaluate each OPEC member's structure according to a different price path. The findings were that the optimal OPEC price was sensitive to the opportunity cost of capital, the substitution cost in importing countries, and the collusion structure of OPEC, but that it was relatively insensitive to the size of reserves and the domestic market growth rate of OPEC countries. Lower oil prices discouraged exploration of oil resources, whereas high oil prices encouraged development of energy alternatives in importing countries.

Najafizadeh (1985) developed a Nash-Cournot non-cooperative model of the world oil market. He assumed that the world oil industry consisted of small producers acting as price takers (the fringe) and of large producers acting independently in the market. He asserted that there was a low degree of interdependence among large producers in OPEC during the 1973-1979 period. This interdependence in turn implied that the output behavior of large producers in OPEC was close to a Nash-Cournot non-cooperative solution and that this was a direct result of independent profit maximization by these producers. Al-Sahlawi (1986) estimated the oil supply of Saudi Arabia for the 1970-1984 period and the pooled sample of the Gulf Cooperation Council (GCC) for the 1974-1984 period. The production of these countries was determined by the lag of oil production, the proven oil reserves, and the oil production from other OPEC countries and from non-OPEC countries. The findings were that Saudi Arabia's supply and GCC's supply had elasticities of .44 and .36, respectively. Also, the study indicated that political factors did influence OPEC's production decisions.

Griffin (1985) analyzed each OPEC member country's production according to a market-sharing cartel model that analyzed the changes in OPEC's market shares over time, where OPEC demand (Q^o) could be derived from the difference between the world demand and the non-OPEC supply ($Q^o = \text{world demand} - \text{non-OPEC supply}$), which was equivalent to OPEC production. Each OPEC member's production (Q_{it}) is a fraction of other OPEC aggregate production (Q^{oo}_{it}).

The cartel model was:

$$Q_{it} = P_{it}^{Bi} Q^{ooBi}_{it}$$

where (P) was the real price of oil.

Griffin's study of the 1971-1983 period estimated the above parameters and demonstrated that the partial market-sharing cartel model served to explain OPEC production behavior better than other OPEC production models did.

COMPETITIVE MODEL

MacAvoy (1982) examined OPEC's behavior from 1966 to 1972 and claimed that market fundamentals, such as reserves and prices, were responsible for OPEC's production behavior during this period. In an open market situation, the price of oil could rise to four-fifths or more of the current price because of the political events in the 1970s. The market fundamentals, under open market conditions, led to an increase in demand, which then caused an increase in the price of oil during the 1970s. The high oil price was not related to cartel behavior.

Griffin (1985) explained that the price increase in the 1970s could be attributed to changes in expected user costs, an increase in the demand for oil, and a decline in oil discovery rates. He stated that under the competitive model, the current production (Q_{it}) was a function of price (P_{it}), perceived user costs (U_{it}), and current extraction costs (M_{it}):

$$Q_{it} = F(P_{it}, U_{it}, M_{it}).$$

Because of the lack of data on U_{it} and M_{it} , Griffin specified production as a function of the real oil price. The competitive model was expressed:

$$Q_{it} = f(P_{it}^{B_i})$$

A positive sign of B_i means that competition in the oil market exists. The competitive model did not explain OPEC behavior, and it was also rejected for 10 OPEC members. Furthermore, the test for the effects of price and reserve lags did not change the outcome of the model.

TARGET REVENUE MODEL

The basis of the target revenue theory was that OPEC members produced to satisfy certain needs, such as financial needs to support their national development plans. The need for revenue was a function of the absorptive capacity of each member's economy. If the market was small and the infrastructure was inadequate, then the country's economy would fail to absorb the domestic investment. The target revenue model was good for short-term analysis

(Griffin and Teece, 1982). Since each country produced to fill its needs, when oil prices rose, the country should have curtailed production to ensure that revenue remained constant, assuming that the needs of the country remained constant. Consequently, less production meant higher prices with lower depletion rates of oil resources (Adelman, 1982). The target revenue model was criticized, because it ignored foreign investment as a possible alternative to domestic investment for a country with limited absorptive capacity (Griffin and Teece, 1982).

In analyzing the target revenue hypothesis, Griffin (1985) used real fixed domestic capital formation as a measure of investment needs. He specified each OPEC member's production as a function of the real oil price and investment need (I_{it}). The target revenue model was expressed:

$$Q_{it} = f(P_{it}^{B_i}, I_{it}^{Y_i})$$

The underlying assumptions of this model are that the domestic investment requirements have to be determined by each OPEC member first, that there should be no foreign investment, and that the investment should depend only on oil revenue. Thus, if $B_i = 1$, then the increase in production should be proportionate to the increase in investment needs. If there is an increase in the price ($y_i = -1$) and the investment need is fixed, then the production should be reduced proportionately. On the basis of Griffin's findings, the target revenue model was rejected as an explanation for OPEC's production behavior.

PROPERTY RIGHTS MODEL

Joheny (1978) contended that the quadrupling of oil prices in 1973 resulted from a shift in ownership from the interactive oil companies to the host countries. Joheny indicated that in the 1950s and 1960s, oil companies anticipated that nationalization would eventually occur in the 1970s, and this nationalization would have led to lower discount rates than the oil companies' discount rates. Thus, the production was shifted from the future to the present time. On the other hand, the discount rate was shifted to a lower level than previously. The shift in property rights was completed by the end of 1973 through the nationalization of the oil companies. As a result, the host country's discount rate was lower than that which was charged by the international companies. It was the discount rate that led to the production cutback and higher prices. Adelman (1982) criticized the property rights model because the production cut of 1973-1974 was caused by the oil embargo and not by the lower discount rate. Also, the host countries were demanding higher production from the companies during the 1950s and 1960s. Whereas the price increase of 1973-1974 may have been the result of the property rights transfer, that transfer did not seem to account for the increase of 1978-1979, since the discount rate was not an issue then (Griffin and Teece, 1982).

According to Griffin (1985), the property rights theory explains production as a function of the percentage of total oil production that is government-controlled

(G_{it}). A high percentage of government-controlled production leads to production cutbacks. The property rights model was expressed:

$$Q_{it} = f(G_{it})$$

The percentage of government equity oil (G_{it}) is used as a measure of government-controlled oil production.

IDENTIFICATION AND MEASUREMENT OF KEY DETERMINANTS

Market Share Stability

The market share can be stable under an equilibrium situation, in which there is an absence of rapid growth and no change in demand or technology (Gort, 1963). But exogenous disturbances, such as a change in demand or the cost condition facing the industry, can affect market share stability. Also, extensive excess capacity can alter the equilibrium. However, effective collusion, as one of the market elements, stabilizes market share. The market structure influence in oligopolistic behavior and in the stability of market share can be tested under two conditions: if there is effective collusion between producers, and if all exogenous disturbances affecting the level of collusion between members are constant (Caves and Porter, 1978). High concentration leads to effective collusion between members and, in turn, stabilizes their market shares (Heggstad and Rhoades, 1976).

Political Instability

OPEC countries have experienced a high rate of socioeconomic change during the 1970s and 1980s. Such rapid change means that these countries are not politically stable (Kirkham et al., 1970). Generally, every country has experienced some type of political instability at some point during its history. For example, the civil disorder in Iran was faced with government sanctions against its people. Furthermore, elitist governments saw the development of political pressures against the existing political systems. In general, the OPEC countries are not stable countries; their political systems are not old enough to allow for political adjustment to occur. Each country is socially and politically unstable until it achieves a high level of modernization and a political system that is satisfactory to the majority of the people (Taylor and Jodice, 1983).

It is essential to this study to distinguish between a potential crisis, such as a war or revolution, and conditions which are less dramatic and emotional. Verba defined a crisis as "a change that requires some governmental innovation and institutionalization if elites are not seriously to risk a loss of their position or if the society is to survive." Political unrest, such as political violence, does not necessarily lead to a crisis (Zimmermann, 1983). Political instability can be defined in different ways, because it has so many dimensions. Feierabend and Feierabend (1965) defined political instability as a degree or amount of aggression that is directed from individuals or groups against other individuals or groups within the

political system. Stewart and Venieris (1985) found that political instability (riots, demonstrations, strikes, irregular changes of government, and death due to domestic political violence) negatively affected money-saving behavior in less-developed countries. Another study found that political instability (domestic civil conflict and violent behavior) affected foreign investment in developing countries negatively (Levis, 1979).

There is no denying the impact of a political crisis on OPEC's production and price activity in 1973 and 1979-1980. This can be shown in the Iran situation of 1979. The oil supply curve of Iran was shifted to the left in 1979 and continued during the Iran-Iraq war to 1981, but the question here is concerned with the political instability of each OPEC member, which might have an impact on OPEC's production decisions over time.

Heiat (1988) measured the political influences on oil production by using the "square root of the sum of the squared residuals of deviations from the trend of oil production in each of the oil-producing countries," dividing that "by the number of observations and using the classical formula for the residual variance." Hence, Heiat's assumption was that all shifts in production from a basic time trend were caused by political influence. Obviously, the realities of production behavior are considerably more complex. Some studies used dummy variables to account for the effects of the oil embargo, the Iranian revolution, and the Iran-Iraq war. These were crisis situations. Political instability is defined in this study in terms of

the magnitude of internal conflicts involving the government of a particular member country. Therefore, political instability is measured by events that influence government policy (i.e., demonstrations, riots, armed attacks, political strikes, and government sanctions) (Taylor and Jodice, 1983). Because the previous political measurements were intended to measure the influence of the oil embargo of 1973, the Iranian revolution of 1979, and the Iran-Iraq war of 1980, the new measurement is better suited to tracing the effect of political instability on production over time.

A recent study based on political events as a measure of political instability found a negative relationship between these events and foreign direct investment. This study criticized previous studies for their failure to show a strong relationship between foreign investment and political events. The fact that they used indexes, based on the expert evaluation of several political events, as a measurement of political instability contributed to the failure of these studies. The study agreed that data on sociopolitical events were the best measure of political stability, despite theoretical and data interpretation problems (Sedah and Safizadeh, 1988). Political influences were measured in this research in the form of the annual aggregate number of strikes, protests, riots, armed attacks, and government sanctions for each OPEC member.

Social Pressure

Alternative measures of social pressure, which are concerned more with the internal satisfaction of a society, can be reflected in the distributional data such

as land, wealth, and income per capita (Taylor and Jodice, 1983). The income distribution can be measured by the index of inequality of income distribution. This index measures the relative well-being of a society. A larger inequality in income distribution would lead to greater demands and pressures on the government by those people who were affected by this inequality. Another measurement is the growth percentage rate of income per capita, which measures the society's needs for public services. A higher income growth rate meant less social pressure on the government and more social stability, because the benefits were greater than the costs of violent actions. In addition, socioeconomic mobility (education index) and the level of population concentration (urbanization) could lead to a higher demand by the public, if this demand did not meet the effects of social pressure would develop (Parvin, 1973). The data on the previous social pressure measurements were not available. Therefore, the population growth rate was used as the measurement of social pressure.

As the population growth rate (POP) increases in OPEC countries, it increases the demand for public services. A large demand leads to an increase in government expenditures to provide these types of services that the public needs. Then pressure is placed on the government to increase its oil production in order to increase its revenue and satisfy its people's needs. This, in turn, affects the stability of OPEC's oil production, assuming there is interdependence among OPEC's members. Also, it is expected that those countries with stable population

growth rates (Iraq, Libya, Algeria, Venezuela, Indonesia, and Nigeria) and those with declining population growth rates (Qatar, U.A.E., and Kuwait) do not have social pressures to increase their oil production. On the other hand, countries with increasing population growth rates (Saudi Arabia and Iran) have pressures to increase their oil production. Overall, a high population growth rate leads to a higher production rate and consequent market share instability for OPEC's member countries.

Excess Capacity

The ratio of reserves to production will be utilized to measure the relative level of potential excess production capacity. Also, excess capacity measures the level of reserve concentration to production. Excess capacity exists when the actual value of the reserves-to-production ratio (present, past, or future values of the ratio Y^*) exceeds the technical limit (the lower limit of the ratio at a point of time, Y^0). Excess capacity is desirable at level Y^* or when that actual value of the reserves-to-production ratio is less than the desired excess capacity at certain times, and there is no threat to cartel stability (Figure 9).

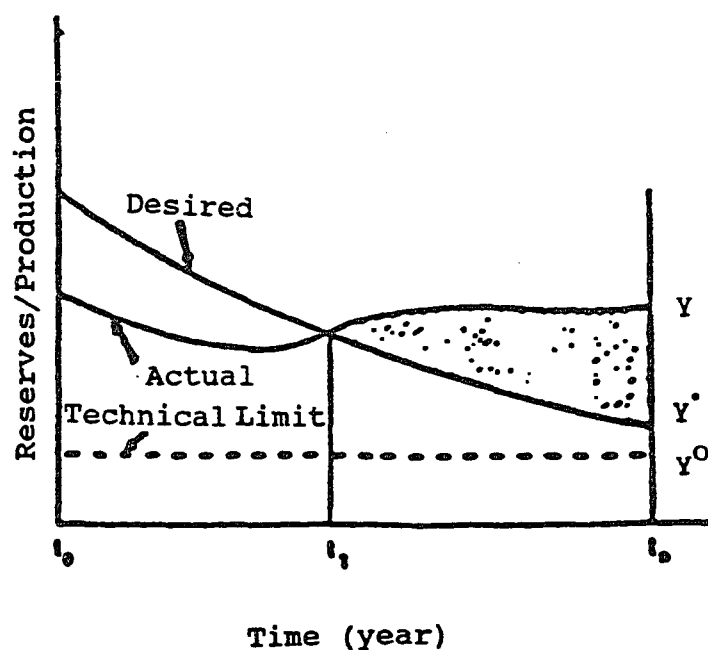


Figure 9. Excess capacity as a destabilizing influence.
Source: Daly et al., 1982.

MONETARY PRESSURE DETERMINANTS

Exchange Rate

The dollar is the medium of exchange for world oil and influences the cost of crude oil (International Energy Outlook, 1989). Exchange rates (EX) were used in the cartel models as a measurement of monetary pressure. The exchange rate variable measures the change in the real value of the dollar relative to foreign currencies. A high exchange rate influences the production negatively, and a low exchange rate influences production positively. An increase in the exchange rate

increases the real price of oil and oil revenue in foreign currencies relative to U.S. dollars (Lowinger, et al., 1985).

Current Account Balance

The current account balance (CAB) represents the balance of trade, the services account, and gift exchanges between countries. A surplus CAB indicates that a country exports more than it imports and has less of a need for oil revenue. In this research, the CAB was scaled as a percentage of GDP.

The CAB can be used as an indicator of the net holdings of foreign assets (Mattione, 1985). In addition, it measures each OPEC member's capacity to absorb imported goods and services on which they have spent a large proportion of their oil revenues (Lea, 1975), where "absorptive capacity represents an attempt to measure the ability of a nation to adjust spending to changes in income" (Mattione, 1985).

Foreign Exchange Reserves

The CAB does not account for the money OPEC members borrow from the foreign reserves. As a solution to this problem, the total of foreign exchange reserves (TF) minus gold was included in the target revenue model as measure of the latent fiscal capacity of these countries.

Fixed Domestic Capital

Griffin (1985) used fixed domestic investment (FC) as a measure of revenue needs, but some economists have been critical of this approach because

it failed to consider foreign investment as an alternative to domestic investment. Fixed domestic capital, lagged one year, was used in the target revenue model.

MODEL SPECIFICATIONS

The variables that Griffin (1985) used in the cartel, competitive, and target revenue models were included in the model specifications for this study. These variables are: the production of each OPEC member, the real price of oil, other OPEC production, lagged oil reserves, and lagged oil price. The competitive model was employed without modification, but it was tested for two time spans.

Cartel Model

This research uses a modified version of the market-sharing cartel model formulated by Griffin (1985). Non-economic variables, such as population growth rate and political instability (number of strikes, armed attacks, protests, riots, government sanctions) are also included (see Appendix A). Some economic variables (e.g., exchange rate, excess capacity, and current account balance) are in this model specification.

The cartel model is expressed as follows:

$$\begin{aligned} \text{Log } Q_{it} = & a_i + B_{1i} \text{Log } RP_{it} + B_{2i} \text{Log } EX_{it} + B_{3i} \text{Log } CAB_{it} + B_{4i} \text{Log } Q_{it}^{\infty} \\ & + B_{5i} \text{Log } POP_{it} + B_{6i} \text{Log } POL_{it} + B_{7i} \text{Log } \frac{R}{Q_{it}^o} + E_{it} \end{aligned}$$

$$i = 1, \dots, N; t = 1, \dots, T$$

Where:

RP = The real oil price relative to Saudi light crude oil (deflated by U.S. 1982 deflator)

Q^{∞} = Total OPEC production (Q°) - Individual production (Q_i)
represents other OPEC members' production in MBD

EX = Exchange rate in U.S. dollars

POP = Population growth rate

POL = Political variables (protests, riots, armed attacks, strikes, government sanctions) in absolute numbers

$\frac{R}{Q^{\circ}}$ = Reserves-to-production ratio (R/Q)

CAB = Current account balance as percentage of GDP in millions of U.S. dollars

The market-sharing hypotheses are tested. Market-sharing hypotheses of Q^{∞} depend on the real oil price's behavior. If the Q^{∞} coefficient is constant and the real oil price's coefficient is not significant ($B_4 = 1, B_1 = 0$), then OPEC has constant market-sharing. But if the Q^{∞} coefficient is constant and the price's coefficient is significant ($B_4 = 1, B_1 \lesseqgtr 0$), then the market-sharing hypothesis is accepted for OPEC members. Furthermore, if the Q^{∞} coefficient is significant and greater than zero, while the price coefficient is significant ($B_4 > 1, B_1 \lesseqgtr 0$), then the partial market-sharing hypothesis is accepted and OPEC is not a fully effective cartel.

The stability of OPEC's market share is influenced by the change in EX, POP, POL, CAB, and R/Q. A higher EX, POL instability, a deficit in the CAB, and a higher R/Q affects OPEC's production negatively, whereas a higher POP leads to an increase in OPEC's production.

Competitive Model

The competitive model's specification was the same as Griffin's (1985) specification, except that this specification used the real crude oil price of OPEC members relative to Saudi's light crude oil to avoid the problem of crude oil price differentiation. The competitive model is specified as follows:

$$\text{Log } Q_{it} = a_i + B_{1i} \text{Log } RP_{it} + B_{2i} \text{Log } R_{it} + B_{3i} \text{Log } RP_{it-1} + B_{4i} \text{Log } R_{it-1} + E_{it}$$

$$i = 1, \dots, N; t = 1, \dots, T$$

R = The proven oil reserves in billions of barrels annually,
as of January 1

RP_{t-1} = The relative crude oil price, lagged one period

R_{t-1} = The proven oil reserves, lagged one period

In a competitive market, all oil producers are price takers, so an increase in the oil prices leads producers to expand their output and sell as much as they can. Therefore, competitive oil producers produce more when the oil prices are higher (+ B_1) and vice versa. But if an increase in oil prices results in a cut in oil production (- B_1) by some producers, then these producers are not behaving as competitive producers.

Target Revenue Model

Griffin (1985) used real fixed domestic capital formation in billions of dollars (GFC) as a proxy of investment needs. This study used GFC and the CAB as a percentage of GDP to measure revenue needs. This is important, because a surplus in the CAB indicates that the country does not need more revenue from the sale of oil; conversely, a deficit in the CAB indicates that the country requires more oil revenues to finance its needs.

