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THE STRUCTURE OF THE BUYER MARKET FOR OIL SHALE RESOURCES*

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A structural analysis of an industry is ordinarily a straightforward kind of research that follows well established procedures. Study almost universally begins by identifying the degree of concentration prevailing in the industry subject to study. A structural study of the oil shale industry is unique in that such an industry does not exist. To define the structure of the future buyer market for oil shale resources we must search for potential competitors and estimate the probable competitive character of the future industry. From knowledge of the required oil shale processing technology, capital requirements for a viable firm, required factors of production, and character of markets in which products from oil shale must be sold, it is possible to identify the industries from which entrants into oil shale production are likely to come and the characteristics required of individual firms for successful entry.

Entry into a new industry is a function of expected profitability after entry. I have assumed the following profitability conditions: that the rate of return is positive even for the first entrant, and that subsequent entry will yield a competitive rate of return. Income in excess of this rate presumably will be paid to the federal government in the form of a competitive bonus bid. It is the landlord's economic rent.

In order to estimate the probable structure of the buyer market for oil shale resources we will examine in Part I the concept of potential competition. After identifying the relevant theory, a discussion of the barriers to entry will follow. Then an inventory will be made of potential entering firms by industry of origin. In Part II the limits on effective competition will be set forth. These limits arise primarily out of a multitude of partnership arrangements currently prevailing among the firms that might become competitors for oil shale resources. In Part III competitive behavior of firms in natural resource markets similar to that of a future oil shale market will be examined. In Part IV the implications will be shown for federal oil shale leasing policy which follow from analysis of the probable future structure of the oil shale buyer market.

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I

POTENTIAL COMPETITION

A. The Theory of Potential Competition

The concept of potential competition is normally introduced in a discussion of mergers between two firms that are not horizontally related to each other. By merger, one firm that might have entered the industry of the other is eliminated as a potential entrant. Potential competition may be thought of as an antitrust "doctrine of last resort." When the stronger case, the charge of restraint of competition between two horizontally related firms, or the somewhat weaker case, the charge of market foreclosure between two vertically related firms, cannot be made, then the last resort is drawn upon, elimination of potential competition between firms in a conglomerate relationship. By definition, merger among two unrelated firms cannot increase concentration ratios since one of them has a concentration ratio of zero in all industries in which the other operates. But the fact of merger indicates that the firm having a zero concentration ratio is interested in entering the industry of its merger partner, hence it is a potential entrant. Elimination of a potential entrant by merger may have prevented entry and thereby eliminated actual competition. Or, merger may simply eliminate a firm that would have "remained at the edge of the market, continually threatening to enter."[1] The presence of a potential entrant may be viewed as a continuous threat by existing firms and may constrain their price behavior. A firm may price its products low in order to preclude entry. Bain wrote that "A vigorous threat of entry which at an appropriate time is anticipated and forestalled may serve to keep firms producing at outputs which give a fairly close approximation to optimum average costs."[2] This application of the potential entry doctrine to an existing industry is relevant to joint ventures and to joint bidding which will be discussed at a later point. Both are in widespread use in the oil industry.

When the potential competition doctrine is invoked for merger prosecution, the universe of potential entrants must be identified. If entry is free (there are no barriers to entry) then the universe of potential entrants is large and the doctrine is useless since an elimination of one such entrant through merger is of no practical consequence.

In the case of a non-existing industry the concept of potential

1. United States v. Penn-Olin Chemical Co. 378 U.S. 158-173 (1964).
2. Bain, *A Note on Pricing in Monopoly and Oligopoly*, 39 Am. Econ. Rev. 448, 459.

competition may be drawn upon to define the probable future industry. This again requires that the universe of potential entrants be identified. In order to systematically identify firms which might enter the oil shale industry, we need a set of criteria to separate potential entrants from all other firms. (1) Industries employing a technology similar to the one required in the new industry represent a primary source of entrants. In the case of oil shale as the new industry, the candidate existing industries in order of importance are, first, the oil industry, second, the mining industry, and third, the chemical industry. (2) Industries having a compatible marketing structure represent a source of entrants. The principal product of an oil shale industry is shale oil and the obvious related industry is the petroleum industry. By-products include ammonia and sulphur and, at some future date following the development of a lower cost extraction technology, dawsonite may be produced and marketed to the aluminum industry. (3) Industries having similar input factors may also be sources of entrants. One critical input factor is a professional labor supply—chemists. This criterion suggests that the petroleum industry and the chemical industry should be considered for entrant firms. (4) As a final criterion for identifying potential entrant sources, functional characteristics of products may be examined. Increasingly, corporate managements are expanding their scope of operations beyond conventional industry boundaries to include other products performing similar functions. For example, oil companies are expanding into the coal industry in search of a new corporate image which they call "the energy company." Oil shale is a source of energy. As such it is related to the following industries, oil, gas, coal, hydroelectric and nuclear. The latter two industries are classified as public utilities and their freedom to expand into other lines of activity is restricted. The coal industry is probably no longer a source of potential entrants since four leading coal companies have recently been acquired through merger by three oil companies and a metals company.[3]

The foregoing criteria for identifying potential entrants are based upon various similarities. Occasionally the opposite situation is a basis for entry, that of dissimilarity. For example, an industry with a seasonal or cyclical pattern of instability may search for entry into another industry that is dissimilar but offers greater stability or even into one having off-setting fluctuations. A firm heavily dependent upon military demands may consciously seek diversification

3. Continental Oil Company acquired Consolidation Coal Company, Occidental Petroleum acquired Island Creek Coal Company, Gulf Oil acquired Pittsburg & Midway Coal Company, and Kennecott Copper acquired Peabody Coal Company.

in a consumer goods industry. While entrance through dissimilarity is not uncommon, such entrance normally takes place through merger rather than original entry. Consequently this source of potential entrants will be given no further consideration.

B. Barriers to Entry

In order to identify firms that are probable entrants into the oil shale industry we need to have a clear understanding of the barriers to entry. The significant barriers are twofold: first, access to the new technology requires a heavy research investment with a long payout period, and second, relatively high capital requirements for production facilities are paired with considerable risk in the early years of the new industry.

While the new industry involves mining the shale, crushing the rock, retorting the crushed rock to produce oil, then refining, including hydrotreating to produce various high quality liquid fuels and other by-products, it is only the retorting that is clearly dependent upon a new technology. There are currently three alternative methods of retorting that have been demonstrated as workable through pilot plant experiments. They are (1) the U.S. Bureau of Mines gas combustion process, (2) the Union Oil Company process which depends primarily on fuel from the carbonaceous residue of the retorted shale rather than on produced gas, and (3) the TOSCO process which consists of several inclined rotary kilns in which the crushed shale is heated to its retorting temperature by a heat exchange process.

