A MODEL OF CARTEL FORMATION

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I. INTRODUCTION

There has been a great deal of controversy in recent years over the potential of developing nations to form successful commodity cartels patterned after OPEC.[1] Algerian President Houari Boumedienne, for example, claims that the OPEC embargo of October 1973 was "a decisive turning point in international relations."[2] More commodity cartels are to be expected, according to Boumedienne, and "a new pattern of global market relationships"[3] is about to emerge. Stephen Krasner has argued, to the contrary, that "oil is the exception" and commodity cartels in other industries are doomed to failure.[4]

The model developed herein analyzes successful and unsuccessful formation of international commodity cartels (ICCs) in terms of two factors. The first factor revolves around five *structural prerequisites* that must be present in the commodity industry and/or among the potential ICC members if successful cartelization is to be realized. In analyzing this first factor, these five sub-factors, it will become evident why OPEC has succeeded where many other would-be ICCs have failed. Even though the proper structure may exist within a commodity industry, stable patterns of cooperation must be established among the relevant national actors if a successful ICC is to be formed. The development of *patterns of cooperation* within a cartel, the second factor in the model, will be analyzed from the perspective of game theory. Utilizing the notions of the Prisoner's Dilemma, the Cooperative Game, and the Chicken Game, three distinct stages of cartel formation will be formulated. One can then trace the development of a

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[1] OPEC is the Organization of Petroleum-Exporting Countries.

[2] "Reflections on the Quarter," *Orbis*, XVIII, Number 1, Spring 1974, p. 23.

[3] Ibid.

[4] The debate is concisely summarized in "One, Two, Many OPEC's...?" a collection of articles in *Foreign Policy*, 14, Spring 1974. The collection includes articles by Zuhayr Mikdashi, "Collusion Could Work"; Stephen Krasner, "Oil Is The Exception"; and C. Fred Bergsten, "The Threat Is Real."

cartel through these three stages. Given a successful cartel such as OPEC, conditions surrounding cartel deterioration will be identified.

These two factors are inextricably linked. The framework of the model, defined in terms of three stages of cartel formation, is derived from examination of the second factor, patterns of cooperation. Transition from one stage to another, however, is largely a function of structural changes within the commodity industry.

This model does not possess any especial predictive capabilities, nor is there any claim that it does. There is a claim that the model describes and explains successful and unsuccessful cartel formation. If nothing else, one can find herein another application of basic game theoretical notions to real world phenomena.

II. A MODEL OF CARTEL FORMATION

As an analytic note, one must make the distinction between "price cartels" and "production cartels." A price cartel exploits its market power simply by charging a high price for its commodity. Prior to the October 1973 war, OPEC's success was based almost entirely on this formula. A production cartel, for reasons to be considered momentarily, is obliged to restrain production before raising the price of its commodity. Since the October 1973 war, OPEC has operated according to this second formula, although efforts to restrain production have met with only limited success.[5] Much is to be gained by making the distinction between production cartels and price cartels. Different problems surround the formation of each type of ICC.

A. STRUCTURAL PREREQUISITES

In the real world, failure has been the rule as far as the successful formation of ICCs is concerned. The ultimate success of an ICC is determined *to a large extent* by changes in the structure of the commodity industry. There are five prerequisites which determine whether or not an international commodity industry is appropriately structured for successful cartel formation. These structural prerequisites will be developed by examining how OPEC, which has been the only successful ICC, differs from other would-be cartels.

The first prerequisite for successful cartel formation is *price inelastic demand* for the commodity in question. Stephen Krasner points out that "the less responsive demand is to price, the greater the benefits of collusion."[6] This unquestionably characterizes oil for the

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[5] See Section III (below), "The Development of OPEC." Also see Raymond F. Mikesell, "More Third World Cartels Ahead?" *Challenge*, 17, No. 5, November-December 1974, pp. 24-31, and George Lenczowski, "The Oil Producing Countries," *Daedalus*, 104, No. 4, Fall 1975, pp. 59-72.

[6] Stephen D. Krasner, "Oil Is The Exception," *Foreign Policy*, 14, Spring 1974, p. 73. It should be noted that Krasner's article serves as a point of focus for much of the discussion in this section.

short term and the middle term and might very well be an accurate description of the long term. In fact, there is evidence that despite pronounced price hikes, the demand for OPEC oil is increasing.[7] However, this is not the case for other raw materials. Bension Varon and Kenji Takeuchi explain:

> The key economic fact is that while demand for most non-fuel minerals is price-inelastic in the short run...this is not necessarily true over the long run, certainly not to the extent that holds for oil. Calculations based on historic experience for tin, aluminum and copper, for example, suggest strongly that in the long run the drop in demand more than offsets any price increase.[8]

Raymond Mikesell states that "According to a World Bank study, short-run world demand for CIPEC copper is so responsive to price changes that CIPEC could barely improve the export earnings of its members through an increase in price."[9]

Further explanation of how price affects the demand for oil differently than it does for other raw materials is found in examination of the second prerequisite, *supply unresponsive to price*. Krasner points out that successful cartel formation requires "effective economic or technical barriers to the entry of new products."[10] In the case of oil, these barriers do exist. However, the situation is quite dissimilar for most major raw materials.

There are three basic ways of affecting supply. The first involves substitutes. Although there is presently no substitute for oil, there are substitutes for a number of other raw materials. For example,

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[7] See Edward Cowan, "U.S. Still Vulnerable to Oil Embargo, And Perhaps More So Than in 1973," *The New York Times*, October 29, 1975, pp. 1 and 69.

[8] Bension Varon and Kenji Takeuchi, "Developing Countries and Non-Fuel Minerals," *Foreign Affairs*, 52, No. 3, April 1974, p. 505.

[9] Mikesell, op. cit., p. 27. CIPEC is the Intergovernmental Council of Copper-Exporting Countries.

[10] Krasner, op. cit., p. 73.

copper, tin and steel can be used in place of aluminum.[11] The mining of manganese nodules from the ocean floor, which is presently being perfected, offers an additional source of large quantities of manganese, nickel, copper and cobalt.[12] Furthermore, there is always the possibility that the developed nations might discover a technical replacement for a mineral resource.[13] A second way to affect supply is through the use of stockpiles. The United States has large stockpiles of tin, manganese, chromium and tungsten.[14] Should a tin cartel attempt to withhold supply or significantly increase price, the United States could simply begin selling its stockpiled tin at a cheaper price, thus driving down the cost of tin. When the price is sufficiently low, and the members of the tin cartel are forced to sell their product, the United States could replenish its stockpiles by purchasing inexpensive tin. The developed nations have not been able to build up large stockpiles of oil. As the "Preliminary Report" of the Energy Policy Project of the Ford Foundation points out, there is little likelihood that the United States will be able to stockpile enough oil to have a major impact on the overall supply equation. The "magnitude of the investment" and "current shortages in the world

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[11]Varon and Takeuchi elaborate: "Bauxite can be replaced by other materials in making aluminum, aluminum can be replaced by tin in making cans, and cans can be replaced by plastic or glass containers." Varon and Takeuchi, op. cit., p. 507.

