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FEDERAL ONSHORE OIL AND GAS LEASE BONUS BIDS, 1972-1977: STATISTICAL STUDIES

By John Lohrenz and John A. Pederson

ABSTRACT

We studied the statistical behavior of Federal onshore oil and gas lease bonus bids. Like offshore bids, these bids exhibited (a) occasional occurrences of low, noise bids, (b) apparent lognormality, (c) standard deviations (using natural logarithms) close to one, (d) apparent disparities between money left on the table given random lognormal bids consistent with flinching, and (e) wide ranges of aggressive and conservative biases of bidders in individual sales. In fact, the only substantive difference found was a far lesser proportion of joint bidding and larger company bidders bidding for these onshore leases which tended to receive lower bids than offshore bids.

INTRODUCTION

Bonus bidding for Federal offshore oil and gas leases has received major attention in the public and technical press. No doubt, the reason is the large sums of money that are involved. Meanwhile, many Federal onshore oil and gas leases have been offered and received bids with far less attention. Bids for these onshore leases tended to be substantially lower than those for offshore leases. The thrust of these studies was to examine the statistical behavior of Federal onshore oil and gas lease bonus bids and compare this with what is known for comparable offshore bids.

The Federal onshore oil and gas lease bonus bid data used in these studies are described in the first section, THE DATA BASE USED. Some few bids appeared to be so low compared to competing bids that one would consider them not part of the "normal" bids. These are called low, noise bids and considered in the next section, THE OCCURRENCE OF LOW, NOISE BIDS. THE STATISTICAL DISTRIBUTIONS OF BIDS section justifies considering the bids as lognormally distributed. The parameters of that distribution applied to bids are examined in the section, POOLED STANDARD DEVIATIONS OF BIDS AND HOMOGENEITY OF VARIANCES. The next two sections, THE HIGHEST BID COMPARED TO THE MEAN OF BIDS FOR LEASES AND MONEY LEFT ON THE TABLE, show how the bids adhere to and depart from mathematical expectations given random lognormal bidding. The section, THE TYPE OF BIDDER AND BID, examines the differences between larger and smaller company bidders and solo and joint bids. Finally, THE BIAS OF BIDDERS section shows that bidders have been both aggressively and conservatively biased in their bidding compared to competing bidders, but that outcomes do not depart from overall expectations to these biased bidders.

THE DATA BASE USED

The data base used for these studies was the LPR-18 data base (Peterson, et al, 1976) for Federal onshore oil and gas lease bidding data updated through calendar year 1977. The data base contained data for 2,237 leases believed to comprise all Federal onshore oil and gas leases offered by sealed bid bonus bidding in sales from August 15, 1972 through December 31, 1977, in the 13 states of Arkansas, Colorado, Kansas, Louisiana, Montana, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, Texas, Utah, and Wyoming.

Three hundred and fifty-six of the 2,237 leases received no bids or were administratively deleted from the offering; 1,881 of the leases received one or more bids. The bids received on these 1,881 leases comprised the data used in these studies.

Table 1 summarizes the bids aggregated by year of the sale and shows a not unexpected trend of highest bids per acre increasing with time. Table 2 presents the bid summaries aggregated according to the state in which the leases were located. Two states were preponderant in the data out of the 13 states involved. These were New Mexico and Wyoming with 57 percent of the leases, 56 percent of the acreage, and 45 percent of the highest bids offered of the total aggregated for all 1,881 leases. The total number of bids received for these 1,881 leases was 5,409 or an "average" of 2.88 per lease. Bonuses offered by highest bidders for these leases accumulated to $33½ million equivalent to an "average" bonus of $72/acre.

Any and all bids for 51 leases receiving bids were rejected. (The rejection frequency was 2.7 percent of leases, 2.1 percent of acreage, and 1.3 percent of the sum of the highest bids offered.) Appendix A gives a breakdown of the 1,830 leases which were issued by sale data; Appendix B gives the same summary for the 51 leases receiving bids, but not issued. In the aggregate, the

Table 1

Summary of Bidding by Calendar Year of Sale

Year	Number of Bonus Bid Leases Receiving Bids	Sum of Acres	Number of Bids	Number of Bids / Number of Leases	Sum of Highest Bids (Millions $)	Sum of Highest Bids / Sum of Acres ($/Acre)
1972*	125	36,165	270	2.16	.766	21.18
1973	294	71,400	928	3.16	2.556	35.79
1974	395	94,635	1030	2.61	6.194	65.45
1975	365	93,800	1026	2.81	6.541	69.73
1976	366	81,804	977	2.67	4.290	52.44
1977	336	85,441	1178	3.51	13.074	153.03
Total	1881	463,245	5409	2.88	33.421	72.15

*8/15 - 12/31

Table 2

Summary of Bidding by the State of the Leases

State	Number of Bonus Bid Leases Receiving Bids	Sum of Acres	Number of Bids	Number of Bids / Number of Leases	Sum of Highest Bids (Millions $)	Sum of Highest Bids / Sum of Acres ($/Acres)
Arkansas	36	12.892	141	3.92	1.314	101.94
Colorado	200	62,485	458	2.29	1.671	26.75
Kansas	20	2,964	38	1.90	.038	12.98
Louisiana	21	3,834	42	2.00	.703	183.42
Montana	138	27,263	287	2.08	.678	24.88
Nebraska	23	13,763	91	3.96	2.395	174.05
New Mexico	390	120,412	1575	4.04	7.900	65.60
North Dakota	40	6,946	116	2.90	2.938	423.04
Oklahoma	159	15,341	440	2.77	6.702	436.90
South Dakota	6	437	10	1.67	.015	33.50
Texas	2	930	4	2.00	.034	36.55
Utah	162	56,933	430	2.65	1.949	34.23
Wyoming	684	139,045	1777	2.60	7.084	50.94
Total	1881	463,245	5409	2.88	33.421	72.15

"average" highest bid per acre on issued leases was $77 per acre, higher than $44 per acre for the leases for which any and all bids were rejected. Individual sales departed from this trend seen in the aggregate, however. In six different sales, the "average" highest bid per acre for any rejected lease(s) was higher than the value for any issued lease(s).

Seven hundred and four different names of bidders were recorded for the 5,409 bids submitted. (One should note that these names reflect only the name used submitting the bid and not any interest for which the bidder might be acting as agent.) In some cases, the bidders simply used different endings such as "Inc.", "Ltd.", "Co.", or "Corp". One bidder used both Jess and Jesse as the first name. Also, some bidders bid sometimes as, say, Smith Oil, other times as Smith, John. Where it appeared quite obvious that the bidder name on the list of 704 names was really the same bidder as another name on the list, we combined the names and the bids thereby paring the list down to 677 bidder names. There are, however, cases where the names were different for the same bidder, but not obviously so. (As a matter of fact, there may be some few cases where what was thought to be obviously the same bidder using different names was, in fact, two bidders.) Examples might be where John Smith bids and James Smith bids, James being the offspring of John who is bidding in James' interest as a minor. Thus, the list of 677 bidder names must be viewed as a flawed list of unique, different bidders actually bidding with, no doubt, errors both in unique bidders improperly combined and the same bidder, from any pragmatic point of view, showing up as two or more bidders. Probably, more errors are of the latter type than of the former type which would mean that the more correct list of bidder names would contain less than 677 entries. As far as is known, the source data necessary to make an absolutely correct and verified list are absolutely non-existent. One could pursue making the

list more correct by reviewing records and contacting bidders, but that effort was rejected because (1) the magnitude of the effort would be huge compared to the benefit felt accruing to the results of these studies, and (2) the result would, at best, still be an imperfect list of bidder names to which the same disclaimer now stated would apply.

Therefore, these studies treated the statistical properties of the 5,409 bids as submitted by the 677 different bidders for the 1,881 leases.

THE OCCURRENCE OF LOW, NOISE BIDS

Low, noise bids are defined as bids so low compared to other bids for the same lease that these low bids should not be considered part of the "regular' population of bids. Such bids might arise for any of a variety of hypothetical reasons. For statistical studies, the reasons are not at issue. What is at issue is that these bids do not appear to behave, statistically, like other bids and including these low, noise in the population of other bids would be statistically incorrect. If the occurrence of low, noise bids is very infrequent in the population of "regular" bids, the effect on the statistical results should be unnoticeable. However, Dougherty and Lohrenz(1976) found low, noise bids in certain Federal offshore oil and gas lease sales introduced severe distortions to the statistical results. They devised an algorithm to define low, noise bids which, after deletion, appeared to allow results without distortions due to low, noise bids.

Just as with the Federal offshore oil and gas lease sales, low, noise bids did not occur or occurred very infrequently in onshore sales as shown in Appendix C. Using exactly the same low, noise bid algorithm, 30 of the 5,409 (0.55 percent) of the bids were defined as low, noise bids. About two-thirds of these 30 low, noise bids occurred in 3 sales. These were the July 27, 1976, Oklahoma sale where 10 percent of all bids were low, noise; the March 9, 1977,

Oklahoma sale where 5 percent were; and the August 9, 1977, Oklahoma sale where 12 percent of all bids were low noise bids. Appendix C details the occurrence of low, noise bids by sale and the bidder.) Twenty-one of the 30 low, noise bidders were submitted by one bidder, who was also identified as the most frequent contributor of low, noise bids for Federal offshore oil and gas bids in the study by Dougherty and Lohrenz(1976). The 30 low, noise bids were deleted from the population of bids used for all statistical studies that followed.

THE STATISTICAL DISTRIBUTION OF THE BIDS

Bonus bids for Federal offshore oil and gas leases have been treated as lognormally distributed(Arps, 1965; Brown, 1969; Crawford, 1970; Dougherty and Lohrenz, 1977). This was supported by (1) the position that bonus bids are computed as a multiplicative process which according to the central limit theorem should yield a lognormally distributed variable and (2) the hypothesis that actual bids were lognormally distributed could not be rejected using a statistical test(Brown, 1969).

Using the same statistical test (Beyer, 1968), we examined these Federal onshore oil and gas bonus bid data. Using a criterion where lognormality would not be rejected if 20 percent of the leases failed the test, we rejected less than 1 percent of leases receiving 3 or more bids.

It should be noted, however, that the fact that these bids passed the statistical test is not strong evidence that the bids are lognormally distributed. We cite two reasons. Firstly, the test used was the Kolmogorov-Smirnov one-sample procedure which, strictly, considers how sample data compares to a distribution hypothesized without considering the data. We "bent" that procedure by determining the statistical mean of the distribution used in the test from the bid data. (On the other hand, we compensate, at least somewhat, by using

a test criterion far more intense than the failure rate we obtained.) Secondly, the Kolmogorov-Smirnov procedure is not a very rigid test of adherence of data to the distribution being tested. This is evident on Figure 1 which shows lognormal probability plots for the two leases receiving the highest numbers of bonus bids in these data--25 bids for parcel no. 13 and 21 bids for parcel no. 9 in the March 20, 1973, New Mexico sale. Exactly lognormally distributed bids would yield an exactly straight line for each lease on graphs like Figure 1 which displays, however, significant deviations from the straight line shown. Yet these deviations are not large enough to fail under the Kolmogorov-Smirnov procedure at the 20 percent criterion.

(Figure 1 shows that the bids for both leases were lower for the highest and higher bids than the "best" straight line through the distribution of the bids. We shall return to that observation in subsequent sections.)

