THE BAN ON INTRAMAJOR JOINT BIDS IN FEDERAL PETROLEUM OFFSHORE LEASE SALES: AN EVALUATION

by

Joseph P. Mulholland

Bureau of Economics Staff Report
to the Federal Trade Commission

October 1984

THE BAN ON INTRAMAJOR JOINT BIDS IN FEDERAL PETROLEUM OFFSHORE LEASE SALES: AN EVALUATION

by

Joseph P. Mulholland

FEDERAL TRADE COMMISSION

JAMES C. MILLER, III, Chairman
MICHAEL PERTSCHUK, Commissioner
PATRICIA P. BAILEY, Commissioner
GEORGE W. DOUGLAS, Commissioner
TERRY CALVANI, Commissioner

BUREAU OF ECONOMICS

WENDY GRAMM, Director
RONALD BOND, Deputy Director for Operations and Research
RICHARD HIGGINS, Deputy Director for Consumer Protection and Regulatory Analysis
DAVID SCHEFFMAN, Deputy Director for Competition and Antitrust
JOHN PETERMAN, Associate Director for Special Projects
JAMES A. HURDLE, Assistant to the Director
JACK CALFEE, Assistant to the Director
THOMAS WALTON, Assistant to the Director
ROBERT ZWIRB, Assistant to the Director
KEITH ANDERSON, Assistant Director for Regulatory Analysis
ROBERT BROGAN, Assistant Director for Competition Analysis
JAMES FERGUSON, Assistant Director for Antitrust
PAULINE IPPOLITO, Assistant Director for Industry Analysis
PAUL RUBIN, Assistant Director for Consumer Protection

This report has been prepared by a staff economist in the Bureau of Economics of the Federal Trade Commission. It does not necessarily reflect the views of the Federal Trade Commission or any of its individual members. The Federal Trade Commission has, however, voted to authorize its release.

ACKNOWLEDGMENTS

This study began under the stimulating guidance of Darius Gaskins, Jr. Helpful comments on earlier drafts were provided by: Keith Anderson, Ronald Bond, Walter Mead, Jon Ogur, Cal Roush and Doug Webbink. Addie Williams and Barbara Battle supplied valuable research assistance. Word processing was ably performed by Betsy Zichterman, Dianne Jones, Angela Newsome, Keith Wilson and Deborah Ruggles.

Many people at the U.S. Department of the Interior gave generously of their time in supplying me with advice and data. Frank Connor, John Lohrenz and Tom Readinger were especially helpful in this regard.

TABLE OF CONTENTS

TABLE OF CONTENTS

List of Figures

TABLE OF CONTENTS

Index of Tables

TABLE OF CONTENTS

Appendices

TABLE OF CONTENTS

Index of Appendix Tables

CHAPTER 1

INTRODUCTION AND SUMMARY

This report analyzes the prohibition of joint bids among large producers, deemed "majors," in Federal offshore petroleum lease sales. The ban, initited in December 1975,[1] specifies that producers with international petroleum production greater than 1.6 million barrels per day are prohibited from joining together in bids for Federal offshore (i.e., Outer Continental Shelf, or OCS) leases.[2] Throughout the period this ban has been in effect, the following eight producers have been subject to its provisions: Exxon Corporation, Texaco Inc., Gulf Oil Corporation, Mobil Oil Corporation, Standard Oil Co. of Indiana, Standard Oil Co. of California, Shell Oil Company, and British Petroleum Company.

The joint venture ban arose primarily out of a concern that joint bids among the major producers were reducing the revenues received by the Government for OCS tracts. It was felt that such combines allowed the major producers to acquire superior information concerning the expected competition for tracts, which in turn allowed them to obtain tracts at a lower cost than smaller companies. Also, intramajor combines allegedly reduced bid-market competition by joining together producers with the capacity for, and intention of, bidding separately for the same tracts.

Critics of the ban have argued that intramajor joint ventures served efficiency purposes by allowing the majors to improve the processing of geological information and to reduce the risk associated with OCS operations. They thus posit that

---

[1] The ban was originally instituted by Interior as a Department regulation. It was subsequently incorporated in the Energy Policy and Conservation Act of 1975 (45 U.S.C. 6201; Pub. L. No. 94-163, 94th Cong., S. 622, December 22, 1975).

[2] These producers are allowed, however, to bid jointly with smaller producers not classified as "majors" under the regulation. Also, the majors can join together with one another after the auction takes place, providing that such a move was not prearranged.

the ban is counterproductive since it serves to increase the costs of operations for the majors, which in turn leads to reduced Interior revenues.

These contrasting views are evaluated by analyzing the record of OCS bid activity during the 1973-79 period. This time frame provides a sufficiently long period for determining effects of the ban while minimizing the influence of structual changes in the OCS market that are unrelated to the ban.

Findings:

Our principal findings are (a) no convincing evidence existed for imposition of the ban in the first place, and (b) the ban's effect on performance in the bid market has been slight, at least in the Gulf of Mexico area which formed the basis for our statistical tests.

The principal justification for the ban was the allegation that the majors were using their contacts formed through joint venture negotiations to acquire tracts at relatively low cost. Statistical analysis does not support these contentions. After holding tract quality constant, regression tests show no pattern in which the major firms, either singly or in associations among themselves, acquired tracts in pre-ban sales at "bargin" prices. There was in fact a tendancy in some sales for the majors to pay relatively high amounts for tracts.

Whatever the validity of original arguments in support of the ban, its effects have been relatively minor. The most obvious change has been in the organization of bid combines as those majors that previously bid with each other were forced to find alternative arrangements. For the most part they tended to select relatively large non-major firms as their new partners. The one significant exception was Exxon which eliminated joint bidding entirely, preferring instead to bid singly for OCS tracts.

Two competition indices were analyzed in order to assess the ban's effect on OCS market performance: the number of bids submitted per tract, and the returns to Interior after taking

account of difference in tract quality across sales. The first is a structural index of the degree of rivalry for OCS tracts. The second is a performance measure; it measures the ability of Interior to maximize its return from the leasing of tracts while allowing the winning bidders a competitive rate of return.

Comparisons of the pre-ban to ban period for these two indices found no support for the expectations of the ban's supporters that competition in the bid market would be enhanced by elimination of intramajor joint ventures. While the number of bids offered by 11 nonmajor firms did increase under the ban, this was offset by a corresponding decline in the number of bids submitted by majors.

Likewise, imposition of the ban brought no identifiable improvement in the rent capture performance of Interior. There may in fact have been a slight decline, at least in the initial sales conducted under the ban.

Structure of the Report:

Chapter 2 provides a general background for the remainder of the report. Patterns of joint venture activity in the OCS sector are outlined, with particular emphasis placed on identifying changes that have taken place under the ban.

Chapter 3 outlines the basic issues involved in the debate over the ban, and the approach we will use to evaluate them.

The principal statistical analysis is performed in Chapters 4 and 5, where the effect of intramajor joint ventures on bid market competition is assessed.

Chapter 6 outlines our findings and presents the conclusions that can be drawn from them.

Throughout this report, the group of "majors" refers to the firms so defined in the ban, with the exception of BP-Sohio. Although BP-Sohio is a large international producer, its OCS activity is small. The company's main link to the OCS is through Sohio, which was acquired by British-Petroleum in 1979. Sohio only began participation in OCS auctions after implementation of the ban in 1977. Thus treatment of BP-Sohio as a "major" would tend to distort the before and after comparisons designed to test the ban's effect.

CHAPTER 2

JOINT VENTURE TRENDS AND ORGANIZATIONAL CHARACTERISTICS IN THE OCS BID MARKET

The leasing of OCS tracts began in 1954. Through 1979 there have been 51 separate auctions (also termed lease sales) at which a total of approximately 4,000 tracts have been leased to private firms and individuals. The bulk of these lease sales have taken place in the Gulf of Mexico area. Other OCS locations have included areas offshore of California, Alaska, and the Mid-Atlantic states. The principal auction form is the bonus sealed bid method, under which a tract is leased to the firm submitting the highest dollar offer (termed the "bonus") for development rights to it. This payment is made at the beginning of the lease period and is independent of the tract's subsequent production activity. In addition, the winning bidder must pay a royalty fee to the government, which has typically been calculated at 16 2/3's percent of the tract's annual gross production revenues.

In this chapter we provide an overview on the role of joint venture activity in the OCS auction market. Particular emphasis is placed on the nature of the major group's joint bidding activity, and how it adapted to the ban. The first section describes overall trends and levels of joint venture activity between 1954, the year OCS leasing began, and 1974 the last year before the ban was enacted. The second section provides a more specific analysis of changes in the investment and organizational characteristics of bid activity between the pre-ban and ban periods. This latter analysis encompases the 1973-79 period, during which 11 important OCS sales took place.

1. Overall Trends

Joint venture activity increased steadily over the 1954-74 period. The value of tracts acquired by joint bids as a percent of the total increased from 30 percent in the 1954-59 period to over 80 percent in the 1971-74 time frame. There was also a significant rise in the importance of intramajor joint ventures:

their percent share of bonus payments increased from 4 percent in the initial period to over 27 percent for 1971-74 [table 2.1].

Table 2.2 presents a more detailed analysis of the intramajor activity that took place in the four principal OCS sales during the 1973-74 period. On average, reliance on intramajor joint ventures was significantly greater for the frontier Mississippi-Alabama-Florida (MAFLA) sale. This pattern reflects the smaller set of potential partners available to the majors in sales in the MAFLA area. The pattern also conforms to the perception that intramajor joint ventures are particularly valuable as a means of offsetting the high cost and risk inherent in frontier auctions.

Table 2.2 also indicates a good deal of variation concerning the preference for intramajor contacts within the majors group. The most consistent participants in such joint venture's were Gulf, Mobil, and Standard of Indiana. At the other end of the spectrum, Shell had no major-company joint venture contacts in any of the four sales observed. The remaining majors displayed varying tendencies. The most marked change in joint venture activity was exhibited by Exxon. Although the company maintained a high level of major joint venture contacts in the MAFLA sale (where over 95 percent of its total bonus payments was submitted in association with other majors), such activity in the subsequent three development sales was minimal. As noted below, this downward trend presaged a complete elimination of joint venture activity by Exxon, starting in 1975.

2. Changes in Joint Venture Activity: 1973-79

We now investigate the nature of producer adaptations to the ban by analyzing changes in bidding activity during the 1973-79 period. This period is sufficiently long to provide for meaningful before and after comparisons, while avoiding the influences of exogeneous structural and regulatory changes that may predominate over longer periods. Our data base consists of the results of 11 important sales that took place during the 1973-79

Table 2.1.--Joint-venture and intra-major joint-venture activity for selected periods: 1954-74

Period	Percent of total bonus payments accounted for by:	
	All joint venture tracts	Intramajor joint venture tracts
1954-58	9.3	3.6
1959-62	39.3	12.4
1963-66	45.7	4.2
1967-70	51.8	18.1
1971-74	80.5	27.4

Table 2.2.--Intramajor joint venture activity for the major producers: selected OCS lease sales, 1973-74

Producer	Value of company's bonus payments submitted through intramajor joint bids as a percent of its total bonus payments			
	MAFLA 12/73	Louisiana 03/74	Texas 05/74	Louisiana 10/74
Exxon Corp.	95.6	0	11.3	0
Gulf Oil	31.2	87.5	0	96.1
Mobil Oil	84.2	92.0	79.7	79.5
Shell Oil	0	0	0	0
Standard Oil (Calif.)	71.7	4.2	11.2	39.7
Standard Oil (Ind.)	100.0	26.7	79.6	75.2
Texaco	100.0	49.6	0	9.3
Total	78.0	35.1	38.6	44.3

Source. FTC tabulation based on U.S. Department of the Interior files.

period.[1] Seven of the sales were classified as "developmental," signifying auctions taking place in areas with a prior history of leasing and production activity. The remaining four sales were "frontier" types; signifying auctions of previously undeveloped areas such as offshore Alaska and the Baltimore Canyon area of the Atlantic Ocean. A description of the individual sales is provided in table 2.3.

The majors' relative importance in OCS lease sales declined during the ban period. As summarized in table 2.4, the majors' average share of total bonus payments dropped in both development sales and in frontier sales during the ban period.[2] There did remain the pre-ban pattern in which the majors' investment share tended to be higher in the frontier sales vis a vis the development-type auction.

Reasons for this reduction in major group activity are not clear. Obviously, one possible influence could be the ban itself, confirming the predictions of the ban's critics that the intramajor form of bid organization was the most efficient one. On the other hand, enactment of the ban coincided with the appearance of a number of other factors that may have affected the group's activity in the OCS sector: the opening up of new onshore lands for development; the increasing uncertainty surrounding the pace of leasing in the OCS; and the perception on the part of some firms that the bonus-bidding process in the OCS had led to excessively high prices being paid for tracts.[3]

---

[1] 1975 sales were omitted due to the possibility of their being influenced by expectations of the ban's enactment. See Appendix A for a detailed description of the data sample.

[2] Also, the average number of bids submitted by firms in the major group declined. Regression estimates of this reduction are reported in Table 4.1 below.

[3] While none of these factors necessarily point to a reduction in large producer OCS production (vis-a-vis that of smaller producers), the obvious disequilibrium situation that they generated could have contributed to the observed shift in the majors' investment patterns. For example, a large part of the decline in the majors group's OCS investment is accounted for by one firm, Amoco. For an account of that company's change in investment strategy, see D. Holt, "How Amoco Finds All that Oil," Fortune (September 8, 1980), pp. 50-56.

Table 2.3.--Description of the Principal Lease Sales Conducted During 1973-79

Offshore Area	Date	Type of sale	Number of tracts bid on
MAFLA	12/20/73	frontier	89
LA-TX	03/28/74	development	114
LA-TX	05/29/74	development	123
LA-TX	10/16/74	development	157
ALASKA	04/13/76	frontier	81
ATLANTIC	08/17/76	frontier	86
LA-TX	06/23/77	development	152
LA-TX	12/19/78	development	88
LA-TX	07/31/79	development	88
LA-TX	11/27/79	development	96
ATLANTIC	12/18/79	frontier	73

Area Codes:

MAFLA - Mississippi-Florida-Alabama

LA-TX - Louisiana-Texas

Atlantic - Baltimore Canyon Area

Table 2.4.--Major group market-share levels: 1974-79 OCS lease sales

(1) Date of sale	Major group market share of total bonus payments (percent)
A--Development sales	
03/28/74	53.5
05/29/74	54.5
10/16/74	51.2
06/23/77	49.6
12/19/78	42.9
07/31/79	37.5
11/27/79	44.1
B--Frontier sales	
12/20/73	68.8
04/13/76	53.1
08/16/76	53.7
12/18/79	54.6
Averages (unweighted)	
Development	
Pre-ban	53.1
Ban	43.5
Frontier	
Pre-ban	68.8
Ban	53.8

Note: Market shares are based on working-interest share of total bonus payments on a sale.