[12]Jack N. Barkenbus, "International Conflict Over Resources: The Case of Manganese Nodules," *Orbis*, XIX, No. 1, Spring 1975, pp. 185-199.

[13]Varon and Takeuchi note "that the field of metallurgy has historically been in the vanguard of experimentation and development of substitutes in the direction of the cheapest and most abundant raw materials." Varon and Takeuchi, op. cit., p. 507. Two excellent examples of technical replacements would be synthetic rubber and synthetic nitrates. The development of the latter had a significant impact on Chile's nitrate exports.

[14]Richard N. Cooper, "Natural Resources and National Security," a paper prepared for the 16th Annual Conference, International Institute for Strategic Studies, Brighton, England, September 1974, p. 13.

market would make it hard to build up stockpiles of oil."[15] The third way to affect supply is through recycling. Once again, oil is non-recyclable while a number of other minerals are. Consider the example of bauxite: "According to some studies, the scrap ratio in aluminum production in the United States can be increased from the current 17 percent to nearly 45 percent under an active recycling policy."[16]

Varon and Takeuchi make the important point that "it is not necessary for all three factors [substitution, stockpiling, recycling] to be at work at the same time. Any one of the three tends to place a ceiling on prices."[17] In the case of oil, none of the factors are at work. The situation is quite different for other raw materials. In view of the increasing demand for oil, the absence of ways to affect supply guarantees for the foreseeable future that OPEC can raise price without seriously affecting demand.

The third prerequisite for successful cartel formation is *proper composition of the cartel*. Gottfried von Haberler writes that

> all the difficulties and obstacles in the way of cartellising a branch of production increase in geometrical proportion to the number of participating countries. It is much more difficult to bring together the producers of several countries than those of one country.[18]

The number of member nations in the cartel is easily calculated. An even more important aspect of "proper composition" is the political outlook of the commodity-exporting nations. This factor is not so easily measured. To be more specific, "Political willingness is a *sine qua non* for cartelization."[19] OPEC is comprised entirely of

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[15]"Exploring Energy Choices," A Preliminary Report of the Energy Policy Project of the Ford Foundation, Washington, D.C., 1974, p. 35.

[16]Varon and Takeuchi, op cit., p. 499.

[17]Varon and Takeuchi, p. 506.

[18]Gottfried von Haberler, *The Theory of International Trade With Its Application To Commercial Policy*, The Macmillan Company, New York, 1950, p. 329.

[19]Mason Willrich and Philip M. Marston, "Prospects For A Uranium Cartel," *Orbis*, XIX, No. 1, Spring 1975, p. 177.

less-developed nations that share a need for raising the price of oil. They have shown no hesitation in forcing the industrialized world to pay that high price. Other groups of non-fuel mineral exporters are often composed of both developed *and* less-developed nations.[20] For example, Jamaica, Surinam, Canada, and Australia are the major exporters of bauxite. It is highly unlikely that Canada and Australia, nations that are closely linked with the industrialized world, would be willing to raise the price of bauxite drastically. The tradition of close commercial relations between Canada, Australia, and the industrialized world would probably be enough to discourage any such indelicate actions on the part of the two bauxite exporters. If nothing else, the close economic links among all the industrialized nations would make reprisal fairly easy.

Although the size of the cartel is not so detrimental to a price cartel, OPEC has a large enough membership that one would expect some modicum of difficulty in this regard. However, OPEC's unique relationship with the oil companies has enabled it to establish a price cartel without difficulty. This notion is considered as the fourth prerequisite: *absence of corporate resistance*. OPEC has had only limited success as far as production cutbacks are concerned. OPEC has had considerable success as a price cartel; one simply charges higher prices. OPEC's success in implementing this strategy was facilitated by the structure of, as well as the direct cooperation of, the oil companies. The oil companies are vertically integrated, few in number and international in nature. For decades, there has been little direct competition among them. When one company raised the price of oil, the others did likewise. To raise the price of oil, *OPEC simply levied higher taxes on the oil companies and the companies passed the price increases on to the industrialized world.* One of the major problems confronting cartel members is contracting with the

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[20] In his article, "Natural Resources and National Security," Richard Cooper provides a listing of 18 important non-fuel minerals. He writes, "It is noteworthy that for only three of the eighteen minerals listed--tin, sulfur and bauxite--are half of world reserves located in less developed countries." Cooper, op. cit., p. 10.

industrialized nations. Although the members may agree on a common price increase, the temptations associated with Prisoner's Dilemma work to undermine the stability of that established price increase.[21] The OPEC members were never faced with this problem because the oil companies did the contracting with the industrialized world and the oil companies, with their long history of cooperation, did not fall victim to cheating.[22] Consequently, OPEC had the perfect vehicle for raising prices and avoiding the problems of the Prisoner's Dilemma. The only non-fuel mineral in a similar position to oil is bauxite.

OPEC's limited success as a production cartel is not the result of the policies of all OPEC members, but rather the result of the policies of a small core of OPEC nations. This leads to the fifth prerequisite: *ability to take a long-term perspective.*[23] As Krasner makes clear and as the framework developed in the next section of this paper stipulates, cartels are at first victims of the Prisoner's Dilemma. This is true with regard to both price cartels and production cartels. The temptation to cheat and increase one's profits is great. As was noted above, the structure of the oil industry enabled OPEC to avoid this problem as a price cartel. However, if a cartel does not have this sort of special relationship, the problem of cheating becomes very real. Cheating reaps dividends in the short run. In the long run it is very likely to be detected. Consequently, nations with the resources to absorb short-run losses and look toward the long run can effectively work to hold a cartel together. Obviously,

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[21]At this point, one can see the problems associated with a large cartel that were described under the third requisite: proper composition of the cartel.

[22]An argument can be made that for purposes of destroying OPEC, the industrialized world should encourage OPEC to nationalize the oil companies. OPEC nations would then be forced to market their own oil. In such a circumstance, the temptation to cheat would be great. There is evidence that European nations are redesigning their bookkeeping systems so that it will be impossible to determine the source of European oil supplies. Such a development would greatly facilitate cheating and complicate the ultimate discovery of those who are cheating. This argument is put forth by M. A. Adelman in "Is The Oil Shortage Real?", *Foreign Policy*, 9, Winter 1972-1973.