Just as has been done for Federal offshore oil and gas lease bonus bids which display similar "soft" evidence in bid data favoring lognormal distributions of bids on leases, we decided to treat these onshore oil and gas lease bonus bids as lognormally distributed. We gained, thereby, the pragmatic advantage of being able to consider the logarithms of bids as lognormally distributed so that all of the statistical tests applicable to normally distributed variables may be used. The effective statistical mean is then the arithmetic mean of the logarithms of bids for a lease:

$$\overline{\ln b} = \frac{\ln b_1 + \ln b_2 + .. + \ln b_i + .. + \ln b_{n-1} + \ln b_n}{n} \quad (1)$$

The right side of Eq. (1) may be exponentiated yielding:

$$\overline{b} = \sqrt[n]{b_1 b_2 \cdots b_i \cdots b_{n-1} b_n} \quad (2)$$

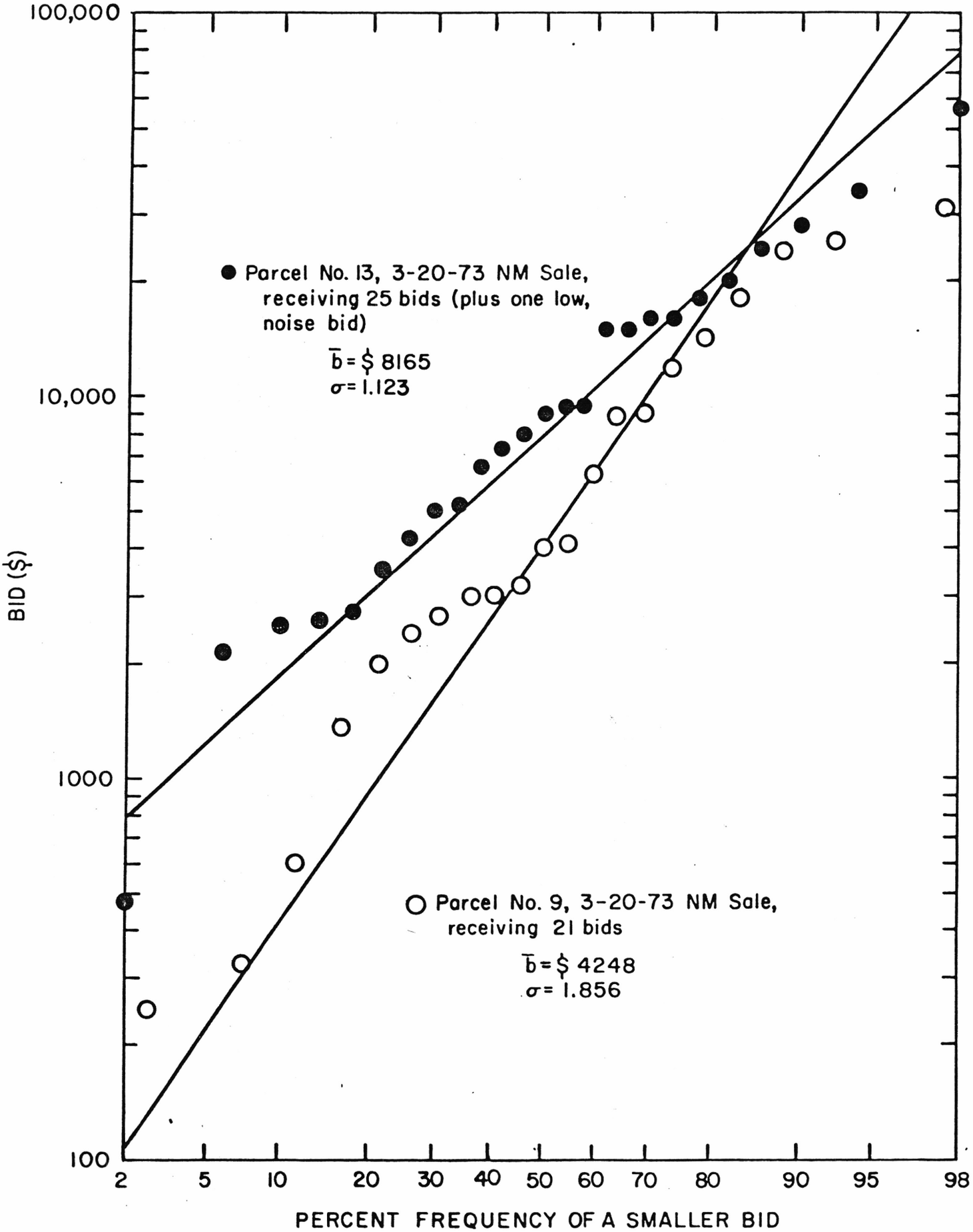

Figure 1 Lognormal Probability Graphs for Bids on Two Leases

where $\bar{b}$ is the geometric mean of all n bids for a lease, i.e. that value on graphs like Figure 1 such that 50 percent of bids are higher and 50 percent are lower.

Bids could, of course, adhere closely to the mean or deviate widely, a property which is measured for normal distributions by the variance or the standard deviation. The variance is computed taking the logarithms of the bids as normally distributed as follows:

$$\sigma^2 = \frac{\sum_{1}^{n} (\ln (b_i/\bar{b}))^2}{n - 1} \tag{3}$$

where σ^2 is the variance (based on natural logarithms) of bids for a lease (σ is the standard deviation). The n-1 term in the denominator of Eq. (3) arises because one degree of freedom was used in computing $\bar{b}$ from bids. The larger the value of σ for bids on a lease and the more steeply the straight line slopes on graphs such as Figure 1, the more highly dispersed the bids for a lease are around the mean $\bar{b}$.

Figure 1 shows the two leases considered displayed different slopes and different values of σ. But, could these different values of σ simply arise due to statistical chance from a distribution with the same underlying standard deviation? Suppose one calculated a variance of the pooled bids across a sample population of leases of size N as follows:

$$\sigma_S^2 = \frac{\sum_{N}^{n} \sum_{1} (\ell n (b_i/\bar{b}))^2}{\sum_{N}^{n} n - N} \tag{4}$$

Can one reasonably consider this pooled variance, σ_S^2, (σ_S is the pooled standard deviation) the source of the variances, σ^2, of the individual leases which may differ from σ_S^2? These are all questions of homogeneity or heterogeneity of variances. Variances may be said to be homogenous if values of

σ^2 for individual leases may be said to arise from an underlying distribution with variance σ_S^2; hetergeneous if not. These questions are addressed in the next section.

POOLED STANDARD DEVIATIONS OF BIDS AND HOMOGENEITY OF VARIANCES

A standard deviation or a variance of bids is a measure of how widely dispersed bids are around their mean, i.e., how much bidders disagreed among each other in their bidding. Certainly, a measurement of this dispersion is relevant in the study of bids. But, even more important, it would be interesting to examine if and, if so, when the dispersion among bidders' bids changed, for example, with time, place, bidders involved, etc. This is why the pooled standard deviations (or variances) computed for an aggregation of bids on leases and the assessment of homogeneity of variances is important. The pooled standard deviation measures the disperson around their mean of an aggregate of bids on leases, but the assessment of homogeneity of variances determines whether this standard deviation is actually applicable across those leases.

Pooled standard deviations for individual sales are shown in Appendix D. The pooled standard deviation for the aggregate of all 1,250 leases receiving 2 or more bids was 1.156. This pooled standard deviation compares quite closely with a value of 1.037 found (Dougherty and Lohrenz, 1976) for a large population of Federal offshore oil and gas lease bonus bids.

But are variances homogeneous such that the pooled standard deviation for the aggregate of all 1,250 leases has meaning? We examined that question using the Bartlett test of homogeneity of variances (Snedecor and Cochran, 1967). The test is applicable without special corrections only when n=6 or more. We aggregated the 219 leases which received 6 or more bids and obtained a test statistic of 201.9. A test statistic that large would be obtained 78 percent of the time if variances were homogeneous. Therefore, we concluded we had good

evidence that variances were homogeneous, at least, on leases receiving 6 or more bids. We aggregated all 1,250 leases receiving 2 or more bids and attempted to use the tabulated special corrections (Pearson and Hartley, 1954) needed when including leases with 2 to 5 bids per lease in the aggregate. Unfortunately, the table does not extend to statistical parameter ranges needed to complete the test. As shown on Table 3, the numbers of leases in the aggregate which received 2 to 5 bids per lease is by far the largest proportion to the extent that one is unable to obtain any reasonable answer using the test with the correction tables. Table 3 does show, however, that pooled standard deviations of bids on leases aggregated by numbers of bids received per lease exhibit no apparent trend for leases with 2 to 5 bids per lease departing from that for leases with 6 or more bids.

Thus, the statistical case favoring the existence of homogeneity of variances rests on (a) a statistical test indicating variances appear to be homogeneous on leases receiving 6 or more bids, and (b) evidence that variances on leases receiving less than 6 bids do not depart from the variances found on leases receiving 6 or more bids. That is not a solid case that homogeneity of variance exists for all the bids on these leases such that the pooled standard deviation of 1.156 may be considered applicable to all sales and leases. On the other hand, it is evidence that the disagreement among bidders in their bids as evidenced by the statistical dispersion in their bids has been quite similar throughout all the sales and leases in the data used.

THE HIGHEST BID COMPARED TO THE MEAN OF BIDS FOR A LEASE

Suppose we randomly choose 5 entrants in a dash and observed the times of all the runners. Then, suppose we randomly choose, from the same group of people, 100 entrants and observed the times of the 100 runners. Now, while one could expect the mean of the times for both races with 5 and 100 entrants

Table 3

Pooled Standard Deviations of Bids
on Leases Aggregated by Number
of Bids per Lease Received

No. of Bids per Lease	No. of Leases	Pooled Standard Deviation σ_S^2
1	631	--
2	454	1.012
3	287	1.150
4	187	1.229
5	103	1.249
6	80	1.003
7	54	1.119
8	31	1.050
9	21	1.178
10	12	1.245
>10	21	1.062
All	1881	1.156

to be the same, one would also expect the winner of the race with 100 entrants to be faster than the winner of the race with 5 entrants. That is not, of course, a physical law, but a good statistical expectation.

From exactly the same logic, one would expect, statistically, that when there are more bidders for a lease, the highest bid will have to be even higher compared to the mean of bids in order to be highest. Table 4 summarizes the highest bids and geometric means of bids for leases aggregated by numbers of bids per lease so this expectation can be observed. Note the tendency for an increasing ratio of the sum of highest bids to the sum of geometric means of bids as the number of bids per lease increases--although the increase appeared to level off at the higher number of bids per lease.

Dougherty, Conner, and Lohrenz (1977) have quantified what the statistical expectation between the highest bid ,b_{max}, and the mean of bids ,$\bar{b}$, is if all bidders can be considered to be bidding from the same lognormal distribution. The curve on Figure 2 shows the relationship. When n=2, all degrees of freedom are used up in computing $\bar{b}$ and σ such that the statistical expectation is constrained to $\sqrt{2}/2$ for all leases. Figure 2 shows not only that, but how much the ratio of the highest bid to the mean of bid can be expected to increase given bidding from the same lognormal distribution.

How do the data compare with the curve? Figure 2 shows that the data compared very well with the predicted statistical expectation at lower values of numbers of bids per lease, but consistently appeared to trend lower at higher values. In other words, as the numbers of bids per lease increased, the radios of the highest bid to the mean of bids tended to be lower than predicted given bidding from the same lognormal distribution. Note that this is consistent with the observation from Figure 1 that there appears to be frequent fall off on the low side from the lognormal distribution for the higher and highest bids. In

Table 4

Summary of Bids by Number of Bids Received per Lease

No. of Bids per Lease	No. of Leases	Acres in the Leases	Sum of Highest Bids (Millions $)	Sum of Geometric Means of Bids (Millions $)	Ratios: Sum of Highest Bids to Acres ($/Acre)	Ratios: Sum of Geometric Means of Bids to Acres ($/Acre)	Ratios: Sum of Highest Bids to Sum of Geometric Means of Bids ($/$)	Sum of Money Left on the Table (Millions $)	Ratio of Sum of Money Left on the Table to Sum of Highest Bids ($/$)
1	631	144,943	4.329	4.329	29.9	29.9	1.00	4.329	1.000
2	454	100,294	3.437	1.920	34.3	19.1	1.79	2.167	.630
3	287	76,898	3.249	1.115	42.3	15.1	2.91	2.032	.626
4	187	54,737	5.618	1.327	102.6	24.2	4.23	3.246	.578
5	103	26,121	3.198	.691	122.4	26.4	4.63	1.742	.545
6	80	22,156	2.608	.573	117.7	25.9	4.55	1.082	.415
7	54	16,667	2.085	.491	125.1	29.5	4.25	.887	.425
8	31	8,147	5.424	2.226	665.8	273.2	2.44	.838	.155
9	21	5,122	1.049	.293	204.7	35.9	3.58	.355	.339
10	12	4,104	.638	.113	154.4	27.4	5.63	.188	.297
≥10	21	4,056	1.786	.388	440.6	95.6	4.61	.453	.254
All	1881	463,245	33.422	13.466	72.1	29.1	2.48	17.319	.518