The target revenue model is expressed as follows:

$$\text{Log } Q_{it} = a_i + B_{1i} \text{Log } RP_{it} + B_{2i} \text{Log } GFC_{it-1} + B_{3i} \text{Log } CAB_{it-1} + B_{4i} \text{Log } TF_{it-1} + E_{it}$$

$$i = 1, \dots, N; t = 1, \dots, T$$

CAB represents investment needs and TR represents the value of foreign reserves minus the value of gold reserves in billions of dollars. If the coefficients B_3 and B_4 are constant and there is an increase in the oil price, the production should be decreased proportionately ($B_1 = -1$); if there is an increase in investment needs, ceteris paribus, the production should be increased proportionately ($B_2 = 1$). Also, the tests were performed for the coefficient ($B_2 > 0, B_1 < 0$), to determine the influence of revenue needs on production level. The coefficient of TR measures the need for withdrawing cash from reserves, which indicates that the country should increase its production.

Property Rights Model

Griffin (1985) specified the property rights model as follows:

$$\text{Log } Q_{it} = a_i + B_i G_{it} + E_{it}$$

$$i = 1, \dots, N; t = 1, \dots, T$$

G_{it} is a percentage of government-controlled production, measured by the government's percentage of oil equity. In this model, G_{it} was measured by the calculated ratio of the parent company's estimated gross share of crude oil production for each OPEC member country to the total production of the same country. This is synonymous with government equity oil, which Griffin used.

OPERATIONALIZATION

Multiple-regression estimation techniques were used to operationalize these four econometric models. The data were transformed using double log format, except for the property rights model. For these models, the data were analyzed for two time periods: 1971-1982 and 1983-1987. Because of the limitations of the data in terms of the limited number of observations, the Chow-test was used to determine whether or not there was a shift in OPEC's production behavior between the two study periods (Maddala, 1977).

To test the homogeneity of the four models' coefficients, the following alternative pooling models were used: least squares with dummy variables (LSDV), seemingly unrelated regressions (SUR), and cross-sectional correlated

and time-wise auto-regression (CCTA) (Kmenta, 1986). The last two models assumed that the disturbance error was stochastic.

DATA COLLECTION

The empirical analysis was based on annual data that covered the 1971-1987 period. Data for all the variables used were available for all 11 members of the cartel, excluding Gabon and Ecuador. As in most cases, the collection of data was not an easy task. Information on the official selling prices, OPEC production, and reserves was obtained from *Basic Petroleum Data Book* (1989). This information was supported by OPEC Annual Statistical Bulletin (1973-1987).

Saudi's light oil (34°) price was used as the base price for all countries for 1971 (Ps1). The relative oil prices of other OPEC members to Saudi's oil price (RP) from 1972-1987 was calculated by the following formula:

$$\text{RP for the 1972-1987 period} = \text{Ps}_{2t} + \frac{\text{Px}_{2it} - \text{Ps}_{2t}}{\text{Ps}_1}$$

Where Ps1 = Pxi is the same for all countries in 1971 (the base year).

Ps2t = Saudi's real price for the second year; t = 1972, ---, 1987.

Px2it = individual country's real oil price for the second year; i = 2, ---, 11; and t = 1972, ---, 1987.

World consumption, excluding that of communist countries, from 1971 to 1985 was obtained from *Annual Energy Review* (1987); the data for 1986-1987 was obtained from *International Energy Outlook* (1989). Population and the parent companies'

estimated gross share of crude oil production were obtained from *OPEC Annual Statistics Bulletin* (1973-1987). All data on the GDP, foreign reserves, the CAB, the exchange rate, the U.S. (1982) deflator rate, and gross domestic fixed capital formation were obtained from *International Financial Statistics* (1989). The political variables (number of strikes, protests, riots, armed attacks, and government sanctions) for 1971-1982 were obtained from the *World Handbook of Political and Social Indicators* (Taylor and Jodice, 1983). The data for the same political variables from 1983 to 1987 were coded according to the previous source. To make this new coding comparable to the previous coding of the *World Handbook of Political and Social Indicators*, the same definitions of political events were used (Taylor and Jodice, 1983). Political events did not include criminal activities or any economic actions (see Appendix A). Two approaches were used to identify the political events: geographic (country name) and subheading (university and bombs) approaches. The primary source used was *The New York Times Index* (1983-1987) in which the political events are available annually. Other secondary sources used were *The Middle East Journal* (1983-1987), and *Keesing's Record of World Events* (1983-1987).

CHAPTER V

EMPIRICAL RESULTS

POOLED MODELS

Different alternative pooling techniques were used in this study in order to satisfy the degree-of-freedom requirement. The cartel, competitive, and target revenue models had at least five independent variables with twelve observations (N_1) in the first period (1971-1982) and five observations (N_2) in the second period (1983-1987). The first alternative was to use the Chow-test to test for a structural shift in OPEC's production behavior between the 1971-1982 and 1983-1987 periods. The second period had few observations and a large number of variables in individual countries' models ($K > N_2$). Therefore, each individual OPEC member's cartel, competitive, and target revenue models were estimated for the 1971-1982 and 1971-1987 periods. Then the difference between the residual sum of squares for the two periods for each individual member's regression model was calculated according to the Chow-test formula, which used an F-test to test for the level of significance (Maddala, 1977). Calculated F-tests were compared to the critical value of the F-test at a 5-percent level. All of the calculated F-tests were not significant at a 5-percent level, and there was no structural shift in OPEC's production behavior for the three models (the results of the Chow-test are shown

in Tables II-IV). Therefore, the two periods were combined. The analysis then proceeded for the entire 1971-1987 period.

The Chow-test was not used for the property rights model, because it was used only for the 1971-1982 period. Since the reliability of the model decreased while the number of variables increased and the number of observations decreased, the decision was made to use other pooling techniques to pool the data and to compare each individual regression coefficient with the chosen pooled model for all the 11 OPEC members (excluding Ecuador and Gabon) for the 1971-1987 period. Consequently, the pooled time-series cross-sectional data increased the sample size and the reliability of the regression coefficients. The decision to pool the data also took into consideration the inappropriateness of pooling due to aggregation bias, because this pooling could have affected the interpretation of the parameters. Therefore, ordinary least squares with dummy variables (LSDV) was estimated for different intercepts and slopes (this is equivalent to estimating each individual country's regression). Also, the LSDV was estimated for the following hypotheses.

The inter-country homogeneity hypotheses were tested, and the three hypotheses were as follows:

1. A common intercept and common slope (H_1).
2. A common slope and different intercepts (H_2). It is referred to as least squares with dummy variables (LSDV).
3. A common intercept and different slopes (H_3).

TABLE II

CHOW-TEST RESULTS OF THE DIFFERENCE BETWEEN 1971-1982 AND 1983-1987 PERIODS FOR THE CARTEL MODEL^A

	RSS ^B	RSS1 ^C	DF ^D	DF1 ^E	Fc ^F
SAUDI	.052	.023	5	4	1
IRAN	.050	.021	=	=	2.22
IRAQ	.011	.002	=	=	4.22
VENEZUELA	.004	.001	=	=	3
QATAR	.012	.002	=	=	6
LIBYA	.024	.011	=	=	4
INDONESIA	.0132	.002	=	=	5.82
U.A.E.	.0185	.006	=	=	1.25
ALGERIA	.0147	.009	=	=	.57
NIGERIA	.009	.005	=	=	.58
KUWAIT	.033	.007	=	=	5.56

A) CHOW-TEST = $\frac{(RSS - RSS1)/N2}{RSS1 / (N1-8)}$ = COMPUTED F (MADDALA, 1977).

B) RSS = RESIDUAL SUM OF SQUARES OF THE INDIVIDUAL COUNTRY FOR THE CARTEL MODEL OVER THE 1971-1987 PERIOD (N1 + N2 = 17).

C) RSS1 = RESIDUAL SUM OF SQUARES OF THE INDIVIDUAL COUNTRY FOR THE CARTEL MODEL OVER THE 1971-1982 PERIOD (N1 = 12).

D) DF (DEGREE OF FREEDOM) = NUMBER OF OBSERVATIONS IN THE 1983-1987 PERIOD (N2 = 5 BECAUSE k+1 > N2).

E) DF1 (DEGREE OF FREEDOM) = NUMBER OF OBSERVATIONS IN THE 1971-1982 PERIOD MINUS NUMBER OF VARIABLES PLUS THE CONSTANT (N1 - 8 = 4).

F) COMPUTED F(Fc) COMPARED TO CRITICAL VALUE OF F(5,4) = 6.26 AT 5% LEVEL.

TABLE III

CHOW-TEST RESULTS OF THE DIFFERENCE BETWEEN 1971-1982 AND 1983-1987
PERIODS FOR THE COMPETITIVE MODEL^A

	RSS ^B	RSS ^C	DF ^D	DF1 ^E	Fc ^F
SAUDI	.105	.055	5	7	1
IRAN	.1564	.146	=	=	.10
IRAQ	.1743	.1696	=	=	.05
VENEZUELA	.0194	.0139	=	=	1
QATAR	.0391	.01391	=	=	1
LIBYA	.1363	.0775	=	=	1
INDONESIA	.0324	.023	=	=	.60
U.A.E.	.0237	.0205	=	=	.21
ALGERIA	.0200	.184	=	=	1
NIGERIA	.032	.028	=	=	.20
KUWAIT	.083	.054	=	=	1

$$A) \text{ CHOW-TEST} = \frac{(RSS - RSS1)/N2}{RSS1 / (N1-5)} = \text{COMPUTED F (MADDALA, 1977)}$$

B) RSS = RESIDUAL SUM OF SQUARES OF THE INDIVIDUAL COUNTRY FOR THE CARTEL MODEL OVER THE 1971-1987 PERIOD (N1 + N2 = 17).

C) RSS1 = RESIDUAL SUM OF SQUARES OF THE INDIVIDUAL COUNTRY FOR THE CARTEL MODEL OVER THE 1971-1982 PERIOD (N1 = 12).

D) DF (DEGREE OF FREEDOM) = NUMBER OF OBSERVATIONS IN THE 1983-1987 PERIOD (N2 = 5 BECAUSE K+1 > N2).

E) DF1 (DEGREE OF FREEDOM) = NUMBER OF OBSERVATIONS IN THE 1971-1982 PERIOD MINUS NUMBER OF VARIABLES PLUS THE CONSTANT (N1 - 5 = 7).

F) COMPUTED F(Fc) COMPARED TO THE CRITICAL VALUE OF F(5,7) = 3.97 AT 5% LEVEL.

TABLE IV

CHOW-TEST RESULTS OF THE DIFFERENCE BETWEEN 1971-1982 AND
1983-1987 PERIODS FOR THE TARGET REVENUE MODEL^A

COUNTRY	RSS ^B	RSS1 ^C	DF ^D	DF1 ^E	Fc ^F
SAUDI	.09	.080	7	5	3
VENEZUELA	.0058	.143	=	=	1.5
KUWAIT	.027	.069	=	=	1
INDONESIA	.018	.034	=	=	.33
ALGERIA	.044	.0374	=	=	1
NIGERIA	.031	.35	=	=	.50

$$(RSS - RSS1)/N2$$

A) CHOW-TEST = $\frac{(RSS - RSS1)/N2}{RSS1 / (N1-5)}$ = COMPUTED F (MADDALA, 1977).

B) RSS = RESIDUAL SUM OF SQUARES OF THE INDIVIDUAL COUNTRY FOR THE CARTEL MODEL OVER THE 1971-1987 PERIOD (N1 + N2 = 17).

C) RSS1 = RESIDUAL SUM OF SQUARES OF THE INDIVIDUAL COUNTRY FOR THE CARTEL MODEL OVER THE 1971-1982 PERIOD (N1 = 12).

D) DF (DEGREE OF FREEDOM) = NUMBER OF OBSERVATIONS IN THE 1983-1987 PERIOD (N2 = 5 BECAUSE k+1 > N2).

E) DF1 (DEGREE OF FREEDOM) = NUMBER OF OBSERVATION IN THE 1971-1982 PERIOD MINUS NUMBER OF VARIABLES PLUS THE CONSTANT (N1 - 5 = 7).

F) COMPUTED F(Fc) COMPARED TO THE CRITICAL VALUE OF F(7,5) = 3.97 AT 5% LEVEL.

These hypotheses were tested using an F-test to determine whether the total residual sum of squares of all estimated regressions differed from the residual sum of squares of each hypothesis (Maddala, 1977).

The estimate of the cartel model with LSDV was not straightforward. The cartel model had too many variables to perform the LSDV on the entire data; instead, the cartel model was divided into three groups, following Eckbo's (1979) grouping. The first group consisted of the *core* countries; the second group consisted of the *price-pusher* countries; the third group consisted of the *expansionist* countries. Also, this type of grouping was useful for determining whether non-economic factors would change the common view of these groups' behavior.

For the core countries, H_1 and H_2 were rejected, but H_3 (the common intercept and different slopes hypothesis) was accepted. The pooling was appropriate for these countries, but H_3 was not the most efficient method for pooling data (Table V). For the price-pusher countries, H_1 was rejected but H_2 and H_3 were accepted. Therefore, the data pooled in two different ways: common slope and different intercepts or common intercept and different slopes (Table VI). The only hypothesis accepted for the expansionist countries was H_3 (Table VII).

Also, LSDV was utilized to test the homogeneity of the competitive coefficients. H_2 and H_3 were accepted, and the pooling was justified (Table VIII). For the target revenue and property rights models, all the hypotheses of homogeneity of the coefficients were rejected, and the pooling was not appropriate

TABLE V
HYPOTHESES TESTING OF THE LSDV RESULTS FOR THE CORE
COUNTRIES (CARTEL) FOR 1971-1987^A

DIFFERENT INTERCEPTS & SLOPES (H)		$S^B = .13$	DF = 45
COMMON INTERCEPT & SLOPE (H1)		$S1^B = 2.13$	DF = 77
COMMON SLOPE & DIFFERENT INTERCEPTS (H2)		$S2^B = .505$	DF = 73
COMMON INTERCEPT & DIFFERENT SLOPES (H3)		$S3^B = .1318$	DF = 49

	COMPUTED F_c^C	CRITICAL F (AT 5%)	IF $F_c > F_t$
H1	F1 20.83	$F1(DF=32,45) = 1.79$	REJECTED
H2	F2 3.33	$F2(DF=28,45) = 1.87$	REJECTED
H3	F3 .67	$F3(DF=4,45) = 5.72$	ACCEPTED

A) LSDV = LEAST SQUARES WITH DUMMY VARIABLES.

B) $S, \dots, S3$ = INDIVIDUAL RESIDUAL SUM OF SQUARES OF THE CORE MODEL FOR EACH HYPOTHESIS (H, \dots, H3) FOR 1971-1987.

$$(S1 - S) / (77 - 45)$$

$$C) F1 = \frac{(S1 - S) / (77 - 45)}{S/45}$$

$$F2 = \frac{(S2 - S) / (73 - 45)}{S/45}$$

$$F3 = \frac{(S3 - S) / (49 - 45)}{S/45} \quad (\text{MADDALA, 1977}).$$

TABLE VI

HYPOTHESES TESTING OF THE LSDV RESULTS FOR THE PRICE-PUSHER COUNTRIES (CARTEL) FOR 1971-1987^A

DIFFERENT INTERCEPTS & SLOPES		$S^B = .083$	DF = 27
COMMON INTERCEPT & SLOPE	(H1)	$S1^B = .921$	DF = 43
COMMON SLOPE & DIFFERENT INTERCEPTS	(H2)	$S2^B = .160$	DF = 41
COMMON INTERCEPT & DIFFERENT SLOPES	(H3)	$S3^B = .056$	DF = 29

	COMPUTED F_c^C	CRITICAL F (AT 5%)	IF $F_c > F_t$
H1	$F1 = 17.45$	$F1(DF=16,27) = 2.2$	REJECTED
H2	$F2 = 1.83$	$F2(DF=14,27) = 2.35$	ACCEPTED
H3	$F3 = 4.50$	$F3(DF=2,27) = 19.5$	ACCEPTED

A) LSDV = LEAST SQUARES WITH DUMMY VARIABLES.

B) $S, \dots, S3$ = INDIVIDUAL RESIDUAL SUM OF SQUARES OF THE PRICE-PUSHER MODEL FOR EACH HYPOTHESIS (H1.....H3) FOR 1971-1987.

$$C) F1 = \frac{(S1 - S) / (43 - 27)}{S/27}$$

$$F2 = \frac{(S2 - S) / (41 - 27)}{S/27}$$

$$F3 = \frac{(S3 - S) / (29 - 27)}{S/27} \quad (\text{MADDALA, 1977}).$$

TABLE VII
HYPOTHESES TESTING OF THE LSDV RESULTS FOR THE EXPANSIONIST
COUNTRIES (CARTEL) FOR 1971-1987

DIFFERENT INTERCEPTS & SLOPES		$S^B = .025$ DF = 27
COMMON INTERCEPT & SLOPE	(H1)	$S1^B = .1389$ DF = 43
COMMON SLOPE & DIFFERENT INTERCEPTS	(H2)	$S2^B = .116$ DF = 41
COMMON INTERCEPT & DIFFERENT SLOPES	(H3)	$S3^B = .0279$ DF = 29

	COMPUTED F_c^C	CRITICAL F_t	$F_c > F_t$
H1	$F1 = 7.22$	$F1(DF=16,27) = 2.24$	REJECTED
H2	$F2 = 4.91$	$F2(DF=14,27) = 2.35$	REJECTED
H3	$F3 = 1.61$	$F3(DF=2,27) = 19.5$	ACCEPTED

A) LSDV = LEAST SQUARES WITH DUMMY VARIABLES.

B) $S \dots S3$ = INDIVIDUAL RESIDUAL SUM OF SQUARES OF THE
EXPANSIONIST MODEL FOR EACH HYPOTHESIS (H1.....H3) FOR 1971-1987.

$$C) F1 = \frac{(S1 - S) / (43 - 27)}{S/27}$$

$$F2 = \frac{(S2 - S) / (41 - 27)}{S/27}$$

$$F3 = \frac{(S3 - S) / (29 - 27)}{S/27} \quad (\text{MADDALA, 1977}).$$

TABLE VIII
HYPOTHESES TESTING OF THE LSDV RESULTS FOR THE COMPETITIVE
MODEL FOR 1971-1987^A

DIFFERENT INTERCEPTS & SLOPES		$S^B = .98$	DF = 154
COMMON INTERCEPT & SLOPE	(H1)	$S1^B = 2.36$	DF = 184
COMMON SLOPE & DIFFERENT INTERCEPTS	(H2)	$S2^B = 1.14$	DF = 174
COMMON INTERCEPT & DIFFERENT SLOPES	(H3)	$S3^B = 1.06$	DF = 164

	COMPUTED F_C^C	CRITICAL F (AT 5%)	$F_C > F_t$
H1	$F1 = 5$	$F1(DF=30,154) = 1.62$	REJECTED
H2	$F2 = 1$	$F2(DF=20,154) = 1.84$	ACCEPTED
H3	$F3 = 1$	$F3(DF=10,154) = 2.54$	ACCEPTED

A) LSDV = LEAST SQUARES WITH DUMMY VARIABLES.