[23]This phrase is borrowed from Krasner, op. cit., p. 78.

a small number of OPEC members have this capability. However, none of the other groups of non-fuel mineral exporters have members with this capability. Foreign exchange earnings are needed immediately and the members cannot afford to chance being double-crossed in the short run. OPEC, even without the benefit of the oil companies' collusion, would have probably been able to raise prices directly because many of its members could have afforded to chance a double-cross.[24]

It is difficult, if not impossible, to devise a precise calculus that could determine to what extent each prerequisite must be met before proper structure is obtained within an international commodity industry. It is nonetheless clear that the other non-fuel minerals groups fail to meet these prerequisites as well as does OPEC.

B. A GAME THEORETICAL PERSPECTIVE

International relations is a game of infinite iterations. Similarly, the "game of cartel formation" can be viewed as a game with an infinite number of "plays." This game is characterized by a three-stage cycle. The three stages of the cartel formation cycle can be thought of as random cooperation, stable cooperation, and deteriorating cooperation. Important for the purposes of analysis is the identification of the three-stage cycle as the basic temporal unit of cartel formation. The fundamental concept of this framework is "cooperation." What are the causes and effects of the varying degrees of cooperation throughout the three stages of cartel formation?

In the first stage of the game of cartel formation, the players are victims of the Prisoner's Dilemma.[25] The Prisoner's Dilemma stage

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[24]This point somewhat weakens the argument of using nationalization as a weapon for cracking OPEC. However, it emphasizes the importance of a new European bookkeeping system. If such a system made it impossible to discover cheating, those nations capable of taking a long-term perspective might reject any "wait and see" approach since they might never be able to detect existing cheating.

[25]It is recognized that these payoff matrices represent a two-person game while cartel formation is concerned with an N-person game. "Conceptually, there is no reason why our theory cannot be generalized to cover negotiations involving more than two bargainers: the basic

of cartel formation is characterized by *random cooperation and non-cooperation*. A reasonable payoff matrix for the first stage is:[26]

	Cooperation	Non-cooperation
Cooperation	10, 10	1, 15
Non-cooperation	15, 1	5, 5

Figure 1

Empirically, it has been demonstrated that as the Prisoner's Dilemma game is played (that is, as the number of plays increases), if none of the players believe that the end of the game is in sight, *the propensity of the players to cooperate increases*.[27] In cartel formation, this propensity to cooperate is indicated by increasing trust among the players and an emerging tradition of cooperation which encourages still more cooperation. As the number of plays increases, the "curse" of the Prisoner's Dilemma is weakened. As the members of an emerging cartel interact over time, the non-cooperative hold of the "one-shot" Prisoner's Dilemma is weakened.

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mechanism of the analysis is left unchanged, and it is possible to apply the same kind of reasoning which we have used in the two person model...Such a model will not change any of the conclusions..." John G. Cross, *The Economics of Bargaining*, Basic Books, Inc., New York, 1969, p. 236.

[26]This is a conventional Prisoner's Dilemma payoff matrix. It should be noted that the selected payoffs are expressed in positive numbers. This is because the least desirable outcome for a commodity producer would be very small exchange earnings. Income (a numerically positive payoff) would still be present, although that level of income would be relatively undesirable when compared to the other payoffs.

[27]Chong Soo Pyun, "Bargaining And Negotiation In A Mixed-Motive Game: Price Leadership Bilateral Monopoly: Comment," *The Southern Economic Journal*, XXXV, No. 2, October 1968, p. 183. Also see Chapter 9, "'Epsilon-Risk' Theory and Iterated Prisoner's Dilemma Games," of Bernard Grofman's Unpublished Ph.D. Dissertation, University of Chicago, 1971.

Figure 2 provides a schematic representation of the emerging pattern of cooperation. It must be emphasized that in order for the players' proclivity toward cooperation to increase, no end of the game must be in sight. Studies in game theory have demonstrated that "when the number of plays in the game is fixed...at the last play, at least, players are most likely to choose their individual maximum strategy pair (x_2, y_2) [the non-cooperative strategies]."[28] Under such conditions, it would be impossible to advance into Stage 2.

As the number of plays in Stage 1 increases, the players reach the point where they transition into Stage 2. This point is labeled Threshold A and it is characterized by the fact that the players have attained the capability to influence the payoff schedule of the game. Once the players reach the point where cooperation is the *modus operandi*, they can jointly manipulate the game for their benefit (see Figure 3). When the threshold is reached, the cartel advances into Stage 2. In this stage of the game of cartel formation, the Prisoner's Dilemma is replaced by a Cooperative Game--one which has a saddle point. The change in payoff matrices occurs because the players themselves can now influence the payoff schedule. The payoff matrix for Stage 2 is:[29]

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[28]Chong Soo Pyun, op. cit., p. 182. Also see Anatol Rapoport and Carol Orwant, "Experimental Games: A Review," *Behavioral Science*, January 1962, pp. 1-37, and Lester Lave, "Factors Affecting Co-operation In The Prisoner's Dilemma," *Behavioral Science*, January 1965, pp. 36-37.

[29]This is a conventional Cooperative Game payoff matrix. The only difference between this payoff matrix and that of the Prisoner's Dilemma Game is the payoff for the cooperative-cooperative (C-C) strategy. In the "game of cartel formation," the basic distinguishing characteristic between Stage 1 and Stage 2 is the consolidation of market power by the cartel. This market power is reflected in the cartel's capability to raise prices. In the case of OPEC, the posted price of oil was raised by a factor of five in 1973. This price increase characterized a four-year period in which OPEC revenues from oil (their actual payoff) increased from one dollar per barrel to ten dollars per barrel. The increase in payoff (by a factor of ten) that resulted from the consolidation of market power is represented in the C-C payoff of the matrix for Stage 2. What then of the other three payoffs in the Cooperative Game? Why are these payoffs identical to those of the Prisoner's Dilemma Game? First, it is essential to note that *only* when the members