Source: FTC tabulation based on U.S. Department of the Interior files.

Table 2.5 displays each major's degree of reliance on joint ventures, defined as the percent of its total number of bids that were submitted via joint venture. On an individual-company basis, the most striking development is the elimination of joint bids by Exxon in the ban period. The extent to which this action can be ascribed to the ban is difficult to assess, however, since the company stopped utilizing joint bids beginning with the February 1975 sale--well before the ban was put into effect (although at a time when the possibility of a ban was being discussed). Treating the remaining six majors as a group, average joint venture indices for the pre-ban and ban periods are as follows.

Average JV bid intensity for the majors group (less Exxon)
(Percent of Bids Submitted as Part of Joint Ventures)

Type of sale	Pre-ban	Ban
Development	71.7	62.6
Frontier	88.1	96.4

We observe a slight tendency for joint venture activity by the majors to move in opposite directions in the development and frontier sales. While the majors (excluding Exxon) actually increased their already high reliance on joint ventures for frontier sales, they exhibited a decline in relative joint venture activity for development sales.

3. Summary

By the onset of the joint venture ban, joint bids in general and intramajor joint bids in particular had come to account for a significant portion of all OCS activity. The effects of the ban on joint-venture preferences among members of the majors group have tended to vary both by firm and by the type of sale considered. The most dramatic change was registered by Exxon (before the ban was imposed), which stopped participating in

Table 2.5.--Joint-venture-intensity indices for the seven major producers, 1973-79

Joint venture index = percent of a firm's total bids submitted via joint venture

A--Development sales

	03/28/74	05/29/74	10/16/74	06/23/77	12/19/78	07/31/79	11/27/79
Exxon	4.3	21.1	4.0	0	0	0	0
Gulf	90.9	40.0	100.0	3.5	23.5	36.4	58.8
Mobil	100.0	84.9	81.6	88.9	54.2	92.6	75.0
Shell	89.2	35.3	63.3	0.0	74.1	75.0	72.7
Standard Oil (Calif.)	89.1	63.0	67.3	83.9	89.5	77.8	60.0
Standard Oil (Ind.)	68.6	85.7	67.4	50.0	50.0	50.0	20.0
Texaco	81.8	77.3	56.3	88.9	*	40.0	85.7
Averages:							
• Seven majors	73.9	58.8	57.3	45.2	52.6	60.2	57.6
• Majors excl. Exxon	82.8	65.2	65.3	52.0	60.4	71.3	66.7
• All producers	67.9	59.9	54.0	55.4	53.8	63.3	62.4

B--Frontier sales

	12/20/73	04/13/76	08/17/76	12/18/79
Exxon	96.7	0	0	0
Gulf	96.2	79.2	94.1	100.0
Mobil	93.1	95.2	100.0	100.0
Shell	89.7	100.0	100.0	100.0
Standard Oil (Calif.)	93.2	75.0	100.0	66.7
Standard Oil (Ind.)	94.7	100.0	90.9	*
Texaco	81.8	100.0	100.0	100.0

Table 2.5.--Joint-venture-intensity indices for the seven major producers, 1973-79--Continued

B--Frontier sales

	12/20/73	04/13/76	08/17/76	12/18/79
Averages:				
• Seven majors	89.5	68.2	71.7	69.3
• Majors excl. Exxon	88.1	93.0	98.9	97.5
• All producers	62.5	63.6	65.1	61.4

* Firm did not participate in the sale.

joint ventures altogether. In contrast, the remaining firms in the majors group continued to rely heavily on joint bidding arrangements. This dependence was most pronounced for the frontier sales, where there was almost exclusive utilization of joint ventures.

There has been a tendency for major firm activity in OCS lease sales to decline after imposition of the ban. This reduction manifests itself in both the relative share of bonus payments and the number of bids accounted for by the group. Unfortunately, the precise cause of this decline is difficult to gauge because of the numerous influences on major group investment decisions that cannot be adequately taken into account.

Notwithstanding this change in the major group's bidding activity, the next two chapters will assess the effects of the ban on selected indices of bid market competition. The possible influence of the majors' declining OCS activity on the results we observe will be evaluated in the concluding section to chapter 4.

CHAPTER 3

BID COMPETITION AND INTRAMAJOR JOINT VENTURES: ANALYSIS AND RESEARCH PLAN

The principal aim of this report is to analyze the effect of intramajor joint ventures on competition in the bid market. In this chapter we review the arguments for and against limitations on joint-venture activity in general and on intramajor joint ventures in particular. We then develop a research plan for evaluating the two contrasting positions.

The data to be analyzed comes from the set of 1973-79 lease sales described in the previous chapter. There are eleven lease sales in this data base: four frontier sales and seven developmental auctions. We will utilize the set of seven development sales, excluding the group of frontier auctions.[1] All seven of these sales took place in the same geographical region: the Louisana-Texas offshore area of the Gulf of Mexico. The relatively short period of analysis is used in order to abstract from changes in the OCS operating environment that took place over longer periods. In addition, the data for two important variables, the Geological Survey presale value and risk estimates (employed as proxies for tract quality) are not available for sales prior to 1974.

A. Arguments in Support of the Intramajor Joint Venture Ban:

Analysis of the ban proceeds under the general assumption that the uncertainty surrounding the "true" value of a tract leads each firm to take the expected actions of its rivals into account when formulating its bid offer. Support for the ban rests on two somewhat different arguments within this theoretical framework. The first views joint ventures as combinations of

---

[1] The exclusion of frontier sales is made necessary by a number of factors. Of perhaps most importance, the estimate of pre-sale value calculated by the Geological Survey was not available for tracts issued at the pre-sale frontier sale. In addition, before-and-after comparisions of the type to be used in this chapter would be difficult because of the sole pre-ban sale and the widely different locations of the three ban sales (offshore Alaska and the Mid-Atlantic region).

potential competitors, whose inevitable result is a reduction in the number of bids, and hence the degree of rivalry for tracts. The second sees intramajor joint ventures as allowing the majors to obtain superior information about the expected degree of competition for tracts, which they use in turn to secure leases at more favorable terms than less informed bidders.

The potential competition position is based on conventional theories of the competition process, which posit a direct relationship between the number of independent agents in a market and market performance.[1] Market performance in the case of the OCS auction is defined in terms of the ability of the seller, the U.S. Department of Interior, to capture the scarcity rents inherent in the tracts it is offering for lease. This rent component is defined in ex ante terms as the present value of the net profit expected to be generated from production on a tract. The competitive result is where the Interior receives the full expected rent on a tract, leaving the winning bidder with an expected rate of return equal to its cost of capital.

Viewed from this perspective, joint ventures are considered potentially harmful because of their ability to reduce the number of independent bids per tract by combining producers who would otherwise have bid individually on the same set of tracts.[2] Intramajor joint ventures are considered to be especially suspect, since overlapping tract interest among the partners is

---

[1] See F. M. Scherer, Industrial Market Structure and Economic Performance (Chicago, 1980), pp. 151-68. In addition, theoretical models of the bid market also generally deduce a positive relation between the number of bids for a tract and the seller's rent-capture ability. See R. B. Wilson, "A Bidding Model for Perfect Competition," Review of Economic Studies (October 1977), pp. 511-18.

[2] The following stylized scenario illustrates this effect: Firm I is interested in bidding on tracts A, B, C, and D and Firm II has an interest in tracts C, D, E, and F. As a combine, they agree to submit one bid each on tracts A through F. The result is a reduction in competition for the tracts of overlapping interest, C and D, where the joint venture effectively reduces the number of competing bidders (and thus bids) by one. Facing less competition for a tract, each bidder may individually lower its bid offer in the expectation that the probability of winning the tract with a relatively low bid is now increased.

likely to be quite high. On the other hand, combines of smaller producers, or a major with smaller producers, represent less of a problem due to the lower potential for overlapping tract interest among partners.

The information asymmetry thesis assumes that intramajor combines may create specific advantages for participating producers through the exchange of information dealing with the expected competition for tracts. The majors use such contacts, it is alleged, to gauge more accurately the degree of competition they expect to face on tracts of interest to them. The following scenario was considered especially relevant by the Department of the Interior:

> Firms I and II open negotiations on a possible joint venture combine. I expresses an interest in tracts A, B, and C, while II prefers B, C, and D. The most valuable aspect of this meeting to I is that II is not interested in tract A, and conversely, II finds out that I is uninterested in tract D. Thus, regardless of whether the joint venture is formed, both firms leave the negotiations with valuable information on the expected number of bids on tracts A and D. Also, they are forewarned of high bid activity on tracts B and C if no joint venture is formed. As a result, firms I and II now have an advantage over rival bidders, since they have a clearer perception regarding the expected average number of bidders: They know that there will be relatively few bids on A and D and a relatively large number for B and C.[1]

---

[1] This is a paraphrase of the hypothesized scenario outlined in U.S. Department of the Interior, Joint Bidding . . ., op. cit., p. 4.

Armed with such information, the majors adjust their bid offers to match the expected degree of competition in such a way as to reduce their overall acquisition price. The effect of this hypothesized information exchange is to give the majors a significant advantage over smaller rivals in the competition for tracts, since the latter must participate with less foresight and thus greater uncertainty concerning both the value of and the degree of competition for tracts.[1]

B. Criticisms of the Ban

Critics of the joint venture ban, on the other hand, view intramajor joint ventures as synergistic instruments that create an expanded range of bid activity for their participants.[2] It is asserted that such associations reduce the costs and risks associated with bidding activity and thus allow the majors to bid on a wider range of tracts than would be the case if such

---

[1] Superior information on the expected number of bids can benefit a firm in a number of ways. First, and most obvious, it can lead a firm to lower its bid on a tract with a small number of competing bids, thus increasing the prospects of acquiring the lease at a "bargain" price. Second, it allows a firm to adjust its bidding strategy so as to avoid paying too much for a tract that receives a large number of bids. The latter situation, termed the "winner's curse," is easiest to envision in a situation where each bidder has an independent and equally likely estimate of what a tract (whose returns are uncertain) is worth. If all participants bid the full value of what they think the tract is worth, then the winning bid will obviously be above the mean of all bids and thus may reflect an overly optimistic estimate of the tract's value. Since the level of the winning bid is a positive function of the number of bids submitted (assumed to be independent of each other), the overvaluation by the winning bid is likewise higher for larger number of bids. Repeated experience in OCS auctions teaches firms to adjust their bid strategy so as to avoid such situations on average, but those with a superior knowledge of the expected degree of competition are allowed to devise more efficient strategies. For a discussion of the role of knowledge about the role of expected competition in OCS type auctions, see R. Englebrecht-Wiggins, "Auctions and Bidding Models: A Survey," Management Science (February 1980), pp. 119-142.

[2] The basic source of objections to the joint venture ban is contained in unpublished comments supplied by the major oil companies in 1975. These comments are on file at the U.S. Department of the Interior. See also petroleum-company testimony reprinted in Energy Industry Investigation . . ., op. cit.; P. Korbin, M. Canes, and P. Murphy, "Is the Ban on Joint Bidding for OCS Leases by Major Oil Companies Warranted?," API Working Paper, February 24, 1977. See also later studies by Cabot Consulting Group, op. cit., A. Rockwood, The Impact of Joint Ventures on the Market for OCS Oil and Gas Leases," Journal of Industrial Economics, (June 1983) 453-465.

combines were prohibited. From this viewpoint, implementation of the ban forces the majors into less efficient combinations, where the costs and risks of bid activity are higher. The anticipated result is a reduction in the level as well as the range of bids made by the major producers.

Since joint venture associations with producers outside the major group are allowed under the ban, critics necessarily infer that smaller producers are not adequate substitutes for the majors as partners. Such smaller companies are considered to lack both the exploration expertise and the financial capability necessary to serve as adequate replacements for the major producers. The implied lower exploration expertise of the smaller producers forces the majors to evaluate tracts with less certainty than was the case when estimates could be compared with those of other majors. As a result, they will submit lower and fewer bids than would otherwise be the case. In regard to capital funding, it is asserted that the ban creates a higher cost to the majors by forcing them to conduct a costly and at times unsuccessful search for the required number of smaller producers necessary to supply the capital funds previously furnished by one or two major producers.

As a result of the above factors, the majors are expected to reduce the value and the number of bids, both individually and collectively, in response to the ban. Critics claimed that competition in high-risk frontier areas was especially vunerable. It was felt that intramajor combines in such areas are particularly important as a means of spreading risk and minimizing presale exploration expenditures.

C. Evaluation and Research Plan:

The issues involved in the debate over the ban involve aspects of both income redistribution and efficiency. For the most part, advocates on both sides of the issue tend to focus on the income transfer aspect, i.e., the extent to which the returns to the U.S. Treasury were affected by, first the intramajor joint ventures and then by their prohibition. There are, however,

potentially significant efficiency effects that tend to be intertwined with the income redistribution aspects. The pro-ban position implies that the majors were engaging in a kind of "rent seeking" activity in that they were wasting resources to combine with each other in search of rents. Critics of the ban suggest that the ban tended to raise the bidding costs of majors by forcing them into bid arrangements that were more costly than those arrived at in the absence of governmental restraint. The implied result is a tendancy for the ban to increase the costs of bidding, including those associated with greater risk.

Our research will focus on the effect of the ban on competition in the bid market, an area that encompasses both efficiency and income distribution elements.

Previous statistical analysis has concentrated on testing assertions and implications of the pro-joint-venture ban position. Initial statistical support for the joint venture ban focused on attempts to document effects of the information-exchange mechanism outlined above. In particular, Interior tested the hypothesis that the majors utilized the information gained via joint venture's to acquire, for relatively low acquisition prices, the tracts where little competition was expected. Initial tabulations indicated apparent support for the information-exchange theory, since a pattern emerged in which the major producers acquired tracts in the March 1974 Gulf of Mexico sale for lower prices (relative to ex ante estimates of tract value) than their smaller rivals.[1] This result, however, was refuted in subsequent work by the American Petroleum Institute (API), which found that the Interior result was due to a statistical error. Correction of this error, and inclusion of an additional sale, eliminated the apparent tendency for the majors to acquire tracts at lower prices than smaller firms.[2]

---

[1] U.S. Department of the Interior, op. cit.

[2] P. Korbin, M. Canes, and P. Murphy, "Is the Ban on Joint Bidding for OCS Leases by Major Oil Companies Warranted?," op. cit.