B) $S, \dots, S3$ = INDIVIDUAL SUM OF SQUARES OF THE COMPETITIVE
MODEL FOR EACH HYPOTHESIS (H1....H3) FOR 1971-1987.

$$C) F1 = \frac{(S1 - S) / (184 - 154)}{S/154}$$

$$F2 = \frac{(S2 - S) / (174 - 154)}{S/154}$$

$$F3 = \frac{(S3 - S) / (164 - 154)}{S/154} \quad (\text{MADDALA, 1977}).$$

(Tables IX and X). LSDV was used to test for the homogeneity of the regression coefficient, but the data could be pooled according to the disturbance behavior. Seemingly unrelated regressions (SUR) assumes that the disturbance is stochastic; SUR is more efficient than OLS, if a researcher believes that there is a high correlation between the cross-sectional unit's residuals and not over time. This model was tested by estimating each cross-sectional residual and then analyzing the correlation matrix between the cross-sectional unit's residuals. There was a correlation between the cross-sectional unit's residuals although it was not high.

After different pooling models were reviewed as alternatives, the decision was made to use the SUR model, because it could not cause any loss in the degree of freedom and it could give aggregate and disaggregate estimates of regression models. This model was found not to be efficient, because the correlation between the cross-sectional units of the residuals was not high enough to increase the reliability of the coefficients. Another technique utilized was cross-sectional correlated and time-wise auto-regressive model (CCTA). This was an appropriate model to use for estimating pooled data. This model assumed that there was heteroskedasticity and a mutual correlation between cross-sectional units and auto-regressive over the time-series units. Also, it was assumed that the disturbance error was randomly distributed. Kmenta (1986) suggested that CCTA was appropriate if the units of analysis were regions or countries; for example, OPEC countries are located in certain regions, and they are developing countries that correlate culturally and ethnically (Danielson, 1988). The CCTA model was

TABLE IX

HYPOTHESES TESTING OF THE LSDV RESULTS FOR THE TARGET
REVENUE MODEL FOR 1971-1987

DIFFERENT INTERCEPTS & SLOPES		$S^B = .214$ DF = 66
COMMON INTERCEPT & SLOPE	(H1)	$S1^B = .591$ DF = 91
COMMON SLOPE & DIFFERENT INTERCEPTS	(H2)	$S2^B = .349$ DF = 86
COMMON INTERCEPT & DIFFERENT SLOPES	(H3)	$S3^B = .284$ DF = 71

	COMPUTED F_c^C	CRITICAL F (AT 5%)	$F_c > F_t$
H1	$F1 = 5.03$	$F1(DF=25,66) = 1.82$	REJECTED
H2	$F2 = 2.26$	$F2(DF=20,66) = 1.95$	REJECTED
H3	$F3 = 9.27$	$F3(DF=5,66) = 4.43$	REJECTED

A) LSDV = LEAST SQUARES WITH DUMMY VARIABLES.

B) $S \dots S3$ = INDIVIDUAL RESIDUAL SUM OF SQUARES OF THE TARGET
REVENUE MODEL FOR EACH HYPOTHESIS (H1...H3) FOR 1971-1987.

$$(S1 - S) / (91 - 66)$$

$$C) F1 = \frac{(S1 - S) / (91 - 66)}{S/66}$$

$$F2 = \frac{(S2 - S) / (86 - 66)}{S/66}$$

$$F3 = \frac{(S3 - S) / (71 - 66)}{S/66} \quad (\text{MADDALA, 1977}).$$

TABLE X
HYPOTHESES TESTING OF THE LSDV RESULTS FOR THE PROPERTY
RIGHTS MODEL FOR 1971-1982^A

DIFFERENT INTERCEPTS & SLOPES		$S^B = .24$	DF = 78
COMMON INTERCEPT & SLOPE	(H1)	$S1^B = 42.78$	DF = 94
COMMON SLOPE & DIFFERENT INTERCEPTS	(H2)	$S2^B = 34.92$	DF = 87
COMMON INTERCEPT & DIFFERENT SLOPES	(H3)	$S3^B = -2720$	DF = 87

	COMPUTED F_c^C	CRITICAL F_t	$F_c > F_t$
H1	$F1 = 886.25$	$F1(DF=16,78) = 2.11$	REJECTED
H2	$F2 = 1284.44$	$F2(DF=9,78) = 3.01$	REJECTED
H3	$F3 = 1260.56$	$F3(DF=9,78) = 3.01$	REJECTED

A) LSDV = LEAST SQUARES WITH DUMMY VARIABLES.

B) $S, \dots, S3$ = INDIVIDUAL RESIDUAL SUM OF SQUARES OF THE PROPERTY RIGHTS MODEL FOR EACH HYPOTHESIS (H1....H3) FOR 1971-1982.

$$(S1 - S) / (94 - 78)$$

$$C) F1 = \frac{(S1 - S) / (94 - 78)}{S/78}$$

$$F2 = \frac{(S2 - S) / (87 - 78)}{S/78}$$

$$F3 = \frac{(S3 - S) / (87 - 78)}{S/78} \quad (\text{MADDALA, 1977}).$$

found to be efficient for pooling the data. Overall, comparing alternative pooling models provided more accurate and efficient estimates than just using a single pooling model.

CARTEL MODEL

Because of its efficiency, the CCTA model was selected to pool the data for the cartel model. The data were stacked into diagonal blocks of cells, with each block containing only the records of each country. The number of armed attacks was selected to represent the internal political instability of OPEC countries. It seemed that the data reported in this variable was more accurate and that the number of armed attacks was the only significant political variable. The estimated pooled model for 11 OPEC members (excluding Ecuador and Gabon) for the 1971-1987 period is thus shown below with standard errors in parentheses:

$$\begin{aligned} \text{Log } Q_{it} = & 2.18 - .06 \text{ Log } RP_{it} + .04 \text{ Log } EX_{it} + .16 \text{ Log } CAB_{it} \\ & (.30) \quad (.01) \quad (.01) \quad (.02) \\ & + .41 \text{ Log } Q^{\infty}_{it} - .26 \text{ Log } POP_{it} - .001 \text{ Log } ATT_{it} - .16 \text{ Log } \frac{R}{Q^{\circ}_{it}} \\ & (.05) \quad (.17) \quad (.001) \quad (.02) \\ \text{Buse } R^2 = & .75 \text{ (see Appendix A)} \quad N = 187 \end{aligned}$$

The coefficient of other OPEC countries' production was significant and positive. Furthermore, the price coefficient was significant and negative. The negative price coefficient could be explained by the fact that OPEC varied its market share according to its oil prices and was willing to sacrifice some of its market share in order to keep the price at a high level. Therefore, the constant

market-sharing hypothesis ($B_4 = 1, B_1 = 0$) and the market-sharing hypothesis ($B_4 = 1, B_1 > 0$) were rejected. OPEC partially shared the oil market; this led to the acceptance of the partial market-sharing hypothesis ($B_4 > 0, B_1 > 0$). The partial-sharing hypothesis indicated that OPEC was a cartel but that it was not fully effective. Ineffective coordination of price and production quotas suggested that OPEC had internal disputes over which price and output best served each country's interest. To control other factors that could explain these different interests and the OPEC market share stability, additional economic and sociopolitical variables were included in the model. It was expected that the exchange rate, which measures the value of dollars to foreign currency, would affect OPEC's production negatively. The coefficient of the exchange rate was significant, and it had a positive effect on OPEC's production. The decline in value of the dollar in 1985 might have contributed to the change in this coefficient.

The CAB was introduced into the model as a proxy to denote the wealth of each country. In the 1980s, most of the OPEC countries experienced deficits in their current accounts. The deficits could have been reduced if the production had been increased to a reasonable level. This meant that a decrease in the CAB deficit could have led to an increase in the production level and consequently an increase in oil revenue. It was thus anticipated that the sign of the CAB coefficient would be negative. However, the coefficient of the OPEC CAB was positive and significant. The positive sign of the CAB might have been caused by the simultaneous problem between OPEC's production and the CAB. Therefore, the CAB lagged one period, but this lag did not solve the problem. Another attempt

to solve the simultaneous problem was not to use CAB. However, the result was not satisfactory; therefore, the final decision was to leave the CAB and keep the original specification of the model. Furthermore, the effect of the CAB deficit was not negative on the production that might have contributed to the sharp increase in OPEC's real prices through the period of 1979-1982. This price increase created surpluses in OPEC's CAB during the same period, while there was a deficit during the 1982-1987 period. Borrowing from the foreign reserve could not be ruled out, because it eased the pressure on increasing production. Also, large-scale economic development projects were completed in the 1980s in some OPEC countries, such as Saudi Arabia. Furthermore, there were surpluses in the CABs of Kuwait, U.A.E., and Qatar through the period of the analysis; these surpluses might have offset the effect of the increased production in the pooled model.

It was hypothesized that the political and social variables would have an impact on OPEC's production. The armed attacks and the population growth rate were representative of political instability and social pressure, respectively. The population growth was expected to be positive, but it turned out to be negative and not significant. The political variable was expected to be negative, because political instability could disrupt production and consequently could create uncertainty about the future. It was not significant at 5 percent, but it was significant at 10 percent, and the coefficient was $(-.001)$.

The coefficient of the reserves-to-production ratio as a measure of excess capacity was a negative and significant factor, which reflected the fact that OPEC's production decreased and the reserves-to-production ratio increased through the

1980s, except for the 1986 period, when OPEC's production increased and the reserves-to-production ratio decreased at the same time. Thus, the excess capacity was a result of the cartel's behavior of restricting its output. In a competitive market, the coefficient would have been expected to be positive.

The pooled model suggested that OPEC behaved as a loose cartel. The model gave a picture of OPEC's behavior as a whole, but it did not explain each individual member's behavior; so it was very important to analyze each individual member's market share behavior based on the estimate of each individual member's regression for the 1971-1987 period. The regressions of the individual member countries offered very detailed information about the countries' production behavior, even though the coefficients' estimates were less reliable than that in the pooled model. Therefore, each individual regression was compared with the pooled model. Table XI shows the results of the 11 countries' regressions.

The Saudi Arabian model showed the oil price coefficient to be positive and insignificant. The coefficient for other OPEC production was significant and positive. The elasticity of this coefficient was 1.06, which indicated that Saudi Arabia's market share was constant and its production was very sensitive to other OPEC production. When the Saudi model was compared with the pooled model, the results suggested that Saudi Arabia was willing to reduce its market share for a higher oil price. Therefore, it appeared that Saudi Arabia's behavior ranged from constant market-sharing to partial market-sharing. Also, Saudi Arabia's coefficient of the reserves-to-production ratio was negative and significant. This finding indicated that Saudi Arabia had reduced its production by 50 percent; this

TABLE XI

POOLED MODEL (CCTA) AND CARTEL RESULTS FOR 11 OPEC MEMBERS FOR
1971-1987^A

	LOGRP	LOGEX	LOGCAB	LOGQOO	LOGPOP	LOGATT	LOGR/QO	R ²
CCTA1 ^B	-.06* (.01) ^C	.04* (.01)	.16* (.02)	.41* (.05)	-.26 (.17)	-.001** (.001)	-.16* (.02)	
SAUDI	.16 (.20)	.91 (1.37)	-.01 (.14)	1.06* (.30)	-.25 (1.15)	.01 (.01)	-.49* (.22)	.90
IRAN	-.16 (.17)	1.69* (.44)	.25 (.37)	.60 (.31)	2.12 (4.02)	-.001 (.001)	-.71* (.21)	.93
IRAQ	-.17 (.13)	1.56 (1.69)	.39* (.15)	1.01* (.12)	-3.5 (2.9)	.001 (.004)	-.30 (.10)	.94
KUWAIT	-.40* (.14)	.01 (.33)	.36 (.23)	.78* (.23)	-.05 (2.45)	.03 (.02)	.02 (.18)	.96
VENEZUELA	-.10* (.03)	-.11 (.06)	.08 (.05)	-.02 (.06)	85.29 (344)	-.004 (.004)	-.49* (.04)	.98
QATAR	-.08 (.07)	-.13 (.21)	.14 (.10)	.70* (.13)	-.09 (.45)	-.02 (.13)	-.20 (.13)	.86
LIBYA	-.24* (.07)	1.44 (.92)	.16 (.13)	.79* (.06)	-.33 (.86)	-.02 (.01)	-.004 (.03)	.94
INDONESIA	.05 (.04)	-.03 (.22)	-.14 (.37)	.78* (.12)	.17 (.61)	-.01 (.01)	-.13 (.13)	.95
U.A.E.	.16* (.05)	-.13* (.04)	-.19 (.14)	1.04* (.11)	-.88 (.57)	-.01 (.02)	-.30* (.14)	.91
ALGERIA	-.08 (.09)	.09 (.10)	-.26 (.22)	.74* (.05)	-.001 (1.26)	.01 (.04)	-.09 (.04)	.96
NIGERIA	.14* (.06)	.01 (.07)	.07 (.19)	.51* (.08)	110* (34.88)	.004 (.004)	-.66* (.13)	.97

* SIGNIFICANT AT 5% LEVEL. ** SIGNIFICANT AT 10% LEVEL.

A) CCTA IS CROSS-SECTIONAL CORRELATED AND TIME-WISE AUTO-REGRESSIVE MODEL.

B) BUSE R² = .75.

C) STANDARD ERRORS ARE IN PARENTHESES.

reduction had led to a 1-percent increase in its excess capacity. It was true that Saudi Arabia cut its production 50 percent or more after 1982.

Because the other OPEC production coefficient was positive in Saudi Arabia's cartel model, it did not act as a dominant producer in varying its production inversely to other OPEC production. But this analysis was extended to test whether Saudi Arabia in the 1980s acted as a world oil market clearinghouse in order to stabilize the world's oil prices, applying the Al-Sahlawi (1986) model of Saudi Arabia's oil supply. Thus, Saudi Arabia's production (Q_S) was regressed on its real oil price deflated by the U.S. GDP 1982 deflator, on non-OPEC production (P^o), and on OPEC production excluding Saudi Arabia's production (Q^{oo}) for the 1971-1987 period; the model's results, with the standard errors in parentheses, are shown below:

$$\text{Log } Q_{S_t} = .02 + .17 \text{ Log } RP_t - .197 \text{ Log } P_t^o + 1.00 \text{ Log } Q_t^{oo}$$

(.04) (.13) (.48) (.44)

$$R^2 = .92$$

The real oil price coefficient was positive and significant. The coefficient of other OPEC production was positive and significant, which indicated that Saudi Arabia was not acting as a dominant producer from 1971 to 1987; otherwise, it would have varied its production inversely to other OPEC production (Figure 10). The coefficient of non-OPEC production was negative, but it was not significant. This meant that Saudi Arabia acted as a dominant producer in the world oil market, but that it did not cut its production significantly over the long range of 17 years.

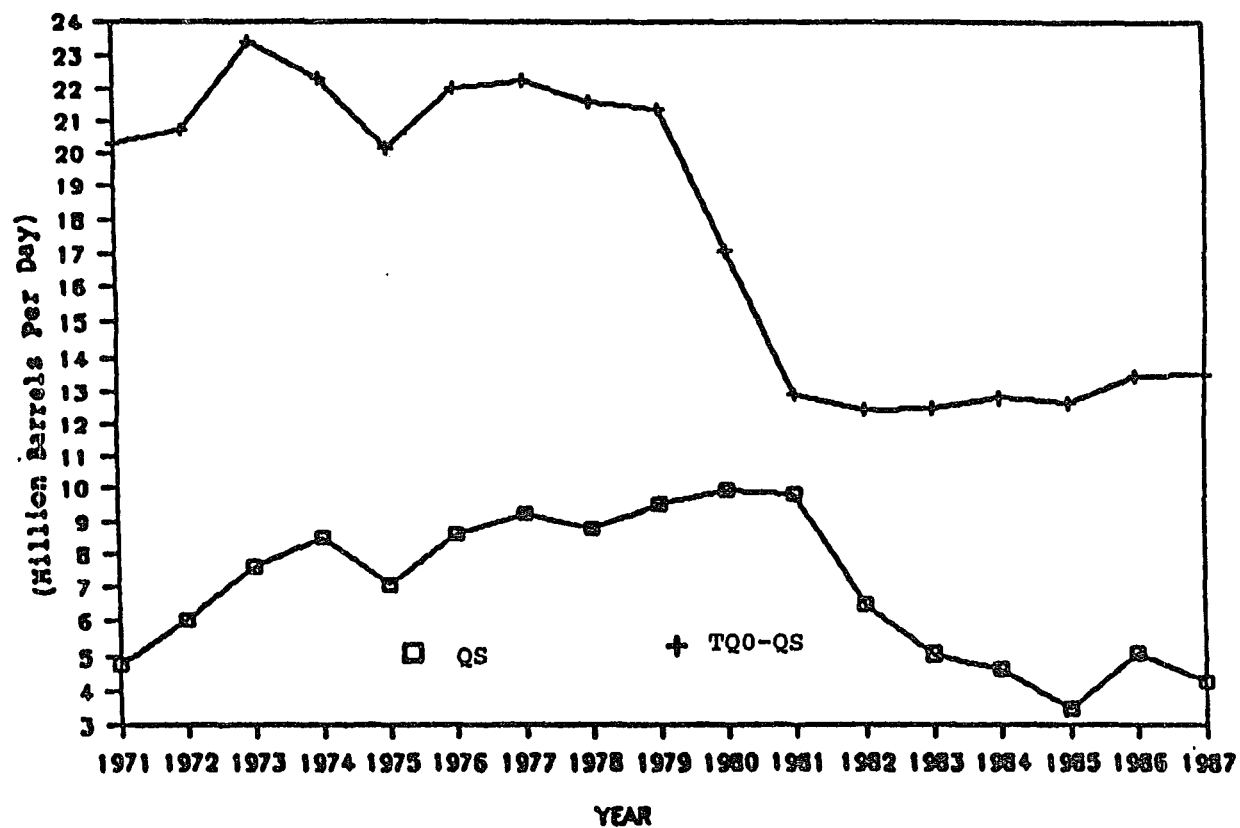


Figure 10. Saudi production (QS) and total OPEC production (TQ0-QS) excluding Saudi production for 1971-1987.

The OPEC literature indicated that Saudi Arabia acted as a stabilizer in the world oil market from 1981 to 1985 (Al-Sahlawi, 1986). The Chow-test was performed to identify when Saudi Arabia changed its role. It was found that the shift occurred between the 1971-1980 and 1981-1987 periods. The 1971-1987 period was divided into the two periods of 1971-1980 and 1981-1987. The model's result for the 1971-1980 period is shown below, with standard errors in parentheses:

$$\text{Log } Q_{tS} = -7.29 + .21 \text{ Log } RP_t + 1.31 \text{ Log } P_t^\circ + 1.26 \text{ Log } Q_t^{\circ\circ}$$

(2.8) (.04) (.40) (.39)

$$R^2 = .86$$

If Saudi Arabia acted as a dominant producer in the world oil market, then the coefficient of P° would have been negative and significant; a sign of $Q^{\circ\circ}$ would have also indicated that Saudi Arabia was a dominant producer within OPEC. The other OPEC and non-OPEC production coefficients for the 1971-1980 period were positive and significant, and they indicated that Saudi Arabia did not act as a dominant producer in either market. The dominant-producer theory for Saudi Arabia was rejected in an economic sense; but the model did not consider the political factors' influence on OPEC's production decisions despite the fact that the OPEC organization is a political as well as an economic one.

The test for the 1981-1987 period is shown below, with the standard errors in parentheses:

$$\text{Log } Q_t^S = 1.67 + .22 \text{ Log } RP_t - 4.51 \text{ Log } P_t^\circ + 5.18 \text{ Log } Q_t^{\circ\circ}$$

(3.9) (.12) (.32) (.78)

$$R^2 = .98$$

This result showed that Saudi Arabia was a dominant producer in the world oil market and that it varied its oil production inversely to non-OPEC production during the 1981-1987 period, because the P° coefficient was significant and negative (Figure 11). But the other OPEC production coefficient ($Q^{\circ\circ}$) was positive and significant, which rejected the dominant-producer model of Saudi Arabia in the same way that the previous model did. Saudi Arabia met the first condition of being a dominant producer, because it has the highest proven oil reserve in the world with a very high production capacity. The second condition, the action of Saudi Arabia that determined its position as a leader in the oil market, was rejected by OPEC producers. At the end of 1985, Saudi Arabia abandoned its role as residual supplier because non-OPEC production increased and some OPEC members violated their quotas (Mead, 1986).