Mining technology involving surface retorting is an extension of existing mining operations. Four processes are available. (1) Room and pillar mining has been used for the pilot plant operations involving surface retorting. (2) Block caving as a mining process involves under-cutting blocks of ore in such a manner that causes them to cave in on the floor of the mine thereby breaking up the ore. (3) The cut and fill mining method has been proposed by the U.S. Bureau of Mines as an ideal method of oil shale mining.[4] It involves a continuous mechanical process of underground excavating, loading, hauling to the retorts, and then returning the spent shale to fill in the underground voids. (4) Open pit mining is a standard operating procedure having a long experience in coal and copper mining as well as some less extensive applications in other minerals.

Capital requirements for entry into the oil shale industry with an

4. U.S. Department of the Interior, Prospects for Oil Shale Development 54-55 (May, 1968).

optimal scale plant are relatively large. Probably the most credible estimates are those of TOSCO since this organization is proceeding with plant development which it expects to have on-stream in 1970. A vice-president of TOSCO testified before the U.S. Senate Committee on Interior and Insular Affairs that the cost of a 58,000 barrel per day plant, including all expenses associated with achieving full production, is $130 million. This includes hydrotreating and by-product recovery facilities.[5] In the course of interviewing oil company executives in charge of oil shale development, estimates in the range $100-150 million were developed for the total capital cost of entering shale oil production. These costs do not however include the raw material cost. Current leasing policies adopted by the Department of Interior for minerals subject to competitive bidding require bonus bids payable at the point of lease. Therefore bonus payments become part of the initial capital cost. A production facility capable of producing 50,000 barrels of oil per day from a retort would require a shale lease large enough to yield about 450 million barrels of oil over a 25 year amortization period. A bid amounting to 20¢ per barrel of oil would require a bonus of nearly $100 million. In the early years of an oil shale industry bonus bids might be expected to be substantially less than 20¢ per barrel.

The initial oil shale processing methods are likely to involve the established room and pillar mining with surface retorting. As the industry matures, however, open pit mining might be employed, particularly where the overburden is thin relative to the richness of the underlying ore. The richest oil shale, averaging at least 25 gallons of oil per ton of rock and 2,000 feet thick, are in the center of the Piceance Creek Basin and unfortunately are buried under about 1,000 feet of overburden. One estimate holds that in order to achieve low cost mining of this rich shale by open pit methods, approximately $500 million must be invested in developmental expenditures before any off-setting revenue is received.[6]

In-situ retorting with nuclear fracturing of the rock may involve a lower capital cost barrier to entry. One estimate by Lekas shows the capital investment varying from a minimum of $29 million under ideal conditions, to a maximum of $162 million, varying with the area covered and inversely with the thickness of the ore.[7] Others have been highly critical of the Lekas low-cost estimates for nuclear

5. Winston, *Hearings Before the Comm. on Interior and Insular Affairs,* 90th Cong., 1st. Sess. 400-02 (1967).

6. Ertl, *Mining Colorado Oil Shale,* Second Symposium on Oil Shale, 88 Colorado School of Mines (1965).

7. Lekas, *Economics of Producing Shale Oil: the Nuclear In-Situ Retorting Method,* Third Symposium on Oil Shale, 102 Colorado School of Mines (1966).

in-situ retorting. For example one highly regarded authority on oil shale technology wrote that

> Lekas took some highly optimistic assumptions and applied them to hypothetical situations to get some idea of the comparative economics of oil shale production. . . . The lowest conceivable figure . . . even if achievable could be applied only to a limited part of the shale reserve in Colorado and not at all in Utah or Wyoming. Furthermore the costs would likely be considerably higher because ideal conditions are almost never encountered.[8]

The same critic concluded that

> it is my belief that shale oil will be produced first by mining and retorting using techniques already in an advanced stage of development and that these methods will be improved still further through commercial application. *In-situ* methods of production may be in use within 20 years, but they will not likely be more economical than the mining/retorting systems of that day.[9]

Available estimates of the capital cost barrier to entry into oil shale production by the optimum methods suggest that the minimum capital requirements will be approximately $130 million plus the resource cost. Given further that there is no operating production scale plant in the United States and consequently costs of production are highly uncertain, it seems likely that only those companies large enough to supply a large fund of capital and also assume considerable risk in the early years of the industry will be able to surmount the capital cost barrier to entry.

C. *Inventory of Potential Entrants*

Company research into oil shale processing is often carried out under armed guards and highly secret surroundings. Accordingly, it is difficult to know which companies have done research and to what extent, in order to become potential entrants into a new oil shale industry. The limited information available is shown in Table 1. Seven integrated oil companies plus one iron company and one strictly oil shale company are known to be engaged in surface retorting research through two joint venture research groups. In addition five more oil companies are known to have engaged in large scale independent research. Thus a total of 12 oil companies are known to have invested heavily in surface retorting of oil shale. In

8. Cameron, *Oil Shale in Focus* 6-7 (Cameron and Jones Inc. 1967).
9. *Id.*

addition, 25 companies, including 17 oil companies, are engaged in a joint venture to conduct research involving *in-situ* retorting with nuclear fracturing. Finally, four firms are jointly financing the "Center for Fundamental Oil Shale Research" at the University of Denver. Research is concerned with the basic physical-chemical structure of the mineral and not with development of either processes or products.

TABLE 1

COMPANIES KNOWN TO BE ENGAGED IN LARGE-SCALE RESEARCH IN OIL SHALE PROCESSING

Companies known to have an independent oil shale research program and to own one or more shale processing patents, but not included in one of the two joint venture surface retorting research groups listed below:

1. Union Oil Co. of California
2. Standard Oil Co. of California
3. Atlantic-Richfield
4. Shell Oil Co.
5. Texaco Inc.

Joint venture research groups:

Colony Development Co. (Surface retorting)[a]

1. Standard Oil Co. of Ohio
2. Cleveland Cliffs Iron Co.
3. The Oil Shale Corp: (TOSCO)

The Anvil Points Group (Surface retorting)[b]

1. Mobil Oil Corp.
2. Humble Oil and Refining Co. (Standard Oil Co. of New Jersey)
3. Pan American Petroleum Corp. (Standard Oil Co. of Indiana)
4. Sinclair Research Inc. (Sinclair Oil Co.)
5. Phillips Petroleum Co.
6. Continental Oil Co.

CER Geonuclear Combine (*In-situ* retorting)[c]

1. Ashland Oil & Refining Co.
2. Atlantic-Richfield
3. Cameron & Jones Inc.
4. Cities Service Oil Co.
5. Continental Oil Co.
6. El Paso Natural Gas Co.
7. Equity Oil Co.
8. Getty Oil Co. (Tidewater)
9. Humble Oil & Refining Co.
10. Marathon Oil Co.
11. Mobil Oil Corp.
12. Murphy Oil Co.
13. Pan American Petroleum Corp.
14. Shell Oil Co.
15. Sinclair Oil & Gas Co.
16. Sohio Petroleum Corp. (Standard Oil of Ohio)
17. Sun Oil Co.
18. Superior Oil Co.
19. Tenneco Oil Co.
20. Texaco Inc.