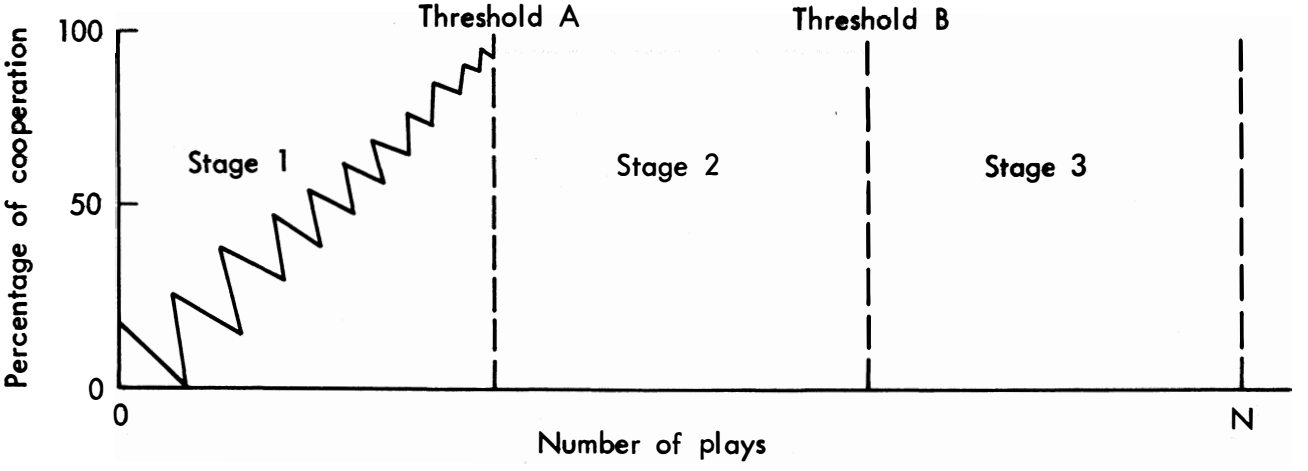

Threshold A
Threshold B
100
50
0
Percentage of cooperation
Stage 1
Stage 2
Stage 3
0
N
Number of plays

Fig. 2

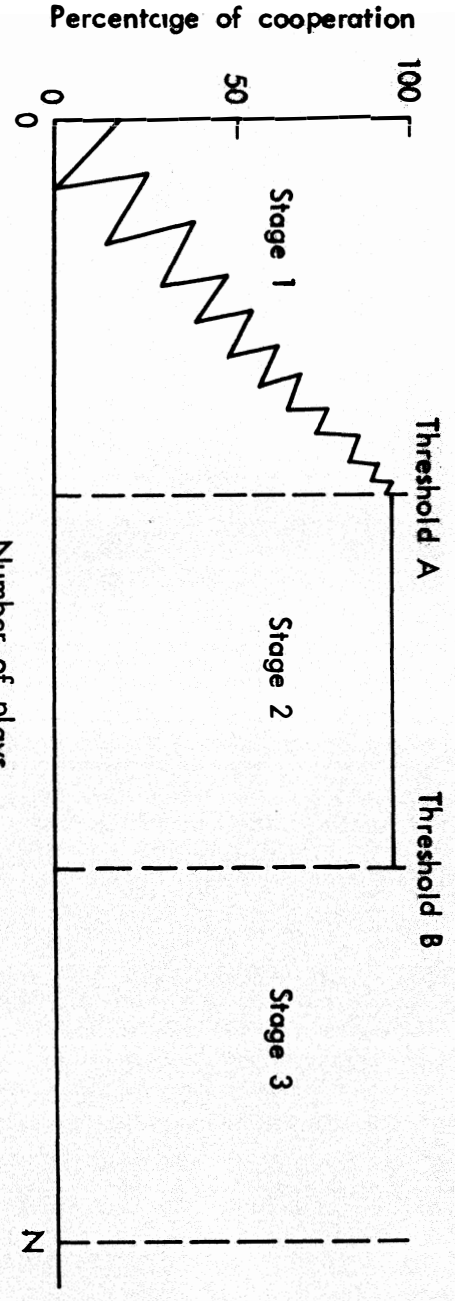

Percentage of cooperation
0
0
50
100
Stage 1
Threshold A
Stage 2
Threshold B
Stage 3
N
Number of plays

Fig. 3

	Cooperation	Non-cooperation
Cooperation	100, 100	1, 15
Non-cooperation	15, 1	5, 5

Figure 4

The second stage of the game of cartel formation is characterized by the emergence of *a stable pattern of cooperation*. In fact, the Cooperative Game is stable by definition. At this point, let us note OPEC's transition from Stage 1 to Stage 2. From the time of its inception until 1970, OPEC was in Stage 1. The Prisoner's Dilemma prevailed. However, as the number of plays increased, cooperation increased accordingly. In early 1971, the threshold was reached. Cooperation was such that the cartel members could influence their payoffs, that is, raise the price of oil. OPEC is presently in Stage 2. In the period since 1971, OPEC has clearly demonstrated that it can reinforce the tendency toward stable cooperation by increasing the payoffs for such a strategy.

It was noted in the introduction that two factors account for successful cartel formation. The factor under consideration at this point concerns the "number of plays of the game." However, certain structural prerequisites must also be present in order for the emerging cartel to enter the second stage. These structural requisites may or may not be present throughout the entire first stage of cartel formation. Structural deficiencies *may* account for unsuccessful cartel formation in cases where the game has in fact been played a "sufficient"

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of the cartel cooperate are they able to consolidate their market power and subsequently raise the price (payoff) of their commodity. If a member of the cartel was to choose the non-cooperative strategy or if the members jointly choose non-cooperative (NC-NC) strategies, their payoffs would be no different from the NC-NC payoff of the Prisoner's Dilemma. The only way the cartel members can alter the payoffs is to choose the C-C strategy; this results in market power. Additionally, by definition, there is no incentive to cheat in a cooperative game, and the C-C outcome is stable.

number of times. However, for the cartel to progress to the second stage, these structural prerequisites must be present. More specifically, the structural requisites must be present at the point of Threshold A. They need not be present throughout Stage 1 as the "number of plays of the game" increases.

There is a third stage of cartel formation and although OPEC has not yet exited Stage 2, the earlier assumption that a cartel has a finite existence requires that it eventually do so. Stages 2 and 3 are separated by Threshold B, which is the point where it appears to cartel members that there will be an imminent price drop, which will restructure the payoff schedule (see Figure 5). There are several ways in which such a situation could occur. For example, a substitute for oil might be discovered in a country which refuses to join OPEC.[30] These changes would be *structural changes* in the commodity industry which would fall outside the scope of control of the cartel. As the cartel moved into Stage 3, the payoff would change to a Chicken Game matrix:[31]

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[30]See the discussion in Section II, Part A, on supply unresponsive to price.