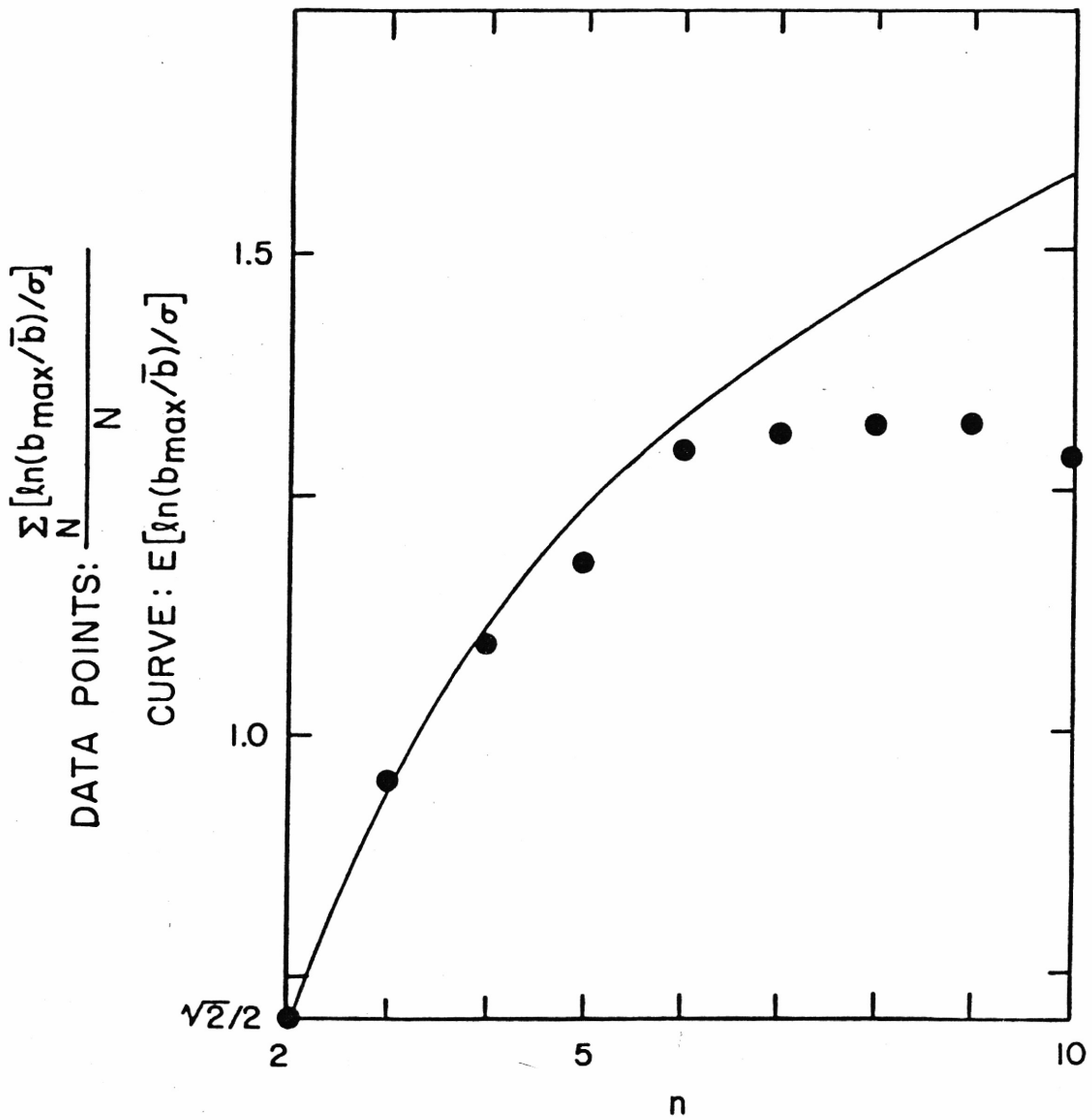

Figure 2

Predicted and Actual Expected Ratios of the Highest Bid to the Mean of Bids for a Lease

the next section, we shall consider these observations further.

MONEY LEFT ON THE TABLE

The term, "money left on the table", was, presumably, coined by some highest bidder referring to the difference between the highest bid and the next highest bid, i.e., the amount of money the highest bidder paid beyond which would have had to be paid to be highest--if the next highest bid were known. Table 4 summarizes the money left on the table and the bids of this study and shows that 52 percent of the sum of highest bids was money left on the table. This percentage of money left on the table compares closely with that found for Federal offshore oil and gas lease bonus bids (Dougherty and Lohrenz, 1977) and geothermal lease bonus bids (Oden, MacGillvary, and Lohrenz, 1978).

The fraction of money left on the table as normally used deals with the highest ranking bid of n bids, b^1, and the next to highest ranking bid of n bids, b^2. Here we use a superscript on a bid value to indicate the bid's rank, r. Thus, the fraction of money left on the table between bids of rank 1 and 2 is:

$$f_{LOT}^{1-2} = \frac{b^1 - b^2}{b^1} \tag{5}$$

Although we no longer deal with "real" money left on the table when considering bids of ranks other than 1 and 2, Eq. (5) can be written in a general form applicable to any pair of adjacent ranks of bids as follows:

$$f_{LOT}^{r-(r+1)} = \frac{b^r - b^{r+1}}{b^r} \tag{6}$$

Dougherty and Lohrenz (1977) have quantified statistical expectation of $f_{LOT}^{r-(r+1)}$ as a function of n assuming all bidders are bidding from the same lognormal distribution. Curves of this function for values of r from 1 through 5 are shown on Figure 3. When n=2, the statistical expected value involving f_{LOT}^{1-2} is constrained to a fixed value, $2\sqrt{2}$, for the same reason as

for $b_{max}/\bar{b}$.

The actual data are compared with the curves on Figure 3. A departure of the actual data from the predicted curves is observed which is consistent with the previous observations regarding Figure 1 and Figure 2. Less money is left on the table than would be predicted if bidders bid from the same lognormal distribution at higher values of n. The departure appeared to decrease as the less higher ranking bids were considered. For example, the agreement between actual data and the curves is excellent on Figure 3 for r=4 and 5.

In summary, we have now three observations from each of Figure 1, 2, and 3 that are consistent with the higher and highest bids tending to be somewhat lower than bids derived from the same lognormal distribution. Dougherty and Lohrenz (1977) hypothesized the possibility of "flinching" by bidders as the reason for these same observations seen in Federal offshore oil and gas lease bonus bids. Flinching occurs when bidders become more cautious with their higher bids than with their lower bids.

In Figure 4, we divided the leases into two populations, one of the leases with a geometric mean of bids per acre greater than $10/acre and another of the other leases. The two populations combined yielded the data points on the left-most graph on Figure 3. Figure 4 shows there is a difference between the two populations. The cheaper leases with $\bar{b}$ less than or equal to $10/acre showed no particular flinching pattern. On the other hand, the more expensive leases with $\bar{b}$ greater than $10/acre show an even more pronounced pattern consistent with flinching.

Federal offshore oil and gas lease bonus bids averaged very much higher on a per acre basis than the onshore bids of this study. Nonetheless, there is evidence that flinching occurred for the onshore bids as well and, even more so, for the higher onshore bids.