21. The Cleveland Cliffs Iron Co.
22. The Oil Shale Corp.
23. Union Pacific Railroad
24. Western Oil Shale Corp.
25. Wolf Ridge Minerals Corp.

Center for Fundamental Oil Shale Research (University of Denver, Denver Research Institute)[d]

1. The Oil Shale Corporation (TOSCO)
2. Aquitaine Oil (a French Government controlled oil company)
3. Humble Oil and Refining Co.
4. Shell Development Co. (subsidiary of Shell Oil Co.)

a. TOSCO, *Oil Shale Development on Federal Lands* 2 (1964). This statement was prepared for the Oil Shale Advisory Board.

b. Watkins, *Hearings Before the Subcommittee on Antitrust and Monopoly of the Senate Committee on the Judiciary,* 90th Cong., 1st Sess. 88 (1967).

c. *Id.,* at 94.

d. Communication with Center for Fundamental Oil Shale Research.

All but eight of the big 20 oil companies (1966 asset position) are shown to be involved in surface retorting research. The companies not known to be so engaged are Gulf Oil, Cities Service, Tennaco, Sun Oil, Signal Oil and Gas, Ashland Oil and Refining, Tidewater Oil (Getty Oil), and Marathon Oil. Six of these eight companies are included in the *in-situ* retorting project. Only Gulf Oil and Signal Oil and Gas do not appear on any research list. Thus, available evidence indicates that 12 oil companies may be qualified to enter the oil shale industry by virtue of their own large scale research into surface retorting and all but two of the big 20 oil companies have demonstrated considerable interest in oil shale research.[10]

In addition to research qualifications, a potential entrant into the oil shale industry must also qualify on the basis of capital requirements. We have indicated above that the minimum estimated capital cost is $100 million for a basic plant and about $130 million if hydrocracking facilities are included. In addition, an unknown sum is required for the shale resource itself. The Sun Oil Company recently entered a similar new industry with a similar capital commitment. Sun is investing approximately $230 million in a plant to process the Athabasca tar sands in Canada. Like oil shale, the technology of processing tar sands has not been demonstrated on a

10. One possible explanation for the absence of Gulf Oil Company, the nation's fourth largest oil company, is its very favorable crude oil reserve position. As of December 1966, Gulf had reserves of 3.32 billion barrels in the Western hemisphere, and 25.86 billion barrels in the Eastern hemisphere. Gulf's 1967 production rate was 832 million barrels per year. Its reserve to production ratio was 35 to 1. This is approximately three times the United States reserve to production ratio. Source, Standard and Poor's, Listed Stock Reports.

large scale. The investment risks for tar sands and oil shale appear to be quite similar. Sun is the fifteenth largest U.S. oil company with total assets of $1.4 billion. It is doubtful that a company much smaller than Sun could undertake a high risk investment of this magnitude. Accordingly, we will assume that potential entrants into the oil shale industry will be limited to those companies having total assets of at least one billion dollars. Table 2 provides a list of 16

TABLE 2

U.S. OIL COMPANIES HAVING TOTAL ASSETS (LESS DEPRECIATION AND DEPLETION) GREATER THAN $1.0 BILLION AS OF 1966

Company	*Assets (Million dollars)*
1. Standard Oil of New Jersey	13,853
2. Texaco	6,363
3. Gulf Oil	5,892
4. Mobil Oil	5,512
5. Standard Oil of California	4,502
6. Standard Oil of Indiana	3,849
7. Shell Oil	3,035
8. Tenneco	2,909
9. Phillips Petroleum	2,673
10. Continental Oil	2,070
11. Union Oil of California	1,899
12. Sinclair Oil	1,791
13. Cities Service	1,721
14. Atlantic-Richfield	1,660
15. Sun Oil	1,412
16. Getty Oil (formerly Tidewater)	1,011

Source: *Fortune*, June 15, 1967, pp. 196-200.

U.S. oil companies that qualify on the basis of asset position as potential entrants into the oil shale industry. They range from Standard Oil Company of New Jersey with nearly $14 billion of total assets down to Getty Oil with slightly more than $1 billion.

Of the 16 oil companies shown in Table 2 that are considered to be potential single entrants into the oil shale industry by virtue of asset size, all but Gulf have shown a research interest. Therefore, our list of potential single firm entrants will be narrowed to 15 firms.

The list may be further narrowed by examining present shale resource ownership of the 15 firms. Those firms having large holdings of both deep rich shale in the Colorado Piceance Basin and shallow rim-type holdings in either Colorado or Utah may be eliminated as potential bidders for federal leases. Such firms are presumed to be fully capable of beginning production at any time by virtue of their research competence, asset strength, and adequate

shale resources. Additional shale is apparently not needed for either research or for a production scale plant. Unusual circumstances may, however, indicate that such companies are still potential bidders.

Table 3 shows oil shale land ownership by company, acreage, and type of land in Colorado and Utah. Five companies (Shell, Sinclair, Getty, Union, and Standard Oil of California) may be eliminated from the list of potential single firm bidders on the basis of their extensive undivided fee holdings. Clearly Shell and Sinclair have adequate holdings of both types of resources. Getty has no apparent deep rich holdings, but its ownership in the easily accessible rim-type deposits is among the largest. The company's 1967 annual report asserts that its holdings are in an area

> considered to be the richest zone of the oil shale formation. Company holdings are well located for possible future development. Canyons that cut the acreage could provide natural waste disposal areas and water rights held by the company are deemed to be adequate. . . .[11]

While the large fee ownership of both Union and Standard of California are shown in the rim-type deposits, the holdings are so extensive that both types of deposits are available to these two companies. Both have approximately 50,000 acres of shale lands. While these five companies are not considered potential bidders for the initial oil shale leases, they may enter the Federal lease auction market at a later date in order to further improve their reserve position or to block-up their holdings.

Sun Oil Company has no apparent shale land holdings in the United States, nor is the company a member of the surface retorting research groups. The company has a heavy financial commitment in the high-risk Canadian Athabasca tar sands. It has indicated that original estimates of the bitumen content of the tar sands was too optimistic and, in addition, construction costs of a processing plant have been 11 percent higher than anticipated.[12] Until this company emerges from its period of high-risk associated with the Athabasca venture it should not be considered a potential entrant into the oil shale industry as another high-risk venture.