[31]This is a conventional "Chicken" payoff matrix. In the "game of cartel formation," the fundamental characteristic distinguishing Stage 2 from Stage 3 (the "Chicken" stage) is structural change which results in price drop. In terms of payoff schedules, even if the members of the cartel continue to cooperate (C-C), their payoff will decline. Hence the decline from 100 to 80. If one member of the cartel finds this lower payoff intolerable, he now has the option to marginally "shave" his prices, increase production substantially and maximize his short-term payoff. This payoff for non-cooperation would be comparable to the payoff to which he had become accustomed in Stage 2 (110↘100). Should one member choose a non-cooperative strategy, the other members will suffer (80→40), as the need for their output declines. However, once one member of the cartel cuts price and increases production to increase his overall payoff, the other members of the cartel will be likely to follow suit. The result will be the NC-NC payoff. At this point the price of the commodity will decline in a series of steps (a "ratchet" effect) to the NC-NC payoff of the Prisoner's Dilemma. (This value is 5, 5.) A final point should be made concerning the Chicken Game. One might say that, in a Chicken Game, the NC-NC payoff should be exceedingly low. Yet, the payoff for the NC-NC outcome in this Chicken payoff matrix is 5, the same payoff for the NC-NC outcome in Prisoner's Dilemma. This payoff

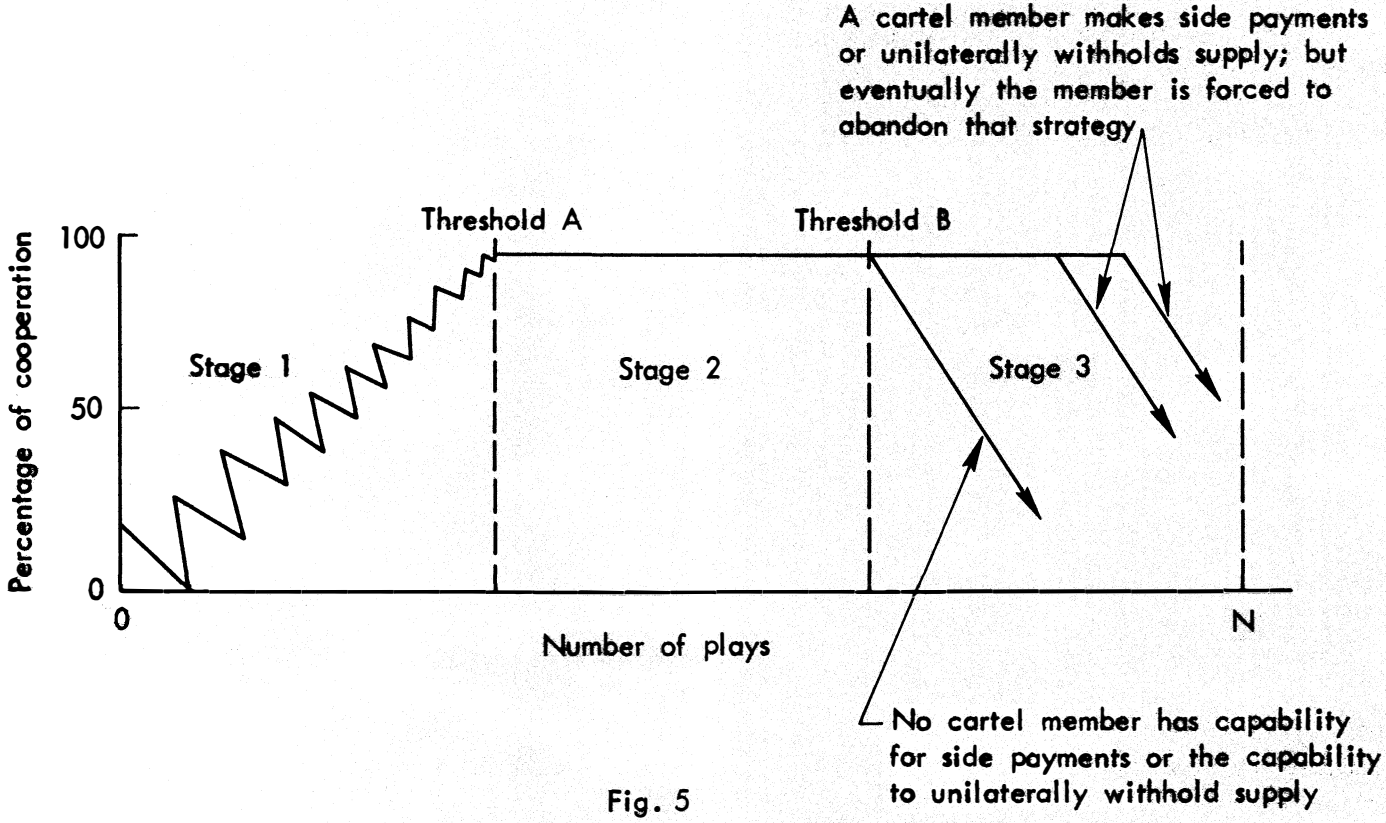

A cartel member makes side payments or unilaterally withholds supply; but eventually the member is forced to abandon that strategy
Threshold A
Threshold B
100
50
0
0
Percentage of cooperation
Stage 1
Stage 2
Stage 3
Number of plays
N
No cartel member has capability for side payments or the capability to unilaterally withhold supply

Fig. 5

	Cooperation	Non-cooperation
Cooperation	80, 80	40, 110
Non-cooperation	110, 40	5, 5

Figure 6

In Stage 3, the goal of the cartel is to maintain the situation where each player chooses the cooperative strategy. Price can best be supported by withholding supply. Such a policy requires close cooperation and some sacrifice because the cartel members have become accustomed to reaping the larger benefits from the cooperative strategy in Stage 2 (see Figure 4). Now, in Stage 3, even if the members follow the cooperative strategy, the payoff will not be as great as it was in the previous stage (see Figure 6). Therefore, if one member chooses the non-cooperative strategy (the member could slightly reduce his price and increase his production of the raw material) he could greatly increase his payoff, although he would injure his fellow cartel members. There are two conditions under which a cartel member would be likely to choose the non-cooperative strategy. First, if the future need for raw material was extremely bleak, there would be an incentive to maximize one's profit before demand (and price) plummeted. As was previously noted, in games with a finite number of plays, cooperation deteriorates near the final play. If a country outside the cartel were to develop a cheap synthetic substitute for the commodity in question, the end of the game would be in sight for all of the cartel nations. In such a circumstance, each member of the cartel would have an incentive to maximize his short-range gain by choosing the non-cooperative