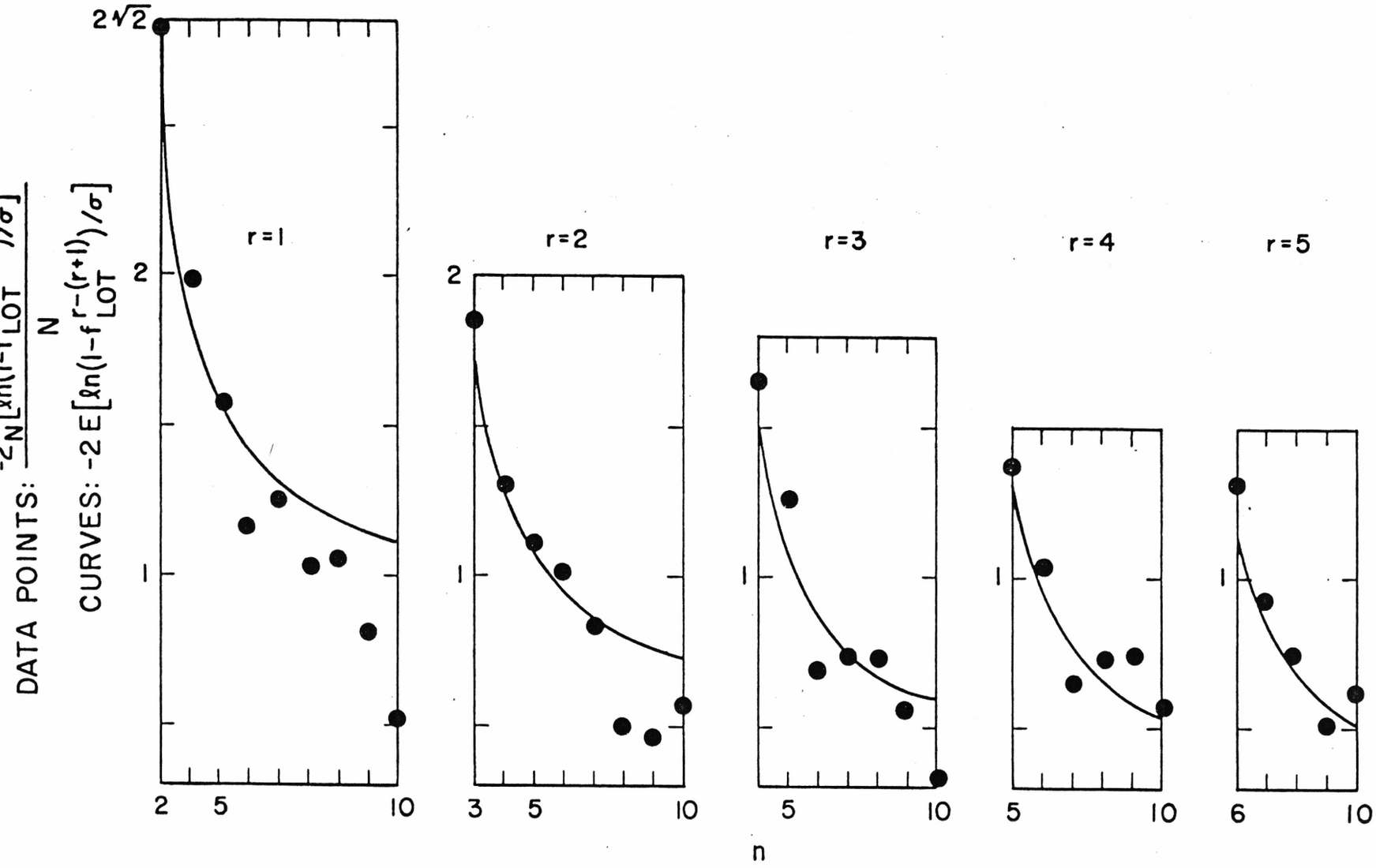

Figure 3

Predicted and Actual Expected Values of the Fraction of Money Left on the Table

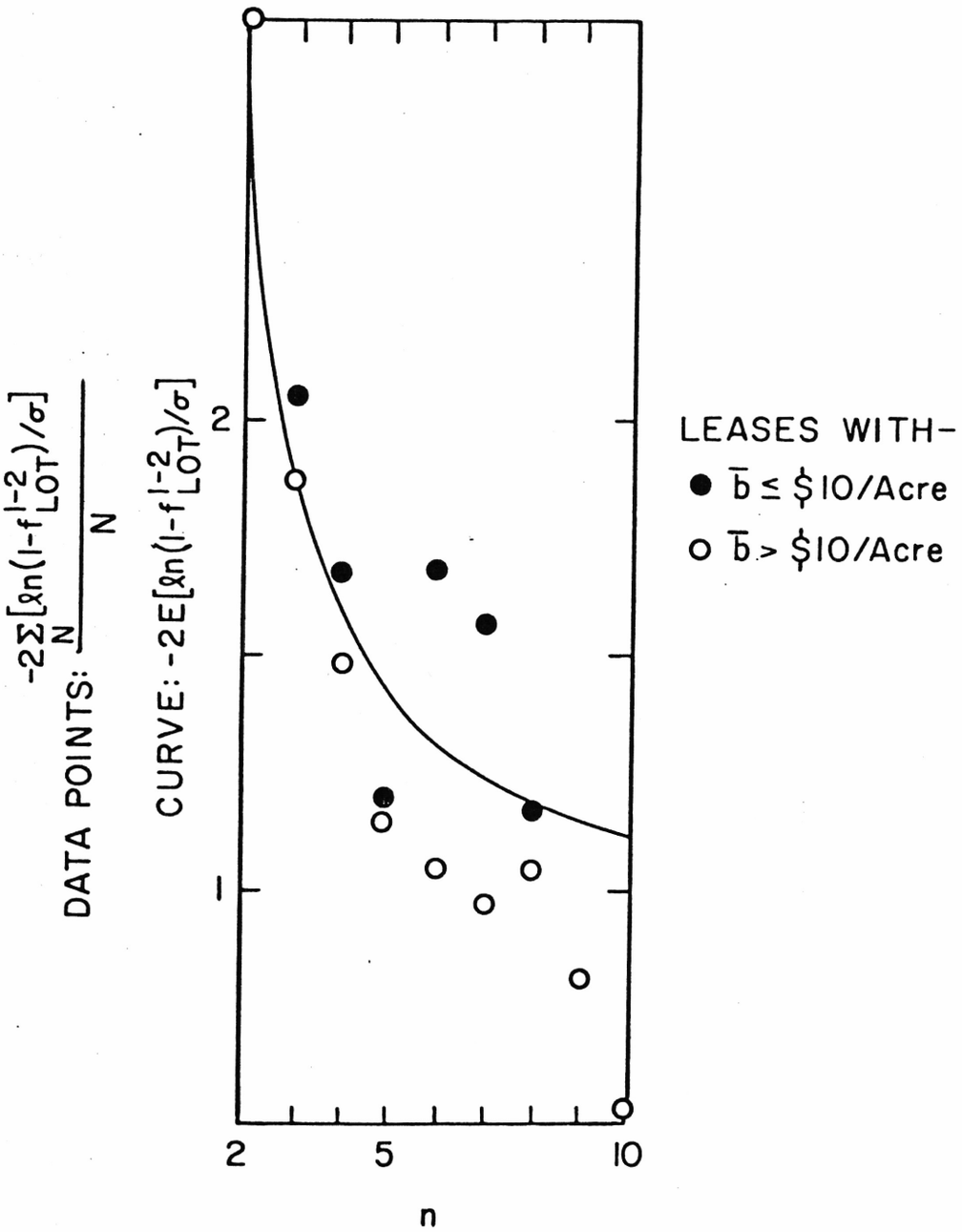

Figure 4

Predicted and Actual Expected Values of the Fraction of Money Left on the Table for Leases Receiving Cheaper and More Expensive Bids

THE TYPE OF BIDDER AND BID

Table 5 summarizes the occurrence of bids by type of bidder and bid. The following companies were arbitrarily classified as "Big 8" companies:

Amoco
British Petroleum (which had no bids)
Chevron
Exxon
Gulf (including British American)
Mobil
Shell
Texaco

These were eight companies classified as "majors" by Dougherty and Lohrenz (1978). The following companies were classified as "Big 9-20" companies:

Amerada Hess
AtlanticRichfield
Burmah (including Signal)
Cities Service
Continental
Getty (including Skelly)
Marathon
Phillips
Sun
Superior
Tenneco
Union

The type of bidder was considered to be a "Big 8" bidder if any of the "Big 8" companies participated in the bid according to the record. (Note that the record did not reflect any cases where the bidder may be an agent for a "Big 8" company or any other party.) The type of bidder was considered to be a "Big 9-20" bidder if no "Big 8" company participated in the bid and any "Big 9-20" company did according to the record. If no "Big 20" company participated in the bid according to the record, that bid was deemed to be given by a non-"Big 20" type of bidder. The type of bid, solo or joint, was defined according to the record with the bid. If only one owner of the bid was listed as bid, that bid was considered a solo bid. Only if two or more owners of the bid were listed with the bid was the bid considered a joint bid.

Table 5

Summary of Bids by Type of Bidder and Bid

	Type of Bidders			Type of Bid	
	Big 8 Bidders	Big 9-20 Bidders	Non-Big 20 Bidders	Solo Bid	Joint Bid
Percentage of:					
- Bids submitted	5.4	4.9	89.7	98.9	1.1
- Highest bids submitted	5.8	5.8	88.4	98.4	1.6
Ratios for leases where the highest bid was submitted:					
-Sum of bids received to number of leases	4.13	3.43	2.74	2.87	2.77
-Sum of highest bids to sum of acres in leases ($/Acre)	84.7	116.8	67.4	72.2	69.8

Table 5 shows that non-"Big 20" bidders submitted and were highest on almost 90 percent of these leases. This contrasts with Federal offshore oil and gas leases where a study showed (Dougherty and Lohrenz, 1978) that more than two-thirds of all bids submitted in sales from December, 1975, through 1976 involved a "Big 8" bidder. Thus, the proportionate amount of bidding of the larger companies appears, according to the bidding record, to be far less for these Federal onshore oil and gas leases than for offshore leases. These onshore leases averaged bonuses paid of about $70 per acre while, during the same period, offshore leases averaged bonuses paid at least an order of magnitude higher. The common supposition is that smaller, i.e., non-"Big 20", companies should be less prone to enter more expensive, especially with regards to cash requirement, projects. This greater share of bidding by the smaller companies for the cheaper, onshore leases compared to the more expensive offshore leases is consistent with that supposition.

Another "soft" observation supporting that supposition can be seen from Table 4 and Figure 5. Table 4 shows a trend of highest bids per acre increasing when there were more bids per lease. On the other hand, Figure 5 shows a trend of the fraction of bids that were non-"Big 20" decreasing slightly, but perceptibly as there were more bids per lease.

Further, Table 5 shows that, in the aggregate, the "Big 8" bidders tended to have the highest bids against more competing bidders than any of the other types of bidders, the "Big 9-20" than the non-"Big 20" bidders, and the non-"Big 20" bidders tended to have the highest bids against the lower number of competing bidders than any other types of bidders. Again, this observation, like the previous two observations, is consistent with the smaller companies tending more so to bid on the cheaper leases.

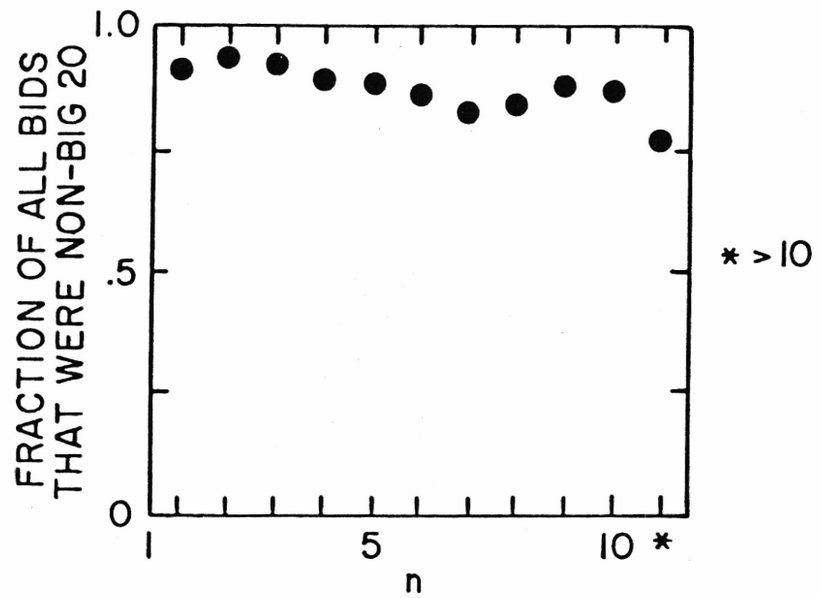

Figure 5

The Fraction of Bids That Were non-Big 20 as a Function of the Number of Bids per Lease

Only a very small proportion, slightly more than 1 percent, of the Federal onshore oil and gas lease bids were joint bids, as shown on Table 5. Joint bidding on these leases has been minimal compared to Federal offshore oil and gas leases where about half of bids have been joint (Dougherty and Lohrenz, 1978).

THE BIAS OF BIDDERS

An "average" bidder, i.e., a bidder who bids like the concensus of all other bidders can statistically expect to have exactly half of all other bids be above his bid and the other half below. Where f_B is the fraction of all other bids below an individual bidder's bid (or kind of bid), this "average" bidder would expect an f_B of 0.5. A bidder need not be average, of course. By design or by accident, an individual bidder could bid more aggressively than the other bidders in which case then bidder's f_B would be greater than 0.5, the greater the more aggressive. Or, an individual bidder could be more conservative than other bidders with an f_B less than 0.5, the lesser the more conservative.

Have individual bidders displayed different aggressive and conservative biases? Figure 6 clearly shows they have within sales. Figure 5 treats the 4 sales in which the greatest number of bids were received. (These all happened to be New Mexico sales.) A data point is shown for all individual bidders in these sales who submitted 10 or more bids. This restricts the treatment to the more frequent bidders in the sales. Figure 6 shows that there is a wide range of biases from very aggressive to very conservative which may be displayed even by these more frequent bidders. We do not know whether the individual bidders intended to be as biased as they were in these sales, but we do know they were.

If, as has just been shown, individual bidders have had a range of biases in individual sales, have they been biased in the aggregate of sales? Figure 7