The remaining nine companies listed among the potential single firm bidders in Table 3 will remain on our list. However, two of them require comment. Atlantic-Richfield and Mobil have participating ownership in both types of deposits. Atlantic-Richfield has no apparent undivided ownership in any type of shale resources. Both

11. Getty Oil Co. Annual Report, 33 (1967).
12. Our Sun, Summer 1966, at 6.

TABLE 3

MAJOR OIL COMPANY OWNERSHIP OF OIL SHALE LAND IN COLORADO AND UTAH

Company name	Utah				Colorado			
	State lease, shallow deposit		Fee land, shallow deposit		Rim-type deposit		Deep, rich shale	
	acres	barrels (billion)	acres	barrels (billion)	acres	barrels (billion)	acres	barrels (billion)
Potential single firm bidders								
1. Atlantic-Richfield	15,500	2.5	1,500	0.2	40% of 20,560	40% of 2.3	25% of 2,080	25% of 3.5
2. Cities Service					7,000	1.5		
3. Continental					69% of 10,000	69% of 0.5		
4. Getty					22,000	4.0		
5. Humble					50% of 6,500[a]	NA		
					50% of 12,360[a]	NA		
					6,500[a]	NA		
6. Mobil					50% of 20,560	NA	50% of 2,080	NA
					10,000			
7. Phillips			1,680	NA				
8. Shell	19,000	NA			21,000[b]	NA	2,000	NA
					5,000	NA		
9. Sinclair					6,500	1.0	1,500	3.5
10. Standard of California					40,000	NA		
					5,600[a]	NA		
11. Standard of Indiana	7,000	3.0			3,000	0.5		
12. Sun								
13. Tenneco							50% of 2,360	
14. Texaco			12,000	NA	14,000	NA		
15. Union					5,400[a]	NA		
					8,200	NA		
					46,000[c]	NA		
Others								
16. Standard of Ohio (partner in Colony Development Co.)					40% of 23,950	NA	40% of 400	NA
17. Gulf					3,700	0.1		
18. Marathon							760	1.5
19. Superior					6,000	NA		

Source: Based on data (1) supplied by Cameron and Jones, Denver, Colorado, assembled from the best available public information, and (2) in Weinberg, *Hearings before the Subcommittee on Antitrust and Monopoly of the Senate Committee on the Judiciary*, 90th Cong., 1st Sess., 181, 192 (1967).

NA—Not available

a. Unpatented mining claims.

firms may want to acquire federal leases in order to gain undivided control over some shale lands. In addition, Atlantic-Richfield has followed a vigorous program of expansion into oil shale. It not only has an energetic research program, but also recently acquired a 40 percent interest in 20,560 acres of Colorado shale lands from Equity Oil Company at a cost of $27 million.[13] Further, it is negotiating for a 30 percent interest in the Colony Development Company with Standard Oil of Ohio, Cleveland Cliffs Iron Company, and TOSCO.[14] One of the reasons given in support of the Atlantic-Richfield merger was that Richfield was in a resource-poor position. Presumably the company's policy in oil shale reflects its reserve position. Mobil also has holdings of both types, but only rim-type in undivided ownership. Mobil's crude oil reserve position is reported to be relatively poor. While the company's interest in federal leases is questionable, it will be retained on the list of potential single firm entrants. The reader should not infer that all nine are expected to bid for all leases offered. Rather, the list is intended to define the universe of potential single bidders only. It must be regarded as a rough approximation at best.

Other oil companies, too small to be single bidders, may be considered potential partners in a joint venture. Signal Oil and Gas and Ashland Oil and Refining are among the big 20 oil companies, but have assets less than one million dollars. Neither has any apparent shale land ownership. In addition, Marathon Oil Company may be added as a potential joint entrant although the company has some Piceance Basin deep shale land as shown in Table 3. Ashland and Marathon are both members of the *in-situ* retorting research combine.

The potential single firm bidders from the oil industry for initial federal oil shale leases may now be summarized as follows:

1. Atlantic-Richfield
2. Cities Service
3. Continental Oil
4. Humble
5. Mobil Oil
6. Phillips Petroleum
7. Standard Oil of Indiana
8. Tenneco
9. Texaco

These nine firms are all qualified by a known research background, by adequate capital, and are not excluded by large holdings of oil shale resources in the rich center of the Piceance Creek Basin where most of the government reserves (both rim-type and deep) are located.

13. Wall Street Journal, March 25, 1968 at 6 Col. 3.
14. *Id.*

Mining companies have remained relatively disinterested in oil-shale mining and processing. Anaconda Copper and Kennecott Copper companies both have assets in excess of one billion dollars. Yet neither is known to have a significant interest in entering the oil shale industry. Kaiser Aluminum and Chemical Corporation and Wolf Ridge Minerals Corporation have conducted studies on dawsonite extraction methods.[15] As indicated earlier Cleveland Cliffs Iron Company is already one of the joint venturers in the TOSCO development. Also, Utah Mining and Construction Company has long been interested in shale mining. None of the mining and metals companies listed here can be considered potential single entrants into the oil shale industry. However, they are all potential partners, particularly Kaiser and Utah Mining, in a joint venture possibly involving an oil company.

The only chemical company known to have an interest in oil shale development is Dow Chemical Company. Dow owns 8,317 acres of shale land in Colorado which are under lease to TOSCO. Since Dow is not a partner in the TOSCO shale enterprise, one may infer that the company's interest is limited to land ownership and rental income. Chemical companies having assets greater than one billion dollars are shown in Table 4 and include five companies in addition

TABLE 4
U.S. CHEMICAL COMPANIES HAVING TOTAL ASSETS (LESS DEPRECIATION AND DEPLETION) GREATER THAN $1.0 BILLION AS OF 1966

Company	*Assets (Million dollars)*
1. Dupont	3,185
2. Union Carbide	2,224
3. Monsanto	1,865
4. Dow Chemical	1,705
5. Allied Chemical	1,494
6. Olin Mathieson	1,162

Source: *Fortune*, June 15, 1967, pp. 196-198.

to Dow. None can be considered potential single entrants, but all are possible partners in a joint venture.

In addition to the nine oil firms that are potential single bidders for federal oil shale resources, one can envision perhaps a half dozen joint ventures made up of smaller oil companies, mining companies, and chemical companies. Therefore, there might be as many as fifteen bidding entities contending for the initial leases. The num-

15. Watkins, *Hearings before the Subcomm. on Antitrust and Monopoly of the Senate Comm. on the Judiciary*, 90th Cong., 1st Sess., 96 (1967).

ber of bidders for any one tract would depend on the number of tracts offered.

II
LIMITS ON COMPETITION

Competitive bidding is required for oil shale resources leased by the federal government.[16] We have seen above that the potential competitors for oil shale leases will be few in number, and given the high capital cost of entry, they are likely to be large firms or combinations of smaller firms. The ability of firms to compete at arms length may be questioned due to the multitude of partnership arrangements prevailing among large oil companies. Partnership arrangements arise out of joint ventures between competing oil companies both on an international and a domestic level. In addition, joint bidding arrangements for domestic oil and gas leases are widespread.