A subsequent study by the API focused on effects of the ban.[1] It tested two predictions by the ban's adherents: (1) The number of participants will increase, and (2) The average number of bids per tract will rise. Utilizing data for the 1954-77 period, neither of these forecasts was supported. No significant change in the number of bidders participating in OCS sales was observed. Moreover, average bids per tract actually declined significantly, leading the API to infer that the ban had led to a decrease in rivalry, which in turn resulted in a significant reduction in Interior revenues.

In what follows we seek to modify and extend the above empirical analysis. Primary attention will center on determining effects of the ban on bid-market competition through a before-and-after comparison of relevant structure and performance indices. Our analysis contrasts with past studies primarily in that (a) two more years of lease sales are included; and (b) a multivariate empirical approach is utilized so as to take into account the influence of tract- and sale-specific factors on bid-market structure and performance.

We analyze two indices of bid-market competition: the average number of bids submitted per tract and the division of rents between Interior and the bidders. Bids per tract is a structural indicator of competitive rivalry in a sale. The division of rents relates to the bid market's competitive performance; at the limit, a perfectly competitive market would allow Interior to capture all rents, leaving the winning bidders with a normal rate of return, considered ex ante.

---

[1] "The Joint Bidding Ban: Pro- and Anticompetitive Theories of Joint Bidding in OCS Lease Sales," American Petroleum Institute Research Paper 010, August 1978. (Subsequently published in the Journal of Economics and Business (Fall 1980), 1-12.)

CHAPTER 4

BIDS PER TRACT ANALYSES

The most detailed analysis of the ban's effect was conducted by the staff of the API, who tested for differences in the average number of bids per tract (NBIDS) observed for the pre-ban and ban sales conducted over the 1954-79 period. A key problem with the API's analysis is that a number of potentially significant influences on per-tract bid frequency were ignored. This omission can be important, since there has in fact been a good deal of change in such influences on bid activity as the quality of tracts offered for sale, expected petroleum prices, governmental regulation, and the state of technology in exploration and development. To the extent that these factors vary systematically over time, they can cause serious biases in univariate tests, such as the API's, where the data are grouped by time period. A sense of the complexity of this issue is gained by reference to figure 1, which charts average bids per tract for 23 large sales conducted during 1954-79.[1] Variation in the bids-per-tract average is seen to be quite high in both periods, with no discernible shift observed at the time the ban was imposed.

An obvious correction to this problem is to explicitly take account of other factors that are apt to influence bid activity via multivariate regression analysis. Such a model takes the following general form:

$$(1)\quad NBIDS_{ij} = a + b\ JVB_j + c\ TRACT_{ij} + d\ SALE_j + e_{ij},$$

where

$NBIDS_{ij}$--the number of bids submitted for the ith tract;

JVB_j--JV-ban dummy: equals 1 if tract offered in sale conducted under ban; zero otherwise;

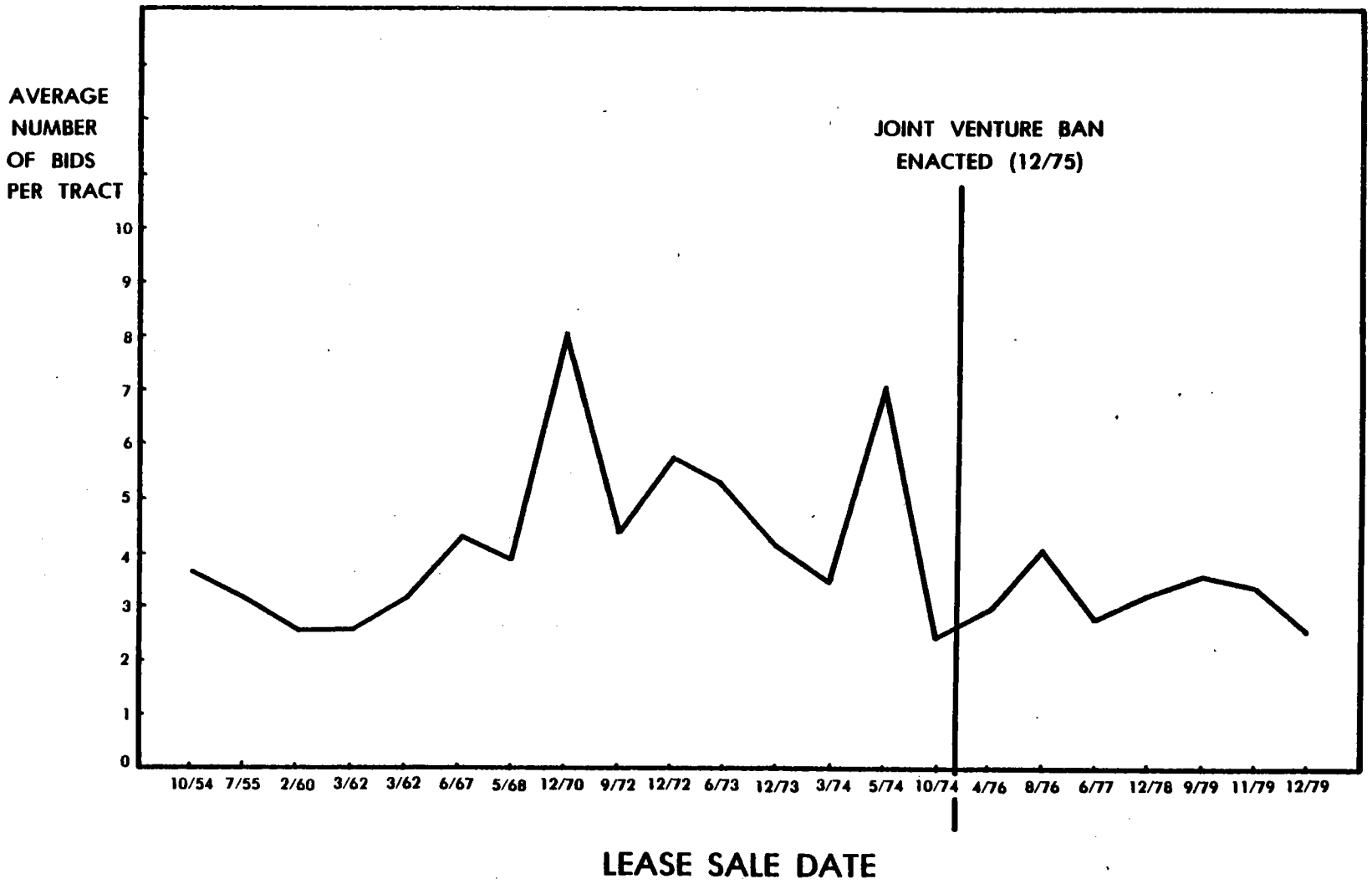
$TRACT_{ij}$--characteristics of the tract;

$SALE_j$--characteristics of the sale in which the tracts were offered;

---

[1] This sample is described in appendix A.

FIGURE 1: AVERAGE NUMBER OF BIDS PER TRACT FOR LARGE NON-DRAINAGE LEASE SALES, 1954-79



e_{ij}--random-error term;

i--tract;

j--sale.

The selected tract- and sale-specific characteristics are control variables designed to isolate the ban's effect on NBIDS. The JVB coefficient thus indicates the change in the average number of bids submitted per tract, holding constant the effect of other variables specified in the equation.

A. An Operational Model

In order to provide a more effective and manageable test of the ban, we narrow the sample to the tracts receiving bids in seven developmental sales conducted in the western portion of the Gulf of Mexico during the 1974-79 period. This data set offers two primary advantages. First, the limitation on time and place avoids the wide variablity in lease sale conditions that occurred over longer periods of time. Second, the sample provides access to the following two ex ante measures of tract quality that are unavailable over longer periods

PSV--the presale value of a tract as estimated by Geological Survey, and

DRYR--dry-hole risk: the probability, as estimated by the U.S. Geological Survey, that a commercial petroleum deposit will not be discovered on a tract.

PSV will be the chief measure of tract value. It is the Geological Survey's presale estimate of the risk-adjusted present value of expected revenues to be derived from a tract's operation.[1]

The basic model to be estimated is

$$(2)\quad LNBIDS_{ij} = a_0 + a_1 JVB_j + a_2 PSV_{ij} + a_3 DRYR_{ij} + a_4 SSROY_{ij} + a_5 DR_{ij} + a_6 TBO_j + a_7 DEPTH_{ij} + a_8 DIST_{ij} + a_9 GAS_{ij} + v_{ij},$$

where

[1] A detailed examination of the Geological Survey's tract-valuation program is provided in appendix D.

$LNBIDS_{ij}$--the log of number of bids submitted for the ith tract offered at the jth sale;

JVB_j--JV-ban dummy:
= 1 if ith sale took place under joint venture ban (i.e., sales occurring in 1976-79 period), zero otherwise;

PSV_{ij}--presale value of a tract as estimated by the Geological Survey ($ million);

$DRYR_{ij}$--dry-hole risk: the probability that no commercial petroleum deposit will be discovered on a tract;

$SSROY_{ij}$--sliding-scale-royalty-tract dummy:
= 1 if tract was classified as a sliding-scale-royalty tract, zero otherwise;

DR_{ij}--drainage-tract dummy:
= 1 if ith tract issued at jth sale was classified as a drainage tract, zero otherwise;

TBO_j--number of tracts bid on at the jth sale;

$DEPTH_{ij}$--water depth of tract (in meters);

$DIST_{ij}$--distance of tract from shoreline (in miles);

GAS_{ij}--gas-tract dummy:
= 1 if tract expected (by the Geological Survey) to be predominantly natural gas, zero otherwise;

v_{ij}--error term that includes sale- and tract-specific influences on NBIDS not taken into account by the explanatory variables;

i--tract; and

j--sale.

LNBIDs is the log of the dependent variable. The logged value is taken so as to symmetrize the distribution of NBIDS; this in turn yields a homoscedastic error term, as required by the regression model.[1] The control variables are expected to influence NBIDS in the following ways:

PSV--Presale Value of a Tract ($ million)

PSV is used as a proxy for the expected value of a tract, defined as the present value of the expected stream of net

---

[1] This semi-log formulation is also used for the high bid regressions reported in chapter 5. There is evidence that both the NBIDS and the high bid variables have highly skewed distributions that tend to be normal in their logged form (See, generally, E.L. Dougherty and J. Lorenz, "Statistical Analysis of Bids for Federal Offshore Leases," paper presented to the Society of Petroleum Engineers of AIME, 1975). In the case of both regression models, the error disturbance term for the semi-log versions have homoscedastic error variances while the corresponding linear models do not. See Appendix B for further discussion.

revenues to be derived from the tract's operation. So defined, PSV is predicted to exert a positive influence on NBIDS: the higher the expected value of a tract, the greater the number of firms that are encouraged to bid for it. This relationship is derived from a model of the bidding process in which the number of bids offered for a tract is predetermined by the original distribution of firms that decided to evaluate it. In this scenario, the decision to evaluate is based on some rough (but unbiased) notion of a tract's ultimate value. The larger the anticipated value of a tract, the greater the number of firms that find it worthwhile to proceed with the costly evaluation process. It is this set of firms that forms the universe of potential bidders when the tract is finally offered for sale. Hence the final bid distribution is directly linked to the initial distribution of evaluators for a tract, which in turn is assumed to be a positive function of tract value.[1]

SSROY--Sliding-Scale-Royalty Dummy

Tracts with sliding scale royalties are those where the royalty rate is not fixed (as are all other tracts in the sample) but is linked to a lease's gross production revenue. The formula is a "sliding scale" one, in which the royalty rates increase with the value of production from a tract.[2] By stipulating

---

[1] A formal model of this relationship has been developed by Gaskins and Teisberg, "An Economic Analysis of Pre-sale Exploration in Oil and Gas Lease Sales," in Essays on Industrial Organization in Honor of Joe S. Bain, ed. Robert T. Masson and P. David Qualls (Cambridge, Mass.: Ballinger Publishing Co., 1976).

[2] A typical sliding-scale formula is the following one, utilized in the March 28, 1974, OCS sale:

$$R = 16\ 2/3 + (V - 1.5);\ 16\ 2/3 \leq R \leq 50,$$

where R refers to the percentage royalty rate and V is the quarterly gross-revenue level for the tract, expressed in millions of dollars. This formula says that the lowest rate to be paid on the tract is 16 2/3 percent, the rate on fixed-royalty tracts. As quarterly production revenues rise above $1.5 million, the royalty rate increases, up to its maximum limit of 50 percent. See Resource Consulting Group, The Effects of Alternative Leasing Systems on OCS Bidding Behavior: An Empirical Analysis, a study prepared for the Department of the Interior (Washington, 1981), exhibit 2.a (no page number).

royalty rates for high production levels that exceeded those for fixed-royalty-rate tracts, Interior sought to share more of the risk of tract development with producers (i.e., by accepting lower bonus payments in lieu of higher royalty fees where the tract turned out to be successful) and thus induce a higher level of bidding activity for SSROY tracts. The expected sign of the SSROY coefficient is thus positive.

DR--Drainage-Tract Dummy

Drainage tracts are those contiguous to previously leased tracts. Since the owners of these adjacent tracts usually possess a significant information advantage, bidding activity for drainage tracts tends to be reduced from what it would be if the tracts were in wildcat areas (i.e., areas with no previous production history). The distribution of information in wildcat areas is less skewed, since no one producer has a locational advantage.

TBO--Number Of Tracts Bid On

The TBO variable measures the number of commercially viable tracts offered at a sale. Holding the number of bidders constant, and assuming a capital constraint facing producers, a rise in the number of tracts offered may tend to spread out bidding activity, leading to a reduction in the number of bids per tract.

DRYR, DEPTH and DIST--Dry Hole Risk, Depth, and Distance From Shore:

All three of these are cost variables; each considered singly should thus exert a negative effect on the value of a tract as perceived by bidders.[1] Ideally, their influence should be fully encompassed in the PSV variable, which is a proxy for tract value. We include them independently in the regression equation, so as to take into account the possibility of systematic valuation differences between the Geological Survey and OCS bidders. An example would be if Geological Survey

---

[1] The risk variable DRYR becomes an implicit cost factor under the (reasonable) assumption that OCS bidders are risk averse.

utilized a consistently lower discount rate for risk than bidders did. A problem could develop here if majors displayed risk preference for tracts that differed from their rivals. Since we are guarding against possible errors in PSV that cannot be specified a priori, the coefficients of DRYR, DEPTH, and DIST carry no expected signs.

GAS--Gas-Prone-Tract Dummy

Natural-gas tracts have tended to attract a wider set of bidders, expecially gas pipelines and utilities. There thus may be a tendency for such tracts to register a larger number of bids than oil-prone tracts.