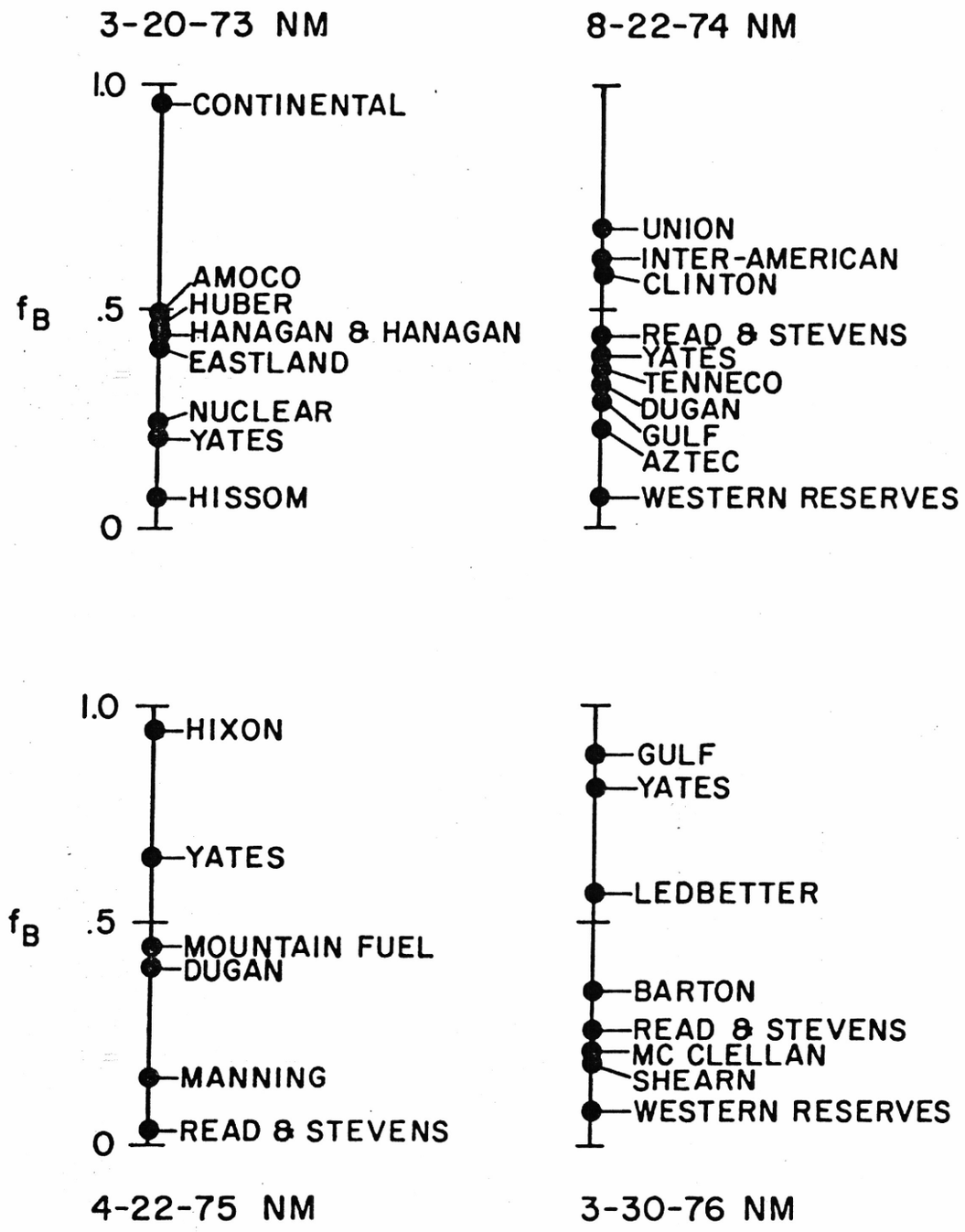

Figure 6

Biases of Bidders in Individual Sales

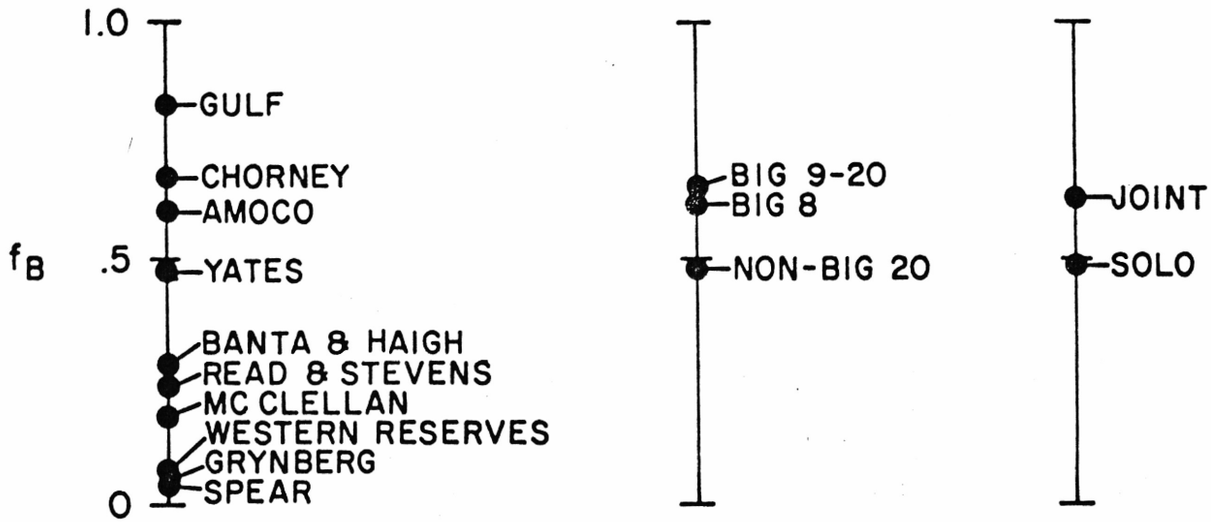

Figure 7

Biases of Bidders Through the Aggregate of Sales

shows they have. In Figure 7, we show a data point for every individual bidder bidding 50 or more times in the Federal onshore oil and gas lease sales of this study. Even these frequent bidders through sales display, whether they wanted to or not, a wide range of aggressive and conservative biases.

Figure 7 also shows that "Big 20" bidders and joint bids tended to be more aggressive in the aggregate than non-"Big 20" bidders and solo bids. This is consistent with what can be observed on Table 5 that the percentage of highest bids for the more aggressive bidders was higher than the percentage of bids submitted. The more aggressive bidders and bids should tend to be highest more so than the more conservative bidders and bids.

What have individual bidders gotten because of bidding aggressively? Or, conservatively? An unbiased bidder, i.e., a bidder whose f_B=0.5 can expect to be higher than all other bidders with a probability of 1/n. In other words, a bidder neither aggressively or conservatively biased can expect to be highest 50 percent of the time bidding against one other bidder, 33 1/3 percent of the time bidding against two other bidders, and so on. An aggressive bidder's frequency of being highest will be higher than 1/n, but if that is a sought for result by bidders, there is a price paid for being aggressive. When an aggressive bidder's bid is highest, that bidder can expect to leave more money on the table as well as "win" with a highest bid to mean bid ratio higher than an unbiased bidder. The opposite is true for a conservative bidder who can expect to be highest less than 1/n of the time, but also expect to leave less money on the table when highest.

Dougherty, Conner, and Lohrenz (1977) have quantified the relationships between (1) the frequency of being highest, (2) the ratio of the highest bid to the mean bid, $b_{max}/\bar{b}$, and (3) the fraction of money left on the table, f_{LOT}^{1-2}, with f_B and n assuming all bidders withdraw a value from the same

lognormal distribution, one bidder biases his value and bids the biased value, and all other bidders actually bid the value drawn. Figures 8, 9, and 10 show the functions developed with respect to the frequency of being highest, L_b/L_h. Actual individual bidder data points are also shown on Figures 8, 9, and 10 for comparison with the predicted functions. All data points from the data of this study were shown meeting certain criteria. The criteria and their reasons follow:

A. Only leases with n of 3 or more were considered. The reason was that only then is a degree of freedom left over after computing $\bar{b}$ and σ for a lease.

B. Points where $f_B=1$ where L_b/L_h were not shown. This is a point constrained by the definition. Actually, if sample sizes were sufficiently large, no bidder would ever have an $f_B=1$.

C. The absolute value of the difference between $\bar{n}$ and $\bar{n}_h$ had to be less than 2. What one, of course, would first seek to do is to consider an aggregation of an individual bidder's bids in a sale on leases all receiving a specific value of n bids. In each sale, however, leases receive various values of n bids and individual bidders bid on leases receiving a range of n bids. Populations of leases in a sale on which a specific bidder bid with a specific number of competing bids are so small as to be useless for analysis purposes. Some kind of aggregation of individual bidders' bids across leases with different values of n was found necessary. Across such an aggregation, however, one can expect a "sorting" effect, i.e., a bidder will tend to be highest more so on the leases in the aggregation with the lower values of n than with the higher values. This criterion mitigates this effect.

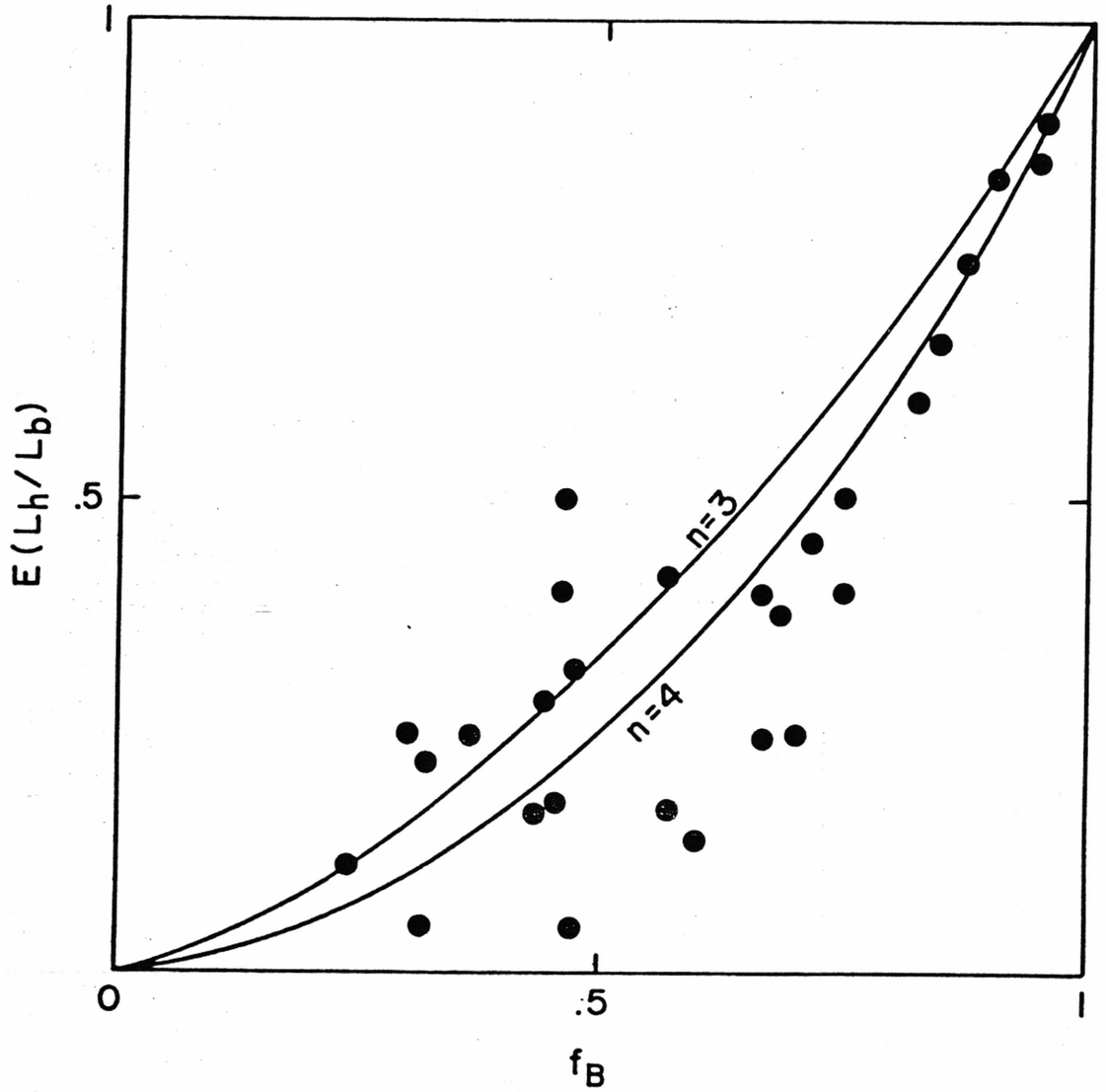

Figure 8

Comparison of Predicted and Actual Frequencies of Submitting Highest Bid for n=3-4

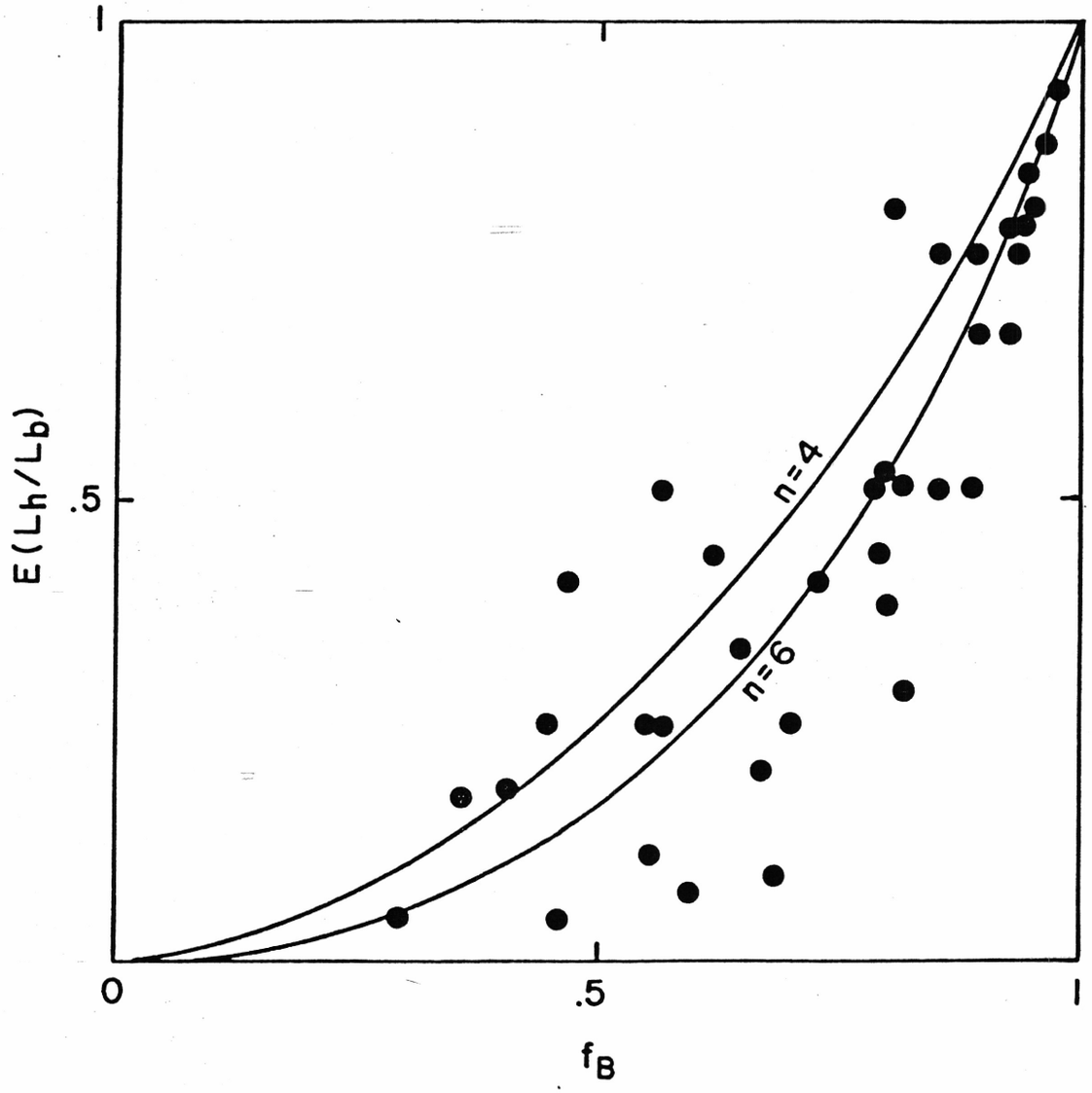

Figure 9

Comparison of Predicted and Actual Frequencies of Submitting Highest Bid for n=4-6