A. Joint Ventures in the Oil Industry

A corporate joint venture may be defined as a new business entity created by two or more corporate partners. One study of joint ventures contained the following opinion: "Perhaps in no other American industry is there so much use made at present of the joint venture corporation as in the oil and gas industry."[17]

Due largely to the high risk involved in international oil exploration and production, the joint venture corporate form is in common use. A detailed study of international oil companies found that "the outstanding characteristic of the world's petroleum industry is the dominate position of seven international companies."[18] The seven companies include five American companies—Standard Oil of New Jersey, Standard Oil of California, Mobil, Gulf Oil, and Texaco. The Federal Trade Commission estimated that the seven companies owned 65 percent of the world's estimated crude oil reserves. Control over various phases of petroleum operations is maintained through devices which include joint ventures. The competitive implications of the Commission's findings are stated as follows: "Such a maze of joint ownership obviously provides opportunity, and even necessity for joint action. With decision-making thus concentrated

16. Mineral Lands Leasing Act of February 25, 1920, ch. 85, § 17, 41 stat. 437.

17. Broden and Scanlon, *The Legal Status of Joint Venture Corporations,* 11 Vand. L. Rev. 673, 689 (1958).

18. Federal Trade Commission, *The International Petroleum Cartel,* Staff report submitted to the Committee on Monopoly of the Senate Select Comm. on Small Business, 82nd Cong., 2nd Sess., 23 (1952).

in the hands of a small number of persons, a common policy may be easily enforced."[19] While use of the joint venture device has continued to expand since 1952, in two conspicuous instances its use has been reduced. The Stanvac joint venture between Standard Oil of New Jersey and Socony-Vacuum Oil Company (now called Mobil) is being dissolved and the Caltex joint venture between Standard Oil Company of California and Texaco is being partially dissolved.

Domestically, joint ventures among horizontally related oil companies are common for pipeline facilities and for crude oil and gas exploration and production in submerged areas and in the state of Alaska. Very little is known about the extent of domestic joint ventures among oil companies. In order to develop basic data, the journals, periodicals, and financial reports where corporate joint ventures are normally reported were searched covering the years 1954 through September 1967. The following joint ventures were included in the study: jointly owned refineries and other manufacturing facilities, jointly owned pipelines and other transportation facilities, joint exploration agreements, and jointly held oil and gas properties and leases. Excluded from the tabulation are the following: joint bids for oil and gas leases, jointly held non-operating concessions and joint producing properties formed under state unitization laws. Since this survey is based upon published reports of joint ventures, it is clearly not complete. It is sufficiently comprehensive, however, to provide a clear understanding of the partnership arrangements arising out of joint ventures which serve to unite horizontally related firms. The results of the survey are shown in Table 5. Among the 500 largest industrial corporations (by 1964 asset position) listed in Fortune magazine, there are 32 oil companies. The findings show that a large number of joint ventures have been created between these horizontally related firms. For example, Standard Oil Company of New Jersey has 299 joint ventures with 27 of the 31 possible competing firms. Mobil Oil Company, which is the second largest U.S. oil company, has 300 joint ventures with 28 out of the 31 possible competitors. The Royal Dutch Shell group has 340 joint ventures with 29 out of 31 American possibilities.

The rows and columns that are blank or show very few joint ventures in Table 5 are occupied generally by the relatively small companies. There are two possible explanations for the absence of joint ventures among the smaller firms. First, joint ventures among such small firms may not be reported to the press. Second, smaller firms may avoid the joint venture structural form.

Most of the joint ventures found are in fact among the largest

19. *Id.* at 29.

TABLE 5

FREQUENCY OF JOINT VENTURES AMONG THE 32 LARGEST OIL COMPANIES[a]

1964 Asset Rank		Standard (N.J.)	Mobil	Texaco	Gulf	Royal Dutch Shell Group	Standard (Ind.)	Standard (Calif.)	Phillips	Continental	Sinclair	Cities Service	Sun Oil	Tidewater	Atlantic Refining	Pure	Signal	Union	Standard (Ohio)	Marathon	Sunray DX	Ashland	Hess	Richfield	Skelly	Kerr-McGee	Amerada	American Petrofina	Murphy	Kern Co. Land	Commonwealth	Superior	Clark	Others
1	Standard (N.J.)																																
2	Mobil	62																															
3	Texaco	24	31																														
4	Gulf		11	14																													
5	Royal Dutch Shell Group[b]	59	51	37	19																												
6	Standard (Ind.)	12	10	15	8	16																											
7	Standard (Calif.)	21	21	50	8	22	2																										
8	Phillips	8	10	9	5	9	6	4																									
9	Continental	13	11	11	9	21	10	5	8																								
10	Sinclair	5	11	9	7	6	10	1	7	13																							
11	Cities Service	16	7	18	5	8	8	1	5	24	14																						
12	Sun Oil	2	6	5	5	4	6		4	5	3	5																					
13	Tidewater	11	6	8	5	7	5	4	3	4	4	12	6																				
14	Atlantic Refining	9	8	10	6	8	9	5	13	8	7	8	11	7																			
15	Pure	2	3	7	7	4	7	1	2	5	10	8	8	1	3																		
16	Signal	3	6	5	2	5	1	7	9	2	1	1		2	4	2																	
17	Union	4	3	5	5	8	5	5	4	8	8	5	5	6	8	3	2																
18	Standard (Ohio)	2	4	1	3	2	2	1	1		2	3	4	2	2	5	2	1															
19	Marathon	9	8	6	2	7	5	1	2	19	6	6	2	3	7	7	2	6	1														
20	Sunray DX	4	7	6	5	11	5	4	24	10	2	9	3	9	1	1	7	4	1	3													
21	Ashland	2	4	3	1	6	1	4	8		1			2	2		6		2		6												
22	Hess																	1															
23	Richfield	3	4	3	5	5	2	8	1	4	2	12	1	6	2	1	7	4	1	3	3	1		1									
24	Skelly	1	1	2	1	1	2		3	5	5	4	1	4	1	3	1	3		1	7				1								
25	Kerr-McGee	1	2		1	2		1	5	1		2		5	2		1	2		1	5	2		2	2								
26	Amerada	4	2		2	6	4		1	8	1		1	2	2		1	3		8	1					1							
27	American Petrofina	4	4	4	1	4	4	3	6	3		1	1	1	1					1	1				1								
28	Murphy	3	2	1		4	1		1	4	2	1	3	1	5	1	1	4	1	2	2						1	1					
29	Kern Co. Land																																
30	Commonwealth			1		3																											
31	Superior	1	4		1	4	6	2	1	2	3	4	6	5	7		1	4		3	4	3		2	2	5	2		2				
32	Clark		1	1		1	1	1		1		1	1			1		1		1	2										1		
	Other oil companies	51	49	28	27	51	21	22	21	40	15	16	13	18	9	2	4	9	6	6	7	6	2	8	6	3	4	8	10		1	6	1	
	Total 32 largest	299	300	286	152	340	163	182	159	214	140	191	97	131	166	92	81	116	42	125	157	54	1	83	52	45	50	41	45	0	4	75	14	470
	Total incl. other	350	349	314	179	391	184	204	180	254	155	207	110	149	175	94	85	125	48	131	164	60	3	91	58	48	54	49	55	0	5	81	15	—