JVB--Joint-Venture-Ban Dummy

Interior's joint venture-ban rationale implies a positive JVB coefficient, i.e., the average number of bids per tract should be higher under the ban. The elimination of intramajor joint venture's is expected to increase NBIDS in either or both of two ways: (a) The majors increase the total number of their bids, since they now bid independently for tracts on which they would have otherwise bid jointly; (b) As anticipated by the information-asymmetry story, the ban tends to equalize information among bidders, inducing smaller firms to increase their bid activity. The latter firms now perceive the auction to be "fairer" in the sense that the majors have less of an information advantage, due to their inability to pool information on the expected degree of competition.

In contrast, a negative JVB coefficient would tend to confirm suspicions of the ban's critics (e.g., the API) that intramajor joint ventures were a procompetitive device. By reducing uncertainty, it is argued, these joint ventures led to an overall increase in major bid activity. Imposition of the ban thus leads to a decrease in the overall number of bids, since no compensating rise in nonmajor bid activity takes place.

Since the dependent variable is logged and JVB is a dummy variable, the change in the average level of NBIDS between the pre and ban periods (holding constant the effect of the control

variables) is measured by the factor e^{a1}., where a_1 is the coefficient of the JVB coefficient. The corresponding percent change in average NBIDS in the post-ban period is $[(e^{a1} - 1) \times 100]$.[1]

Under either the pro- or anti-joint venture-ban theories, use of a single dummy variable (i.e., JVB) to test the ban's effect implies instantaneous adjustment by bidders, beginning with the first sale under the ban. To test for the possibility that the effect of the ban may have taken place gradually or that it may have caused a temporary disequilibrium, we will also experiment with an alternative formulation that allows for sale-to-sale variation in the estimated value of LNBIDS during the ban period. To do this we add the following dummy variables to the equation:

BANSALE2 = 1 if the tract was offered at the second sale conducted under the ban; zero otherwise.

BANSALE3 = 1 if the tract was offered at the third ban sale; zero otherwise.

BANSALE4 = 1 if the tract was offered at the fourth (and last) sale conducted during the ban period; zero otherwise.

Under this formulation, the ban variable (JVB) coefficient measures the change in the average level of NBIDS between the pre-ban period and the first sale under the ban. The coefficient of a BANSALE variable in turn measures the proportionate change

---

[1] In exponontial form, the relationship between NBIDS and JVB hypothesized in equation (1) is

$$NBIDS = e^{a_1 JVB} \; EXP(a_o + \Sigma B_i X_i)$$

where x_i refers to the remaining variables. Since the JVB variable is a discountinuous one taking the value of either zero (for tracts issued in the pre-ban period) or one (for tracts issued under the ban) implementation of the ban affects the number of bids submitted for a tract by a multiplicative factor e^{a_1}. The factor e^{a_1} is the ratio of the average NBIDS in the ban period to the average NBIDS in the pre-ban period $(e^{a_1(1)} / e^{a_1(0)} = e^{a_1})$. It follows then that the percent change in NBIDS between the two is $[(e^{a1}-1) \times 100]$. See R. Halvorsen and R. Palmquist, "The Interpretation of Dummy Variables in Semilogarithmic Equations," American Economic Review (June 1980), pp. 474-75.

in NBIDS between that particular sale and the first ban sale. For example, the coefficient of BANSALE2 measures the change in NBIDS between the first and second sale conducted under the ban.[1]

B. Empirical Results

The DEVELOP data set consists of 735 tracts, 349 of which were offered for sale prior to the ban and 386 of which were sold under its provisions.[2] Table 4-1 presents least-squares estimates of the various formulations of the NBIDS model discussed above. In the simple univariate case (eq. a), the JVB coefficient is positive and marginally significant (at the 10-percent level). This result does not hold, however, when additional influences on NBIDS are taken into account.

Estimation of the principal multivariate model (eq. b) indicates that the JVB coefficient is insignificant. This result indicates that after account is taken of the influence of the other variables specified in the model, no significant change took place in the average number of bids per tract between the pre-ban and ban periods. Also, addition of the sale dummies, did not add to the explanatory power of the model (eq. c). Thus, the hypothesis that the ban exerted a significant effect on the frequency of bidding activity, in either an instantaneous or a lagged form, cannot be supported. On the other hand, three of the control variables--PSV, TBO, and DR--exhibited a significant influence on NBIDS, all in the expected direction.

We further investigate the pattern of bids per tract over the 1974-79 period by dichotomizing the LNBIDS variable into the number of bids submitted by majors (LNMAJ) and the remaining bids, in which no major took part (LNMIN, the number of bids by

---

[1] Note that in all of these cases the interpretation of the dummy variable coefficients is the same as in the original JVB coefficient, as explained in the preceeding footnote.

[2] Appendix A describes the data set in greater detail. Appendix table C-3 lists average values for the variables utilized in the regression analysis of this chapter.

Table 4.1.--Regression estimates of bids-per-tract model

	Regression coefficients (t-values in parentheses) Dependent Variable:				
Variable	LNBIDS (a)	LNBIDS (b)	LNBIDS (c)	LNMAJ (d)	LNMIN (e)
Intercept	.78	1.45	1.76	1.12	1.17
PSV		.003 (5.3)	.003 (5.0)	.002 (5.3)	.001 (3.3)
DRYR		.27 (1.6)	.29 (1.7)	.18 (1.4)	.10 (.7)
SSROY		-.02 (.3)	.001 (.01)	.03 (.5)	-.04 (.6)
DR		-.25 (3.0)	-.24 (2.8)	-.10 (1.7)	-.21 (3.2)
TBO		-.01 (4.2)	-.01 (3.2)	-.003 (3.4)	-.003 (3.3)
DEPTH		-.001 (2.6)	-.001 (2.7)	.0002 (.8)	-.001 (4.3)
DIST		-.001 (1.8)	-.002 (.9)	-.002 (2.9)	.003 (.6)
GAS		-.11 (1.8)	-.12 (1.8)	-.10 (2.2)	-.03 (.6)
JVB	.009 (1.8)	-.03 (.4)	.03 (.4)	-.19 (3.6)	.15 (2.6)
BANSALE 2			-.19 (1.1)		
BANSALE3			-.19 (1.1)		
BANSALE4			-.17 (1.0)		
R^2/F	.003/3.2	.097/8.6	.098/6.6	.097/8.1	.091/8.3
Degrees of Freedom	7303	725	722	725	725

"minor" producers).[1] Least-squares estimation results with LNMAJ and LNMIN substituted for NBIDS as the dependent variable, are reported in Table 4-1 equation (d) and (e).

We see that the ban dummy becomes significant in these formulations--negative for the NMAJ model and positive for the NMIN version. There has thus been, ceteris paribus, a significant decline in the average number of bids submitted by majors and a corresponding increase in bids in which no major participated between the pre-ban and ban periods.[2] The insignificant JVB coefficient in equations with NBIDS as the dependent variable indicates that these two trends cancel each other out, leaving the overall level of NBIDS unchanged. Among the control variables, inspection of the GAS-coefficient estimate in equations (d) and (e) indicates that majors are less interested in gas-prone tracts than in others, while nonmajors are indifferent between the two.

To summarize, the above results show no significant effect of the ban on the overall level of bidding activity. API assertions that the ban has led to a significant drop in the number of bids per tract are thus not confirmed. The decline in average NBIDS found by the API appears to be due to shifts in the distribution of tracts offered for sale and to changes in the type of sale in which they were sold, rather than to the ban itself. Nonetheless, predictions of a significant rise in bidding activity implied by the ban's supporters are likewise contradicted.

---

[1] As is the case with NBIDS, the variables denoting the number of bids submitted by majors (NMAJ) and non-majors (NMIN) were entered in the regression equation in their logged form. Since the number of bids submitted by a major or a "minor" producer could be zero for a particular tract, the NMAJ and MNIN variables were redefined as their original values plus one so that the logs of their values could always be calculated.

[2] The estimated coefficient for the NMAJ variable shows a 17 percent decline in the ban period while NMIN indicate a 16 percent increase in the number of bids submitted by non-major firms during the same period.

CHAPTER 5

HIGH BID ANALYSIS

We now examine the ban's influence on high bid (HB) levels, i.e., on the value of the highest bid submitted for a tract. Our principal aim is to provide insight into the effect of the majors' joint venture activity on the division of rents between Interior and purchasers of OCS tracts.

A tract's "true" valuation is defined as the discounted present value of the net revenues expected to be obtained from its operation. This value (VAL) is determined by differences between the price of petroleum and the cost of extraction (the latter including a competitive rate of return to the producing company). Assuming that Interior has no alternative uses for OCS leases, all of a tract's value is a "rent" that is due ultimately to the inherent scarcity of petroleum.[1] Interior's aim is to capture as much of this rent as possible in the bonus paid for a tract by the winning bidder (i.e., HB).[2] The remainder (VAL-HB) is the rent acquired by the bidder; it represents expected profits over and above that necessary to induce development of the tract. Since VAL is unobservable, we use as a proxy the presale tract value estimated by the Geological Survey (PSV). Due to a downward bias in the PSV variable (see appendix D), we cannot obtain the company's rent-capture portion by simply subtracting HB from PSV. Rather, a cross-sectional analysis must be performed where rent-capture indices are related to variables theoretically linked to the extent of rent capture. We do this

---

[1] We thus use the term "scarcity rent" in its broad sense to refer to all returns to ownership of a petroleum tract that are due to the resource's inherent scarcity. A finer distinction can be made in which the term "Ricardian (or 'differential') rents" are used to reflect differences in tract valuations caused by variations in their productivity. See Mark Blaug, Economic Theory in Retrospect (Cambridge, 1978), pp. 79-88, 407-8.

[2] To simplify the discussion here we are assuming away the existence of royalty payments, so that the bonus offer represents the total payment for a tract.

via multiple-regression analysis, where the Interior's rent-capture level (HB) is regressed on PSV and selected sale and tract characteristics. The general form of the model is

$$(1)\quad LHB_i = a_0 + a_1 PSV_i + \sum_{k=1}^{g} b_k X_i + \sum_{n=1}^{h} c_n Z_i + v_i,$$

where X refers to quality-related characteristics not fully captured in the PSV variable and Z to the hypothesized determinants and indicators of rent capture. Thus the c_n coefficients represent the association between Z_i and the variation in HB over and above that due to those tract quality differences reflected in PSV and X_i.

The first part of this section tests the rent-capture ability of selected groups of bidders. Our aim is to further explore Interior allegations that combines including majors tended to acquire tracts at a lower relative price (i.e., relative to tract value) than do bids associated solely with smaller companies. The second part analyzes effects of the ban on Interior's rent-capture ability.

A. Rent Capture by the Majors: An Intrasale Analysis

Interior's evidence in support of the ban consists of the finding that the majors as a group acquired tracts at the pre-ban March 1974 Gulf of Mexico sale at a lower relative cost (measured as the ratio of HB to PSV) than other bidders. This result was viewed as consistent with the information-asymmetry hypothesis, according to which intramajor joint venture's provided these companies with superior information. Interior's results were subsequently contested by the API, which could find no such relationship for either the March 1974 or the July 1974 sale. We will attempt to cast added light on this issue by applying a more general test of the Interior allegations to the seven-sale DEVELOP sample.

Of particular interest are the broader implications of Interior's allegations. Purchase of a tract for relatively low cost imputes an above-average expected (i.e., ex ante) rate of return to the purchaser. Discovery of a pattern in which a

particular group of bidders is consistently able to purchase tracts at low cost is thus indicative of an inefficient market in which ex ante rates of return fail to tend toward equality. Such a pattern implies the existence of some impediment to competitive forces, such as that contained in the Interior information-asymmetry story, that prevents rates of return from equalizing. In the spirit of this more general issue, we test for the existence of above-average rates of return by focusing on those tracts acquired by the following classes of bidders:

- majors,
- intramajor joint ventures, and
- solo majors.

In regard to each group, the expectation of an above-average rate of return relates to the potential information advantages connected with intramajor joint ventures. In the case of all majors, it is posited that the joint venture negotiations among themselves allow all group members to gain tracts at low cost, due to their more accurate information regarding the expected degree of competition. Use of the remaining two groups implies that the information advantage is more restricted. The intra-major-joint venture category implies that above-average profits can be made only within the intramajor group itself. This comes about because intramajor joint ventures in effect combine the most probable competition for a tract, allowing the combine to successfully lower its bid. In contrast, the solo-majors category implies that the information gain accrues only to independent bids made outside all joint venture endeavors. Similar expectations for each of the above ownership categories can also be based on a collusion model in which the majors explicitly avoid competition with each other so as to minimize tract acquisition costs.

Each of these market-imperfection hypotheses is tested via multiple regression. The original analysis by both Interior and the API tested for differences in the average HB/PSV ratio between the major and nonmajor tracts. The approach taken by

Interior and the API is equivalent to estimation of the following regression model:

$$(2)\quad \frac{HB}{PSV_i} = a_0 + a_1 MAJ_i + e_i,$$

where

MAJ--major dummy:
= 1 if a major was involved as high bidder on the ith tract, zero otherwise; and

i--tract.

In the foregoing model, the MAJ coefficient signifies the difference in average HB/PSV between the majors and nonmajors groups. We modify and expand this model using the following formulation:

$$(3)\quad LHB_i = a_0 + PSV_i + a_2 DR_i + a_3 DRYR_i + a_4 DEPTH_i + a_5 DIST_i + a_6 OWN_i + v_i',$$

where

LHB_i--log of the value of the high bid offered for the tract ($000);

PSV_i--presale value ($000);

DR_i--drainage-tract dummy:
= 1 if a drainage tract, zero otherwise;

$DRYR_i$--dry-hole risk;

$DEPTH_i$--water depth of tract (meters);

$DIST_i$--distance of tract from shore (miles);

OWN_i--a series of ownership dummies, each to be entered in a separate regression;

MAJ_i--major owner:
= 1 if major had part or whole interest in the winning bid, zero otherwise;

$INMAJ_i$--intramajor owner:
= 1 if winning bid submitted by an intramajor joint bid, zero otherwise;

$MAJSOLO_i$--solo major owner:
= 1 if solo major bid won the tract; and zero otherwise.

i--tract.

As in the analysis presented in Chapter 4, PSV, DRYR, DIST, and DEPTH are quality indices designed to hold constant differences

in the basic attractiveness of leases to bidders.[1] The drainage-tract dummy variable, DR, is included to control for cases where competition is distorted due to the superior information held by owners of the adjoining tracts. Each of the OWN coefficients measures the differences in the average high bid, adjusted for quality, between the particular ownership group and all other high bidders in a particular sale. The market-imperfection hypotheses described above posit a negative coefficient for one or more of these variables, indicating that the particular group had consistently been able to acquire tracts at relatively low cost. For example, a negative MAJ coefficient would imply that the average quality-adjusted high bid submitted for tracts acquired by majors was lower than that for all other tracts in a sale.