Kuwait's and Libya's price coefficients were negative and significant, whereas other OPEC production coefficients were positive and significant. The reserves-to-production ratio coefficients were not significant, and this finding suggested that those countries were sacrificing their market shares for higher prices. The partial market-sharing hypothesis was accepted for these two countries. In Venezuela's model, the only coefficient that was significant was the

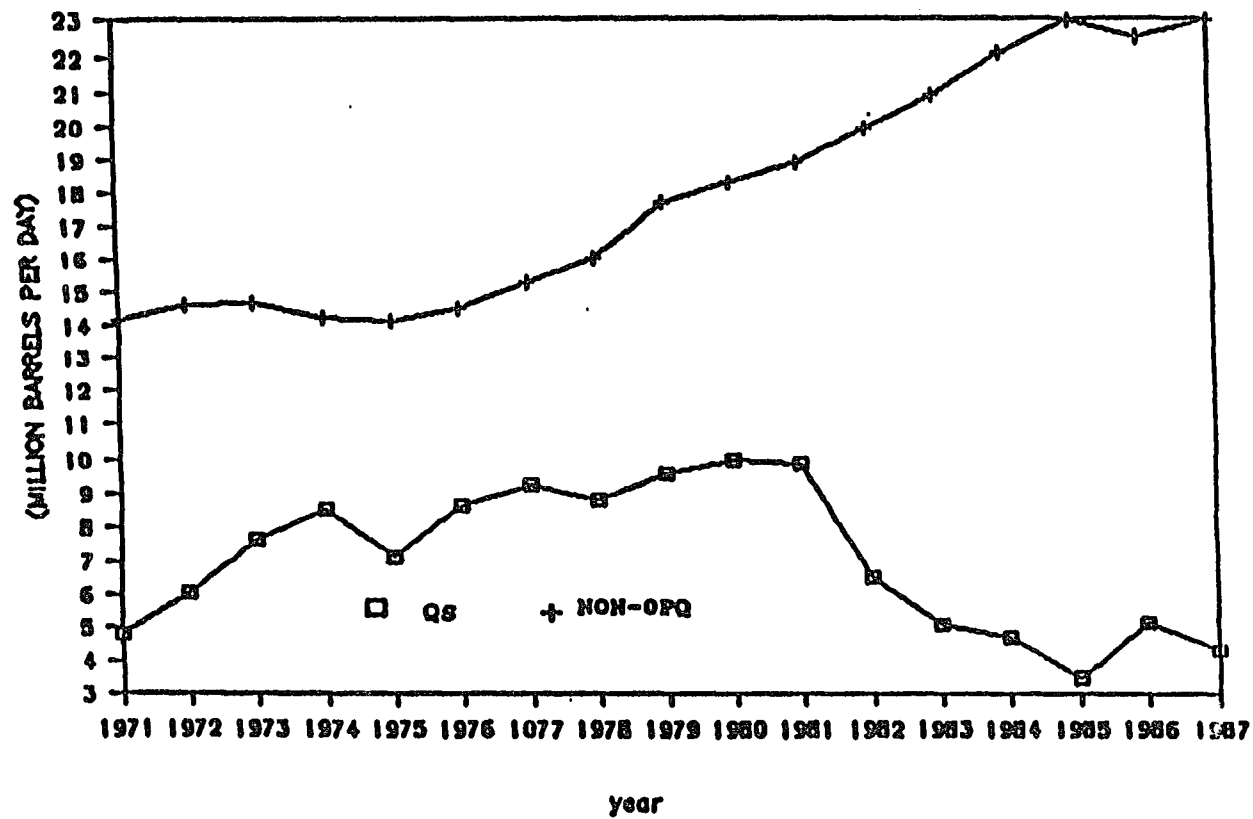


Figure 11. Saudi production (QS) and non-OPEC production (NON-OPQ) total excluding communist production for 1971-1987.

reserves-to-production ratio and it was negative. In general, this country's behavior was consistent with the general view of the price-pusher group.

Indonesia's and Nigeria's models showed that the prices and other OPEC production coefficients were positive and significant. Also, their reserves-to-production ratios were negative and significant. Nigerian population growth was positive and significant, indicating the need for more oil production to generate more revenues. The partial market-sharing hypothesis could not be rejected, and this is consistent with the expansionist's output behavior.

U.A.E.'s coefficient of other OPEC countries' production was unitary and significant, while its price was positive and significant. The exchange rate coefficient was negative and significant. Its reserves-to-production ratio was negative and significant. The outcome of this reflected the position of U.A.E.: it demanded a higher production quota, despite its low population and lesser income needs. The market-sharing hypothesis was accepted for U.A.E. Iran's model showed that the exchange rate coefficient was significant and positive. This might reflect its need for hard currencies. The reserves-to-production ratio was significant and negative. This might have resulted from the war, which limited its production capacity. But the coefficient sign of the price was consistent with the general behavior of Iran as a price-pusher. Iraq's coefficient of other OPEC countries' production was positive and significant, whereas the price coefficient was negative and not significant. The ratio of reserves to production was significant and negative. The coefficient of CAB was expected to be negative, but was positive and significant. The market-sharing hypothesis was accepted.

Qatar's and Algeria's models showed that the other OPEC countries' production coefficients were positive and significant, while the coefficients for price were negative and insignificant. The reserves-to-production ratio was negative and insignificant for both. This seemed to fit the constant market-sharing hypothesis.

The results of the cartel models were compared with those of Griffin's (1985) cartel models (Table XII). The other OPEC countries' production coefficients (Q^o) were very consistent with Griffin's estimates. The price coefficients of Kuwait, Libya, and U.A.E. were consistent with his estimates, while the other countries' price coefficients were not significant but were close in their magnitude to Griffin's (1985) estimates. However, the insignificance of these countries' price coefficients could be attributed to the large number of variables used in the cartel model, a few observations, and the change in oil production and prices after 1983, which Griffin's study did not cover.

The OPEC countries were grouped according to core, price-pusher, and expansionist groups (Eckbo, 1979). First, it was useful to test OPEC's production behavior for each group to identify common behavior after including the non-economic factors. Second, in a statistical sense, it was meaningful to compare each individual country's regression coefficients with the LSDV coefficients of the different hypotheses (H_1 , H_2 , and H_3) as another alternative to check for efficiency and consistency. It was expected that LSDV for each group would be more efficient than the estimate of each individual's regression, because LSDV had a higher degree of freedom.

TABLE XII
COMPARISON OF THIS STUDY'S CARTEL RESULTS AND GRIFFIN'S (1985)
CARTEL RESULTS

	FAHED(1990) CARTEL RESULTS			GRIFFIN(1985) CARTEL RESULTS		
	LOGRP	LOGQ00	\bar{R}^2	LOGP	LOGQ00	\bar{R}^2
SAUDI	.16 (.20)	1.06* (.30)	.90	.29 (.04)	.74 (.13)	.49
IRAN	-.16 (.17)	.60 (.31)	.93	.05 (.02)	.88 (.15)	.69
IRAQ	-.17 (.08)	1.01* (.12)	.94	.29 (.05)	-.06 (.48)	.49
KUWAIT	-.40* (.14)	.78* (.23)	.96	-.39 (.03)	1.41 (.12)	.90
VENEZUELA	-.10* (.03)	-.02 (.06)	.98	-.25 (.02)	.17 (.08)	.75
QATAR	-.08 (.07)	.70* (.13)	.86	-.03 (.02)	.88 (.08)	.73
LIBYA	-.24* (.07)	.79* (.06)	.94	-.27 (.05)	.72 (.18)	.59
INDONESIA	.05 (.07)	.78* (.12)	.95	.26 (.02)	.56 (.06)	.83
U.A.E.	.16* (.05)	1.04* (.11)	.91	.20 (.02)	1.00 (.08)	.80
ALGERIA	-.08 (.09)	.74* (.05)	.96	.005 (.02)	.74 (.07)	.69
NIGERIA	.14* (.06)	.51* (.08)	.97	.10 (.03)	1.13 (.11)	.68

* SIGNIFICANT AT 5% LEVEL.
A) STANDARD ERRORS ARE IN PARENTHESES.

The hypotheses of overall homogeneity (H_1) and partial homogeneity of the slope's coefficients (H_2) were rejected for the core group; these countries did not behave the same way, and this difference contradicted the general view of this group's behavior. This group was pooled according to the partial homogeneity of a common intercept and different slopes (H_3). Table XIII shows the LSDV results for this group. The LSDV results were compared with those for each individual member of this group. The overall results were consistent with the individual member's results, but the individual member's results were more efficient than these for LSDV.

The price-pusher group was pooled according to the hypotheses of common slope and different intercepts (H_2) and common intercept and different slopes (H_3) as shown in Tables XIV and XV. LSDV (H_2) indicated that the price coefficient was negative and significant, whereas the other OPEC production coefficient was positive and significant. Also, the exchange rate and CAB coefficients were significant and positive. The coefficient for the population growth rate was negative and significant. This was the only group for which the coefficient of armed attacks was significant and negative as expected. The reserves-to-production ratio was negative and significant. Thus, the partial market-sharing hypothesis was accepted. The behavior of this group was consistent with the price pushers' behavior, because this group was willing to sacrifice some of its market share for higher oil prices.

TABLE XIII
CORE COUNTRIES (LSDV, H3) RESULTS FOR 1971-1987^A

	LOGRP	LOGQ00	LOGEX	LOGCAB	LOGPOP	LOGATT	LOGR/Q0
SAUDI	.17 (.14) ^B	1.09* (.15)	.59 (.55)	-.09 (.10)	-.23 (.77)	.005 (.01)	-.50* (.14)
QATAR	-.05 (.11)	.67* (.17)	.41 (.48)	.09 (.15)	.07 (.50)	-.02 (.03)	-.43* (.16)
LIBYA	-.25* (.08)	.55* (.12)	.99* (.44)	.21 (.13)	.08 (.85)	-.01 (.02)	-.001 (.04)
U.A.E.	.07 (.08)	.67* (.16)	-.07 (.08)	-.09 (.13)	.23 (.88)	-.006 (.01)	-.37* (.17)
KUWAIT	-.16 (.14)	.68* (.21)	.60 (.41)	.24 (.18)	.82 (1.6)	.01 (.01)	-.31 (.18)

* SIGNIFICANT AT 5% LEVEL.

A) LSDV IS THE LEAST SQUARES WITH DUMMY VARIABLES. H3 IS THE
HYPOTHESIS OF COMMON INTERCEPT AND DIFFERENT SLOPES.

B) STANDARD ERRORS ARE IN PARENTHESES.

TABLE XIV
PRICE-PUSHER CUNTRIES (LSDV, H2) RESULTS FOR 1971-1987^A

LOGRP	LOGQ00	LOGEX	LOGCAB	LOGPOP	LOGATT	LOGR/Q0
-.12* (.02) ^B	.35* (.10)	.11* (.02)	.36* (.12)	-3.76* (1.45)	-.003* (.001)	-.29* (.05)

TABLE XV
PRICE-PUSHER COUNTRIES (LSDV, H3) RESULTS FOR 1971-1987^C

	LOGRP	LOGQ00	LOGEX	LOGCAB	LOGPOP	LOGATT	LOGR/Q0
IRAN	-.07 (.11)	.80* (.20)	1.39* (.29)	.1* (.25)	1.69* (2.86)	-.00* (.001)	-.77* (.15)
VENEZUELA	-.08 (.10)	.01 (.34)	-.004* (.27)	.05* (.19)	156.38* (68.29)	-.004 (.009)	-.56 (.29)
ALGERIA	-.12 (.10)	.55* (.10)	.12 (.11)	-.22 (.28)	-.62 (1.5)	.01 (.01)	-.11 (.06)

* SIGNIFICANT AT 5% LEVEL.

A) LSDV IS THE LEAST SQUARES WITH DUMMY VARIABLES. H2 IS THE HYPOTHESIS OF COMMON SLOPE AND DIFFERENT INTERCEPTS.

B) STANDARD ERRORS ARE IN PARENTHESES.

C) H3 IS THE HYPOTHESIS OF COMMON INTERCEPT AND DIFFERENT SLOPES.

For the expansionist group, the hypotheses of overall homogeneity (H_1) and partial homogeneity of the slope's coefficients (H_2) were rejected. These countries' production behavior was not consistent with the common view of expansionist behavior. The hypothesis of common intercept and different slopes (H_3) was accepted for this group. The data were pooled according to this hypothesis, and the results are shown in Table XVI. These results did not contradict the model results for the individual members of this group. However, each individual country's model results were more efficient than the LSDV results.

COMPETITIVE MODEL

As could be seen from the outcome of this project, the cartel model did indeed explain OPEC's behavior; thus, the test of the competitive model was primarily to further clarify OPEC's behavior. The estimate of the competitive model for the 11 OPEC countries for the 1971-1987 period (excluding Ecuador and Gabon) is as follows, with standard errors in parentheses:

$$\begin{aligned} \text{Log } Q_{it} = & 1.91 - .05 \text{ Log } RP_{it} + .18 \text{ Log } R_{it} - .06 \text{ Log } RP_{it-1} \\ & (.22) \quad (.01) \quad (.03) \quad (.01) \\ & + .14 \text{ Log } R_{it-1} \quad \text{Buse } R^2 = .40 \quad N = 187 \\ & (.03) \end{aligned}$$

The coefficient of the price was negative and significant. This finding contradicted the premise of the competitive model. OPEC did not respond to the change in oil price and vary its production as it should have done in a competitive

TABLE XVI
EXPANSIONIST COUNTRIES (LSDV, H3) RESULTS FOR 1971-1987^A

	LOGRP	LOGQ00	LOGEX	LOGCAB	LOGPOP	LOGATT	LOGR/Q0
IRAQ	-.13 (.10) ^B	.98* (.09)	.23 (.49)	.45* (.10)	-3.06 (2.15)	-.00 (.002)	-.29* (.10)
INDONESIA	.02 (.07)	.70* (.14)	-.13 (.24)	-.07 (.40)	.12 (.67)	.01 (.02)	-.15 (.14)
NIGERIA	.14 (.08)	.54* (.25)	.01 (.10),	.07 (.20)	72.70 (47.93)	.01 (.01)	-.67* (.17)

* SIGNIFICANT AT 5% LEVEL.

A) LSDV IS THE LEAST SQUARES WITH DUMMY VARIABLES. H3 IS THE
HYPOTHESIS OF COMMON INTERCEPT AND DIFFERENT SLOPES.

B) STANDARD ERRORS ARE IN PARENTHESES.

market. The competitive model did not offer any further explanation of OPEC's behavior.

TARGET REVENUE MODEL

The target revenue model was utilized for 6 of OPEC's 13 members. The countries were Saudi Arabia, Venezuela, Kuwait, Indonesia, Algeria, and Nigeria, for which data were available on the four independent variables. The target revenue model for the 1971-1987 period with standard errors in parenthesis is as follows. The strict version of the target revenue theory ($B_2 = 1$, $B_1 = 1$) states that investment needs have an impact on OPEC's production decisions and that OPEC varies its production according to investment needs, measured by the gross fixed capital formulation, the CAB, and foreign reserves as follows, with standard errors in parentheses:

$$\begin{aligned} \text{Log } Q_{it} = & 2.86 - .11 \text{ Log } RP_{it} + .13 \text{ Log } GFC_{it-1} + .13 \text{ Log } FR_{it-1} \\ & (.10) \quad (.05) \quad (.06) \quad (.03) \\ & +.0001 \text{ Log } CAB_{it-1} \quad \text{Buse } R^2 = .33 \quad N = 102 \\ & (.005) \end{aligned}$$

The real oil price coefficient was negative and insignificant, whereas the GFC coefficient was positive and significant. The pooled model and the regression of individual countries rejected the strict version of the target revenue model. However, the investment needs could have had some influence on OPEC's production ($B_2 > 0$, $B_1 < 0$); the pooled model rejected this version too. The regression models for Kuwait and Algeria showed that the investment and price

coefficients were significant. Thus, the partial version of the target revenue theory could not be rejected for these two countries. This outcome did not mean that the investment needs did not influence OPEC's production, since the investment coefficients for five of the six countries were positive and significant. In addition to investment needs, there were other needs that each individual country might have wanted to satisfy, such as reducing the CAB deficit or building more foreign reserves for long-term needs. This model accounted for these variables. The pooled model showed that the CAB coefficient was negative and insignificant. Only the Algerian regression model produced a CAB coefficient that was negative and significant.

Foreign reserves were included in the target revenue model, in order to control OPEC's borrowing from its own foreign reserves. The foreign reserve coefficient was positive and significant for the pooled model. The individual coefficients were positive and significant for only two countries: Kuwait and Algeria. The foreign reserve data did not show a rapid decline in foreign reserves for each individual country; thus, there was probably no need for an increase in the output, which might have affected OPEC's stability.

PROPERTY RIGHTS MODEL

The property rights model was performed for eight OPEC members (Saudi Arabia, Iran, Libya, Indonesia, U.A.E., Algeria, Nigeria, and Kuwait) for the 1971-

1982 period for which the data were available, with standard errors in parentheses:

$$Q_{it} = 3.21 + .09 \text{ GCP}_{it}$$

(.01) (.01) Buse $R^2 = .28$ $N = 88$

The pooled model showed that the coefficient of government production control (GCP) was positive and significant. The property rights model was consequently rejected for OPEC. However, the individual regressions showed negative and significant signs for Libya and Kuwait only. The prediction of the property rights model was very weak; this weakness could be attributed to misspecification or to the deficiency of the theory itself. It is important to note that there has been a strong disagreement about the effect of the property rights model. Recently, Adelman (1989) has argued that the nationalization of the oil companies by the host countries did not lead to lower discounts, but instead to higher discounts. The property rights model clearly supported Adelman's argument.

CHAPTER VI

IMPLICATIONS

OPEC MARKET SHARE STABILITY

Short-Term

It was evident in this study that a partial market-sharing cartel model best explained OPEC's production behavior. This short-term analysis indicated that the internal cartel market share stability depended on the oil price elasticity of supply, OPEC's oil production, the ratio of reserves to production, the dollar value in relation to foreign currencies, and the CAB. Also, the results showed that OPEC's production was influenced by the political instability of some OPEC members. The price elasticity of supply of $-.06$ indicated that OPEC's production was not sensitive to an increase in the real oil price. But each OPEC member's individual production depended on other OPEC production, which has a moderate elasticity of $.41$. This meant each OPEC member's production is sensitive to other OPEC production and there is potential for quota violation. But if OPEC members cooperate with each other and keep their production up to their agreeable production quotas, the problem could be avoided. Historically, OPEC's quota violations came most often from Kuwait and U.A.E. At the end of 1989, U.A.E.'s over-production was creating serious problems to the cartel in keeping the oil price

at approximately \$18 per barrel (Sullivan and Tanner, 1990). The ratio of reserves to production (as a measure of potential production) has an elasticity of $-.16$. In this situation, OPEC can increase its production with less of an effect on its excess capacity, so that there is no threat to the cartel's market share stability. Therefore, the market share of OPEC has to increase while its reserves-to-production ratio must decline, to maintain the organization's market share stability, because a surplus in the excess capacity and a decreased market share rate would lead to instability of the cartel.