Sources: Moody's Industrials; Oil and Gas Journal; Wall Street Journal; annual reports of each company, Federal Trade Commission, Staff Report to U.S. Senate Subcommittee on Monopoly of the Select Committee on Small Business, *The International Petroleum Cartel*, 82nd Cong., 2nd Sess. (1952)

a. Sales ranking for 1964, Fortune, August 1965, pp. 24-40.

b. The asset size rank for the Royal Dutch Shell Group is based on the position of the U.S. company, Shell Oil.

oil companies. If the tabulation is restricted to the 20 largest oil companies, we find that 14 of the 20 have joint venture arrangements with all of the remaining 19. Standard Oil of New Jersey as the largest American oil company has 280 joint ventures with the 19 other companies in the big 20 list, and 171 of these partnership arrangements are with its five largest competitors. Mobil has a total of 276 joint ventures with the other big 19 and 186 of them are with the five largest. Four of the big 20 have joint ventures with all but one of the remaining 19. Sun Oil Company and Signal Oil are the least joint venturesome of the big 20. They have partnership arrangements with 17 of 19 possible other firms.

These findings raise substantial doubts about the independence of the large American oil companies. A joint venture of the Caltex variety requires a harmony of interest for its successful management. Such harmony and cooperation may require that the partners be discrete in other areas where they are expected to compete with each other.

B. Joint Bidding for Oil and Gas Leases

In addition to joint ventures as discussed above, oil companies commonly form combines for the purpose of bidding for oil and gas leases offered by the federal and state governments. Joint bidding combines have not been included in the joint ventures shown in Table 5. They are tabulated separately in Table 6. Among the big eight oil companies of 1964, we find bidding partnership arrangements in 19 out of 28 possible two-firm combinations. The record shows that Mobil on one or more occasions bid jointly with each of the other big eight firms. Phillips on the other hand bids with only two of the other big eight. Phillips has a long history of bidding with Standard Oil of Indiana and a group of smaller firms.

The joint bidding record, like the joint venture record, establishes the fact that there are a great many partnership arrangements among the very largest competing firms in the oil industry, but it does not establish that competition is either weakened or stimulated.

Evidence has been presented elsewhere showing that joint bidding among oil companies restrains competition among them. The bidding record in Alaska and the Gulf of Mexico was examined for the pattern of bidding between partners to joint bidding agreements. The evidence clearly established that (1) simultaneous joint bidding and competitive bidding between two or more partner firms is a rare occurrence, and (2) in the two year period following the dissolution of a joint bidding agreement, the former partners do

TABLE 6

JOINT BIDDING INVOLVING THE BIG-EIGHT[a] OIL COMPANIES IN OFFSHORE OIL AND GAS LEASE SALES, THROUGH FEBRUARY 1968

	Standard Oil of N.J.	*Mobil Oil*	*Texaco*	*Gulf Oil*	*Shell Oil*	*Standard Oil of Ind.*	*Standard Oil of Cal.*	*Phillips Petroleum*
Standard Oil of N.J.								
Mobile Oil	X							
Texaco	X	X						
Gulf Oil	X	X	X					
Shell Oil	X	X	X	X				
Standard Oil of Ind.		X	X	X				
Standard Oil of Cal.	X	X		X	X			
Phillips Petroleum		X				X		

Sources: Oil and gas lease sale reports of the Bureau of Land Managements for Pacific Coast and Gulf of Mexico outer continental shelves, and the states of Alaska and California for offshore areas.

a. The big-eight firms are those listed in Fortune for the year 1964.

not bid against each other with the frequency which random behavior would require.[20]

The apparent inconsistency of partnership arrangements among competitors may be justified by basic physical and economic conditions prevailing in the oil industry. The following justifications have been suggested and elaborated elsewhere.[21] (1) Absolute capital requirements, due to large scale production, may be so high that only a few firms are capable of entry. (2) Risks associated with a given investment may be so great that few or no existing firms are able or willing to assume such risks alone. (3) Separate operations may be economically wasteful. As an example, 21 oil companies interested in bidding for oil and gas resources in Bristol Bay, Alaska, joined together to conduct joint seismic work. Separate exploration would have involved wasteful repetition. (4) Finally, a joint venture may

20. Mead, *The Competitive Significance of Joint Ventures,* 12 Antitrust Bull. 819-849 (1967).

21. *Id.* at 823-25.

be justified where a large investment is expected to produce important external economies that accrue indiscriminately to firms in a given industry rather than primarily to the investing firm. An excellent example is research and development investment in retorting with nuclear fracturing of the rock (i.e., the CER Geonuclear Combine). Apart from these possible justifications, the conflict between co-operative and competitive behavior remains as a substantial doubt upon the ability of oil companies to compete at arms-length in the market for oil shale resources.

In sum, the structure of the future buyer market for oil shale leases will probably be limited to a few large firms plus some joint ventures among smaller firms. Effective competition is likely to be further limited by the fact of a multitude of partnerships arising out of joint ventures and joint bidding agreements among horizontally related firms.

III
COMPETITIVE BEHAVIOR IN SIMILAR NATURAL RESOURCE MARKETS

Since there is no record of bidding for Federal or state oil shale leases, there is no opportunity to test the effectiveness of competition in that market. However there is an extensive record of competition for government oil and gas leases where bidders are few in number. Competitive behavior and performance may be examined in these markets and inferences may be drawn concerning the effectiveness of competition in the future market for oil shale resources.

A. The Market for Federal Oil and Gas Leases in the Gulf of Mexico

An analysis of the record of competition for federal oil and gas leases in the Gulf of Mexico can provide valuable insights into the character of future competition for oil shale leases since the two situations involve important similarities. Both are subject to considerable capital cost and risk. The capital cost for offshore oil and gas resources arises out of bonus payments plus exploration and production costs in advance of any income. The risks in offshore oil exploration are of a different character from oil shale and are probably greater. Risks arise due to an uncertain presence of oil and gas rather than an uncertain technology. The bidders for the deep water offshore leases are large oil companies and combines.

The record of bidding for federal oil and gas leases in the Gulf

of Mexico offshore from Louisiana from 1954 through 1967 is shown in Table 7. During this period exactly 1800 tracts were of-

TABLE 7

RECORD OF BIDDING FOR FEDERAL OIL AND GAS LEASES IN THE GULF OF MEXICO, OFFSHORE FROM LOUISIANA, 1954-1967

1. Number of tracts offered	1,800
2. Number of tracts receiving bids	1,015
3. Percent of tracts receiving bids (Row 2 ÷ 1)	56
4. Total number of bids received	3,247
5. Average number of bids per tract offered (Row 4 ÷ 1)	1.8
6. Average number of bids per tract bid on (Row 4 ÷ 2)	3.2

Source: Bureau of Land Management, Lease Sale Reports, New Orleans, La.

fered for lease. However only 56 percent of these actually received bids. A total of 3,247 sealed bids were offered for 1,015 tracts. The average number of bids received for all tracts offered was only 1.8. Limiting the analysis of tracts actually receiving bids, there was an average of 3.2 bidders. Viewed in either sense, this appears to be an inadequate degree of competition. It is clear that with only an average of 1.8 bidders per tract offered, a speculator may submit nominal bids (fishing bids) for any number of tracts and, in terms of the average, he can reasonably expect to win about half of his offers by virtue of being the single bidder.