Table 5-1 lists least-squares estimates for alternative formulations of equation 3.[2] Three regressions were estimated for each sale--one for each ownership-dummy variable. Predictions by the market-imperfection hypothesis of negative coefficients for the ownership dummies were not supported. In fact, the predominant pattern was one of positive coefficients--at times significantly so. This result indicates that the relevant major groups may, in fact, tend to pay above the average for their tracts in certain circumstances. Such a pattern complements Smith's finding of a positive relation between firm size and bonus offer.[3]

---

[1] As noted in Chapter 4, PSV should suffice for this purpose. We include the other variables so as to account for the possibility that part of the tract valuation is missed by PSV and is picked up by these variables.

[2] We also estimated the regressions with NBIDS added as a control variable. The OWN coefficients in this case measured the extent to which the specified ownership-group tracts differed in HB after account was taken of both tract quality and degree of competition. The results, listed in appendix table C-5, are similar to those reported in table 5-1.

[3] J. Smith, "Risk Aversion and Bidding Behavior for Offshore Petroleum Leases," Journal of Industrial Economics (March 1982), pp. 251-269. See also G. Gilly and G. Kavels, "The Competitive Effect in Bonus Bidding: New Evidence," Bell Journal (Fall 1981), pp. 637-648.

Table 5.1.--Tests of bid-market-imperfection hypotheses: regression coefficients for major- and JV-related high-bidder variables

Dependent variable: value of high bid ($000)

Sale date	Regression coefficients* (t-values in parentheses) MAJ	INMAJ	MAJSOLO	No. of observations
3/28/74	.31 (1.1)	-.07 (.2)	.18 (.5)	114
5/29/74	.94 (3.8)	1.46 (4.0)	-.61 (1.7)	119
10/16/74	.18 (.7)	.19 (.5)	-.53 (1.7)	116
6/23/77	.45 (1.7)		.50 (1.6)	134
12/19/78	.37 (1.1)		-.12 (.3)	77
7/31/79	.63 (2.0)		.55 (1.4)	85
11/27/79	.69 (2.6)		.64 (2.0)	90

Notes: The basic regression utilized is:

$$HB = a_0 + a_1PSV + a_2DRYR + a_3DR + a_4DEPTH + a_5DIST + a_6 \text{ (selected ownership dummy)}.$$

Each of the above high-bid ownership-dummy variables (MAJ, INMAJ, and MAJSOLO) is entered singly in the equation. Thus, a separate regression is estimated for each of the high-bid owner dummies. The high-bid owner-dummy variables are defined as follows:

MAJ -- 1 if a major participated in winning bid; zero otherwise;
INMAJ -- 1 if an intramajor joint venture was high bidder; zero otherwise; and
MAJSOLO -- 1 if a solo major was high bidder; zero otherwise.

* Regression estimates for all variables in the equation (for the 3/28/74 through 11/27/79 sales) are presented in appendix table C-6.

To conclude, we find no support for the Interior contention that majors were able to acquire tracts at below-average cost. While this result does not by itself conclusively undermine the rationale for the joint venture ban, it does strongly cast doubt on the thesis that majors were able to appropriate gains from intramajor joint ventures through either the alleged information exchange or other means. What remains to be examined is the broader hypothesis that intramajor joint ventures, by reducing the level of competitive rivalry, managed to increase rent capture for all producers, both major and nonmajor. This issue will be studied in the next section.

B. Rent Capture by Interior: 1974-79

An alternative test for the influence of intramajor joint venture activity on high bid levels is to search for changes in the division of rents once this type of venture was eliminated. To this end, we estimate the following determinants of high bid equation for the set of tracts issued over the 1974-79 period:

$$(4)\quad LHB_{ij} = a_0 + a_1 JVB_j + a_2 PSV_{ij} + a_3 NBIDS_{ij} + a_4 DRYR_{ij} + a_5 DR_{ij} + a_6 SSROY_{ij} + a_7 DIST_{ij} + a_8 DEPTH_{ij} + a_9 TBO_j + v_{ij},$$

where

LHB_{ij}--log of the value of high bid for the tract ($000);

JVB_j--JV-ban dummy:
= 1 if jth sale took place under JV ban (i.e., sale occurred in 1976-79 period), zero otherwise;

PSV_{ij}--presale value of a tract as estimated by Geological Survey ($000);

$NBIDS_{ij}$--number of bids submitted for the tract;

$DRYR_{ij}$--dry-hole risk: probability that no commercial hydrocarbon deposit will be found on the tract;

DR_{ij}--drainage-sale dummy:
= 1 if ith tract issued at jth sale was classified as a drainage tract, zero otherwise;

$SSROY_{ij}$--sliding-scale-royalty dummy:
= 1 if ith tract issued at jth sale was auctioned under sliding-scale system, zero otherwise;

TBO_j--number of tracts bid on at the jth sale;

$DEPTH_{ij}$--water depth of tract (in meters);

$DIST_{ij}$--distance of tract from shoreline (miles);

v--error term that includes sale- and tract-specific influence on HB not taken into account by the explanatory variables;

i--tract; and

j--sale.

The tract characteristic variables are the same as in the intra-sale high bid equation, and have similar rationales for their inclusion. The number-of-tracts-bid-on variable (TBO) is hypothesized to have a negative effect on bid levels: increases in the number of tracts offered may lead to less funds being available for any particular lease.

The effect of the ban is measured by the coefficient of the JVB variable. A positive JVB coefficient would be predicted by supporters of the ban: denied the ability to consult with each other via joint venture's, the majors are forced into a more arm's-length-competitive situation that dictates that they bid closer to expected value. Under this scenario, each major must consider all other majors as potential competitors for a tract when formulating its bid. By contrast, a smaller number had to be taken into account in the pre-ban period, due to joint venture combinations.

Critics of the ban would expect a negative JVB coefficient, due to the increased uncertainty surrounding tracts for which the majors would otherwise have bid jointly. The increased costs of forming consortia, now that the majors must typically find a number of smaller producers to take the place of each major partner, are also expected to exert a negative influence on high bid values.

---

[1] We also estimated the high bid equation without the NBIDS variable. In this form, the JVB coefficient measures the effect on the average level of high bid of both changes in the number of bids submitted, and of changes in bid strategy between the ban and pre-ban periods. The resulting estimates (reported in Appendix table C-7) are similar to those reported in the text.

Under either of the above scenarios, use of the JVB variable alone implies an instantaneous adjustment by bidders to the ban. In order to take account of a lagged response we will experiment with adding to equation (4) the same set of sale dummy variables, utilized in the NBIDS model.

Least squares estimates of the high bid models are reported in table 5-2. The JVB coefficient is negative and significant in the instantaneous effects model (eq. a) indicating that the average return to Interior declined between the pre-ban and ban periods. The bulk of this negative effect appears to have been concentrated in the first two sales under the ban, however. This can be seen by inspection of the BANSALE coefficients in the second estimated equation. In this formulation, the JVB coefficient estimates the effect of the ban on Interior revenues for the first sale of the ban period. The BANSALE coefficients in turn measure the difference in returns between the sale referenced by the particular BANSALE coefficient and the first sale under the ban. A summary of the relevant coefficient estimates from this equation are reproduced below:

Variable:	Regression coefficient (t value)	Interpretation: percent change in the adjusted high bid average[1]
JVB	-.59 (4.3)	-45 percent: 1st ban sale vs. pre-ban average
BANSALE2	-.06 (.2)	-6 percent: 2nd ban sale vs. 1st ban sale
BANSALE3	.11 (.4)	+11 percent: 3rd ban sale vs. 1st ban sale
BANSALE4	.73 (2.9)	+109 percent: 4th ban sale vs. 1st ban sale

We observe that after the second sale during the ban period, average Interior returns begin to increase relative to the initial sale results (as reflected in the positive sign of the

[1] The formula for devising the percent change from the coefficient estimate is explained in footnote 1, p. 30.

Table 5.2.--Regression estimates of the high-bid model

Dependent variable: LHB-Log of the High Bid ($000)

Variables	Regression coefficients (t-values in parentheses)		
	Full sample		First two ban sales ommitted
	(a)	(b)	(c)
Intercept	10.4	10.0	10.3
PSV	.003 (3.5)	.003 (3.7)	.003 (3.4)
NBIDS	.34 (20.5)	.34 (20.9)	.32 (16.7)
DRYR	-.43 (1.6)	-.48 (1.8)	-.67 (2.3)
DR	.24 (1.8)	.22 (1.7)	.09 (.6)
SSROY	.14 (1.0)	.11 (.8)	.06 (.3)
DIST	-.001 (1.1)	-.0002 (.2)	-.002 (1.8)
DEPTH	-.0002 (.44)	-.0002 (.7)	.001 (1.1)
TBO	-.003 (1.5)	-.0001 (.03)	-.0003 (.1)
JVB	-.50 (4.4)	-.59 (4.3)	-.09 (.4)
BANSALE2		-.06 (.2)	
BANSALE3		.11 (.4)	
BANSALE4		.73 (2.9)	
R^2	.437	.457	.421
F statistic	62.5	50.7	41.5
Degrees of freedom	725	722	514

coefficients for BANSALE3 and BANSALE4). The strongest increase is registered for the last sale.

The foregoing pattern suggests that the ban's negative effects were most significant in the first sale, possibly due to the high adjustment costs on the part of the majors in adapting to the ban. This was followed by a gradual moderation in effect, perhaps a reflection that the majors began to adjust to the ban's stipulations. Alternatively, the rising trend in high bid for the ban period could be explained by the ban's supporters as a reflection of an increasing degree of rivalry due to the predicted benefits of the ban's gradually taking hold.

In any event, it appears that the negative effect of the ban on Interior rent capture was confined to the early sales under the ban. In equation (c) of table 5-2, estimates are made with the observations of the first two sales under the ban eliminated. The JVB coefficient now becomes insignificant, indicating no appreciable difference in Interior's rent-capture performance between the 1974 sales and those that took place in 1979 (the last year of the sample period).

The remaining control variables behaved largely according to expectations. The most important influence on HB is NBIDS; its addition to the model increases R^2 from .13 to over .40. (Estimates of high bid model without NBIDS are reported in Appendix table C-7). Although part of this influence may be due to tract quality factors not included in the other variables, the evidence seems persuasive that competition at the tract level does play a significant role in determining the level of Interior's rent capture. The PSV variable is positive and significant, as predicted. The negative DRYR coefficient supports the general notion that bidders are risk adverse and reduce their bid offers as the perceived risk of failure grows. This was also found by Smith in his study of individual bid levels.[1] Nevertheless, the DR coefficient is insignificant,

---

[1] Smith, op. cit.

indicating that the higher certainty of valuation for such tracts did not translate into higher returns for Interior. The insignificant SSROY variable is similar to that found in other research.[1] It supports the notion that the sliding-scale-royalty formula was a relatively mild one whose effect on risk was perceived by bidders as being insignificant.

---

[1] Resource Planning Associates, The Effect of Alternative Leasing Systems on OCS Bidding Behavior: An Empirical Analysis (Cambridge, Mass., 1980).

CHAPTER 6

SUMMARY AND CONCLUSIONS

The principal task of this report was to make empirical comparisons of OCS bidding activity for periods before and after enactment of the intramajor joint venture ban. The results of these tests do not confirm expectations of the ban's supporters that competition in the bid market would be enhanced by elimination of intramajor joint ventures. While the number of bids offered by nonmajor firms did increase under the ban, this was offset by a corresponding decline in the number of bids submitted by majors. Likewise, imposition of the ban brought no significant improvement in the rent capture performance of Interior. There may actually have been a slight decline, at least in the initial sales conducted under the ban. Finally, cross-section analysis on a sale-by-sale basis uncovered no pattern in which major-associated bid groups, including intramajor joint ventures in the pre-ban period, acquired tracts at relatively low prices (quality adjusted).

Inferences as to the effect of the ban on competition must be qualified by the our inability to take account of the effect of the decline in major firm participation in OCS lease sales during the ban period. This reduction could, of course, be attributed to the ban itself, as predicted by some of the regulation's critics. Or, it could be due to factors unrelated to the ban. Since the investment decisions of such large, diversified concerns as the major producers are subject to many influences outside the scope of this report, this issue remains unresolved.

Nonetheless, our judgment on the ban is not a positive one. Notwithstanding a host of caveats concerning the possible influence of alternative factors on OCS competition, we can reasonably assert that no empirical support exists for the propositions that: (a) some type of limitation on major joint ventures was needed to improve bid-market performance, and (b) the intramajor joint venture ban chosen to deal with these alleged problems achieved significant competitive benefits.

APPENDIX A

Description of the Data Used in the Regression Analysis

The leasing of Outer Continental Shelf (OCS) tracts began in 1954. Through 1979, 4,077 tracts had been leased via 51 separate auctions. The empirical analyses in this report utilize two subsets of sales from the 1954-79 period of OCS leasing. The first, termed FULL, is a relatively large group spanning the entire 1954-79 period and is designed to analyze broad changes in bidding activity. The FULL data set is used as the basis of Figure 4.1. The second data set, DEVELOP, is a more restricted sample of developmental sales drawn from the 1974-79 period. The DEVELOP sample serves as the basis for a more detailed analysis of bid activity that abstracts from various exogenous factors, such as locale, type of sale, etc., that are difficult to quantify.

1. FULL: 1954-79

The FULL set consists of 2,982 tracts that were issued at 23 sales during the 1954-79 period. This data set includes all sales conducted during the 1954-79 period, with the exception of the following:

(a) sales classified as "drainage" by the Department of Interior (drainage sales are those where the bulk of tracts offered are contiguous to tracts issued in previous auctions);

(b) "small" sales, in which fewer than 50 tracts were issued;

(c) all sales conducted during 1975;

(d) the 12/20/77 Alaska sale, where bidding via royalty (instead of bonus) was extensively utilized; and

(e) sales conducted offshore California.

Drainage sales were excluded because the pattern of bidding at such auctions tends to be dictated by the ownership of adjacent tracts. Similarly, small sales also have the potential for distorting bid patterns, since the relatively meager offerings can

discourage some OCS producers from participating at all. Sales conducted in 1975 were excluded because there was evidence that the major producers anticipated the ban and began to restrict their intramajor ties significantly.[1] The Alaska sale presented a potential problem because it was the first sale in which significant numbers of royalty tracts were offered.[2] Since these tracts tended to be above average in quality, a distortion of bid activity for the residual group of bonus tracts may have resulted. Finally, California tracts were excluded because of their heterogeneous character; each sale was part frontier and part development, thus precluding a single designation being used as a sale-characteristic variable.