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does not seem too terrible in light of the Prisoner's Dilemma. This observation is superficially correct but it ignores the fundamental characteristic of payoffs: they are relative to one another. The payoff of 5 is not intolerable in the Prisoner's Dilemma game. However, once the players have become accustomed to the stable payoff of 100 (C-C in the Cooperative Game), a payoff of 5 represents a drastic reduction. The perspective from which one evaluates the desirability of payoffs is determined by one's expectations and payoff history.

strategy. The second condition under which a cartel member would opt for the non-cooperative strategy would be if the reduced payoffs from the cooperative strategy in Stage 3 were insufficient for domestic needs. A country which is a member of a successful cartel receives substantial monetary reward during Stage 2. Members of such cartels are often less-developed countries (as illustrated by the case of OPEC) and are rarely in the position where they can afford a sudden reduction in income. For example, Iran, which has recently grown accustomed to receiving significant earnings from its membership in OPEC and which is financing most of its development programs with these revenues, would be in a very precarious position if the resulting payoff from pursuing a cooperative strategy diminished significantly--as it does in Stage 3. The Shah might be forced to choose the non-cooperative strategy, hoping to maintain an income flow comparable to that of Stage 2. One might argue that Iran would be hurting itself in the long run for what are nothing more than short-term benefits. However, the Shah might be in the position where if he did not solve his short-term problems, there would be no future to worry about. Under such circumstances, the Shah would probably opt for the non-cooperative strategy and hope that for the long run an alternative approach would develop.

There are two possible ways in which this situation can be avoided. First, a cartel member(s) with a reserve of revenues and no need to maintain the same high level of incoming revenues experienced in Stage 2 would be in a position to absorb all the cartel's production cuts by itself. Saudi Arabia is an example of a nation that might be in such a position. Iran would then not have to cut its supply and could conceivably work out an arrangement to increase its production to offset any cuts in price. The second means of avoiding breakdown would be for a member with large financial reserves to provide side payments to the member(s) threatened with internal instability--should he cut back his supply. Of course, if a cartel does not have anyone in a position to unilaterally cut supply or provide side payments, the non-cooperative strategy will prevail and the cartel will collapse

immediately. The problem with side payments and unilateral supply cutting is that they do not solve the fundamental problem (structural change); they merely forestall the final collapse. At some point, Saudi Arabia is going to begin to feel the pinch resulting from decreased revenues and/or monies spent for side payments. When this point is reached, the cartel will deteriorate. This highlights the important point that, at Threshold B, significant structural change occurs. The result is that the payoff matrix has changed such that it eventually becomes impossible to maintain the cooperative strategy. The end result is the deterioration of the cartel. However, there is the possibility that the final collapse may be delayed for a period of time. Once the cartel has collapsed, it returns to Stage 1. Where it goes from there depends on the industry's new structural configuration and what remnants of cooperation exist among the players.

III. THE DEVELOPMENT OF OPEC

The first stage of cartel development, random cooperation, is a period when the members of a cartel are ruled by the Prisoner's Dilemma. The distribution of benefits (payoffs) in this stage of cartel development is such that there is a strong incentive to "cheat" on the other members of the cartel in any joint cooperative venture. There is a lack of coordination, understanding and trust among the members of the cartel. Stable patterns of cooperation cannot emerge under these circumstances. The second stage of cartel development, stable cooperation, is a "Cooperative Game" with high payoffs for joint cooperation among the members of the cartel. Joint cooperation is preferable to cheating. OPEC is presently in the second stage of cartel development. Given this framework, three propositions present themselves:

1. At one time OPEC experienced a period of random cooperation.
2. As time passed, cooperative behavior among the members of OPEC tended to dominate non-cooperative behavior.
3. Relatively stable patterns of cooperation now prevail in OPEC.

It was noted in the previous section that cartel development was comprised of three stages. The third stage of cartel development is one of deteriorating cooperation. Stable cooperation will deteriorate when the cartel as a collective begins to lose its capability to support high commodity prices. In game theoretical terms, the cartel's payoff for joint cooperation declines. Since OPEC is presently in the second stage of cartel development, it seems imperative to examine the circumstances under which OPEC will deteriorate and to identify what courses that deterioration might follow.

The first step in the historical analysis of OPEC is the identification of the first two stages of cartel development and Threshold A, which separates them. As a point of reference, the price hikes of early 1971 mark Threshold A.

OPEC was established in September 1960 in response to reductions in the posted price of oil in February 1959 and August 1960. However, to identify the formation of OPEC as the "first move" in the "game of cartel formation" is to ignore an important tradition of interaction among petroleum exporting countries that predates 1960. The formation of OPEC was but one in a series of interactions and attempts at cooperation among these oil-exporting nations: OPEC itself was not the "beginning of the game." Iranian-Venezuelan contacts dated back to 1947. Venezuelan-Saudi contacts in the 1947-1950 period stimulated Saudi moves that led to the Saudi-ARAMCO accord of 1950.[32] In turn, several of the other Persian Gulf oil exporting countries followed the Saudi lead and renegotiated their oil revenue contracts with the oil companies. Also predating the formation of OPEC was the Arab Petroleum Congress which first convened in April 1959. Sessions of the APC were also held in later years.

The first stage of OPEC's development as a cartel was by no means a period of stable and successful cooperation among the members of the cartel. There were several important instances of non-cooperation during this period as well as other failures to realize objectives. Importantly, however, cooperation tended to predominate in OPEC in certain respects by the end of the 1960s.

OPEC had three basic policy objectives in the 1960s:

1. Restoration of posted prices[33] to their pre-1959 levels;
2. "Royalty expensing";[34]
3. Establishment of a cartel-wide production control system.

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[32]This accord changed the formula that determined the amount of oil revenue that the Saudi Arabian government would receive; a "fixed amount per barrel" formula was replaced by a more appealing (to the Saudis) profit-sharing formula.

[33]Posted prices are the prices from which taxes and royalties are calculated. They are substantially higher than the actual market price.

[34]Royalty expensing is a change in accounting procedures, resulting in a 12.5 percent increase in government oil revenues.

Throughout the 1960s, all OPEC attempts to establish a cartel-wide production control policy failed abysmally. The first attempt at "prorationing" was made in 1960. It failed when Venezuela, Iran and Saudi Arabia each advocated prorationing formulas that best benefited themselves; no compromise was reached. In September 1965 and again in 1966, an effort was made to establish a production control policy that would proration expansion of production (as opposed to prorationing of present production). Even this modest proposal failed.

Non-cooperation among the members of OPEC was also evident in Iranian and Venezuelan policy at the time of the 1967 Arab-Israeli war. Although the Arab oil exporting nations withheld production (or, *some* Arab states *attempted* to withhold production), Iran and Venezuela increased their production to obtain larger profits under good market conditions. Iraq bolted soon thereafter. The Arab oil embargo of 1967 consequently collapsed.