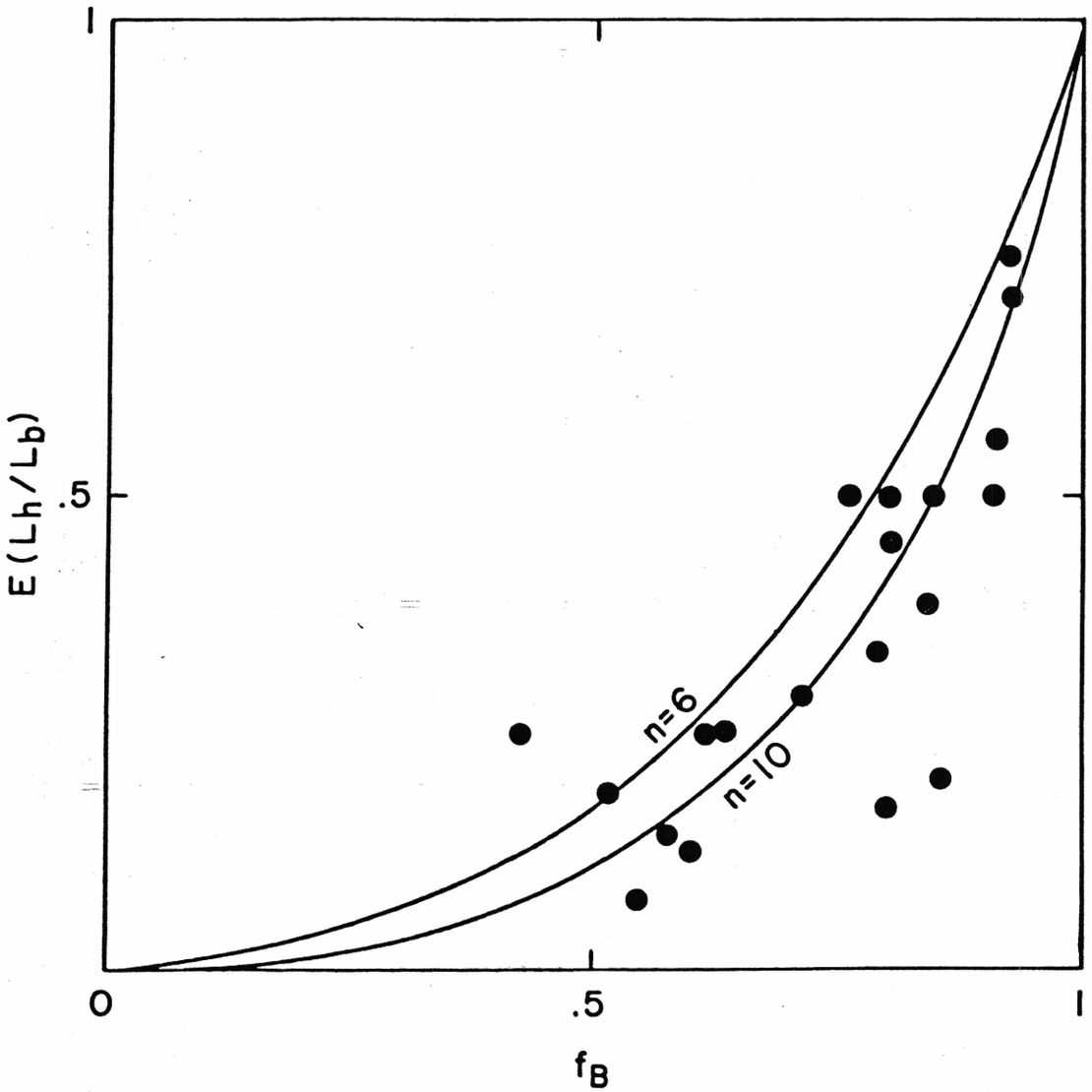

Figure 10

Comparison of Predicted and Actual Frequencies of Submitting Highest Bid for n=6-10

D. The effective value of n for the aggregate of leases was computed as $(\bar{n}+\bar{n}_h)/2$. Note that if a bidder never was the highest bidder in a sale, the effective value of n was not computed and no data point was shown. For effective values of n from 3 through 4, the data points are plotted on Figure 8; for values greater than 4 through 6, on Figure 9; and for values greater than 6 through 10, on Figure 10.

E. The size of the aggregate of leases meeting the previous criteria for an individual bidder in a sale had to be 4 or more. The reason was to try to get populations of leases sufficiently large so that the results would show overall trends.

The comparison of the actual data and predicted relationships on Figures 8, 9, and 10 shows individual bidders in different sales doing both better and worse than the predictions. The most important observation that follows from Figures 8, 9, and 10 is that about as many bidders are above the curve as below the curve. It appears, just as has been found for Federal offshore oil and gas lease bids (Dougherty, Conner, and Lohrenz, 1977), that due to the luck of the draw, an individual bidder can have done better or worse than the expected relationships with respect to the frequency of being highest. But, just as in a gambling game where some players win some and others lose some, the winners and losers aggregate around the "house odds".

In the previous sections, we have already observed departures from the expected values of $b_{max}/\bar{b}$ and f_{LOT}^{1-2} taking all bids as arising out of the same lognormal distribution (with no bidder biasing his bids). It is reasonable to presume that these same departures exist for biased bidders, either aggressively or conservatively. According to Figure 2, however, there was good agreement between predicted and actual values of $b_{max}/\bar{b}$ at lower values of n, say less than 5. Figure 11 shows the curve defined by Dougherty, Conner,

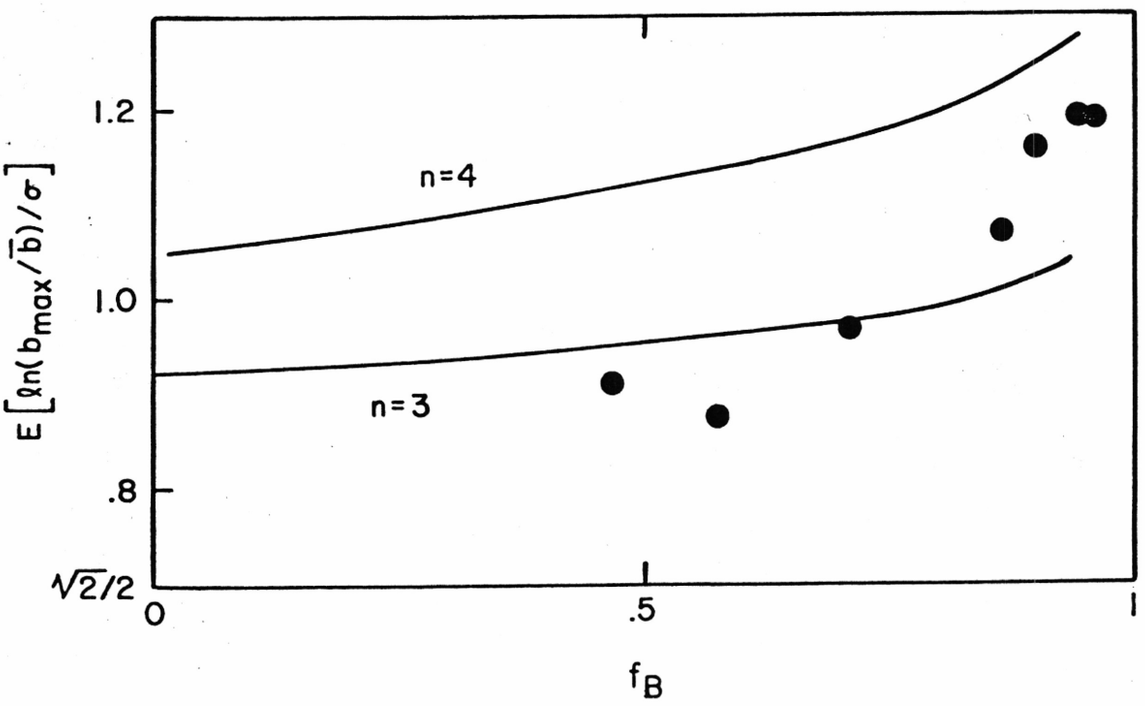

Figure 11

Comparison of Predicted and Actual Ratios of the Highest to the Mean of Bids for n=3-4

and Lohrenz (1977) showing how $b_{max}/\bar{b}$ can be expected to vary with f_B for n=3 and 4. Using criteria A, B, and C; values of $(\bar{n}+\bar{n}_h)/2$ of 3 through 4, and all cases in the data where an individual bidder in a sale had 4 or more highest bids in the aggregate, the data points shown were selected. (Data points tend to occur much more so at higher values of f_B because more aggressive bidders tend more so to have 4 or more highest bids.) Figure 11 shows reasonable agreement of the actual data, albeit only sparse data are available in meeting the criteria, and the predictions.

CONCLUDING SUMMARY

We have examined the bonus bids received on 1,881 Federal onshore oil and gas leases in sales starting in 1972 through 1977. During this period, Federal offshore oil and gas lease bonus bid sales have been held where highest bids averaged much more than $1000 per acre. These onshore bids averaged $70 per acre. In spite of this large difference in how high the bids were, our studies showed many statistical similarities between these Federal onshore and offshore bids. From our study of Federal onshore oil and gas lease bonus bids, we concluded the following:

1. Low, noise bids occurred, but less than one percent of the time and, if so, tended to occur more so in certain sales. This duplicated what had been observed for Federal offshore bonus bids.

2. Onshore bids could be considered lognormally distributed just as offshore bonus bids have been. Further, the pooled standard deviations of the onshore bids, 1.16, is in relative agreement with that shown for offshore bids.

3. The onshore bids displayed the same apparent departure from lognormality consistent with flinching that had been noted for offshore bids.

4. Unlike offshore bidding, onshore bidding has not displayed the relative amount of joint bidding and participation of the larger companies as onshore bids have--at least according to the record of the bids as bid.

5. Individual bidders and individual sales have displayed wide ranges of aggressive and conservative biases, but what they got for their biased bids appeared not to depart from statistical expectations.

ACKNOWLEDGMENTS

The hard part of these studies was gathering the data and getting it into shape. When that work was done well as it was, our work was made easier. We are impelled to acknowledge the host of people who pulled the "data" oars in the galley so our ship could perambulate. We cite, in particular, Cyndi Nethaway of the U.S. Geological Survey, Gordon Peterson of the General Services Administration, and Joan Keiper of PRI Services.