A description of the auctions included in the final sample is presented in table A-1. Table A-2 surveys those lease sales excluded from the sample.

2. DEVELOP: 1974-79

The DEVELOP sample consists of seven developmental sales that took place in the Louisiana-Texas area during the 1974-79 period. The narrow scope of the sample is due primarily to the time-series nature of the empirical tests analyzing the ban's effect, which requires a consistent set of presale estimates of over the period. Considering this goal, the following reasoning led to the sample selected:

(1) The 1974-79 timespan was selected, since this was the only period in which the Geological Survey utilized a consistent methodology for generating presale tract values (i.e., its Monte Carlo model [see appendix D]). In addition, the risk variable for the likelihood of dry holes (DRYR) is not available for pre-1974 tracts.

---

1 "Low bids off South Texas dim outlook for the Gulf," Oil and Gas Journal, 10 February 1975, pp. 19-21.

2 Royalty tracts are those for which ownership is awarded to the firm offering to pay the highest royalty rate on gross production revenues. As expected, such tracts attracted a good deal of small-firm participation, with offered royalty rates going as high as 85 percent. "Lower Cook Inlet sale spending tops $40 million," Oil and Gas Journal, 7 November 1977, pp. 44-46.

Table A-1.--FULL sample: tracts offered at large nondrainage OCS lease sales, 1954-79

(1) Date of sale	(2) Area	(3) Number of tracts bid on	(4) Number of bids submitted	(5) Bids per tract = (4)÷(3)
10/13/54	LA-TX	90	327	3.6
7/12/55	LA-TX	121	384	3.2
2/24/60	LA-TX	173	444	2.6
3/13/62	LA-TX	211	538	2.6
3/16/62	LA-TX	210	666	3.2
10/01/64	PACF	101	223	2.2
6/13/67	LA-TX	172	742	4.3
2/06/68	PACF	75	164	2.2
5/21/68	LA-TX	141	556	3.9
12/15/70	LA-TX	127	1,043	8.2
9/12/72	LA-TX	74	324	4.4
12/19/72	LA-TX	119	690	5.8
6/19/73	LA-TX	104	551	5.3
12/20/73	MAFLA	89	373	4.2
3/28/74	LA-TX	114	402	3.5
5/29/74	LA-TX	123	352	7.2
10/16/74	LA-TX	149	387	2.5
12/11/75	PACF	70	166	2.4
4/13/76	ALASKA	81	242	3.0
8/17/76	ATLANTIC	86	410	4.1
6/23/77	LA-TX	152	424	2.8
12/19/78	LA-TX	88	288	3.3
6/29/79	PACIFIC	55	112	2.0
7/31/79	LA-TX	88	316	3.6
11/27/79	LA-TX	96	322	3.4
12/18/79	ATLANTIC	73	189	2.6

Note: Tracts include those where high bid was rejected by Interior.

Table A-2.--1954-79 OCS lease sales excluded from FULL sample

(1) Date of sale	(2) Area	(3) Reason for exclusion*	(4) Number of tracts bid on	(5) Number per per bids submitted	(6) Bids per tract = (5)÷(4)
11/09/54	LA-TX	S	19	90	4.7
5/26/59	LA-TX	S	23	23	1.0
8/11/59	LA-TX	D	19	45	2.4
10/09/62	LA-TX	D	14	26	1.9
5/14/63	PACF	S	58	70	1.2
4/28/64	LA-TX	D	23	69	3.0
3/29/66	LA-TX	D	18	64	3.6
10/18/66	LA-TX	D	32	79	2.5
12/15/66	PACIFIC	D	1	7	7.0
11/19/68	LA-TX	D	21	38	1.8
1/14/69	LA-TX	D	26	40	1.5
12/16/69	LA-TX	D	16	58	3.6
7/21/70	LA-TX	D	21	59	2.8
11/04/71	LA-TX	D	13	33	2.5
7/30/74	LA-TX	D	49	57	1.2
2/04/75	LA-TX	P	143	281	2.0
5/28/75	LA-TX	P	102	191	1.9
5/29/75	LA-TX	P	80	179	2.2
2/18/76	LA-TX	D	41	81	2.0
11/16/76	LA-TX	D	48	117	2.4
10/27/77	ALASKA	R	91	240	2.6
3/28/78	ATLANTIC	S	57	99	1.7
4/25/78	LA-TX	D	101	283	2.8
10/31/78	LA-TX	S	35	62	1.8
2/28/79	ATLANTIC	S	44	73	1.7

Note: Tracts include those where high bid was rejected by Interior.

*Exclusion codes: D--drainage sale;
S--small sale;
R--royalty sale;
A--1975 sales in which joint-bidding ban was anticipated.

(2) Frontier sales were omitted, because all such auctions were undertaken only during the post-ban segment of the 1974-79 period.

The seven development sales selected represent all such auctions in the FULL data set for the 1974-79 period. There are a total of 818 tracts offered at these sales that received at least one bid. The regression analysis reported in the text is based on 735 tracts. The omitted tracts fall into the following categories:

- missing presale value data (PSV)--8 tracts where Geological Survey made a PSV evaluation that is now missing from its files in Reston, Virginia.
- royalty tracts--eight leases auctioned on the basis of highest royality bid (with a fixed bonus).
- no-evaluation tracts--67 tracts for which no PSV estimate was made by Geological Survey. These tracts represent cases where Geological Survey data showed no indication of a structure likely to contain hydrocarbons.[1] The fact that bids were nevertheless received for such tracts suggests one of two possibilities: the companies possessed information indicating (a) the presence of petroleum that was not available to Interior; or (b) in the absence of such information, the companies were speculating that drilling on adjacent tracts would uncover favorable information. Since either case makes it difficult to assign a value to such tracts, they were eliminated from the main regression analysis.

Table A-3 presents a general profile of the DEVELOP sample.

---

[1] These tracts are distinct from those assigned a negative value by Geological Survey. The latter do show signs of hydrocarbons but not enough to provide a positive profit.

Table A-3.--General profile of sales included in the DEVELOP sample, 1974-79

Date of sale	Number of tracts: Total tracts bid on	Missing information	Royalty tracts	NOEVAL--tracts with no PSV value	Total number of tracts used in regression analysis
3/28/74	114	0	0	0	114
5/29/74	123	1	0	3	119
10/16/74	157	0	8	33	116
6/23/77	152	0	0	18	134
12/19/78	88	5	0	6	77
7/31/79	88	1	0	2	85
11/27/79	96	1	0	5	90
Total	818	8	8	67	735

Note: Tracts for which high bid was rejected by Interior (and thus were not issued) are not included.

APPENDIX B

Analysis of Residuals in the Inter-sale regression equations

This appendix reports on tests for heteroscedasticity (non-constant variance of the error term) in the inter-sale regression equations utilized in the text. The existence of this condition violates the constant variance assumption (homoscedasticity) of the ordinary least squares model, resulting in regression coefficient estimates that, while unbiased, exhibit high variances.[1]

To test for the existence of heteroscedasticity we utilize a procedure suggested by Glejser in which the absolute value of the residual is regressed on the suspected sources of non-constant variance.[2] In the present case, the two most likely sources are, (1) the fact that tracts are offered at several sales, each with distincitive characteristics that may generate unique error structures; and (2) the wide variation in the potential value of a tract (as measured by the pre-sale value estimate, PSV) which may cause the error term variance to be associated with the size of tract.

Results of the test are reported in table B-1. The dependent variable is the absolute value of the residual generated by the particular regression equation. The independent variables are the PSV variable and a series of dummy variables denoting the particular sales. Two sets of regression tests were performed. The first was the semi-log formulation used in the text. The second was a linear formulation in which the dependent variable was entered in unlogged form.

In both the NBIDS and high bid equations, the semi-log formulation generates residuals that pass the Glejsler test for homoscedasticity, i.e., the null hypothesis of no significant

---

[1] The variance is "high" in the sense that there exists, in theory, an unbiased estimator that exhibits lower variance. See G.S. Maddala, Econometrics (New York, 1977), pp. 292-305.

[2] Glejser "A New Test for Heteroscedasticity," Journal of the American Statistical Association, September 1965, 316-323.

association between the set of independent variables and the residual term cannot be rejected. By contrast, the linear formulations of the NBIDS and high bid regressions both generate a significant association between the posited sources of heteroscedasticity and the error term.

Table B-1.--Results of heteroscedasticity tests

Regression equation used to generate the residual used as the dependent variable:		summary statistics for regression of absolute value of the residual on sale dummies and PSV:		
Equation	Dependent variable	R^2	F	Significance level
1.	NBIDS	.05	5.21	.0001
2.	LNBIDS	.02	1.62	.12
3.	HB	.09	10.01	.0001
4.	LHB	.01	1.48	.17

notes:
The NBIDS model tested did not include the BANSALE variables, while the HB equation did. The relevant equations in the text referring to the logged models are eq. (b) of Table 4.1 and eq. (b) of Table 5.2.

APPENDIX C

Miscellaneous Tables

Table C-1.--Frequency distribution of major-producer joint-venture leases according to ownership category: 1971-74 OCS lease sales

Producer	Total number of joint-venture leases	Financial-dominance leases	
		Number of leases	Number as percent of all joint venture leases acquired by producer
Exxon Corp.	15	5	33.3
Texaco, Inc.	39	8	20.5
Standard Oil co. (Ind.)	89	20	22.5
Gulf Oil Corp.	55	3	5.5
Mobil Oil Corp.	80	5	6.3
Shell OIl Co.	37	30	81.1
Standard Oil Co. of Calif.	79	24	30.4
Total	394	95	24.1

Note: Financial-dominance leases are those in which producer maintained either a majority (> 50 percent) financial interest or where it had a plurality interest and the remaining partners were ranked below the 20th-largest oil producers on a national basis.

Source: FTC tabulation based on U.S. Department of the Interior files.

Table C-2.—Joint-venture associations among the seven major petroleum producers: 1971-74 OCS lease sales

Percentage of the total value of Firm A's winning bids accounted for by joint bids with Firm B

Firm A	Firm B						
	Exxon	Texaco	Std. Oil (Ind.)	Gulf	Mobil	Shell	Standard Oil (Calif.)
Exxon Corp.	—	.0	.0	.0	52.3	.0	0.8
Texaco, Inc.	.0	—	.0	20.1	7.6	.0	.0
Standard Oil Co. of Indiana	.0	.0	—	3.6	50.0	.0	10.0
Gulf Oil Corp.	.0	28.3	5.5	—	41.5	.0	12.5
Mobil Oil Corp.	24.0	7.6	30.2	28.4	—	.0	12.3
Shell Oil Co.	.0	.0	.0	.0	.0	—	.0
Standard Oil Co. of California	1.2	.0	14.6	14.0	20.3	0.0	—

Source: FTC tabulation based on U.S. Department of the Interior files.

Table C-3.--Average values for variables used in the regression tests

Variable	Pre-ban	Post-ban	All sales
NBIDS	2.9	3.2	3.1
PSV	36,645	18,801	27,275
DR	0.9	.22	.16
SSROY	0.0	.26	.14
HB	120,878	83,450	101,222
DRYR	.52	.74	.64
DIST (miles)	65.3	45.0	54.6
DEPTH (meters)	89.2	58.0	72.8
GAS	.76	.66	.70
TBO	131.4	112.1	121.2
NMAJ	1.4	1.2	1.3
NMIN	1.5	2.0	1.8
No. of observations	349	386	735
No. of sales	3	4	7

* Variables are defined in table E-1.

Table C-4.--Correlation matrix for variables used in the Regression Analysis

	JVB	HB	NBIDS	LINT	PSV	TBO	DR	SSROY	ACRS	NMAJ	NMIN	MAJ	INMAJ	GAS	DRYR	DIST	DEPTH
JVB	1.00	-.13	.06	.91	-.18	-.36	.18	.38	-.02	-.07	.15	-.17	-.28	-.11	.52	-.26	-.17
HB	-.13	1.00	.59	-.06	.32	-.08	.06	-.01	-.03	.58	.45	.20	.20	-.07	-.18	-.08	.00
NBIDS	.06	.59	1.00	.09	.17	-.16	-.05	.07	.10	.81	.90	.13	.04	-.03	.06	-.05	-.08
LINT	.91	-.06	.09	1.00	-.15	-.61	.22	.49	-.04	-.03	.16	-.16	-.26	-.07	.48	-.25	-.15
PSV	-.18	.32	.17	-.15	1.00	-.04	.21	-.07	-.02	.21	.10	.08	.13	-.05	-.40	-.04	-.05
TBO	-.36	-.08	-.16	-.61	-.04	1.00	-.18	-.46	-.02	-.10	-.17	.06	.10	-.12	-.16	-.05	.07
DR	.18	.06	-.05	.22	.21	-.18	1.00	.05	-.28	-.03	-.06	-.01	-.01	-.15	-.30	-.11	-.12
SSROY	.38	-.01	.07	.49	-.07	-.46	.05	1.00	.08	.06	.07	-.06	-.11	-.01	.28	-.08	.02
ACRS	-.02	-.03	.10	-.04	-.02	-.02	-.28	.08	1.00	.03	.13	-.02	.05	.19	.20	.29	.23
NMAJ	-.07	.58	.81	-.03	.21	-.10	-.03	.06	.03	1.00	.47	.48	.15	-.10	-.02	-.08	.03
NMIN	.15	.45	.90	.16	.10	-.17	-.06	.07	.13	.47	1.00	-.16	-.05	.03	.11	-.03	-.16
MAJ	-.17	.20	.13	-.16	.08	.06	-.01	-.06	-.02	.48	-.16	1.00	.27	-.05	-.08	-.02	.07
INMAJ	-.28	.20	.04	-.26	.13	.10	-.01	-.11	.05	.15	-.05	.27	1.00	-.05	-.16	-.001	.04
GAS	-.11	-.07	-.03	-.07	-.05	-.12	-.15	-.01	.19	-.10	.03	-.05	-.05	1.00	.02	.37	-.15
DRYR	.52	-.18	.06	.48	-.40	-.16	-.30	.28	.20	-.02	.11	-.08	-.16	.02	1.00	.21	.13
DIST	-.26	-.08	-.05	-.25	-.04	-.05	-.11	-.08	.29	-.08	-.03	-.02	-.001	.37	.21	1.00	.25
DEPTH	-.17	.002	-.08	-.15	-.05	.07	-.12	.02	.23	.03	-.16	.07	.04	-.15	.13	.25	1.00

Table C-5.--Tests of bid-market-imperfection hypotheses: regression coefficients for majors and JV-related high-bidder variables
[NBIDS included as independent variable]

Sale date	Regression coefficients (t-values in parentheses) MAJ	INMAJ	MAJSOLO	No. of observations
3/28/74	.13 (.7)	-.34 (1.3)	-.07 (.3)	114
5/29/74	-.57 (2.7)	1.1 (3.7)	-.49 (1.7)	119
10/16/74	.21 (1.0)	.17 (.6)	-.32 (1.2)	116
6/23/77	.09 (.4)		.08 (.3)	134
12/19/78	.45 (1.8)		.25 (.8)	77
7/31/79	.17 (.7)		.15 (.5)	85
11/27/79	.31 (1.3)		.45 (1.7)	90

Notes: Dependent variable: value of high bid ($000). The basic regression utilized is:

$$HB = a_0 + a_1PSV + a_2DRYR + a_3DR + a_4DEPTH + a_5DIST + a_6NBIDS + a_7 \text{ (selected ownership dummy)}.$$

Each of the above high-bid owner-dummy variables (MAJ, INMAJ, and MAJSOLO) is entered singly in the equation. Thus, a separate regression is estimated for each of the high-bid owner dummies. The high-bid owner-dummy variables are defined as follows:

MAJ -- 1 if a major participated in winning bid, zero otherwise;
INMAJ -- 1 if an intramajor JV was high bidder, zero otherwise;
MAJSOLO -- 1 if a solo major was high bidder, zero otherwise.