On the other hand, OPEC was successful on the issue of royalty expensing. This more advantageous accounting formula was incorporated into all contracts with the oil companies by the end of 1964. Only Libya failed to get royalty expensing at that time. However, the OPEC nations unanimously supported Libya (by resolution) in 1965 in its negotiations on this topic. Eventually, Libya was also successful on this count.

On the issue of posted prices, OPEC failed to have pre-1959 levels reinstituted. However, OPEC's pressures on the oil companies accounted for the fact that the oil companies never again reduced posted prices.

Another important factor in OPEC's development was the importance of establishing a forum for discussion and a mechanism for multilateral communication. Tendencies toward cooperation were reinforced simply by the existence of the organization. It accustomed these governments to working together and put them in an excellent position to take advantage of the situation that arose in 1970.[35]

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[35] See Zuhayr Mikdashi, "Cooperation Among Oil Exporting Countries with a Special Reference to Arab Countries: A Political Economy Analysis," *International Organization*, Winter 1974, passim.

An important move toward stable cooperation was made in June 1968 by OPEC. At that time a resolution was passed calling for an increase in the posted price of oil, a new tax objective of 55 percent (the existing tax rate of 50 percent), and an increase in participation in the oil companies. This resolution has been interpreted as the "first significant step toward consolidation of OPEC's power."[36] The resolution is especially significant in that these objectives were subsequently attained by the OPEC nations (in 1970-1971); this kind of success increased the credibility of the organization from the perspective of the member nations.

The trend toward increased cooperation among OPEC members was most apparent on issues concerning oil price. Progress was made on this front in the 1960s and this progress encouraged even more cooperation. On issues of production rationing and production control, non-cooperation among the members of OPEC was the rule. The distinction between price and production is important. Price cartels are more of a cooperative game than are production cartels, which more closely resemble the Prisoner's Dilemma game. Cooperation was more likely to emerge on the issue of price than on the issue of production limitation. The first stage of OPEC's development as a cartel was characterized by examples of both cooperation and non-cooperation among the members of the cartel. However, a pattern of cooperation did emerge in the case of price issues.

The threshold between Stage 1 and Stage 2 of OPEC's development was occasioned by increasing global demand for OPEC oil and a contraction in alternative sources of oil. In 1970, the supply of oil available on the world market (especially the European market) shrunk: the Suez Canal had been closed since 1967 and a tanker shortage reduced supply from the Persian Gulf; the pipeline from Saudi Arabia had been sabotaged and not yet repaired; the civil war in Nigeria interrupted supply from that source; the United States had gradually ceased

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[36]"The Middle East: U.S. Policy, Israel, Oil and the Arabs," *Congressional Quarterly*, April 1974, p. 29.

to be a major exporter of oil. Because of this *intersection of supply shortages*, Europe relied heavily on Libya for oil.

Libya, under the new revolutionary government headed by Colonel Muammar el-Qaddafi, took advantage of this situation and cut back production. Because of its accumulated financial reserves, Libya could afford to withhold production. Libya's demands of the oil companies revolved around the related issues of posted prices and tax inadequacies. Libya's demands were met by the oil companies, one by one, by September 1970; posted prices and the tax rate were raised. By taking a long-term perspective, Libya's long-term income was increased with higher posted prices, although short-term income declined temporarily, due to the production cuts.

An important OPEC conference was held in December 1970. In light of Libya's recent success, the OPEC nations agreed to demand an increase in the posted prices of oil and an increase in the tax rate to 55 percent; it was agreed that these demands would be supported with a threat to curtail supply. For the first time, a coordinated plan for negotiation was formulated. Negotiating by regions (the Persian Gulf, the Eastern Mediterranean, Libya), OPEC generated a "leapfrog" effect; an accord in one region inspired new demands in another. The net result was a "triple victory." In addition to the original Libyan accord, agreements were signed in Teheran (February 14, 1971) and again in Tripoli (April 2, 1971). Posted prices and tax schedules were increased throughout the Middle East. Coordinated bargaining was successful.

It is interesting to note the role "leadership" played in the development of OPEC's aggressive posture. Libya, not OPEC, initially made the new demands on the oil companies. The OPEC "chorus" was conducted by the Shah of Iran. With strong national leadership, OPEC demonstrated "increased ability to act in concert."[37] Additionally,

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[37] *Congressional Quarterly*, op. cit., p. 27.

the Teheran negotiations were the "first example of collective bargaining carried out by a ministerial commission appointed by the OPEC Conference."[38]

These advances in cooperative behavior mark Threshold A and OPEC's transition from Stage 1 to Stage 2 of the model of cartel development. The payoff schedules of the members of the cartel had been restructured, albeit slightly.

OPEC concluded two relatively minor agreements with the oil companies (January 1972, June 1973) over readjustment of the OPEC nations' purchasing power following the U.S. dollar devaluations of the early 1970s. These agreements also reinforced trends toward cooperation among OPEC nations.

Another interesting aspect of this reinforcement process concerns the notion of side payments. When Iraq nationalized the Iraqi Petroleum Company in June 1972, it might have cut the price of the nationalized output to guarantee a market for it. (There was an Iraqi fear of a Western European boycott of nationalized crude.) In order to enable Iraq to maintain the price of its oil, OPEC nations loaned over 25 million dollars to the Iraqi government. In this way, the price of OPEC oil would not be undercut. Side payments can be viewed as another means of reinforcing cooperation in a slightly unstable situation (given the financial resources necessary to make side payments).

OPEC's development with respect to cooperation in general and pricing in particular was consolidated in 1973. In October and again in December, the posted price of OPEC oil was increased 70 percent, raising the posted price of OPEC oil to (an average of) $11.65 per barrel. Again, the role of leadership was important in obtaining these price increases. This time, the Persian Gulf nations led the way in raising prices; the other OPEC nations raised their prices accordingly. The 1973 price increases drastically altered the OPEC nations' joint cooperative payoff. By this point, the nature of the game had clearly become "cooperative."