The record of federal offshore Louisiana oil and gas leases is further analyzed in Table 8 for the period ending 1966. We see that 42 per cent of the leases were reasonably competitive having three or more bidders and averaging 5.2 bidders per lease. The remaining 58 percent, however, cannot be considered to be effectively competitive. There were only two bidders for 21 percent of the tracts and only one bidder for 37 percent.

Table 8 shows clearly that the average high-bid per acre varies with the number of bidders. Those tracts having an average of 5.2 bidders per lease yielded an average high-bid of approximately five times those tracts having only one bidder. The reader should be cautioned against interpreting these findings to mean that the high-bid is a single value function of the number of bidders. Rather the number of bidders is probably correlated with the estimated value of the tract as an oil and gas property. Therefore, the number of bidders variable is also a proxy for the quality of the lease.

TABLE 8

RECORD OF BIDDING FOR BLM OIL AND GAS LEASES, OFFSHORE LOUISIANA, 1954-1966

Number of bidders per lease	*Number of leases*	*Percent of total leases*	*Number of acres leased*	*Average number of bidders per lease*	*Average bid per acre*			*Ratio*	
					High bid	*Second high bid*	*Low bid*	*High bid to low bid*	*High bid to second high bid*
					dollars				
Three or more	308	42	1,316,585	5.2	610.08	330.73	56.83	10.74	1.84
Two	149	21	624,923	2.0	186.38	—	43.63	4.27	—
One	269	37	1,120,982	1.0	102.48	—	102.48	—	—
Total	726	100	3,062,490						

Source: Bureau of Land Management, Lease Sale Reports, New Orleans.

The sale price as determined by the high-bid displays a capricious behavior. For those sales having three or more bidders, the average high-bid is 1.84 times the value of the second high-bid and is 10.74 times the value of the low-bid. For those sales having only two bidders, the ratio of high-bid to low-bid is 4.27. Thus, in the oil and gas lease market there is no sense of a going price such as we find in the grain market, the stock market, egg market, etc. Rather the lease price shows wide variation with the number of sealed bids received.

The analysis shown in Tables 7 and 8 indicates, first, that the average number of bidders for federal oil and gas leases in the offshore areas is too small to produce reliably competitive results. Second, the resulting lease price appears to be a capricious and chaotic function of the number of bidders although anticipated quality of the property is also a variable important in determining the lease price.

The chaotic results of bidding for offshore leases may be illustrated by two specific cases. In the August 11, 1959, oil and gas lease sale in the Gulf of Mexico, Shell Oil Company bid $26.1 million for a tract where the second high-bidder was a combine composed of Texaco, Pan American Petroleum Company, and Gulf Oil Company bidding $12.4 million. Thus on this single tract Shell left $13.7 million "on the table." The low-bidder in this three-bidder sale offered $7.6 million. Thus the high-low spread was $18.5 million and the high-bid was 3.4 times the low-bid.[22] In another case involving substantially less money but a much higher ratio of high-bid to second high-bid, Tenneco bid $826,446 for a tract in Alaska. The second high-bidder was Pan American Petroleum Company bidding only $8,775. The ratio of high-bid to second high-bid was 94 to 1. Gulf Oil as the low-bidder in this eight-bidder sale offered only $2,291. The high-bid in this case was 360 times the low-bid.[23]

B. Onshore Federal Oil and Gas Leasing Experience

There is also an extensive record of oil and gas leasing through Bureau of Land Management state offices. The Colorado BLM state office ranks third among state offices in the number of competitive oil and gas leases awarded. The results in Colorado are similar to those of the Gulf of Mexico except that the high bids for Colorado leases are low relative to the Gulf and the proportion of effectively competitive leases is lower in Colorado. Table 9 shows that

22. Bureau of Land Management, Lease sale reports, Tract No. 694, New Orleans, La.
23. Department of Natural Resources, State of Alaska, Results of the 16th Competitive Oil and Gas Lease Sale, Tract No. C 16-191, Anchorage, Alas.

only 27 percent of the tracts leased received three or more bids per tract. The remaining 73 percent received either one or two bids and 44 percent received only one bid. Also the relationship between the average high-bid, the second high, and the low-bid shows the same capricious results found for offshore leasing.

Given these results, there is an apparent need for a refusal price established by the government—a price below which bids would not be acceptable. However, by current practice the federal government as the lessor does not conduct pre-sale exploration to determine the quality of the property. In the absence of such information a refusal price that reflects the estimated value of the property cannot be determined with any degree of reliability. Furthermore, the current leasing statute precludes pre-sale core drilling by interested bidders. Pre-sale exploration is limited to geological and geophysical examination. Accordingly, the lessor does not know what he is selling, and the lessee does not know what he is buying. Under such conditions the observed wide variation in bid prices should be expected.

This condition of enormous uncertainty concerning the presence of an economic resource is characteristic of crude petroleum but not of oil shale. If the available evidence from similar markets indicates that competition among contenders for oil shale leases is likely to be unreliable, then one may realistically propose a system of refusal prices for shale resources. A great deal is known about the presence, quantity, and quality of shale resources. As experience develops in shale oil production, technological uncertainty will be reduced. This will permit refusal prices to be established as a means of protecting the public interest against questionable competitive behavior.

While analysis of the record of bidding for oil and gas resources indicates a high degree of chaos in price determination, the findings should not be interpreted to imply implicit collusion among the bidders. There may be too many bidding units for successful collusion. For example, in the February 6, 1968, federal oil and gas lease sale offshore from California, 164 bids were received on 75 tracts, averaging 2.19 bids per tract. There were 27 presumably independent bidding units represented. These bidding units consisted only of six single firms plus 21 combines (joint bidders). The number of combines shown involves a kind of multiple counting due to rearrangement of bidding partners for bidding on various tracts. For example, the group of small firms and individuals associated with Edwin Pauley submitted 11 bids for tracts in the California lease sale. There was a slight difference in the membership of the combine on most occasions so these 11 bids represented 7 different combinations. The Pauley group did not compete against itself, of course.

TABLE 9

RECORD OF BIDDING FOR BLM OIL AND GAS LEASES, COLORADO, THROUGH 1966[a]

Number of bidders per lease	*Number of leases*	*Percent of total leases*	*Number of acres leased*	*Average number of bidders per lease*	*Average bid per acre*			*Ratio*	
					High bid	*Second high bid*	*Low bid*	*High bid to low bid*	*High bid to second high bid*
					dollars				
Three or more	47	27	8,453	4.6	48.94	21.32	4.90	9.98	2.30
Two	50	29	11,587	2.0	9.37	—	2.53	2.53	—
One	76	44	16,067	1.0	6.90	—	6.90	—	—
Total	173	100	36,107						

a.The leases tabulated are based on an incomplete sample. All leases readily available at the Denver BLM office were included. The record is probably incomplete for early years of the leasing program, however.