Table C-6.--Regression estimates for market-imperfections tests: all coefficients

Sale date		Dependent variable: HB--value of highest bid offered for a tract									
		Regression coefficients (t-values in parentheses)									
		INTERCEPT	PSV	DRYR	DR	DEPTH	DIST	MAJ	INMAJ	MAJSOLO	R^2
3/28/74											
(a)	1	11.3	.004 (2.7)	-.66 (.8)	-.55 (1.4)	.001 (.3)	-.003 (.9)	.31 (1.1)			.06
(b)	2	11.4	.004 (2.8)	-.57 (.7)	-.44 (1.1)	.001 (.7)	-.003 (1.0)		-.07 (.20)		.05
(c)	3	11.4	.004 (2.8)	-.60 (.7)	-.51 (1.3)	.001 (.7)	-.004 (1.0)			.18 (.52)	.05
5/29/74											
(a)	4	12.5	.002 (.9)	-1.8 (2.3)	-3.1 (2.3)	-.001 (.5)	-.01 (1.7)	.94 (3.8)			.19
(b)	5	12.8	.005 (1.9)	-1.4 (1.8)	-2.5 (1.9)	-.0003 (.2)	-.02 (2.2)		1.5 (4.0)		.20
(c)	6	14.1	.002 (.8)	-2.3 (2.9)	-2.4 (1.7)	-.001 (.6)	-.02 (2.8)			-.61 (1.7)	.11

Table C-6.--Regression estimates for market-imperfections tests: all coefficients--Continued

Dependent variable: HB--value of highest bid offered for a tract

Sale	INTERCEPT	PSV	DRYR	DR	DEPTH	DIST	MAJ	INMAJ	MAJSOLO	R^2
		Regression coefficients (t-values in parentheses)								
10/16/74										
(a) 7	10.4	.007 (2.5)	.59 (.8)	.97 (1.9)	.001 (.8)	-.01 (3.1)	.18 (.7)			.16
(b) 8	10.5	.006 (2.3)	.62 (.9)	.91 (1.8)	.001 (.9)	-.01 (3.3)		.19 (.5)		.15
(c) 9	10.6	.006 (2.1)	.63 (.9)	.87 (1.7)	.002 (1.3)	-.01 (3.2)			-.52 (1.7)	.17
6/23/77										
(a) 10	9.3	.005 (.9)	.70 (.6)	.20 (.4)	-.003 (2.8)	.006 (1.2)	.45 (1.7)			.07
(c) 11	9.1	.005 (1.0)	.95 (.8)	.23 (.5)	-.004 (2.9)	.006 (1.3)			.50 (1.6)	.06
12/19/78										
(a) 12	10.0	.02 (2.8)	-.13 (.1)	-.11 (.2)	.003 (.5)	-.003 (.3)	.37 (1.2)			.09
(c) 13	10.2	.02 (2.8)	-.13 (.1)	-.16 (.4)	.006 (.8)	-.006 (.7)			-.12 (.3)	.08

Table C-6.--Regression estimates for market-imperfections tests: all coefficients--Continued

Sale	INTERCEPT	PSV	DRYR	DR	DEPTH	DIST	MAJ	INMAJ	MAJSOLO	R^2
	Dependent variable: HB--value of highest bid offered for a tract									
	Regression coefficients (t-values in parentheses)									
7/31/79										
(a) 14	10.2	.01 (3.3)	-.19 (.2)	-.28 (.7)	.001 (.8)	.0001 (.03)	.63 (2.0)			.09
(c) 15	10.4	.01 (3.1)	-.30 (.3)	-.28 (.6)	.001 (.5)	.001 (.3)			.55 (1.4)	.06
11/27/79										
(a) 16	10.1	.01 (2.1)	.54 (.5)	-.34 (.9)	.01 (3.1)	-.002 (.5)	.69 (2.6)			.16
(c) 17	10.4	.01 (2.5)	.47 (.4)	-.52 (1.3)	.01 (3.1)	-.004 (.8)			.65 (2.0)	.13

Note: HB and PSV are measured in thousands of dollars.

Table C-7.--Regression estimates of the high-bid model with NBIDS omitted

Dependent variable: LHB-Log of the High Bid ($000)

Variables	Regression coefficients (t-values in parentheses)		
	Full sample		First two ban sales omitted
	(a)	(b)	(c)
Intercept	11.9	12.0	12.3
PSV	.007 (6.1)	.007 (6.1)	.01 (5.6)
DRYR	-.14 (.4)	-.16 (.5)	-.43 (1.2)
DR	-.04 (.3)	-.06 (.4)	-.26 (1.3)
SSROY	.12 (.7)	.13 (.7)	.04 (.2)
DIST	-.002 (1.6)	-.002 (1.2)	-.004 (2.6)
DEPTH	-.001 (1.3)	-.001 (1.5)	.0004 (.6)
TBO	-.01 (3.6)	-.01 (2.1)	-.01 (2.2)
JVB	-.49 (3.4)	-.49 (2.9)	-.19 (.7)
BANSALE2		-.38 (1.1)	
BANSALE3		-.12 (.3)	
BANSALE4		.42 (1.4)	
R^2	.112	.130	.106
F statistic	11.4	9.8	7.6
Degrees of freedom	726	723	515

APPENDIX D

The Presale Tract-Evaluation Program

1. General description of the tract evaluation program

The Geological Survey (GS) division of the Department of Interior estimates the value of each tract before it is offered for sale. This presale value (PSV) is an estimate of a tract's net present value, i.e., the discounted stream of net revenues expected to be derived from the tract's operation. It is exclusive of bonus costs but incorporates the effect of royalty payments (to Interior), calculated as a percent of a tract's gross revenues. Along with the degree of competition exhibited for a tract, the PSV is used to determine the acceptability of industry bids. From 1 to 10 percent of the high bids in a sale are rejected by Interior as being below "fair market value." Such tracts are reoffered at subsequent sales.

The presale tract-evaluation program began in 1968. Through 1973, PSV estimates were generated by a geologic-engineering model based on point estimates of the relevant elements used to calculate tract value.[1] Beginning with the March 1974 sale and continuuing to the present, a Monte Carlo simulation model has been utilized. Under this approach, probability distributions for key elements in the appraisal process (e.g., reservoir thickness, well depth, recovery factors, etc.) are entered into the model, which in turn generates a number of different present-value estimates based on a random sampling of the relevant variables. The published PSV figure is the risk-adjusted mean of the distribution of the present values generated by the Monte Carlo program. It is defined as the expected net present value of a tract, taking into account probability estimates regarding

---

[1] Toward the end of the 1968-73 period, some probabilistic analyses (based on Monte Carlo techniques) were utilized, mainly as a check on the engineering-model estimates. See M. F. Uman et al., "Oil and Gas in Offshore Tracts: Estimates Before and After Drilling," Science, 3 August 1979, pp. 489-90.

the volume and value of reserves as well as the chance that no petroleum at all will be found (termed dry-hole risk).

GS also provides separate estimates of the following risk variables:

1--Dry-hole risk: an index that reflects the probability that no petroleum will be found on the tract. This measure is specified exogenously by GS personnel. It is used to transform the mean of the unrisked present values generated by the Monte Carlo model into the risked mean used as the final PSV estimate.

2--Development risk: the standard deviation of the simulated net present values, conditional on the presence of petroleum. This figure does not directly influence the PSV estimate but rather reflects the spread of the distributions specified for the entered variables. Viewed in this way, the standard-deviation figure can also be considered as an index of the reliability of information available to GS: The less reliable the data utilized by GS, the greater the variance it specifies in the distribution of inputted variables, which leads in turn to a higher variance in the distribution of present-value estimates generated by the Monte Carlo model.

2. Potential data problems involved in the use of presale value estimates:

The PSV estimate is used as a proxy for the industry's evaluation of a tract. An area of concern is potential differences between these two sets of evaluators. Such differences can occur at any one of the four principal stages of the tract valuation process:

a--geological: the analysis of sedimentary rocks, based chiefly on information obtained from drilling.

b--geophysical: analysis of the nature and contour of underground geological structures through nondrilling methods. The principal data source is the seismic survey, where the rate of transmission of shock waves through the earth is measured and recorded by a seismograph.

c--engineering: estimation of hydrocarbon-recovery factors as well as the projection of the costs involved in the exploration and development of a tract for commercial production.

d--economic: projection of prices to be received for the hydrocarbon reserves over the life of the tract and the appropriate discount rate at which to evaluate the anticipated future income receipts in terms of the initial period.

A priori, little can be predicted about the contribution of the engineering and economic elements to valuation differences. On the other hand, some patterns of disagreement between GS and industry, due to geological and geophysical analysis, can be anticipated. In general, the GS's geological analysis should be closest to that of the industry, while significant divergences can be expected in the realm of geophysical analysis. These patterns are due both to the differences in the quality of data available to GS and to its ability to interpret them. The Survey is generally considered to have a superior geological data base, since it has access to all company information obtained by drilling. This information advantage can be expected to offset potential interpretation advantages possessed by industry. In contrast, the Survey's geophysical analysis tends to diverge most from that of industry, due to a less reliable data base and (perhaps more important) less sophisticated evaluation techniques.[1]

The net effect of the above pattern is that the GS valuation estimate should track that of industry most closely for developmental sales, which, by definition, occur in areas where an extensive geological base of information has been acquired through previous drilling activity. In contrast, a much looser correspondence between GS and industry can be expected for

---

[1] A useful discussion of the potential deficiences in the GS evaluation program is presented in GAO, OCS Oil and Gas Development--Improvements Needed in Determining Where to Lease and at What Dollar Value, 30 June 1975, pp. 18-32.

frontier sales, i.e., those held in areas with little or no previous drilling history. Valuation programs in the latter areas tend necessarily to emphasize the more speculative geophysical analysis. For much the same reason, variations in value estimates among companies should also be greatest for the frontier sales.

The gap between GS and industry evaluation is perhaps greatest for those tracts receiving bids from industry for which GS could find no evidence of hydrocarbons at all. For such tracts, no evaluation is made by GS.[1] These tracts were dropped from the sample, since no reasonable proxy value could be determined. Table D-1 lists the number of "no evaluation" tracts for each sale conducted during the 1974-79 perod. As expected, the frequency of such tracts is greater for the frontier sales, where the initial information available to Interior is low. The positive value placed on such tracts by the industry suggests the existence of greater information acquired by the companies and/or their willingness to take a risk that such tracts, while not now indicating productive potential, will prove commercially viable after drilling activity on adjacent tracts generates more promising information.

---

[1] These tracts are distinct from those assigned a negative value by GS. The latter do show signs of hydrocarbons but not enough to provide a positive profit.

Table D-1.--The frequency of tracts for which no Geological Survey evaluation was performed: 1974-79

Sale date	Area	Number of tracts bid on	No-evaluation tracts	
			Number	Percent of total
3/28/74	LA-TX	114	0	0
5/29/74	LA-TX	123	3	2.4
10/16/74	LA-TX	157	38	24.2
4/13/76	AL	81	10	12.3
8/17/76	AT	101	11	10.9
6/23/77	LA-TX	152	18	11.8
12/19/78	LA-TX	88	6	6.8
7/31/79	LA-TX	88	2	2.3
11/27/79	LA-TX	96	5	5.2
12/19/79	AT	73	40	54.8
	Totals:	1073	133	
Pre-ban vs. ban				
	Pre-ban	394	51	12.9
	Ban	679	31	7.3
	Total	1073		
Frontier vs. development				
	Frontier	255	61	23.9
	Development	818	72	11.2

APPENDIX E

Description of Variables Used in the Regression Analysis

Table A-1 lists the variables used in the text's empirical analysis. The code name and a short definition of each variable are given. In addition, the following conventions were applied:

(a) The letter "L" preceding a variable indicates that the natural log was taken of its values. For example: LNBIDS = ln (NBIDS); LHB = ln (HB), etc.

(b) For all regressions in which the effect of the JV ban is estimated, the tract-value variables (HB, GMEAN, PSV) are adjusted for inflation by dividing each observation by the GNP deflator. For example,

$$HB^*_{ijt} = \frac{HB_{ijt}}{PI_t},$$

where PI_t refers to the value of the GNP deflator in the t th year.

(c) i refers to a tract, j to a sale.

(d) The major producers are the seven firms specified in the joint venture ban, with the exception of British Petroleum:

- Exxon
- Mobil
- Gulf
- Texaco
- Shell
- Amoco
- Socal

Table E-1.--List of variables used in the statistical analysis

DEPTH . . . water depth of tract (meters).

DIST . . . . distance of tract from shore (miles).

DR . . . . . drainage-tract dummy. Equals 1 if tract designated drainage, i.e., it is adjacent to previously leased tracts that have been developed; zero otherwise.

DRYR . . . . dry-hole risk: probability that the tract will contain no hydrocarbons. Estimated by Geological Survey.

GAS . . . . gas-prone-tract dummy. Equals 1 if tract's expected yield is predominantly gas, zero otherwise.

HB . . . . . high bid: value of the highest bid offer submitted for a tract.

INT . . . . JV-ban adjustment term. Equals 1 for all pre-ban sales. For ban sales, it is a counter starting with two for the first sale under the ban, three for the second, etc.

JVB . . . . JV-ban dummy. Equals 1 if tract issued in sale conducted under the ban, zero otherwise.