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[38]Mikdashi, "Cooperation Among Oil Exporting Countries with a Special Reference to Arab Countries: A Political Economy Analysis," p. 10

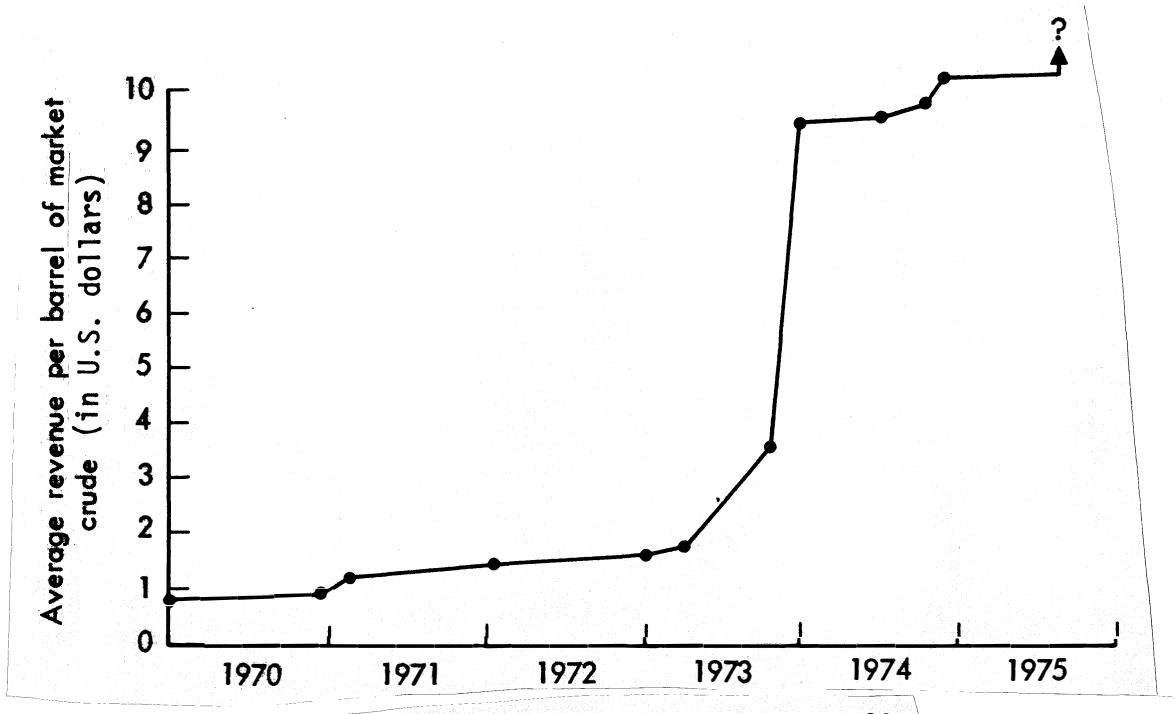


Fig. 7—The OPEC price threshold [39]

The Arab oil embargo and oil cutbacks announced on October 16, 1973, further emphasized the development of cooperative tendencies within OPEC. In the past, any attempt at establishing a joint production policy had met with failure. While acknowledging the inadequacies of the embargo, one must recognize that a joint production-control program of this magnitude was unprecedented.

Since early 1971, OPEC has been in the second stage of cartel development. This stage of cartel development is characterized by high payoffs for joint cooperation and relatively little incentive to "cheat." For the past several years, OPEC has exhibited these characteristics. There have been some allegations of "price shaving" (up to one dollar per barrel) during this period. It is reasonable to assume that there have been incidents of price shaving. The more important question is whether or not such relatively minimal "cheating" is threatening to the structure of the Cooperative Game itself. At this point, it seems that OPEC's price supports are stable; price shaving is not likely to cause the game to deteriorate. One of OPEC's mechanisms for maintaining the structure of the Cooperative Game while permitting some price shaving is to allow the shaving of "quality

[39] *The Economist*, September 20, 1975, p. 84.

differentials." In this way, nations can improve their income position marginally without disrupting the structure of the game.

The stability of the Cooperative Game is a function of the capability of the cartel to maintain a high payoff for joint cooperation. When this payoff (price) declines relative to other payoffs, the stability of the game will deteriorate. Because of extensive developmental programs, Algeria, Iraq, and Iran need a steady (or even increasing) flow of oil revenue. Given a decline in the oil revenues available to the governments of the OPEC nations, Algeria, Iraq, and Iran would be tempted to "cheat," so as to maximize their short-run payoffs. There might be no alternative for OPEC nations with extensive economic programs. Although they would be undermining the remnants of the Cooperative Game by doing so (and harming themselves in the long run), it is necessary for one to survive the short run in order to consider the long run.

At that point, deterioration would be imminent. The *rate of deterioration* would depend on several factors. As was noted above, two *secondary factors* that tend to reinforce cooperative behavior are side payments and leadership. When members of OPEC become inclined to cheat and undermine the game, cooperation can be reinforced in one of two ways. In the first place, a few members of OPEC could assume leadership roles and assume all production cuts necessary to maintain the required relationship between demand and supply. In the second place, these leaders could make side payments to needy nations that have assumed horrific production cuts. The emergence of leaders among the OPEC nations is a likely development and has indeed occurred in the past. However, the capability of these nations to assume production cuts and/or to make side payments depends on the financial resources available to these governments.

Throughout 1975, only two-thirds of OPEC's oil production capacity was utilized. Importantly, Saudi Arabia and Kuwait accounted for

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[40] *Newsweek*, March 1, 1976, p. 69.

more than half of the production cuts.[41] Kuwait produced oil at 51 percent of capacity and Saudi Arabia at 59 percent of its capacity.[42] On the other hand, Algeria found it necessary to operate at 90 percent of capacity.[43] Saudi Arabia and Kuwait are clearly bearing the brunt of a slightly unattractive market situation. One doubts whether Saudi Arabia and Kuwait can maintain such a position over time. Their financial reserves are not limitless. Saudi Arabia and Kuwait are "low absorbers" of oil revenue; they are not "non-absorbers." Further cutbacks would seem difficult. The Saudi government maintains that it could remain solvent with the revenue from less than 15 percent of its production capacity. Again, whether such a position could be maintained over time is problematic.

Oil-importing nations could aggravate the situation through oil conservation programs or greater reliance on oil substitutes. Oddly enough, if the West were to encourage the low absorbers toward increased economic development, their capability to make side payments or to assume production cuts would decrease. More of their revenue would be absorbed and less would be available as a financial cushion for the cartel. For that matter, any economic development within OPEC that absorbs oil revenue will ultimately aggravate the side-payment and production-cut factor. By way of example, accelerated Iraqi development might force Iraq to increase production which would require a low absorber to decrease production.

Economic development within the OPEC nations is accelerating. It is beyond the scope of this model and this essay to pinpoint when OPEC might actually disintegrate. For the immediate future, at least, it seems certain that OPEC will be able to continue to maintain high prices for oil and the payoffs of the Cooperative Game.

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[41] *Newsweek*, op. cit.

[42] *Ibid.*

[43] *Ibid.*