The exchange rate and CAB elasticities were $.04$ and $.16$, respectively. Despite the low elasticity of these two factors, OPEC should take them into account in its production decisions in order to maximize its revenues. The potential for political instability has an impact on OPEC's production decisions, so OPEC should not overlook this matter and should allow some flexibility in its assigned quotas to overcome this problem. Also, previous studies showed that the short-term price elasticities of supply and demand ranged from $-.04$ to $.21$, and from $-.05$ to $.31$, respectively (Table XVII); these findings were consistent with the outcomes of this study. Also, this study indicated that Saudi Arabia acted as a dominant producer in the world oil market in order to stabilize world oil production and prices during the 1981-1987 period. Because Saudi Arabia was trying to stabilize the world oil market and gain non-OPEC cooperation to ease the pressure on its shrinking market share, the world oil market could not be stabilized without the agreement between non-OPEC countries and OPEC countries on the oil prices and production for an agreeable market share distribution.

TABLE XVII
PRICE ELASTICITIES OF OIL DEMAND AND SUPPLY

Demand				
	Short run	Long run	20YEARS	25YEARS
MacAvoy(1982) ^m	-----	-.29		
Griffin(1979) ^m	.31	-.71		
Marquez(1984) ^m	-.05	-.25		
WOMS ^w	-.04	-.335	-.558	-.64
MORRISON ^w	-.065	-.35	-.60	
EMF ^w	-----	----	-----	-.60
SWEENEY ^w	-.09			-.60

Supply				
	Short run	Long run		
E.I.E. ^c	.04	.8		
GATELY, KYLE, FISCHER ^c	.01	.22		
KENNEDY ^c	---	.33		

Source: m) Marquez, 1984; w) Baldwin and Prosser, 1988;
c) MacAvoy, 1982.

Long-Term

The internal and external OPEC market share stability depends not only on the short-term factors discussed above, but also on the long-term factors. Forecasting the OPEC oil supply for five or ten years into the future is a complex process, as uncertainty will always exist. In the long run, all factors that are constant in the short term will change, and what is inelastic can become less inelastic or elastic. Economic, social, and political stabilities can change suddenly in the long term. All this can lead to a supply disruption like the ones that occurred in 1973 and 1979.

OPEC's long-term market share stability will depend on the price elasticity of the crude oil supply, the world demand, non-OPEC production, and the excess capacity of OPEC's production. The higher price elasticity of the world oil demand (-.73) will lead to lower oil production by the cartel and may increase the real oil price to \$32 per barrel by the year 2000, whereas a lower elasticity (-.365) will lead to instability in the core countries' production, which may reduce the real oil price to \$15 per barrel. Other studies, such as Energy Modeling Forum's, had a lower estimated elasticity range of -.375 to -.6 by the year 2000 (Daly, Griffin, and Steele, 1982). Previous literature estimated the long-term elasticity of the oil demand and supply as indicated above.

According to the *International Energy Outlook* (1989), world oil prices are expected to increase from \$18 a barrel in 1990 to about \$35 a barrel in 2000, assuming the trend of high world oil prices continues (Figure 12). The oil

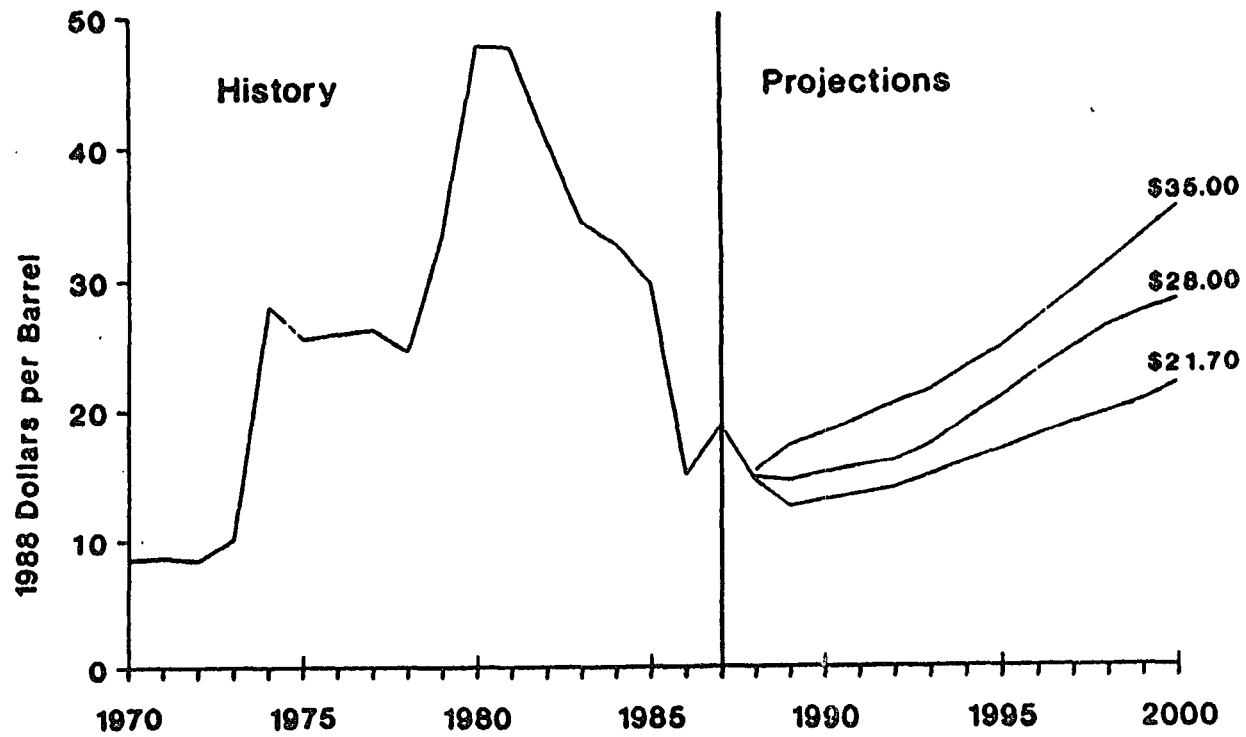


Figure 12. World oil prices for 1970-2000.
Source: International Energy Outlook, Energy Information Administration, 1989.

demand in the market economies will grow slowly for the next five years, as a result of lower world oil prices and economic growth in importing countries. The oil demand will increase from about 48 MBD in 1987 to about 52 MBD by 1993. But the oil demand will increase slightly after 1993, and it will be relatively stable from then until the year 2000, as shown in Figure 13. The oil consumption is predicted to grow in the range of 1 to 2.4 percent in the developing countries, especially the OPEC countries, throughout the 1990s; and the growth of oil consumption for OECD will range from 0 to 1.2 percent through the same period. Excess production capacity will disappear by the year 2000, because of the increase in world oil consumption. In turn, oil prices will rise, and this increase will enable OPEC members to gain power again in the world oil market. OPEC must maintain its quotas through the 1990s to gain more of the market share and higher prices by 2000. A slow world oil demand will not increase the price of oil without reducing the over-production problem. Excess production capacity was evident in 1985, and it will likely continue until 1994. This excess resulted from non-OPEC production, Iraq's production after the cease-fire, and the violation of quotas by some OPEC members. OPEC's demand will be strong by 1995, because non-OPEC production capacity will start to decline and the world demand will increase as a result of low oil prices in the early 1990s. OPEC's production capacity will continue to rise through the 1990s from 28.2 MBD in 1988 to 36 MBD, while non-OPEC production capacity will decline from 27.5 MBD to 24.3 MBD (Table XVIII).

Figure 14 contrasts world oil production capacity, consumption, and excess production capacity; this comparison shows that excess production

TABLE XVIII
OIL PRODUCTION CAPACITY, 1988-2000
(MILLION BARRELS PER DAY)

COUNTRY	ESTIMATED 1988	PROJECTION RANGES		
		1990	1995	2000
UNITED STATES	10.6	9.8-10.2	8.4-9.4	7.8-9.1
CANADA	2.0	1.9-2.1	1.6-1.8	1.4-1.6
MEXICO	2.9	2.9-3.1	3.1-3.4	3.1-3.5
NORTH SEA	3.94.0	4.0-4.3	3.4-3.9	2.9-3.4
OTHER NON-OPEC	8.1	8.4-9.2	7.4-8.5	6.0-7.2
TOTAL NON-OPEC	27.5	27.2-28.6	24.3-26.6	21.6-24.3
ALGERIA	1.2	0.9-1.1	0.9-1.1	0.7-0.9
ECUADOR	0.3	0.2-0.3	0.2-0.3	0.2-0.3
GABON	0.2	0.2-0.3	0.2-0.3	0.1-0.2
INDONESIA	1.5	1.4-1.5	1.2-1.4	1.0-1.2
IRAN	3.0	3.0-4.0	3.5-4.5	3.3-4.5
IRAQ	2.7	3.5-4.5	4.0-5.0	4.5-5.5
KUWAIT	2.5	2.8-3.0	3.0-3.5	3.0-3.8
LIBYA	1.6	1.5-1.7	1.3-1.7	1.3-1.7
NIGERIA	1.7	1.5-1.7	1.2-1.6	1.1-1.5
QATAR	0.6	0.5-0.6	0.4-0.6	0.3-0.5
SAUDI	8.5	8.0-9.5	9.0-10.5	9.5-11.0
U.A.E.	2.0	2.0-2.2	2.2-2.6	2.5-3.0
VENEZUELA	2.4	2.4-2.6	2.5-2.9	2.5-3.0
TOTAL OPEC	28.2	28.6-32.3	30.6-35.0	31.3-36.0
NET OPEX EXPORTS	2.4	2.2-2.7	1.4-2.4	1.0-2.0
TOTAL MARKET ECONOMIES	58.1	58.8-62.7	57.7-62.7	55.4-60.9

SOURCE: International Energy Outlook, Energy Information Administration, 1989.

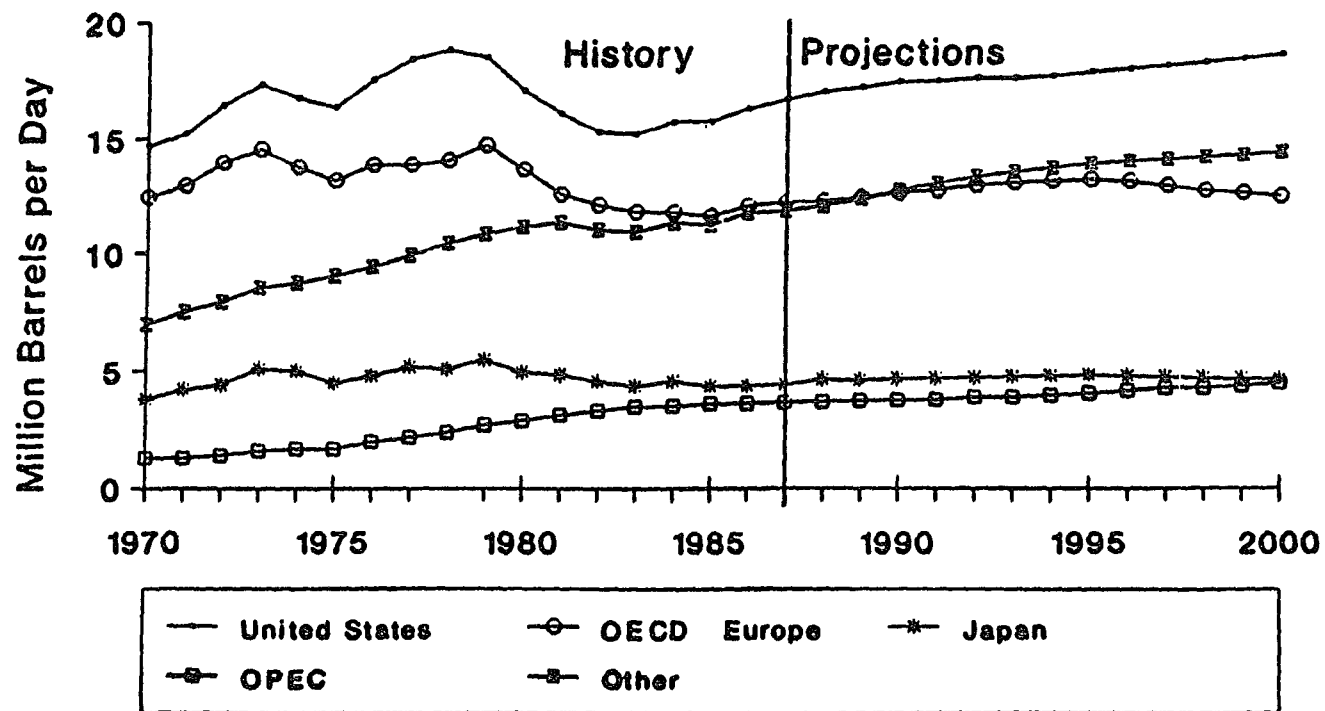


Figure 13. Oil consumption in the market economies for 1970-2000.
 Source: International Energy Outlook, Energy Information Administration, 1989.

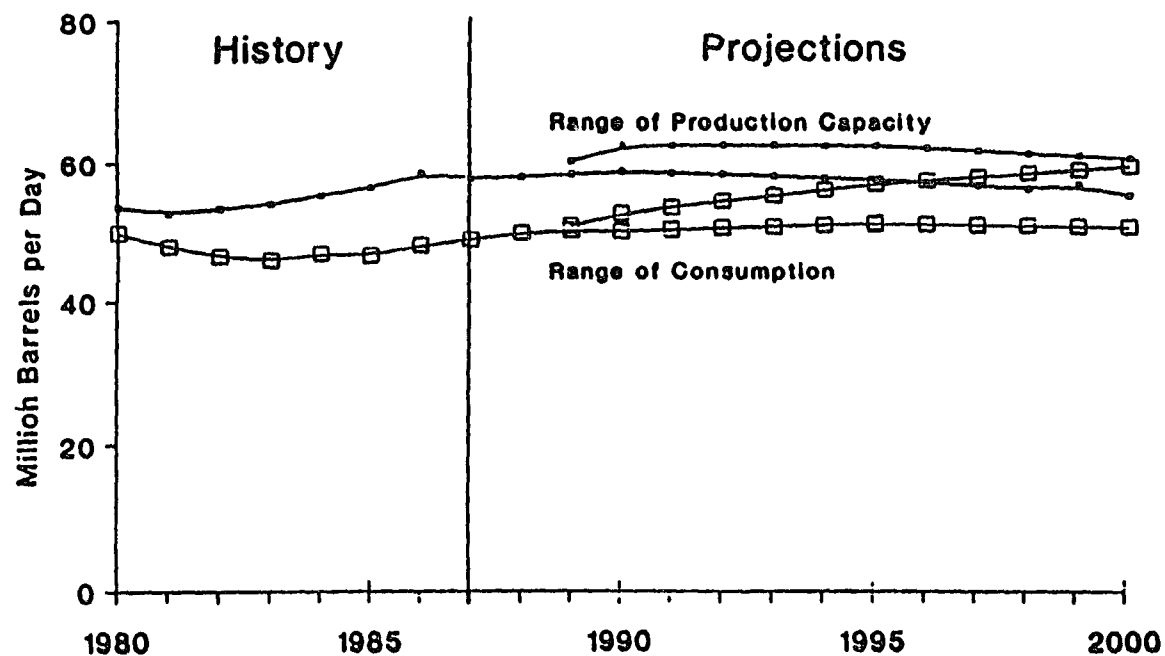


Figure 14. Uncertainty of oil production, capacity, consumption and excess production capacity for 1980-2000.
 Source: International Energy Outlook, Energy Information Administration, 1989.

capacity will decline by 1995, when the world's consumption will increase. This will lead to an increase in OPEC's market share. It is expected that OPEC's market share will increase from 42 percent in 1989 to 53 percent in 2000. Non-OPEC production will continue to increase until 1994, when it will start to decline. Non-OPEC countries will not be able to increase oil discovery rates or reserves, because of low world oil prices. Production capacity and market share are influenced by the price of crude oil and the sum of available resources. High oil prices will increase non-OPEC production and the discovery rate, which will increase OPEC's production. The OPEC countries' excess capacity means a lower market share and higher oil prices, as in the late 1970s and the beginning of the 1980s. OPEC's internal market share can be stabilized if its share in the world oil market increases and its reserves-to-production ratio decreases. Unfortunately, this kind of stabilization did not occur in the late 1970s and the 1980s (Figure 15). The internal and external OPEC market share stability in the future will also be related to non-OPEC production and world energy consumption. Non-OPEC production capacity will decline after 1995, while the world energy demand will be increasing but at a slower rate. Conversely, OPEC will increase its production capacity through the 1990s, if there is no disruption in its production (*International Energy Outlook*, 1989).

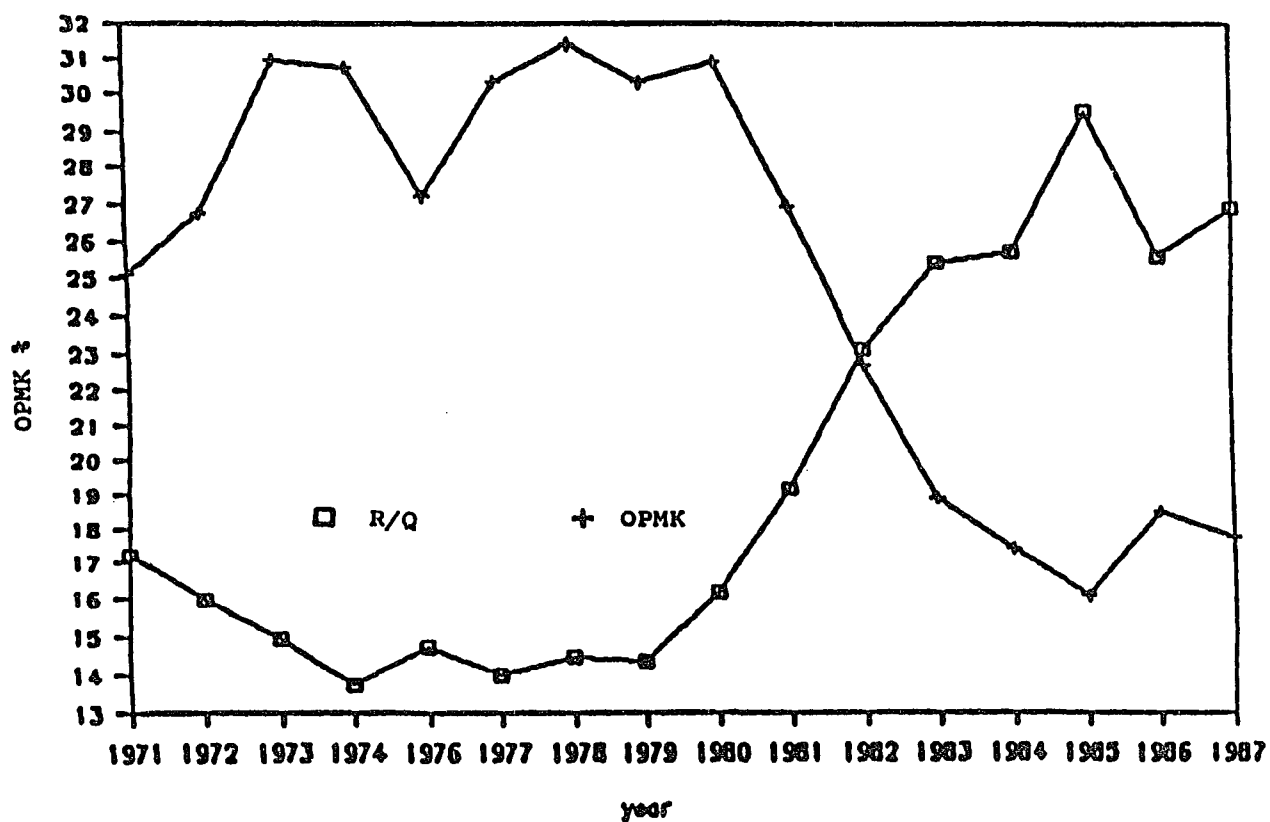


Figure 15. OPEC reserves to production ratio (R/Q) and OPEC's market share (OPMK) of the free world production for 1971-1987.