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NOTATION

b_i	=	a particular bonus bid for a lease, $
$\bar{b}$	=	geometric mean of bids for a lease, $
$\overline{\ln b}$	=	arithmetic mean of the natural logarithms of bids for a lease
b^r	=	the rth ranking bid in descending order of bids for a lease such that b^1 is the highest bid
b_{max}	=	b^1
E	=	statistical expectation operator
f_B	=	fraction of all competing bidders' bids below an individual bidder's bids
$f_{LOT}^{r-(r+1)}$	=	generalized fraction of money left on the table for adjacent ranking bids compared to the higher ranking bid
L_b	=	number of leases on which an individual bidder bid
L_h	=	number of leases on which an individual bidder bids highest
N	=	number of leases in a population
n	=	number of bids received for a lease
$\bar{n}$	=	ratio of the sum of bids received for a population of leases to the number of leases in the population
$\bar{n}_h$	=	ratio of the sum of bids received for leases on which a bidder bid highest to the number of leases on which that bidder bid highest
σ	=	standard deviation of bids for a lease computed using natural logarithms
σ_S	=	pooled standard deviation of bids for an aggregation of leases computed using natural logarithms

APPENDIX A

SUMMARY OF BIDDING BY DATE OF SALE FOR LEASES THAT WERE ISSUED

(4 pages)

SALE DATE	STATE	Number of Bonus Bid Leases Receiving Bids	BONUS BID LEASES ISSUED: Number of Leases	Number of Bids	Number of Bids / Number of Leases	Sum of Acres	Sum of Highest Bids (Millions$)	Sum of Highest Bids / Sum of Acres($/acre)	Sum of Bids (Millions$)	Sum of Bids / Sum of Acres ($/acre)
08-15-72	OK	7	7	9	1.29	659	.026	39.62	.030	45.52
08-30-72	KS	2	2	5	2.50	797	.010	12.42	.015	18.82
08-30-72	WY	28	28	37	1.32	6680	.070	9.01	.073	10.93
09-27-72	AK	8	8	24	3.00	4727	.408	86.40	.751	158.87
09-27-72	CO	16	16	24	1.50	3262	.430	6.63	.028	8.58
12-04-72	UT	34	34	113	3.32	12333	.154	12.46	.315	25.54
12-20-72	CO	12	12	22	1.83	4837	.035	7.33	.054	11.16
12-27-72	WY	18	18	36	2.00	2870	.051	17.71	.076	26.48
01-16-73	OK	10	10	23	2.30	438	.024	55.18	.043	98.17
03-20-73	NM	50	50	330	6.60	17085	.705	41.28	2.089	122.27
04-10-73	OK	12	11	31	2.82	789	.110	138.11	.241	305.45
04-14-73	LA	1	1	3	3.00	120	.004	37.08	.011	91.67
04-18-73	KS	1	1	1	1.00	40	.001	22.68	.001	25.00
04-18-73	WY	21	21	48	2.29	6042	.119	19.76	.218	36.08
05-23-73	WY	23	23	37	1.61	3210	.002	7.01	.003	.93
06-05-73	NM	3	3	38	12.67	360	.578	1605.00	2.963	8.23
06-13-73	CO	6	6	7	1.17	2625	.036	13.80	.037	14.10
06=20-73	WY	22	22	64	2.91	5919	.161	27.20	.409	69.10
07-11-73	CO	4	4	5	1.25	1907	.020	10.24	.021	11.01
08-14-73	MT	1	1	1	1.00	240	.004	15.13	.004	16.67
08-15-73	CO	10	10	17	1.70	4617	.036	6.26	.029	6.28
08-15-73	UT	12	12	12	1.00	5461	.019	3.45	.019	3.48
08-22-73	WY	19	19	42	2.21	5070	.139	27.41	.314	61.93
08-29-73	LA	5	5	7	1.40	1915	.103	53.58	.111	57.96
09-05-73	CO	5	5	6	1.20	207	.005	22.29	.005	24.15
09-11-73	OK	13	13	21	1.62	834	.047	56.07	.065	77.94
09-11-73	TX	1	1	1	1.00	500	.009	17.69	.009	18.00
09-19-73	CO	10	10	24	2.40	1846	.039	21.16	.075	40.63
10-16-73	NM	18	18	115	6.39	2387	.239	99.96	.716	299.96
10-17-73	WY	12	12	20	1.67	2246	.031	13.68	.049	21.82
10-30-73	MT	9	9	21	2.33	1558	.023	14.55	.031	19.90
11-21-73	CO	7	7	11	1.57	1701	.023	13.79	.032	18.81
12-19-73	WY	19	19	40	2.11	4283	.067	15.61	.111	25.92
01-15-74	OK	4	4	12	3.00	401	.126	313.38	.250	623.44
01-24-74	UT	1	1	3	3.00	520	.021	41.37	.031	59.62
02-06-74	CO	12	12	27	2.25	4594	.063	13.79	.106	23.07
02-20-74	WY	41	41	110	2.68	9412	.561	59.62	.921	97.85
03-06-74	CO	3	3	8	2.67	360	.025	68.22	.051	141.67
04-10-74	CO	8	8	23	2.88	693	.020	29.34	.034	49.06
04-16-74	MT	42	42	90	2.14	9952	.086	8.60	.131	13.16

			BONUS BID LEASES ISSUED							
SALE DATE	STATE	Number of Bonus Bid Leases Receiving Bids	Number of Leases	Number of Bids	Number of Bids / Number of Leases	Sum of Acres	Sum of Highest Bids (Millions$)	Sum of Highest Bids / Sum of Acres($/acre)	Sum of Bids (Millions$)	Sum of Bids / Sum of Acres ($/acre)
04-17-74	KS	1	1	1	1.00	40	.0002	5.53	.0002	5.00
04-17-74	WY	38	38	58	1.53	11369	.101	8.88	.145	12.75
05-15-74	CO	3	3	8	2.67	463	.316	682.75	.503	1086.39
05-22-74	WY	21	21	32	1.52	3363	.037	11.03	.046	13.68
06-26-74	UT	6	6	8	1.33	1705	.030	17.59	.040	23.46
07-10-74	MT	7	7	12	1.71	1106	.015	13.54	.018	16.27
07-17-74	KS	3	3	5	1.67	97	.002	22.21	.003	30.93
07-17-74	WY	15	15	35	2.33	2977	.320	106.93	.641	215.32
08-15-74	OK	10	10	21	2.10	993	.299	300.81	.584	588.12
08-21-74	KS	1	1	5	5.00	20	.003	126.50	.004	200.00
08-21-74	WY	20	20	52	2.60	2568	.128	49.20	.187	72.82
08-22-74	NM	80	85	300	3.75	25079	1.642	65.47	2.963	118.15
08-27-74	ND	3	3	23	7.67	361	.525	1453.02	2.142	5.93
09-17-74	TX	1	1	3	3.00	430	.025	58.48	.040	93.02
10-23-74	WY	26	26	77	2.96	4768	.159	33.30	.302	63.34
11-06-74	CO	15	15	27	1.80	6142	.114	18.62	.169	27.52
11-18-74	ND	9	9	13	1.44	1288	1.277	991.30	1.277	991.46
12-04-74	CO	9	9	39	4.33	2645	.266	100.58	.528	199.62
12-17-74	MT	5	5	20	4.00	1387	.020	14.27	.051	36.77
12-17-74	SD	6	6	10	1.67	437	.015	33.50	.018	41.19
01-08-75	LA	3	3	4	1.33	488	.010	21.46	.015	30.74
03-05-75	CO	9	9	24	2.67	3807	.081	21.38	.156	40.98
03-11-75	UT	15	15	26	1.73	6139	.112	18.32	.163	26.55
03-19-75	WY	30	30	138	4.60	7886	.839	106.42	2.172	275.42
04-22-75	NM	68	68	270	3.97	23842	1.829	75.70	3.937	165.13
04-23-75	WY	16	16	31	1.94	4837	.215	44.51	.277	57.27
04-30-75	AK	5	5	6	2.00	2088	.350	167.69	.552	264.37
05-20-75	OK	12	12	17	1.42	575	.029	50.05	.041	71.30
05-21-75	WY	15	15	24	1.60	3006	.144	47.86	.162	53.89
06-25-75	WY	28	28	74	2.64	5155	.379	73.56	.738	143.16
07-08-75	MT	3	3	8	2.67	280	.017	61.71	.039	139.29
07-08-75	ND	1	1	1	1.00	240	.001	5.00	.001	4.17
07-09-75	AK	17	17	97	5.71	3683	.322	87.56	.894	242.74
08-19-75	ND	11	11	17	1.55	3187	.298	93.59	.338	106.06
08-20-75	WY	19	19	33	1.74	2243	.040	18.01	.059	26.30
09-10-75	AK	2	0	0	0.0	0	.0	0.0	.0	0.0
10-08-75	CO	30	30	53	1.77	11557	.145	12.55	.209	18.08
10-21-75	MT	6	6	14	2.33	1154	.114	98.67	.155	13.43
10-21-75	OK	26	15	62	4.13	1532	.397	258.87	1.382	902.09
11-18-75	ND	3	3	15	5.00	481	.679	1411.94	1.576	3276.51

SALE DATE	STATE	Number of Bonus Bid Leases Receiving Bids	BONUS BID LEASES ISSUED: Number of Leases	Number of Bids	Number of Bids / Number of Leases	Sum of Acres	Sum of Highest Bids (Millions$)	Sum of Highest Bids / Sum of Acres($/acre)	Sum of Bids (Millions$)	Sum of Bids / Sum of Acres ($/acre)
12-09-75	UT	17	17	38	2.24	4486	.147	32.69	1.997	445.16
12-17-75	WY	29	28	46	1.64	4601	.320	35.10	.161	34.99
01-13-76	MT	3	1	1	1.00	40	.003	76.50	.003	75.00
01-27-76	MT	5	4	5	1.25	127	.0005	3.81	.001	7.87
02-26-76	OK	10	9	13	1.44	1318	.037	27.86	.046	34.90
03-10-76	AK	1	1	5	5.00	80	.014	176.16	.033	412.50
03-10-76	LA	4	4	13	3.25	506	.496	981.15	.529	1045.45
03-16-76	MT	1	1	2	2.00	310	.124	399.52	.188	606.45
03-23-76	ND	4	4	22	5.50	600	.050	84.11	.124	206.67
03-30-76	NM	79	73	299	4.10	19777	.853	43.13	1.700	85.96
04-14-76	KS	1	1	2	2.00	40	.001	25.30	.001	25.00
04-14-76	WY	23	23	57	2.48	4546	.261	57.49	.463	101.85
04-21-76	AK	1	0	0	0.0	0	.0	0.0	.0	0.0
06-08-76	MT	22	18	41	2.28	4178	.031	7.51	.062	14.84
06-08-76	ND	2	2	2	1.00	140	.001	8.84	.001	7.14
06-23-76	UT	2	2	3	1.50	400	.002	5.73	.002	5.00
06-23-76	WY	21	20	52	2.60	3519	.151	43.18	.210	59.68
07-20-76	MT	2	2	2	1.00	634	.005	8.18	.005	7.89
07-21-76	WY	27	27	82	3.04	3979	.110	27.73	.164	41.22
07-27-76	OK	9	8	25	3.13	821	.347	423.23	1.078	1313.03
08-04-76	CO	24	24	58	2.42	5305	.169	31.81	.304	57.30
08-17-76	NM	61	61	61	1.00	21857	1.085	49.64	1.085	49.64
08-18-76	WY	28	28	68	2.43	3348	.067	20.08	.101	30.17
10-13-76	AK	1	1	1	1.00	122	.003	20.50	.003	24.59
10-13-76	LA	6	5	9	1.80	405	.075	184.81	.094	232.10
10-14-76	MT	10	10	22	2.20	1914	.048	25.05	.094	49.11
10-20-76	WY	18	18	54	3.00	4079	.121	29.75	.253	62.03
10-21-76	ND	1	1	6	6.00	9	.062	6935.89	.183	20333.33
01-18-77	NM	26	25	105	4.20	6741	.833	123.58	1.547	229.49
01-19-77	WY	20	20	47	2.35	2314	.142	61.26	.270	116.68
02-15-77	OK	2	2	4	2.00	1593	.291	182.91	.424	266.16
03-08-77	ND	2	2	6	3.00	160	.009	57.10	.013	81.25
03-09-77	OK	21	19	70	3.68	1819	.351	193.12	.666	366.14
03-23-77	WY	32	32	147	4.59	6873	.943	137.21	2.134	310.49
04-06-77	AK	1	1	1	1.00	119	.002	14.74	.002	18.81
04-06-77	CO	17	17	75	4.41	5917	.263	44.40	.815	137.74
04-06-77	LA	2	2	4	2.00	280	.013	47.90	.017	60.71
05-18-77	KS	1	1	2	2.00	588	.002	3.40	.004	6.80
05-18-77	WY	19	19	85	4.47	5167	.662	128.06	1.223	236.69
06-15-77	UT	8	8	8	1.00	2905	.053	18.09	.053	18.24