Source: Bureau of Land Management, Lease Sale Reports, Denver.

For federal leases offshore from Louisiana where water depth is less, risks are lower, and consequently barriers to entry are more moderate, we find a larger number of bidding units. For example, in the June 13, 1967, lease sale where 742 bids were received for 172 tracts, averaging 4.31 bids per tract, a total of 67 bidding units were represented. This total consists of 20 single firms as bidders plus 47 combines.

McKie's studies of the structure of the oil and gas exploration sector of the petroleum industry reached similar conclusions. Regarding the structure of the buyer market McKie wrote "No measure shows concentration high enough to support tightly disciplined oligopolistic collusion among large firms to fix the price of leases, to determine the rate of exploratory drilling, or to set up artificial barriers to entry."[24] Rather the data on competitive results indicate that the prevalence of joint bidding reduces the number of independent decision-making centers when large firms fully capable of separate bidding join together to submit a single bid. Also the analysis indicates that the practice of permitting buyers to nominate tracts for lease in effect confers upon such buyers some control over the quantity of leases to be offered. The result is that a large number of leases are offered relative to the number receiving bids and the available bids are then spread thinly over many tracts. This practice increases the probability of a bidder obtaining desired tracts at a token price.

IV

CONCLUSIONS AND LEASING POLICY IMPLICATIONS

This analysis of the structure of the buyer market for oil shale resources has shown that the potential bidders for Federal leases are likely to be few in number—approximately 15. The two significant barriers to entry are first, an adequate research background into the technology of oil shale retorting, and second, relatively high capital requirements for oil shale processing facilities. In addition, data have been presented which show that large American oil companies, as the most likely potential entrants into the oil shale industry, are not independent competitors. Rather, they are partners in a multitude of joint ventures and joint bidding arrangements. Their status as partners, which requires a degree of cooperative behavior, is in conflict with their expected behavior as arm's length

24. McKie, *Market Structure and Uncertainty in Oil and Gas Exploration*, 74 Q.J. Econ. 543, 570 (1960).

competitors. Analysis of the bidding record in the oil and gas resource markets, which are quite similar to the future oil shale resource market, indicates that where bidders are few in number competitive bidding produces capricious and chaotic results. From these findings the following five policy implications may be drawn with respect to federal oil shale leasing policy.

1) If a nomination system is used by the federal government in order to identify tracts to be offered for lease, the tracts nominated should be treated only as suggested areas of interest. The government should not surrender its right to determine the quantity of shale resources offered for lease.

2) Given the conclusion that bidders for oil shale leases will be few in number, at least during the early life of an oil shale industry, barriers to entry should be minimized. First, to avoid requiring that each firm make a substantial investment in core drilling of proposed leases in order to identify the quantity and quality of the resource, the government should fully explore tracts offered for lease and make the findings available to all interested parties. This should not preclude any interested buyer from doing additional exploratory research. Second, if bonus bidding is used as a device for selecting the high bidder and determining the price, then a delayed payment schedule should be established whereby bonus payments are spread over a period of years, perhaps 10 years. In addition, the first payment might be delayed for about five years following issuance of the lease. This would permit bonus payments to be met out of income. A deferred payment schedule would not only reduce the barrier to entry, but would also avoid the low bonus problem arising out of relatively high discount rates used by the oil industry to calculate present values. Third, if a high rental requirement is included in the lease terms then such rental payments might become effective five years after issuance of the lease.[25]

3) Joint bidding among horizontally related firms should be restricted to those firms unable, due to a capital limitation, to enter the oil shale market as a single bidder. Joint bidding by horizontally related firms fully capable of separate entry should be subject to antitrust prosecution. The Sherman Act clearly specifies that "Every contract, combination in the form of trust or otherwise, or conspiracy, in restraint of trade or commerce among the several states . . . is hereby declared illegal."[26] A joint bid is a combination in

25. For an argument in support of a high rental requirement as well as bonus bidding see Mead, *Hearings before the Sumcomm. on Antitrust and Monopoly of the Senate Comm. on the Judiciary,* 90th Cong., 1st Sess., 378-402 (1967).

26. Sherman Antitrust Act, ch. 647, § 1, 26 Stat. 209 (1890).

which two or more firms agree to submit one bid. In the case of firms too small to bid separately, joint bidding has the opposite effect. By pooling their resources and spreading the risk such small firm joint bidding increases the number of bids by one. In Clayton Act terminology, where the effect of joint bidding "may be substantially to lessen competition," joint bidding should not be permitted. A joint bid among firms too small to bid separately clearly does not lessen competitive bidding competition. As a rule of thumb for horizontally related firms, total asset size of one billion dollars might be the dividing line between exempt and illegal joint bidding for oil shale leases.

4) Sealed bidding should be used in preference to oral bidding. Under oral bidding procedures the identity of all bidders is known at the point of the auction. Firms that must preserve a harmonious relationship due to partnership arrangements among them arising out of one or more joint ventures might be reluctant to deliberately bid against each other and thereby bid up the price of oil shale resources which their partner must pay. Sealed bidding has the merits of anonymity and uncertainty. Where the rules of the game are observed the identity of sealed bidders does not become known until the bids are opened, and at this point bids are both irrevocable and cannot subsequently be raised. Under such circumstances bidders might be expected to bid their estimated present value of the property, adjusted up or down to reflect their judgment about the strength of competition. If only one bid is received, it is still possible that such a bid might correspond with the true value of the property. Under oral bidding procedures and only one interested bidder, one should not expect to find such bidder bidding against himself. Accordingly, the lease price would be totally non-competitive.

Since sealed bidding permits only one opportunity to make an offer, and one can never be certain of the extent of competitive opposition, there is a tendency for firms seriously interested in the property to submit a sealed bid which reflects their true estimate of its present value. In situations where few competitors are expected and cooperative arrangements exist among these few, the uncertainty feature of sealed bidding is an important asset which should be used to protect the public interest.[27]

5) Given doubts about the effectiveness of competitive behavior in the future market for oil shale, the government should establish

27. For a more detailed analysis of the oral and sealed bidding option see Mead, *Natural Resource Disposal Policy—Oral Auction versus Sealed Bids* 7 Natural Resources J. 194-224 (1967).

a refusal price below which bids would be rejected.[28] The refusal price should be based upon a calculation of discounted future net income. A responsible calculation of a refusal price requires that government appraisers have access to current cost and revenue data for companies operating on Federal oil shale leases.

28. For a similar policy recommendation *see* Clawson & Held, The Federal Lands: Their Use and Management 203 (1957).