CHAPTER VII

CONCLUSIONS

The conclusions of this study were that the Chow-test indicated no structural shift in OPEC's overall production behavior between the 1971-1982 and 1983-1987 periods. The CCTA cartel model showed a very significant result, and there was a clear distinction between its result and those of other OPEC models. Therefore, the partial market-sharing hypothesis was confirmed to be significant for all OPEC members included in this study. Furthermore, internal political stability was significant at 10 percent. It was also significant at 5 percent for the price-pusher group (Iran, Venezuela, and Algeria). This was the only group pooled, due to common slope and different intercepts, using LSDV. The price-pusher group's production behavior was consistent with the common view and these countries' behavior; they were accepting lower market shares for higher oil prices. Also, this study found that Saudi Arabia did not act as a dominant producer within OPEC but it did act as a dominant producer in the world oil market through the 1981-1987 period. In general, the CCTA model's results indicate that OPEC's production strategies are irrational, based only on economic factors, without accounting for non-economic factors. Political instability in any

OPEC country can lead to a crisis situation, which will disrupt its oil supply and jeopardize its economic interests.

LIMITATIONS OF THE STUDY

This study was limited by the available data. The OPEC data were deficient, and sometimes the researcher had to use two sources of data and then to check the consistency among these sources. The potential for deficiency can be seen in energy data that has to be revised almost every year.

It was expected that political instability would have a stronger impact on oil production in some OPEC countries, such as Iraq and Nigeria, especially during the 1980s. Historical data on these two countries showed that political instability persisted. This instability might not be captured by the use of annual political data, but it would be captured by the use of monthly or quarterly data. This meant that the effects of political events were stronger in the very short term than in the long term. The unavailability of political information that is updated on a monthly or quarterly basis restricted the use of these data. But annual political data were available for the period from 1971 to 1982, and they had to be coded up to 1987.

Furthermore, the researcher has to wrestle with the question of whether the data on OPEC's decisions about the production and prices really reflected what occurred in every OPEC meeting. Nevertheless, these data are the best available statistical energy data and they have been used by well recognized

energy economists. However, it was the responsibility of the researcher to make the best of the available energy information.

SUGGESTIONS FOR FURTHER RESEARCH

This study was concerned with OPEC's production behavior and its implications in the short and long terms. The political variables were used here to measure the internal political instability of each OPEC country only. The results of this study revealed that political instability certainly did have an impact on OPEC's oil production. Even though this study did find a simple direct relationship between the political instability in OPEC countries and their oil production decisions, more complex relationships should be developed. This study should be expanded to cover more political dimensions.

Further research should be extended to cover the political events that occur among OPEC countries (inter-OPEC countries). Also, the research should not only focus on the negative effects of political instability (conflictive events), but it should examine the positive aspects of political stability (cooperative events).

Furthermore, future research should investigate the political events that occur between OPEC nations and non-OPEC nations. Inclusion of all three aspects of the political environment--intra-country, inter-OPEC nations, and external OPEC political stability--will lead to a comprehensive study of OPEC countries' political instability, which will increase understanding of the relationship between the political instability in OPEC countries and OPEC's production behavior.

Overall, potential research should examine the absolute magnitude of each OPEC member in response to the intensity of political events, in terms of the increase or decrease in these political events and the implication of each country's magnitude for future OPEC production.

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APPENDIX A

POLITICAL VARIABLES AND BUSE R^2 DEFINITIONS

APPENDIX A

POLITICAL VARIABLES DEFINITIONS

An armed attack (705) is an act of violent political conflict carried out by (or on behalf of) an organized group with the object of weakening or destroying the power exercised by another organized group. It is characterized by bloodshed, physical struggle, and the destruction of property. A wide variety of weapons may be used, including guns, explosives (conventional bombs, hand grenades, letter bombs), chemicals, bricks and other primitive hand weapons such as spears, knives or clubs. This category is intended to encompass all organized political violence, although assassinations are coded separately. It excludes all spontaneous violence. Also excluded are activities of organized crime which are not observed to be directly relevant to political cleavages and issues. The target of an armed attack is typically a regime, a government, or a political leader, but it may also be a religious, ethnic, racial, linguistic, or special interest minority. When a government is unable or unwilling to control an insurgency situation by normal sanctions . . . it may also resort to armed attacks. For the 1968-1982 period, whenever possible, armed attacks by governmental and military forces (707) were coded separately from those undertaken by insurgents (706). When it was impossible to determine which side initiated the event, or when a battle or clash was reported, the generic armed attack code (705) was used. All three types were aggregated together in the annual and quarterly series.

Protest demonstration (type: 700) is a non-violent gathering of people organized for the announced purpose of protesting a regime, a government, or one of its leaders; its ideology, policy, or intended policy, or its previous action or intended action. The issues of protest involved are perceived as significant at the national level, but within that framework demonstrations directed at all levels and branches of government are included. This category of events includes demonstrations for or against a foreign government, its leaders, or its visiting representatives when such demonstrations are reported to indicate opposition to the demonstrator's own government. Not included are election meetings and rallies, political parades, and normal holiday celebrations. A residual category of other protests (712) was coded separately for the 1968-1982 period, but was aggregated with demonstrations in the annual and quarterly series.

Political strike is a work stoppage by a body of industrial or service workers or a stoppage of normal academic life by students to protest a regime or its leaders' policies or actions. Strikes which were primarily directed at economic goals (higher wages, better working conditions, shorter hours) were not coded, even if the employer was a public enterprise. If there were a greater political significance to the strike, we coded it. An indicator of such significance would be a political party's or movement's embracing of these economic demands, and supporting and disseminating them with the objective of embarrassing the government, eroding its base of support and even precipitating its fall. For the 1968-82 period[,] we distinguished political strikes involving workers (710) from those involving only students (711). The two were added together in the annual and quarterly series. A political strike may last for many days or weeks, but it was counted as a single event, unless its essential nature changed. For example, a new category of strikers might join in or a new set of goals might be announced. In cases of this sort, a new event was coded.

The imposition of censorship (726) includes actions by the government to limit, to curb, or to intimidate the mass media, including newspapers, magazines, books, radio, and television. Typical examples of such action are the closing of newspapers or journals, the censoring of articles in the domestic press, and the controlling of dispatches sent out of the country. The relaxation of censorship (729) involves the modification or elimination of controls on the mass media. These event types are reported in the daily events file, but they are combined with reports of the imposition and relaxation of other restrictions in the annual and quarterly events file.

The imposition of other political restrictions (727) includes actions taken by the government to neutralize, to suppress, or to eliminate a perceived threat to the security of the government, the regime, or the state itself. Although this category encompasses a diversity of governmental activities, all of them share the characteristic of constituting specific responses to a perceived security problem at the national level even though sanctions are sometimes carried out by subnational governmental units. An attempt has been made to exclude sanctions against criminal behavior that has no political relevance. This does not mean that organized crime or crime in the streets are unimportant or that they do not indicate a degree of social dissatisfaction. Rather, we have tried to maintain a focus on behavior that is directly political, i.e., behavior concerned with the distribution and use of political power in the polity. The relaxation of political restrictions (730) involves the modification or elimination of these restrictions.

A riot (704) is a violent demonstration or disturbance involving a large number of people. Riots are distinguished from protest demonstrations by the presence of violence. Violence implies the use of physical force and is usually evidenced by the destruction of property, the wounding or killing of people, the

use of riot control equipment such as clubs, guns, gas, and water cannons, and by the rioters' use of various weapons. If destruction of property (e.g., the burning of automobiles, the smashing of storefronts, and the throwing of molotov cocktails) is an essential component of the observed behavior, the event is coded as a riot rather than as a demonstration. Demonstrations that changed nature within the course of a single day were coded for the 1968-1982 period separately. Peaceful demonstrations that were met by police violence (702) and demonstrations that turned into riots of their own accord (703) were coded as single events each and were aggregated in the annual and quarterly series with riots to form a series comparable with the riots series of the first 20 years. Frequently, demonstrations turning violent were the result of two or more rival groups clashing when their demonstrations ran afoul of each other. In these instances, the participation of a multiplicity of groups was noted among the attributes, but only one event was coded.

Riots are distinguished from armed attacks by the degree of spontaneity. Riots may sometimes be planned, but the riot organizers constitute a small, often invisible, portion of the rioters. Events were classified as riots if it appeared from the report that most of those involved were violently agitated in their behavior, that they formed an excited or confused mob or crowd, that they were engaged in unpredictable acts of disorder, and that the objects of their violence would not seem to be closely related to the objects of their political discontent in the analysis of a dispassionate observer (*World Handbook of Political and Social Indicators*, 1985).

BUSE R^2

Buse R^2 can be interpreted in the same way as R^2 with ordinary least squares. The only difference is that Buse R^2 cannot be used to test for the significance of the regression (Buse, 1973).

APPENDIX B

BASIC TIME SERIES CRUDE OIL DATA

APPENDIX B

Definitions of Variables

QS	=	Saudi Arabia's oil production in million barrels per day.
QIRAN	=	Iran's oil production in million barrels per day.
QIRAQ	=	Iraq's oil production in million barrels per day.
QV	=	Venezuela's oil production in million barrels per day.
OL	=	Libya's oil production in million barrels per day.
QQ	=	Qatar's oil production in million barrels per day.
QUAE	=	United Arab Emirates' oil production in million barrels per day.
QALG	=	Algeria's oil production in million barrels per day.
QIND	=	Indonesia's oil production in million barrels per day.
QNIC	=	Nigeria's oil production in million barrels per day.
QK	=	Kuwait's oil production in million barrels per day.
PRIC	=	OPEC's nominal oil price.
RESB	=	OPEC's crude oil reserves annually as of January 1st in billions of barrels.
EX	=	Exchange rate in U.S. dollars.
CABB	=	Current account balance in billion U.S. dollars.
GNB82	=	The 1982 U.S. GPD deflator rate.

GDPB	=	Gross domestic product in billion dollars.
POP	=	Population growth rate.
TQ ^{oo}	=	OPEC's oil production in million barrels per day.
Q ^{oo}	=	Other OPEC production, excluding individual production, in million barrels per day.
PRTS	=	Annual number of protests in Saudi Arabia.
PRTIR	=	Annual number of protests in Iran.
PRTIQ	=	Annual number of protests in Iraq.
PRTV	=	Annual number of protests in Venezuela.
PRTQ	=	Annual number of protests in Qatar.
PRTL	=	Annual number of protests in Libya.
PRTIN	=	Annual number of protests in Indonesia.
PRTUAE	=	Annual number of protests in United Arab Emirates.
PRTAL	=	Annual number of protests in Algeria.
PRTN	=	Annual number of protests in Nigeria.
PRTK	=	Annual number of protests in Kuwait.
riot	=	Annual number of riots.
att	=	Annual number of protests.
str	=	Annual number of strikes.
gs	=	Annual number of government sanctions.
FR	=	Foreign reserves minus gold in billion dollars.

*All variables are for annual time periods.

gfc	=	Fixed domestic capital in billion dollars.
GCP	=	Parent company's estimated gross share of crude oil production in million barrels per day.
gcp%	=	GCT divided by individual oil production.
R/Q	=	The ratio of reserves to production.
TCAB	=	The total of OPEC's current account balance in billion dollars.
TWS	=	Non-communist oil consumption in million barrels per day.
OPMK	=	Percentage of OPEC's market share of non-communist world oil production.
NON-OP	=	Non-OPEC oil production, excluding communist countries, in million barrels per day.

Data for Cartel Model and Competitive Models

YEAR	...QS	PRIC	RESB	EX	CABB
1971.00	4.77	1.75	141.35	4.49	0.97
1972.00	6.02	1.90	157.47	4.14	2.09
1973.00	7.60	2.10	146.00	3.71	2.52
1974.00	8.48	9.60	140.75	3.55	23.03
1975.00	7.08	10.46	173.15	3.52	14.39
1976.00	8.58	11.51	151.80	3.53	14.36
1977.00	9.20	12.09	154.55	3.53	11.99
1978.00	8.76	12.70	153.10	3.40	-2.21
1979.00	9.53	13.34	168.94	3.36	11.17
1980.00	9.90	26.00	166.48	3.33	41.40
1981.00	9.81	32.00	168.03	3.38	41.13
1982.00	6.49	34.00	167.85	3.43	7.58
1983.00	5.06	34.00	165.32	3.45	-17.14
1984.00	4.65	29.00	168.85	3.52	-18.40
1985.00	3.47	29.00	171.71	3.62	-12.93
1986.00	5.10	28.00	171.49	3.70	-11.90
1987.00	4.26	17.52	169.18	3.75	-9.57

GNP82	GDPB	POP	TQ00	Q00
0.44	5.11	0.02	25.09	20.32
0.47	6.82	0.02	26.71	20.69
0.50	10.94	0.02	30.99	23.39
0.54	27.98	0.02	30.75	22.27
0.59	39.69	0.05	27.20	20.13
0.63	46.61	0.05	30.56	21.98
0.67	58.17	0.05	31.42	22.22
0.72	65.82	0.05	30.37	21.61
0.79	73.91	0.05	30.91	21.38
0.86	115.97	0.05	26.94	17.04
0.94	153.91	0.04	22.68	12.87
1.00	153.06	0.04	18.89	12.41
1.04	120.19	0.04	17.54	12.48
1.08	105.57	0.04	17.44	12.79
1.11	90.23	0.04	16.12	12.65
1.14	75.25	0.04	18.54	13.44
1.18	71.47	0.12	17.76	13.50

year\$	QIRAN	PRIC	RESB	EX	CABB
1971	4.55	1.75	70.00	75.75	-0.12
1972	5.02	1.91	55.50	75.75	-0.39
1973	5.86	2.11	65.00	68.88	0.15
1974	6.02	10.63	60.00	67.63	12.27
1975	5.35	10.67	66.00	67.64	4.71
1976	5.92	11.62	64.50	70.22	7.66
1977	5.70	12.81	63.00	70.62	2.82
1978	5.21	12.81	62.00	70.48	0.10
1979	3.17	13.45	59.00	70.48	11.97
1980	1.66	30.00	58.00	70.62	-2.44
1981	1.38	37.00	57.50	78.33	-3.45
1982	2.28	34.20	57.00	83.60	5.73
1983	2.49	31.20	55.31	86.36	0.36
1984	2.19	28.00	51.00	90.03	-0.41
1985	2.26	28.00	48.50	91.05	2.47
1986	1.93	28.05	47.88	78.76	-1.27
1987	2.45	17.50	48.80	71.46	-0.51

GNP82	GDPB	POP	TQ00	Q0
0.44	12.79	0.03	25.09	20.32
0.47	15.95	0.03	26.71	20.69
0.50	25.61	0.03	30.99	23.39
0.54	45.69	0.03	30.75	22.27
0.59	51.92	0.03	27.20	20.13
0.63	66.89	0.03	30.56	21.98
0.67	84.22	0.03	31.42	22.22
0.72	78.46	0.04	30.37	21.61
0.79	89.89	0.03	30.91	21.38
0.86	98.08	0.05	26.94	17.04
0.94	106.26	0.04	22.68	12.87
1.00	128.66	0.04	18.89	12.41
1.04	156.00	0.04	17.54	12.48
1.08	163.31	0.04	17.44	12.79
1.11	164.65	0.04	16.12	12.65
1.14	165.06	0.04	18.54	13.44
1.18	177.44	0.04	17.76	13.50

year\$	QIRAQ	PRIC	RESB	EX	CABB
1971	1.71	1.75	32.00	0.35	0.20
1972	1.45	3.14	35.90	0.33	0.55
1973	2.02	3.48	29.00	0.30	0.80
1974	1.97	11.65	31.50	0.30	2.62
1975	2.26	11.65	35.00	0.30	2.70
1976	2.28	11.65	34.30	0.30	2.49
1977	2.49	12.77	34.00	0.30	2.99
1978	2.63	13.17	34.50	0.30	4.15
1979	3.48	13.83	32.10	0.30	11.07
1980	2.51	29.29	31.00	0.30	11.01
1981	0.99	37.50	30.00	0.30	-11.22
1982	0.97	34.93	29.70	0.30	-14.14
1983	0.92	34.83	41.00	0.31	-5.99
1984	1.20	29.83	43.00	0.31	-1.73
1985	1.44	29.83	44.50	0.31	-0.84
1986	1.75	28.18	44.11	0.31	-4.34
1987	2.08	17.60	47.10	0.31	-0.06

GNP82	GDPB	POP	TQ00	Q00
0.44	4.14	0.03	25.09	23.38
0.47	4.37	0.03	26.71	25.26
0.50	5.39	0.03	30.99	28.97
0.54	11.62	0.03	30.75	28.77
0.59	13.85	0.03	27.20	24.94
0.63	18.17	0.03	30.56	28.28
0.67	20.46	0.03	31.42	28.92
0.72	24.47	0.03	30.37	27.74
0.79	38.57	0.03	30.91	27.43
0.86	53.59	0.03	26.94	24.43
0.94	37.29	0.03	22.68	21.69
1.00	42.26	0.03	18.89	17.92
1.04	42.13	0.05	17.54	16.62
1.08	47.59	0.04	17.44	16.24
1.11	46.80	0.03	16.12	14.68
1.14	41.14	0.03	18.54	16.79
1.18	53.48	0.03	17.76	15.68

year\$	QV	PRIC	RESB	EX	CABB	130
1971	3.55	1.75	14.00	4.45	-0.01	
1972	3.22	2.45	13.90	4.40	-0.10	
1973	3.37	2.60	13.70	4.30	0.88	
1974	2.98	9.30	14.00	4.29	5.76	
1975	2.35	11.00	15.00	4.29	2.17	
1976	2.29	11.12	17.70	4.29	0.25	
1977	2.24	12.72	15.27	4.29	-3.18	
1978	2.17	12.82	18.20	4.29	-5.74	
1979	2.36	13.36	18.00	4.29	0.35	
1980	2.16	25.20	17.87	4.29	4.73	
1981	2.11	32.88	17.95	4.29	4.00	
1982	1.89	32.88	20.30	4.29	-4.25	
1983	1.78	32.88	21.50	4.29	4.43	
1984	1.81	27.88	24.85	4.29	4.57	
1985	1.62	27.88	25.85	4.29	3.67	
1986	1.58	27.10	25.59	7.02	-1.47	
1987	1.57	16.72	25.50	7.50	-1.13	