NBIDS . . . number of bids submitted for a tract.

NMAJ . . . . number of major bids: includes all bids in which at least one major producer took part.

NMIN . . . . number of minor bids: number of bids in which no major took part.

PSV . . . . presale value: tract value estimate developed by the Geological Survey prior to the sale.

SSROY . . . sliding-scale-royalty dummy. Equals 1 if tract issued under a sliding-scale-royalty system; zero otherwise.

TBO . . . . number of tracts bid on at a sale.

APPENDIX F

The Utilization of Proxies for Tract Valuation

A tract's "true" valuation is the present value of the net returns from its operation. Since our research focuses on the results of OCS decisionmaking, we are interested in the ex ante concept of tract value viewed from the perspective of the bidders themselves. Expected tract value (termed VAL) is utilized in two slightly different ways. For the determinants of bids-per-tract (NBIDS) model, VAL reflects the expected value of a tract before active exploration takes place. It is a key variable in the decision made by each firm as to whether to enter the auction for a particular tract. In terms of the Gaskins-Teisberg model, a firm decides to initiate an exploratory program on a tract if the expected profits from such action are at least equal to the total evaluation costs.[1]

(1) $$E(\Pi)_i = 1/n\ f(n)\ E(V_i) > C_i,$$

where

$E(\Pi)$--expected profits from entering the auction for ith tract,

n--number of bidders,

1/n--probability of winning the tract,

$f(n)$--rent-capture fraction: $f'(n) < 0$,

$E(V)$--expected value of tract,

C--total evaluation costs, and

i--tract.

In the determinants-of-HB equation, VAL refers to expected tract value at the time of the auction; it thus reflects expectations based on information generated from exploratory activity. For example, in a simple bid-model formulation where

---

[1] D. Gaskins and T. Teisberg, "An Economic Analysis of Presale Exploration in Oil and Gas Lease Sales," in Essays on Industrial Organization in Honor of Joe S. Bain, ed. R. Masson and D. Qualls (Cambridge, Mass.: 1976).

each bidder seeks to determine that bid-offer value (B_0) that maximizes the expected profit function,

$$E(\Pi) = (VAL - B_0)\ P(W),$$

where P(W) refers to the probability that bid B_0 will in fact win the tract.[1]

The Geological Survey presale value (PSV) is used as a tract-value proxy in both of the above formulations. Since PSV is not revealed until after the auction takes place, use of PSV as a VAL proxy implicitly assumes that the same process used to generate PSV also produces the individual valuation estimates for individual bidders. In probabilistic terms, we posit that the Geological Survey and the set of bidders select VAL randomly from the same distribution.[2] This assumption is a functionally useful one that is utilized in most bid models and is implicit in bid-activity research efforts. It is not possible to directly test its validity, since the VAL estimate of individual bidders is not revealed. The available circumstantial evidence is supportive, however. It indicates that although PSV is biased downwards, it does bear a positive and significant relationship to VAL.

(a) PSV is biased downward. The PSV variable is generally considered to be intentionally biased downward.[3] This is indicated in the comparison of PSV to HB and GMEAN for the DEVELOP sample, shown in table F-1. On a tract-by-tract comparison, the PSV measure was lower than HB in 82 percent of the cases and lower than GMEAN in 75 percent of the cases. Also indicative of downward bias is the number of tracts receiving bids for which the GS estimated value was below the minimum bid

---

[1] Keith Brown, Bidding for Offshore Oil: Toward an Optimal Strategy (Dallas: 1969).

[2] Brown, op. cit., p. 44.

[3] A. Smiley, Competitive Bidding Under Uncertainty (Cambridge, Mass.: 1979), p. 16.

Table F-1.--Comparison of presale estimate to high bid and average bid: development sample, 1974-79

Sale	Total number of tracts	Cases where PSV lower than:			
		High bid		Average bid	
		No.	% of total	No.	% of total
3/28/74	112	79	70.5	68	60.7
5/29/74	122	100	82.0	90	73.8
10/16/74	146	130	89.0	123	84.2
6/23/77	152	119	78.3	107	70.4
12/19/78	85	75	88.2	69	81.2
7/31/79	87	74	85.1	61	70.1
11/27/79	95	86	90.5	81	85.3
All tracts	799	661	82.7	599	75.0

Note: Tracts not evaluated by Interior (NOEVAL) are included; they are counted as cases where the PSV is lower than high-bid/ average-bid.

level ($25 per acre). For the sample as a whole, approximately 40 percent of the tracts receiving bids exhibited a PSV value less than $25 per acre.

(b) PSV does bear a direct relationship to VAL. The result of individual-bidder decisionmaking is the bid offer submitted for a tract. One index of valuation estimates is thus the geometric mean of all bids submitted for a tract (GMEAN). The relation between PSV and GMEAN is relatively low but is positive and significant for all sales in the DEVELOP sample. The simple correlation coefficient between PSV and GMEAN ranges from .18 to .45 (table F-2).

Table F-2.--Correlation between average bid value and the Geological Survey presale estimate

	Development-sale sample, 1974-79	
Sale date	Number of observations	Simple correlation coefficient: GM - PSV[1]
3/28/74	112	.31**
5/29/74	119	.18*
10/16/74	113	.33**
6/23/77	134	.25**
12/19/78	79	.45**
7/31/79	85	.41**
11/27/79	90	.35**
Totals	732	.37**

[1] GM--Geometric mean of all bids values submitted for a tract

PSV--Geological Survey presale value estimate for tract

Significance levels:

* 5 percent

** 1 percent

APPENDIX G

The Definition of "Major" Under the Intramajor JV Ban

The Interior Department's formulation of the JV ban placed exclusive emphasis on minimizing the rule's cost, defined in terms of the possibility that the ban would include firms that required large-company joint ventures for efficient operation. In particular, the Department's formula for the definition of "major" focused on the risk-absorption abilities of producers in a situation where joint ventures would be eliminated entirely. As a result, the ban was aimed at that group of producers deemed capable of participating in OCS lease sales without the need to combine with companies of similar or larger size. Producers with an international petroleum production level greater than 1.6 million barrels per day were deemed to be within this class. Such a production level was actually considered consistent with a scope of exploration and production activity sufficient for a producer to diversify efficiently without resorting to joint ventures at all.

The 1.6-million-barrels-per-day threshold was determined in the following manner:[1] The principal risk facing an OCS operator is assumed to be the variance of its rate of return from petroleum operations. Within this framework, it can be shown that 80 percent of a producer's risk is eliminated if it maintains a portfolio of 25 independent exploration prospects (i.e., the expectation of success on each prospect is uncorrelated with that of the others), where the cost and individual risk of each is assumed equal. Since additional prospects beyond the first 25 contribute relatively little to risk reduction,[2] this magnitude

---

[1] The mechanics of the JV ban formula are provided in the U.S. Department of the Interior working paper, "An Analysis of the Proposed Ban on Joint Bidding" (Office of OCS Program Coordination, June 1975), appendix I.

[2] For example, a percentage reduction in profit rate variance of 10 points is achieved by increasing the number of prospects from 15 to 25, but a further reduction of 10 percentage points would require a doubling of prospects, from 25 to 50. Ibid., table 1, p. 6.

of operation is considered "efficient" for a producer desiring to balance the benefits of risk reduction against the increased transactions costs entailed in joint venture operations. The size of an independent prospect was assumed to be 23.7 million barrels, the reserve total for a relatively large Gulf of Mexico tract. A producer developing 25 such prospects in a year would exhibit a production level of 1.6 million barrels per day, the size cutoff for the JV ban.

Petroleum production is defined by Interior as the sum of a producer's international output of crude oil, natural gas, and natural-gas liquids. Under the 1.6-million-barrels-per-day criterion, eight producers originally qualifed as majors under the JV ban. The largest major is Texaco, with 4.7 million barrels per day, while the smallest is Standard Oil of Indiana, with 1.6 million barrels per day.[1] Beyond this level there is a sharp drop to the next largest producer, Atlantic Richfield, whose production level is approximately 0.8 million barrels per day (see table G-1).

The Interior formula for determining producers subject to the JV ban is a simple pragmatic approach to what in reality is a highly complicated issue. As a result, a number of elements in the joint venture decision process are either not considered or are treated in an incomplete manner. Not incorporated in the analysis are the utilization of joint ventures to exploit scale economies nor the risk-reducing effects of petroleum-company diversification levels. Also, the Interior formula did not consider the ability of a producer to combine with smaller companies, an alternative allowed under the current ban. Finally, the assumed size of an independent prospect may be understated. The nature of each of these factors and their probable effect on the definition of a major producer are considered below.

---

[1] Public sources indicate that Standard Oil of Indiana's production level is slightly below the 1.6-million-barrels-per-day cutoff. Since the company has always considered itself as under the JV ban, the public production-level data may be somewhat understated.

Table G-1.--Twenty largest worldwide producers of crude oil, natural-gas liquids, and natural gas: 1976

Rank	Producer	Total net petroleum production, 1976 (barrels per day)
1	Texaco, Inc.	4,682,837[1]
2	Exxon Corp.	4,580,974[2]
3	Standard Oil Co. of Calif.	3,716,671
4	British Petroleum Co.	3,602,211
5	Royal Dutch Shell Group	3,479,569
6	Mobil Oil Corp.	2,663,537[3]
7	Gulf Oil Corp.	2,146,059
8	Standard Oil Co. (Ind.)	1,501,476
9	Atlantic Richfield Co.	808,534
10	Continental Oil Co.	742,473
11	Getty Oil Co.	594,152[4]
12	Union Oil Co. of Calif.	586,247
13	Phillips Petroleum Co.	564,073[5]
14	Sun Oil Co.	487,519
15	Marathon Oil Co.	473,231
16	Cities Service Co.	390,897
17	Tenneco, Inc.	296,608
18	Amerada-Hess Corp.	274,513
19	Occidental Petroleum Corp.	167,710
20	Kerr-McGee Corp.	81,165[4]

Note: Natural-gas liquids converted to barrels of oil per day using the following equivalency factor:

1 bbl. oil = 1.454 bbls. of natural-gas liquids; natural gas converted to barrels of oil per day using equivalency factor:
1 bbl. oil = 5.626 cubic feet of natural gas.

[1] Figures for crude oil are gross, including interest in subsidiary companies.

[2] Figures for crude oil are gross.

[3] Figures for natural-gas production are gross.

[4] Figures used are 1975 gas-production figures--1976 figures are not available.

[5] Foreign gas production not available for either 1975 or 1976.

Sources: Natural Petroleum News, Fact Book Issue, mid-May 1977, pp. 22-23; Moody's Industrial Manuals, 1976 and 1977; Moody's Public Utility Manual, 1977; and John Herold, Inc., Oil Industry Comparative Appraisals, various dates.

(a) Scale economies. The Interior formula focused exclusively on the role of joint ventures as a device for reducing the variability of a producer's earnings stream by allowing him to engage in a larger number of independent prospects. Not considered is the role of joint ventures as a means of exploiting scale economies in exploration and development. This element becomes most important in frontier areas, where the number of tracts issued is low relative to the initial expenditures required for exploration programs. Producers in such areas often participate in joint ventures, because their expected tract purchases do not justify a solo exploration effort at an efficient scale of operation. Since the nature and extent of scale economies will vary in different areas, the worldwide production figure used by Interior is not directly relevant to this aspect of the joint venture process.

(b) Interior's formula does not take into account the role of a producer's activities outside of petroleum production on its assessment of a prospect's risk. For a diversified firm, the riskiness of a prospect is its impact on the variability of the company's overall income stream, including revenues generated from nonexploration activities. If such activities are not perfectly correlated with the exploration prospect under consideration, they serve to lower the prospect's risk component. Hence, the rate of diversification becomes an important element in assessing a producer's ability to operate without joint ventures. The greater the degree of diversified operations, the better a producer's ability to absorb the risk of exploration operations without the need for joint ventures.

(c) As a simplifying device, the Interior formula focused only on the ability of a producer to operate without joint ventures at all. Thus, the Interior cutoff level is relevant for a complete joint venture prohibition, not the milder restriction actually put into effect that allows the majors to combine with smaller companies.

(d) The assumed size of an independent exploration prospect utilized in the Interior calculations may be too small. The size of an independent prospect was considered to be 23.7 million barrels of reserves, the size level of a relatively large OCS tract in the Gulf Coast area. It would appear, however, that the probability of success on such a tract is not independent of other tracts in the same area. Often the expected returns from a number of tracts in an OCS lease sale will be highly correlated with each other if they are part of the same geological structure.[1] In terms of Interior's formula, an upward adjustment in the average prospect size results in a higher threshold size level for the major group and thus a smaller list of producers affected by the ban.

The above factors impart both negative and positive biases on the scope of the joint venture ban devised by Interior. Holding other factors constant, inclusion of the scale-economy factor and incorporation of a larger prospect size tends to reduce the number of majors subject to the ban. On the other hand, the portfolio effects of diversified operations plus the ability of the majors to combine with smaller producers created a conservative bias.

---

[1] A case in point is the 1973 MAFLA sale. Thirty-four tracts were located within one structure--the Destine anticline. So far, none of the 85 tracts leased at the sale have proved commercial. "Mafla hopes still alive despite more dry tests," Oil and Gas Journal, 27 February 1978, pp. 57-58.

Table G-2.--Size rankings of large petroleum producers

Producer	Size rankings			
	International oil production, 1976 (barrels per day)	U.S. petroleum production, 1976 (barrels per day)	Asset size, 1976	Bonus value of OCS acquisitions, 1970-74
Texaco, Inc.	1	3	3	3
Exxon Corp.	2	1	2	2
Standard Oil Co. of Calif.	3	8	6	5
British Petroleum Co.	4	*	5	*
Royal Dutch Shell	5	2	1	7
Mobil Oil Corp.	6	5	4	1
Gulf Oil Corp.	7	6	7	4
Standard Oil Co. (Ind.)	8	4	8	6
Atlantic Richfield Co.	9	7	9	11
Continental Oil Co.	10	14	11	17
Getty Oil Co.	11	9	16	9
Union Oil Co. of Calif.	12	10	14	12
Phillips Petroleum Co.	13	11	12	**
Sun Oil Co.	14	12	13	8
Marathon Oil Co.	15	16	18	19
Cities Service Co.	16	13	17	14
Tenneco, Inc.	17	15	10	10
Amerada-Hess Corp.	18	17	19	**
Occidental Petroleum Corp.	19	**	15	20
Kerr-McGee Corp.	20	18	**	**

* Company had no participation in indicated category.

**Below top 20 of its category; therefore, not ranked.

Source: Bureau of Economics tabulations based on U.S. Department of the Interior files.