GNP82	GDPB	POP	TQ00	Q00
0.44	12.91	0.03	25.09	21.54
0.47	13.98	0.03	26.71	23.49
0.50	17.02	0.03	30.99	27.62
0.54	26.19	0.03	30.75	27.77
0.59	27.56	0.03	27.20	24.85
0.63	31.49	0.03	30.56	28.26
0.67	36.27	0.03	31.42	29.18
0.72	39.38	0.03	30.37	28.21
0.79	48.40	0.03	30.91	28.56
0.86	59.22	0.03	26.94	24.78
0.94	66.44	0.03	22.68	20.57
1.00	67.86	0.03	18.89	17.00
1.04	67.67	0.03	17.54	15.76
1.08	95.40	0.03	17.44	15.63
1.11	108.24	0.03	16.12	14.50
1.14	70.37	0.03	18.54	16.96
1.18	95.92	0.03	17.76	16.19

year\$	QQ	PRIC	RESB	EX	CABB
1971	0.43	1.75	4.30	4.75	0.16
1972	0.48	2.59	6.00	4.39	0.20
1973	0.57	2.71	7.00	4.00	0.35
1974	0.52	11.67	6.50	3.95	1.72
1975	0.44	11.17	6.00	3.93	1.19
1976	0.49	11.85	5.85	3.96	1.00
1977	0.45	13.19	5.70	3.96	0.59
1978	0.48	13.19	5.60	3.88	0.92
1979	0.51	14.03	4.00	3.77	1.29
1980	0.47	29.42	3.76	3.66	2.65
1981	0.41	37.42	3.59	3.64	2.38
1982	0.33	35.45	3.43	3.64	1.12
1983	0.30	34.49	3.43	3.64	0.41
1984	0.40	29.49	3.33	3.64	0.83
1985	0.30	29.24	3.35	3.64	0.55
1986	0.34	28.10	3.30	3.64	-0.19
1987	0.31	17.82	3.15	3.64	0.07

GNP82	GDPB	POP	TQ00	Q00
0.44	0.40	0.08	25.09	24.66
0.47	0.51	0.08	26.71	26.23
0.50	0.79	0.13	30.99	30.42
0.54	2.40	0.06	30.75	30.23
0.59	2.51	0.06	27.20	26.76
0.63	3.28	0.06	30.56	30.07
0.67	3.62	0.05	31.42	30.97
0.72	3.89	0.05	30.37	29.89
0.79	5.63	0.05	30.91	30.40
0.86	7.83	0.09	26.94	26.47
0.94	8.66	0.04	22.68	22.28
1.00	7.60	0.08	18.89	18.56
1.04	6.47	0.07	17.54	17.25
1.08	6.70	0.03	17.44	17.04
1.11	6.27	0.06	16.12	15.82
1.14	4.95	0.06	18.54	18.19
1.18	5.36	0.06	17.76	17.45

year\$...QL	PRIC	RESB	EX	CABB
1971	2.76	1.75	29.20	0.36	0.78
1972	2.24	2.80	25.00	0.33	0.24
1973	2.18	3.10	30.40	0.30	0.07
1974	1.52	14.30	25.50	0.30	2.70
1975	1.51	11.98	26.60	0.30	0.39
1976	1.92	12.21	26.10	0.30	2.84
1977	2.06	13.74	25.50	0.30	2.16
1978	1.99	13.80	25.00	0.30	0.74
1979	2.09	14.52	24.30	0.30	3.77
1980	1.83	34.50	23.50	0.30	8.21
1981	1.14	40.78	23.00	0.30	-3.96
1982	1.18	36.50	22.60	0.30	-1.56
1983	1.08	35.10	21.50	0.30	-1.64
1984	1.07	30.15	21.37	0.30	-1.52
1985	1.07	30.15	21.10	0.30	2.08
1986	1.14	30.15	21.30	0.32	-0.05
1987	0.97	18.52	21.30	0.30	0.15

GNP82	GDPB	POP	TQ00	Q0
0.44	0.58	0.04	25.09	20.32
0.47	0.59	0.04	26.71	20.69
0.50	0.67	0.04	30.99	23.39
0.54	1.15	0.04	30.75	22.27
0.59	1.12	0.04	27.20	20.13
0.63	1.45	0.04	30.56	21.98
0.67	1.71	0.04	31.42	22.22
0.72	1.68	0.04	30.37	21.61
0.79	2.32	0.04	30.91	21.38
0.86	3.12	0.04	26.94	17.04
0.94	2.77	0.04	22.68	12.87
1.00	2.62	0.05	18.89	12.41
1.04	2.53	0.04	17.54	12.48
1.08	2.24	0.04	17.44	12.79
1.11	2.13	-0.01	16.12	12.65
1.14	2.04	0.04	18.54	13.44
1.18	1.90	0.04	17.76	13.50

year\$	QUAE	PRIC	RESB	EX	CABB
1971	0.93	1.75	11.80	4.75	0.40
1972	1.05	2.54	18.95	4.39	0.40
1973	1.53	2.64	20.77	4.00	0.64
1974	1.69	11.88	25.50	3.96	3.57
1975	1.69	10.87	33.92	3.96	2.85
1976	1.89	11.92	32.20	3.95	3.42
1977	2.00	12.50	31.20	3.90	1.89
1978	1.83	13.26	32.43	3.87	1.49
1979	1.83	14.10	31.32	3.82	5.26
1980	1.70	29.56	29.41	3.71	10.07
1981	1.50	36.56	30.41	3.67	9.21
1982	1.25	35.50	32.18	3.67	7.00
1983	1.12	34.56	32.35	3.67	5.26
1984	1.10	29.56	32.24	3.67	7.46
1985	1.15	29.31	32.39	3.67	6.95
1986	1.33	28.15	32.89	3.67	1.85
1987	1.45	15.55	33.05	3.67	3.81

GNP82	GDPB	POP	TQOO	Q00
0.44	0.93	0.19	25.09	24.16
0.47	1.51	0.16	26.71	25.66
0.50	2.85	0.14	30.99	29.46
0.54	7.86	0.12	30.75	29.06
0.59	9.97	0.16	27.20	25.51
0.63	12.90	0.14	30.56	28.67
0.67	16.24	0.14	31.42	29.42
0.72	15.68	0.13	30.37	28.54
0.79	20.97	0.11	30.91	29.08
0.86	29.62	0.09	26.94	25.24
0.94	32.99	0.08	22.68	21.18
1.00	30.62	0.07	18.89	17.64
1.04	28.03	0.06	17.54	16.42
1.08	27.73	0.05	17.44	16.34
1.11	27.08	0.05	16.12	14.97
1.14	21.33	0.04	18.54	17.21
1.18	23.15	0.03	17.76	16.31

year\$	QALG	PRIC	RESE	EX	CABB
1971	0.77	1.75	30.00	4.91	0.04
1972	1.05	3.54	12.25	4.49	-0.13
1973	1.10	3.30	47.00	3.96	-0.45
1974	1.01	14.00	7.64	4.18	0.18
1975	0.96	12.00	7.70	3.95	-1.66
1976	1.05	12.85	7.37	4.16	-0.89
1977	1.12	14.30	6.80	4.15	-2.32
1978	1.22	14.25	6.60	3.97	-3.54
1979	1.14	14.81	6.30	3.85	-1.63
1980	1.02	30.00	8.44	3.84	0.25
1981	0.80	40.00	8.20	4.32	0.09
1982	0.70	37.00	8.08	4.59	-0.18
1983	0.70	35.50	9.44	4.79	-0.09
1984	0.64	30.50	9.22	4.98	0.07
1985	0.64	30.50	9.00	5.03	1.02
1986	0.67	29.50	8.82	4.70	-2.23
1987	0.63	17.30	8.80	4.85	0.14

GNF82	GDPB	POP	TQ00	Q00
0.44	4.78	0.03	25.09	24.33
0.47	6.10	0.03	26.71	25.66
0.50	8.10	0.03	30.99	29.89
0.54	11.60	0.03	30.75	29.74
0.59	14.26	0.03	27.20	26.24
0.63	16.45	0.03	30.56	29.51
0.67	19.75	0.03	31.42	30.29
0.72	26.22	0.03	30.37	29.15
0.79	33.35	0.03	30.91	29.77
0.86	42.35	0.03	26.94	25.92
0.94	44.37	0.03	22.68	21.88
1.00	45.21	0.03	18.89	18.19
1.04	48.82	0.03	17.54	16.84
1.08	52.15	0.03	17.44	16.80
1.11	57.52	0.04	16.12	15.47
1.14	59.38	0.03	18.54	17.67
1.18	62.37	0.07	17.76	17.13

year\$	QIND	PRIC	RESB	EX	CABB	135
1971	0.89	1.75	10.00	391.88	-0.37	
1972	1.08	2.96	10.40	415.00	-0.33	
1973	1.34	2.96	10.01	415.00	-0.48	
1974	1.38	10.80	10.50	415.00	0.60	
1975	1.31	12.60	15.00	415.00	-1.11	
1976	1.50	12.80	14.00	415.00	-0.91	
1977	1.68	13.55	10.50	415.00	-0.05	
1978	1.64	13.55	10.00	442.05	-1.41	
1979	1.59	13.90	10.20	623.06	0.98	
1980	1.58	27.50	9.60	626.99	2.86	
1981	1.60	35.00	9.50	631.76	-0.57	
1982	1.31	35.00	9.80	661.41	-5.32	
1983	1.39	34.53	9.55	909.30	-6.34	
1984	1.47	29.53	9.10	1025.90	-1.86	
1985	1.24	29.53	8.65	1110.60	-1.92	
1986	1.26	28.53	8.50	1282.60	-3.91	
1987	1.19	17.56	8.30	1643.80	-2.15	

GNP82	GDPB	POP	TQ00	Q00
0.44	9.37	0.02	25.09	24.20
0.47	11.00	0.02	26.71	25.63
0.50	16.27	0.02	30.99	29.65
0.54	25.80	0.02	30.75	29.37
0.59	30.47	0.03	27.20	25.89
0.63	37.27	-0.02	30.56	29.05
0.67	45.81	0.02	31.42	29.73
0.72	51.46	0.02	30.37	28.73
0.79	51.40	0.02	30.91	29.32
0.86	72.48	0.02	26.94	25.36
0.94	92.01	0.02	22.68	21.08
1.00	94.46	0.02	18.89	17.58
1.04	81.05	0.02	17.54	16.16
1.08	84.86	0.02	17.44	15.97
1.11	85.29	0.02	16.12	14.88
1.14	74.71	0.02	18.54	17.27
1.18	89.29	0.02	17.76	16.57

year\$	QNIG	PRIC	RESB	EX	CABB	136
1971	1.53	1.75	9.30	0.71	0.41	
1972	1.82	2.80	11.68	0.66	-0.34	
1973	2.05	3.10	15.00	0.66	-0.01	
1974	2.26	12.60	20.00	0.63	4.90	
1975	1.79	11.80	20.90	0.62	0.04	
1976	1.79	12.84	20.20	0.63	-0.36	
1977	2.07	14.33	19.50	0.64	-1.02	
1978	2.10	14.33	18.70	0.64	-3.79	
1979	1.91	14.80	18.20	0.60	1.66	
1980	2.30	29.97	17.40	0.55	5.10	
1981	2.06	40.00	16.70	0.62	-6.22	
1982	1.45	36.50	16.50	0.67	-7.24	
1983	1.30	35.50	16.75	0.72	-4.34	
1984	1.24	30.00	16.55	0.77	0.11	
1985	1.39	28.00	16.65	0.89	2.62	
1986	1.46	28.65	16.60	1.35	0.37	
1987	1.46	18.92	16.00	4.02	1.64	

GNP82	GDPB	POP	TQ00	Q00
0.44	10.00	0.03	25.09	23.56
0.47	11.67	0.03	26.71	24.89
0.50	16.65	0.03	30.99	28.94
0.54	29.86	0.03	30.75	28.49
0.59	35.00	0.03	27.20	25.41
0.63	43.76	0.03	30.56	28.77
0.67	50.89	0.03	31.42	29.35
0.72	55.54	0.03	30.37	28.27
0.79	71.92	0.03	30.91	29.00
0.86	85.53	0.03	26.94	24.64
0.94	95.43	0.03	22.68	20.62
1.00	93.62	0.03	18.89	17.45
1.04	90.32	0.03	17.54	16.24
1.08	92.61	0.03	17.44	16.20
1.11	90.61	0.03	16.12	14.72
1.14	60.58	0.03	18.54	17.07
1.18	28.35	0.03	17.76	16.30

year\$	QK	PRIC	RESB	EX	CABB
1971	3.00	1.75	79.95	0.36	1.81
1972	3.28	2.37	78.20	0.33	2.01
1973	3.02	2.48	72.90	0.30	2.58
1974	2.55	10.85	72.75	0.29	9.07
1975	2.09	10.37	81.45	0.29	5.93
1976	2.15	11.30	71.20	0.29	6.93
1977	1.97	12.37	70.55	0.29	4.56
1978	2.10	12.27	70.10	0.28	6.13
1979	2.50	12.83	69.44	0.28	14.03
1980	1.66	27.50	68.53	0.27	15.30
1981	1.13	35.50	67.93	0.28	13.78
1982	0.82	32.30	67.73	0.29	4.87
1983	1.08	32.20	67.15	0.29	5.29
1984	1.12	27.30	66.75	0.30	6.37
1985	1.04	27.55	92.71	0.30	4.82
1986	1.51	27.10	92.46	0.29	5.34
1987	1.23	16.70	94.52	0.28	4.41

GNP82	GDPB	POP	TQOO	Q00
0.44	3.84	0.05	25.09	22.09
0.47	4.44	0.06	26.71	23.43
0.50	5.35	0.06	30.99	27.97
0.54	13.15	0.05	30.75	28.20
0.59	12.02	0.07	27.20	25.11
0.63	13.24	0.06	30.56	28.41
0.67	13.99	0.06	31.42	29.45
0.72	15.21	0.06	30.37	28.27
0.79	24.01	0.06	30.91	28.41
0.86	27.58	0.06	26.94	25.28
0.94	22.19	0.04	22.68	21.55
1.00	21.15	0.05	18.89	18.07
1.04	22.00	0.04	17.54	16.46
1.08	19.43	0.05	17.44	16.32
1.11	19.43	0.04	16.12	15.08
1.14	16.61	0.04	18.54	17.03
1.18	19.44	0.04	17.76	16.53

year\$	PRTS	riot	att	str	gs
1971	0.00	0.00	0.00	0.00	0.00
1972	0.00	0.00	1.00	0.00	0.00
1973	0.00	0.00	0.00	0.00	0.00
1974	0.00	0.00	0.00	0.00	0.00
1975	0.00	0.00	0.00	0.00	0.00
1976	0.00	0.00	0.00	0.00	0.00
1977	0.00	0.00	0.00	0.00	0.00
1978	0.00	0.00	0.00	0.00	0.00
1979	0.00	0.00	0.00	0.00	1.00
1980	1.00	2.00	4.00	0.00	3.00
1981	0.00	0.00	0.00	0.00	3.00
1982	1.00	0.00	1.00	0.00	1.00
1983	1.00	2.00	0.00	0.00	1.00
1984	0.00	0.00	0.00	0.00	0.00
1985	0.00	0.00	1.00	0.00	0.00
1986	0.00	0.00	0.00	0.00	0.00
1987	0.00	0.00	0.00	0.00	0.00

year\$	PRTIR	riot	att	str	gs
1971	0.00	0.00	1.00	0.00	2.00
1972	0.00	2.00	8.00	0.00	2.00
1973	0.00	0.00	2.00	0.00	3.00
1974	0.00	0.00	0.00	0.00	0.00
1975	2.00	0.00	1.00	0.00	3.00
1976	0.00	0.00	17.00	0.00	7.00
1977	0.00	2.00	1.00	0.00	0.00
1978	12.00	62.00	13.00	9.00	31.00
1979	49.00	59.00	65.00	3.00	44.00
1980	34.00	20.00	35.00	1.00	29.00
1981	14.00	11.00	55.00	0.00	42.00
1982	2.00	1.00	70.00	0.00	16.00
1983	1.00	5.00	13.00	0.00	3.00
1984	8.00	0.00	10.00	0.00	1.00
1985	4.00	0.00	24.00	0.00	1.00
1986	1.00	0.00	9.00	0.00	2.00
1987	0.00	0.00	9.00	0.00	0.00

year\$	PRTIQ	riot	att	str	gs	139
1971	0.00	0.00	5.00	0.00	5.00	
1972	0.00	2.00	4.00	0.00	3.00	
1973	0.00	0.00	4.00	1.00	6.00	
1974	2.00	0.00	17.00	0.00	3.00	
1975	0.00	0.00	8.00	0.00	3.00	
1976	0.00	0.00	2.00	0.00	1.00	
1977	1.00	2.00	4.00	0.00	3.00	
1978	0.00	0.00	0.00	0.00	1.00	
1979	0.00	0.00	1.00	0.00	4.00	
1980	0.00	1.00	3.00	0.00	0.00	
1981	0.00	0.00	0.00	0.00	1.00	
1982	0.00	0.00	1.00	0.00	0.00	
1983	0.00	1.00	4.00	0.00	0.00	
1984	0.00	0.00	1.00	0.00	0.00	
1985	0.00	0.00	0.00	0.00	0.00	
1986	0.00	0.00	0.00	0.00	0.00	
1987	0.00	0.00	2.00	0.00	0.00	

year\$	PRTV	riot	att	str	gs
1971	3.00	1.00	1.00	0.00	3.00
1972	1.00	2.00	3.00	0.00	0.00
1973	1.00	4.00	1.00	0.00	2.00
1974	0.00	0.00	0.00	0.00	0.00
1975	0.00	0.00	2.00	0.00	1.00
1976	1.00	0.00	0.00	0.00	1.00
1977	0.00	0.00	1.00	0.00	1.00
1978	0.00	0.00	0.00	0.00	0.00
1979	0.00	0.00	0.00	0.00	2.00
1980	0.00	0.00	2.00	0.00	1.00
1981	0.00	0.00	0.00	0.00	0.00
1982	0.00	0.00	1.00	0.00	0.00
1983	1.00	0.00	0.00	0.00	0.00
1984	1.00	0.00	2.00	1.00	0.00
1985	0.00	0.00	0.00	0.00	0.00
1986	1.00	0.00	0.00	0.00	0.00
1987	2.00	1.00	1.00	0.00	1.00

year\$	PRTQ	riot	att	str	gs
1971	0.00	0.00	0.00	0.00	0.00
1972	0.00	0.00	0.00	0.00	0.00
1973	0.00	0.00	0.00	0.00	0.00
1974	0.00	0.00	0.00	0.00	0.00
1975	0.00	0.00	0.00	0.00	0.00
1976	0.00	0.00	0.00	0.00	0.00
1977	0.00	0.00	1.00	0.00	0.00
1978	0.00	0.00	0.00	0.00	0.00
1979	0.00	0.00	0.00	0.00	0.00
1980	1.00	0.00	0.00	0.00	0.00
1981	0.00	0.00	0.00	0.00	0.00
1982	0.00	0.00	0.00	0.00	0.00
1983	0.00	0.00	1.00	0.00	0.00
1984	0.00	0.00	0.00	0.00	0.00
1985	0.00	0.00	0.00	0.00	0.00
1986	0.00	0.00	0.00	0.00	1.00
1987	0.00	0.00	0.00	0.00	0.00

year\$	PRTL	riot	att	str	gs
1971	0.00	0.00	0.00	0.00	2.00
1972	0.00	1.00	0.00	0.00	8.00
1973	1.00	2.00	0.00	0.00	3.00
1974	0.00	0.00	0.00	0.00	2.00
1975	2.00	0.00	0.00	0.00	4.00
1976	0.00	1.00	0.00	0.00	5.00
1977	0.00	1.00	1.00	0.00	0.00
1978	0.00	0.00	0.00	0.00	0.00
1979	3.00	0.00	1.00	0.00	0.00
1980	0.00	0.00	0.00	0.00	0.00
1981	0.00	0.00	2.00	0.00	0.00
1982	0.00	0.00	0.00	0.00	0.00
1983	0.00	0.00	0.00	0.00	0.00
1984	0.00	0.00	0.00	0.00	0.00
1985	0.00	0.00	0.00	0.00	0.00
1986	0.00	0.00	0.00	0.00	0.00
1987	0.00	0.00	0.00	0.00	0.00

year\$	PRTIN	riot	att	str	gs
1971	0.00	0.00	1.00	0.00	1.00
1972	0.00	1.00	0.00	0.00	3.00
1973	0.00	1.00	0.00	0.00	1.00
1974	1.00	3.00	0.00	0.00	8.00
1975	0.00	0.00	0.00	0.00	2.00
1976	0.00	0.00	0.00	0.00	3.00
1977	0.00	0.00	0.00	0.00	0.00
1978	3.00	0.00	0.00	0.00	5.00
1979	0.00	0.00	0.00	0.00	0.00
1980	2.00	0.00	0.00	0.00	0.00
1981	1.00	1.00	0.00	0.00	0.00
1982	1.00	1.00	0.00	0.00	7.00
1983	0.00	0.00	0.00	0.00	0.00
1984	0.00	2.00	0.00	0.00	0.00
1985	1.00	1.00	2.00	0.00	0.00
1986	0.00	1.00	1.00	0.00	0.00
1987	0.00	0.00	0.00	0.00	0.00

year\$	PRTUAE	riot	att	str	gs
1971	0.00	0.00	1.00	0.00	0.00
1972	0.00	0.00	0.00	0.00	2.00
1973	0.00	0.00	2.00	0.00	0.00
1974	0.00	0.00	1.00	0.00	0.00
1975	0.00	0.00	0.00	0.00	0.00
1976	0.00	0.00	0.00	0.00	1.00
1977	0.00	0.00	1.00	0.00	2.00
1978	0.00	0.00	2.00	0.00	0.00
1979	0.00	0.00	0.00	0.00	0.00
1980	0.00	0.00	0.00	0.00	0.00
1981	0.00	0.00	0.00	0.00	0.00
1982	0.00	0.00	0.00	0.00	1.00
1983	0.00	0.00	0.00	0.00	0.00
1984	0.00	0.00	0.00	0.00	0.00
1985	0.00	0.00	1.00	0.00	0.00
1986	0.00	0.00	1.00	0.00	0.00
1987	0.00	0.00	0.00	0.00	0.00

year\$	PRTAL	riot	att	str	gs	142
1971	0.00	0.00	0.00	0.00	1.00	
1972	0.00	0.00	0.00	0.00	1.00	
1973	0.00	0.00	0.00	0.00	0.00	
1974	0.00	0.00	1.00	0.00	0.00	
1975	0.00	0.00	0.00	0.00	1.00	
1976	0.00	0.00	0.00	0.00	1.00	
1977	0.00	0.00	0.00	0.00	0.00	
1978	0.00	0.00	2.00	0.00	0.00	
1979	0.00	0.00	0.00	0.00	0.00	
1980	1.00	1.00	1.00	0.00	2.00	
1981	2.00	1.00	0.00	0.00	2.00	
1982	1.00	0.00	2.00	0.00	1.00	
1983	0.00	0.00	1.00	2.00	0.00	
1984	0.00	0.00	0.00	0.00	0.00	
1985	0.00	0.00	2.00	0.00	0.00	
1986	0.00	1.00	1.00	0.00	0.00	
1987	0.00	0.00	0.00	0.00	1.00	

year\$	PRTN	riot	att	str	gs
1971	1.00	3.00	0.00	0.00	3.00
1972	0.00	1.00	0.00	1.00	3.00
1973	0.00	1.00	1.00	1.00	3.00
1974	2.00	4.00	0.00	1.00	5.00
1975	1.00	0.00	3.00	17.00	8.00
1976	2.00	6.00	1.00	0.00	6.00
1977	0.00	1.00	1.00	0.00	3.00
1978	2.00	2.00	2.00	2.00	4.00
1979	1.00	0.00	0.00	1.00	2.00
1980	0.00	1.00	0.00	0.00	2.00
1981	1.00	3.00	5.00	1.00	8.00
1982	2.00	4.00	0.00	0.00	2.00
1983	0.00	2.00	0.00	0.00	0.00
1984	0.00	2.00	1.00	0.00	0.00
1985	0.00	1.00	0.00	0.00	0.00
1986	2.00	0.00	0.00	0.00	1.00
1987	0.00	1.00	1.00	0.00	1.00

year\$	PRTK	riot	att	str	gs
1971	0.00	0.00	0.00	0.00	1.00
1972	0.00	0.00	0.00	1.00	1.00
1973	0.00	0.00	0.00	0.00	1.00
1974	0.00	0.00	1.00	0.00	0.00
1975	0.00	0.00	0.00	1.00	0.00
1976	0.00	0.00	1.00	0.00	7.00
1977	0.00	0.00	1.00	0.00	2.00
1978	0.00	0.00	0.00	0.00	1.00
1979	1.00	1.00	0.00	0.00	0.00
1980	0.00	0.00	2.00	0.00	0.00
1981	0.00	0.00	0.00	0.00	2.00
1982	2.00	0.00	1.00	0.00	0.00
1983	0.00	0.00	2.00	0.00	0.00
1984	0.00	0.00	1.00	0.00	0.00
1985	0.00	0.00	0.00	0.00	0.00
1986	0.00	0.00	2.00	0.00	0.00
1987	0.00	0.00	0.00	0.00	0.00

YEAR	TOO	PRIC	...R/Q	...TCAB
1971.00	25.09	3.98	17.21	3.31
1972.00	26.71	4.04	15.92	4.11
1973.00	30.99	4.20	14.96	7.02
1974.00	30.75	17.78	13.72	66.65
1975.00	27.20	17.73	17.83	31.46
1976.00	30.56	18.27	14.72	36.85
1977.00	31.42	18.04	14.02	20.17
1978.00	30.37	17.64	14.48	-3.78
1979.00	30.91	16.89	14.39	59.24
1980.00	26.94	30.23	16.17	100.21
1981.00	22.68	34.04	19.15	44.56
1982.00	18.89	34.00	23.11	-7.31
1983.00	17.54	32.69	25.38	-19.72
1984.00	17.44	26.85	25.71	-3.68
1985.00	16.12	26.13	29.55	6.52
1986.00	18.54	24.56	25.63	-19.96
1987.00	17.76	14.85	26.92	-6.76

YEARTWSWC	...OPMK	...NON-OP
1971.00	39.29	41.04	0.64	14.20
1972.00	41.31	43.83	0.65	14.60
1973.00	45.69	47.00	0.68	14.70
1974.00	45.00	45.80	0.68	14.25
1975.00	41.32	44.60	0.66	14.12
1976.00	45.07	47.50	0.68	14.51
1977.00	46.68	49.50	0.67	15.26
1978.00	46.37	50.70	0.65	16.00
1979.00	48.60	52.20	0.64	17.69
1980.00	45.23	49.70	0.60	18.29
1981.00	41.55	47.80	0.55	18.87
1982.00	38.79	46.30	0.49	19.90
1983.00	38.39	45.30	0.46	20.85
1984.00	39.52	46.80	0.44	22.08
1985.00	39.07	46.50	0.41	22.95
1986.00	41.06	48.00	0.45	22.52
1987.00	40.75	48.90	0.44	22.99

Data for Target Revenue Model

QS	PRIC	FR	gfcu	EX	CABB	GNP82	GDPB
4.77	1.75	1.33	0.65	4.49	0.97	0.44	5.11
6.02	1.90	2.38	0.82	4.14	2.09	0.47	6.82
7.60	2.10	3.75	1.53	3.71	2.52	0.50	10.94
8.48	9.60	14.15	2.37	3.55	23.03	0.54	27.93
7.06	10.46	23.19	5.03	3.52	14.39	0.59	39.69
8.58	11.51	26.90	9.50	3.53	14.36	0.63	46.61
9.20	12.09	29.90	14.50	3.53	11.99	0.67	53.17
8.76	12.70	19.20	19.67	3.40	-2.21	0.72	65.82
9.53	13.34	19.27	23.22	3.36	11.17	0.79	73.91
9.90	26.00	23.44	29.15	3.33	41.40	0.86	115.97
9.81	32.00	32.24	31.47	3.38	41.13	0.94	153.91
6.49	34.00	29.55	35.66	3.43	7.58	1.00	153.06
5.06	34.00	27.29	33.46	3.45	-17.14	1.04	120.19
4.65	29.00	24.75	29.33	3.52	-18.40	1.08	105.57
3.47	29.00	25.00	25.20	3.62	-12.93	1.11	90.23
5.10	28.00	18.32	21.65	3.70	-11.90	1.14	75.25
4.26	17.52	22.68	17.38	3.75	-9.57	1.18	71.47

QK	PRIC	FR	gfcu	EX	CABB	GNP82	GDPB
3.00	1.75	0.19	0.36	0.36	1.81	0.44	3.84
3.28	2.37	0.27	0.39	0.33	2.01	0.47	4.44
3.02	2.48	0.28	0.50	0.30	2.53	0.50	5.35
2.55	10.85	1.25	0.76	0.29	9.07	0.54	13.15
2.09	10.37	1.49	1.45	0.29	5.93	0.59	12.02
2.15	11.30	1.70	1.93	0.29	6.93	0.63	13.24
1.97	12.37	2.88	2.83	0.29	4.56	0.67	11.99
2.10	12.27	2.50	2.82	0.28	6.13	0.72	13.21
2.50	12.83	2.87	2.82	0.28	14.03	0.79	24.01
1.66	27.50	3.93	3.26	0.27	15.30	0.86	27.58
1.13	35.50	4.07	0.39	0.28	13.78	0.94	22.19
0.82	32.30	5.91	4.97	0.29	4.87	1.00	21.15
1.08	32.20	5.19	5.28	0.29	5.29	1.04	22.00
1.12	27.30	4.59	4.37	0.30	6.37	1.08	19.43
1.04	27.55	5.47	4.43	0.30	4.82	1.11	19.43
1.51	27.10	5.50	3.79	0.29	5.34	1.14	16.61
1.23	16.70	4.14	3.71	0.28	4.41	1.18	19.44

QV	PRIC	FR	gfcu	EX	CABB	GNP82	GDPB
3.55	1.75	1.10	3.00	4.45	-0.01	0.44	12.91
3.22	2.45	1.31	3.60	4.40	-0.10	0.47	13.98
3.37	2.60	1.94	4.33	4.30	0.88	0.50	17.02
2.98	9.30	6.03	4.89	4.29	5.76	0.54	26.29
2.35	11.00	8.40	7.13	4.29	2.17	0.59	27.56
2.29	11.12	8.12	9.97	4.29	0.25	0.63	31.49
2.24	12.72	7.74	14.10	4.29	-3.18	0.67	36.27
2.17	12.82	6.04	16.75	4.29	-5.74	0.72	39.38
2.36	13.36	7.32	15.28	4.29	0.35	0.79	48.40
2.16	25.20	6.60	14.95	4.29	4.73	0.86	59.22
2.11	32.88	8.16	16.27	4.29	4.00	0.94	66.44
1.89	32.88	6.58	16.35	4.29	-4.25	1.00	67.86
1.78	32.88	7.64	12.90	4.29	4.43	1.04	67.67
1.81	27.88	8.90	13.38	4.29	4.57	1.08	95.40
1.62	27.88	10.25	16.43	4.29	3.67	1.11	108.24
1.58	27.10	6.44	13.35	7.02	-1.47	1.14	70.37
1.57	16.72	5.96	16.08	7.50	-1.13	1.18	95.92

QIND	PRIC	FR	gfcu	EX	CABB	GNP82	GDPB
0.89	1.75	0.19	1.48	391.88	-0.37	0.44	9.37
1.08	2.96	0.57	2.07	415.00	-0.33	0.47	11.00
1.34	2.96	0.81	2.91	415.00	-0.48	0.50	16.27
1.38	10.80	1.49	4.33	415.00	0.60	0.54	25.80
1.31	12.60	0.58	6.20	415.00	-1.11	0.59	30.47
1.50	12.80	1.50	7.72	415.00	-0.91	0.63	37.27
1.68	13.55	2.51	9.22	415.00	-0.05	0.67	45.81
1.64	13.55	2.63	10.57	442.05	-1.41	0.72	51.46
1.59	13.90	4.06	10.76	623.06	0.98	0.79	51.40
1.58	27.50	5.39	15.13	626.99	2.86	0.86	72.48
1.60	35.00	5.01	27.42	631.76	-0.57	0.94	92.01
1.31	35.00	3.14	26.32	661.41	-5.32	1.00	94.46
1.39	34.53	3.72	23.83	909.30	-6.34	1.04	81.05
1.47	29.53	4.77	21.62	1025.90	-1.86	1.08	84.86
1.24	29.53	4.97	22.63	1110.60	-1.92	1.11	85.29
1.26	28.53	4.05	18.40	1282.60	-3.91	1.14	74.71
1.19	17.56	5.59	18.34	1643.80	-2.15	1.18	89.29

QALG	PRIC	FR	gfcu	EX	CABB	GNP82	GDPB
0.77	1.75	0.30	1.75	4.91	0.04	0.44	4.78
1.05	3.54	0.28	2.29	4.49	-0.13	0.47	6.10
1.10	3.30	0.91	3.36	3.96	-0.45	0.50	8.10
1.01	14.00	1.45	4.26	4.18	0.18	0.54	11.60
0.96	12.00	1.13	6.18	3.95	-1.66	0.59	14.26
1.05	12.85	1.77	7.50	4.16	-0.89	0.63	16.45
1.12	14.30	1.68	9.47	4.15	-2.32	0.67	19.75
1.22	14.25	1.98	12.82	3.97	-3.54	0.72	26.22
1.14	14.81	2.66	13.09	3.85	-1.63	0.79	33.35
1.02	30.00	3.77	14.30	3.84	0.25	0.86	42.35
0.80	40.00	3.70	14.58	4.32	0.09	0.94	44.37
0.70	37.00	2.42	15.58	4.59	-0.18	1.00	45.21
0.70	35.50	1.88	16.76	4.79	-0.09	1.04	48.82
0.64	30.50	1.46	17.55	4.98	0.07	1.08	52.15
0.64	30.50	2.82	18.43	5.03	1.02	1.11	57.52
0.67	29.50	1.66	20.41	4.70	-2.23	1.14	59.38
0.63	17.30	1.64	21.60	4.85	0.14	1.18	62.37

QNIG	PRIC	FR	gfcu	EX	CABB	GNP82	GDPB
1.53	1.75	0.41	1.80	0.71	0.41	0.44	10.00
1.82	2.80	0.36	2.12	0.66	-0.34	0.47	11.67
2.05	3.10	0.56	3.80	0.66	-0.01	0.50	16.65
2.26	12.60	5.60	4.70	0.63	4.90	0.54	29.86
1.79	11.80	5.59	8.10	0.62	0.04	0.59	35.00
1.79	12.84	5.18	12.87	0.63	-0.36	0.63	43.76
2.07	14.33	4.23	14.72	0.64	-1.02	0.67	50.89
2.10	14.33	1.89	14.67	0.64	-3.79	0.72	55.54
1.91	14.80	5.55	15.17	0.60	1.66	0.79	71.92
2.30	29.97	10.24	19.71	0.55	5.10	0.86	85.53
2.06	40.00	3.90	17.81	0.62	-6.22	0.94	95.43
1.45	36.50	1.61	13.40	0.67	-7.24	1.00	93.62
1.30	35.50	0.99	11.29	0.72	-4.34	1.04	90.32
1.24	30.00	1.46	5.36	0.77	0.11	1.08	92.61
1.39	28.00	1.67	5.98	0.89	2.62	1.11	90.61
1.46	28.65	1.08	5.42	1.35	0.37	1.14	60.58
1.46	18.92	1.16	2.83	4.02	1.64	1.18	28.35

Data for Property Rights Model

YEAR	QS	GCP	gcp%
1971	4.77	0.04	0.01
1972	6.02	0.04	0.01
1973	7.60	1.87	0.25
1974	8.48	4.96	0.59
1975	7.08	4.13	0.58
1976	8.58	5.04	0.59
1977	9.20	5.43	0.59
1978	8.76	4.87	0.56
1979	9.53	5.59	0.59
1980	9.90	9.67	0.98
1981	9.81	9.58	0.98
1982	6.49	6.34	0.98

year\$	QIRAN	GCP	gcp%
1971	4.55	0.20	0.04
1972	5.02	0.25	0.05
1973	5.86	5.64	0.96
1974	6.02	5.79	0.96
1975	5.35	5.12	0.96
1976	5.92	5.66	0.95
1977	5.70	5.39	0.95
1978	5.21	4.96	0.95
1979	3.17	3.00	0.95
1980	1.66	1.47	0.88
1981	1.38	0.00	0.00
1982	2.28	0.00	0.00

year\$	QL	GCP	gcpt
1971	2.76	0.01	0.00
1972	2.24	0.08	0.04
1973	2.18	1.22	0.56
1974	1.52	0.92	0.61
1975	1.51	0.93	0.61
1976	1.92	1.24	0.65
1977	2.06	1.37	0.66
1978	1.99	1.30	0.65
1979	2.09	1.41	0.67
1980	1.83	1.23	0.67
1981	1.14	0.83	0.73
1982	1.18	0.81	0.69

year\$	QIND	GCP	gcpt
1971	0.89	0.11	0.12
1972	1.08	0.18	0.16
1973	1.34	0.31	0.23
1974	1.38	0.42	0.30
1975	1.31	0.44	0.34
1976	1.50	0.55	0.37
1977	1.68	0.73	0.43
1978	1.64	0.73	0.45
1979	1.59	0.72	0.45
1980	1.58	0.72	0.46
1981	1.60	0.75	0.46
1982	1.31	0.69	0.53

year\$	QUAE	GCP	gcpt
1971	0.93	0.00	0.00
1972	1.05	0.00	0.00
1973	1.53	0.33	0.21
1974	1.69	0.83	0.49
1975	1.69	0.80	0.47
1976	1.89	1.20	0.64
1977	2.00	1.25	0.63
1978	1.83	1.18	0.64
1979	1.83	1.17	0.64
1980	1.70	1.10	0.64
1981	1.50	0.99	0.66
1982	1.25	0.84	0.67

year\$	QK	GCP	gcpt
1971	3.00	0.04	0.01
1972	3.28	0.04	0.01
1973	3.02	0.73	0.24
1974	2.55	1.40	0.55
1975	2.09	1.14	0.54
1976	2.15	1.94	0.90
1977	1.97	1.89	0.96
1978	2.10	2.01	0.96
1979	2.50	2.34	0.94
1980	1.66	1.51	0.91
1981	1.13	1.04	0.92
1982	0.82	0.75	0.91

year\$	QNIG	GCP	gcpt
1971	1.53	0.00	0.00
1972	1.82	0.00	0.00
1973	2.05	0.51	0.25
1974	2.26	1.24	0.55
1975	1.79	0.98	0.55
1976	1.79	1.14	0.64
1977	2.07	1.14	0.55
1978	2.10	1.04	0.50
1979	1.91	1.64	0.86
1980	2.30	1.46	0.64
1981	2.06	1.01	0.49
1982	1.45	0.90	0.62

year\$	QALG	GCP	gcpt
1971	0.77	0.55	0.71
1972	1.05	0.82	0.78
1973	1.10	0.84	0.76
1974	1.01	0.77	0.76
1975	0.96	0.76	0.79
1976	1.05	0.97	0.93
1977	1.12	1.04	0.92
1978	1.22	1.03	0.84
1979	1.14	1.06	0.93
1980	1.02	0.96	0.94
1981	0.80	0.79	0.98
1982	0.70	0.70	0.99