		BONUS BID LEASES ISSUED							
SALE DATE	STATE	Number of Bonus Bid Leases Receiving Bids	Number of Leases	Number of Bids	Number of Bids / Number of Leases	Sum of Acres	Sum of Highest Bids (Millions$)	Sum of Highest Bids / Sum of Acres($/acre)	Sum of Bids (Millions$)	Sum of Bids / Sum of Acres ($/acre
08-09-77	OK	23	19	83	4.37	1767	4.596	2601.21	21.903	12395.59
08-17-77	KS	3	3	6	2.00	974	.006	5.75	.007	7.19
08-17-77	WY	21	21	77	3.67	3905	.274	70.06	.557	142.64
09-13-77	UT	25	25	54	2.16	8433	.507	60.17	.582	69.01
09-20-77	MT	22	22	37	1.68	2976	.161	54.13	.189	63.51
09-20-77	ND	4	4	10	2.50	480	.035	73.32	.059	122.92
09-20-77	UT	42	42	165	3.93	14551	.903	62.07	1.864	128.10
10-19-77	KS	7	4	8	2.00	248	.014	55.59	.015	60.48
10-19-77	WY	15	15	60	4.00	2430	.608	250.33	.894	367.90
12-14-77	NE	23	22	88	4.00	13443	2.391	177.89	4.200	312.43
TOTALS:		1881	1830	5262	2.88	453695	33.00	72.74	79.32	174.83

APPENDIX B

SUMMARY OF BIDDING BY DATE OF SALE FOR

LEASES FOR WHICH ANY AND ALL BIDS

WERE REJECTED

(4 pages)

SALE DATE	STATE	Number of Bonus Bid Leases Receiving Bids	BONUS BID LEASES FOR WHICH ALL BIDS WERE REJECTED							
			Number of Leases	Number of Bids	Number of Bids / Number of Leases	Sum of Acres	Sum of Highest Bids (Millions$)	Sum of Highest Bids / Sum of Acres($/acre)	Sum of Bids (Millions$)	Sum of Bids / Sum of Acres ($/acre)
08-15-72	OK	7								
08-30-72	KS	2								
08-30-72	WY	28								
09-27-72	AK	8								
09-27-72	CO	16								
12-04-72	UT	34								
12-20-72	CO	12								
12-27-72	WY	18								
01-16-73	OK	10								
03-20-73	NM	50								
04-10-73	OK	12	1	2	2.00	24	.004	173.63	.006	250.00
04-14-73	LA	1								
04-18-73	KS	1								
04-18-73	WY	21								
05-23-73	WY	23								
06-05-73	NM	3								
06-13-73	CO	6								
06-20-73	WY	22								
07-11-73	CO	4								
08-14-73	MT	1								
08-15-73	CO	10								
08-15-73	UT	12								
08-22-73	WY	19								
08-29-73	LA	5								
09-05-73	CO	5								
09-11-73	OK	13								
09-11-73	TX	1								
09-19-73	CO	10								
10-16-73	NM	18								
10-17-73	WY	12								
10-30-73	MT	9								
11-21-73	CO	7								
12-19-73	WY	19								
01-15-74	OK	4								
01-24-74	UT	1								
02-06-74	CO	12								
02-20-74	WY	41								
03-06-74	CO	3								
04-10-74	CO	8								
04-16-74	MT	42								

SALE DATE	STATE	Number of Bonus Bid Leases Receiving Bids	BONUS BID LEASES FOR WHICH ALL BIDS WERE REJECTED							
			Number of Leases	Number of Bids	Number of Bids / Number of Leases	Sum of Acres	Sum of Highest Bids (Millions$)	Sum of Highest Bids / Sum of Acres($/acre)	Sum of Bids (Millions$)	Sum of Bids / Sum of Acres ($/acre)
04-17-74	KS	1								
04-17-74	WY	38								
05-15-74	CO	3								
05-22-74	WY	21								
06-26-74	UT	6								
07-10-74	MT	7								
07-17-74	KS	3								
07-17-74	WY	15								
08-15-74	OK	10								
08-21-74	KS	1								
08-21-74	WY	20								
08-22-74	NM	80	5	6	1.20	1485	.003	2.05	.003	2.02
08-27-74	ND	3								
09-17-74	TX	1								
10-23-74	WY	26								
11-06-74	CO	15								
11-18-74	ND	9								
12-04-74	CO	9								
12-17-74	MT	5								
12-17-74	SD	6								
01-08-75	LA	3								
03-05-75	CO	9								
03-11-75	UT	15								
03-19-75	WY	30								
04-22-75	NM	68								
04-23-75	WY	16								
04-30-75	AK	3	2	4	2.00	1280	.194	151.51	.338	264.06
05-20-75	OK	12								
05-21-75	WY	15								
06-25-75	WY	28								
07-08-75	MT	3								
07-08-75	ND	1								
07-09-75	AK	17								
08-19-75	ND	11								
08-20-75	WY	19								
09-10-75	AK	2	2	2	1.00	435	.018	41.85	.018	41.38
10-08-75	CO	30								
10-21-75	MT	6								
10-21-75	OK	26	11	15	1.36	618	.008	13.40	.009	14.56
11-18-75	ND	3								

SALE DATE	STATE	Number of Bonus Bid Leases Receiving Bids	BONUS BID LEASES FOR WHICH ALL BIDS WERE REJECTED							
			Number of Leases	Number of Bids	Number of Bids / Number of Leases	Sum of Acres	Sum of Highest Bids (Millions$)	Sum of Highest Bids / Sum of Acres($/acre)	Sum of Bids (Millions$)	Sum of Bids / Sum of Acres ($/acre)
12-09-75	UT	17								
12-17-75	WY	29	1	2	2.00	200	.005	25.15	.006	30.00
01-13-76	MT	3	2	2	1.00	6.34	.005	8.18	.005	7.89
01-27-76	MT	5	1	1	1.00	13	.00008	6.00	.00008	6.15
02-26-76	OK	10	1	3	3.00	67	.012	183.90	.023	343.28
03-10-76	AK	1								
03-10-76	LA	4								
03-16-76	MT	1								
03-23-76	ND	4								
03-30-76	NM	79	6	45	7.50	1559	.124	79.30	.442	283.52
04-14-76	KS	1								
04-14-76	WY	23								
04-21-76	AK	1	1	1	1.00	358	.003	7.49	.003	8.38
06-08-76	MT	22	4	8	2.00	760	.022	29.19	.027	35.53
06-08-76	ND	2								
06-23-76	UT	2	1	5	5.00	200	.002	11.40	.007	35.00
06-23-76	WY	21								
07-20-76	MT	2								
07-21-76	WY	27								
07-27-76	OK	9	1	1	1.00	39	.00004	1.03	.00004	1.03
08-04-76	CO	24								
08-17-76	NM	61								
08-18-76	WY	28								
10-13-76	AK	1								
10-13-76	LA	6	1	1	1.00	120	.001	8.10	.009	75.00
10-14-76	MT	10								
10-20-76	WY	18								
10-21-76	ND	1								
01-18-77	NM	26	1	3	3.00	240	.009	37.76	.016	66.67
01-19-77	WY	20								
02-15-77	OK	2								
03-08-77	ND	2								
03-09-77	OK	21	2	2	1.00	438	.0005	1.10	.0005	1.14
03-23-77	WY	32								
04-06-77	AK	1								
04-06-77	CO	17								
04-06-77	LA	2								
05-18-77	KS	1								
05-18-77	WY	19								
06-15-77	UT	8								

SALE DATE	STATE	Number of Bonus Bid Leases Receiving Bids	BONUS BID LEASES FOR WHICH ALL BIDS WERE REJECTED: Number of Leases	Number of Bids	Number of Bids / Number of Leases	Sum of Acres	Sum of Highest Bids (Millions$)	Sum of Highest Bids / Sum of Acres($/acre)	Sum of Bids (Millions$)	Sum of Bids / Sum of Acres ($/acre)
08-09-77	OK	23	4	6	1.50	640	.002	2.39	.002	3.13
08-17-77	KS	3								
08-17-77	WY	21								
09-13-77	UT	25								
09-20-77	MT	22								
09-20-77	ND	4								
09-20-77	UT	42								
10-19-77	KS	7	3	3	1.00	120	.0003	3.00	.0004	3.33
10-19-77	WY	15								
12-14-77	NE	23	1	3	3.00	320	.004	12.78	.008	25.00
TOTALS:		1881	51	115	2.25	9550	.418	43.72	.9241	96.76

APPENDIX C

SUMMARY OF LOW, NOISE BIDS RECEIVED BY

SALE DATE

(4 pages)

Summary of Low, Noise Bids Received for Bonus Bid Leases

SALE DATE	STATE	NUMBER OF BONUS BID LEASES RECEIVING BIDS	NUMBER OF BIDS RECEIVED	NUMBER OF LOW, NOISE BIDS
08-15-72	OK	7	9	
08-30-72	KS	2	5	
08-30-72	WY	28	37	
09-27-72	AK	8	24	
09-27-72	CO	16	24	
12-04-72	UT	34	113	
12-20-72	CO	12	22	
12-27-72	WY	18	36	
01-16-73	OK	10	23	
03-20-73	NM	50	331	1
04-10-73	OK	12	33	
04-14-73	LA	1	3	
04-18-73	KS	1	1	
04-18-73	WY	21	48	
05-23-73	WY	23	37	
06-05-73	NM	3	38	
06-13-73	CO	6	7	
06-20-73	WY	22	64	
07-11-73	CO	4	5	
08-14-73	MT	1	1	
08-15-73	CO	10	17	
08-15-73	UT	12	12	
08-22-73	WY	19	42	
08-29-73	LA	5	7	
09-05-73	CO	5	6	
09-11-73	OK	13	21	
09-11-73	TX	1	1	
09-19-73	CO	10	24	
10-16-73	NM	18	115	
10-17-73	WY	12	20	
10-30-73	MT	9	20	
11-21-73	CO	7	11	
12-19-73	WY	19	40	
01-15-74	OK	4	12	
01-24-74	UT	1	3	

Summary of Low, Noise Bids Received for Bonus Bid Leases

SALE DATE	STATE	NUMBER OF BONUS BIDS LEASES RECEIVING BIDS	NUMBER OF BIDS RECEIVED	NUMBER OF LOW, NOISE BIDS
02-06-74	CO	12	27	
02-20-74	WY	41	110	
03-06-74	CO	3	8	
04-10-74	CO	8	23	
04-16-74	MT	42	90	
04-17-74	KS	1	1	
04-17-74	WY	38	58	
05-15-74	CO	3	8	
05-22-74	WY	21	32	
06-26-74	UT	6	8	
07-10-74	MT	3	5	
07-17-74	WY	15	35	
08-15-74	OK	10	21	
08-21-74	KS	1	5	
08-21-74	WY	20	52	
08-22-74	NM	85	307	1
08-27-74	ND	3	23	
09-17-74	TX	1	3	
10-23-74	WY	26	77	
11-06-74	CO	15	27	
11-18-74	ND	9	14	1
11-04-74	CO	9	39	
12-17-74	MT	5	20	
12-17-74	SD	6	10	
01-08-75	LA	3	4	
03-05-75	CO	9	24	
03-11-75	UT	15	26	
03-19-75	WY	30	138	
04-22-75	NM	68	271	1
04-30-75	AK	5	10	
05-20-75	OK	12	17	
05-21-75	WY	15	24	
06-25-75	WY	28	74	
07-08-75	MT	3	8	
07-08-75	ND	1	1	

Summary of Low, Noise Bids Received for Bonus Bid Leases

SALE DATE	STATE	NUMBER OF BONUS BIDS LEASES RECEIVING BIDS	NUMBER OF BIDS RECEIVED	NUMBER OF LOW, NOISE BIDS
07-09-75	AK	17	97	
08-19-75	ND	11	17	
08-20-75	WY	19	35	
09-10-75	AK	2	2	
10-08-75	CO	30	53	
10-21-75	MT	6	14	
10-21-75	OK	26	78	1
11-18-75	ND	3	15	
12-09-75	UT	17	38	
12-17-75	WY	29	49	1
01-13-76	MT	3	3	
01-27-76	MT	5	6	
02-26-76	OK	10	16	
03-10-76	AK	1	5	
03-10-76	LA	4	13	
03-16-76	MT	1	2	
03-23-76	ND	4	22	
03-30-76	NM	79	344	
04-14-76	KS	1	2	
04-14-76	WY	23	57	
04-21-76	AK	1	1	
06-08-76	MT	22	49	
06-08-76	ND	2	2	
06-23-76	WY	2	3	
06-23-76	UT	21	57	
07-20-76	MT	2	2	
07-21-76	WY	27	82	
07-27-76	OK	9	29	3
08-04-76	CO	24	58	
08-17-76	NM	61	61	
08-18-76	WY	28	69	1
10-18-76	AK	1	1	
10-13-76	LA	6	11	1
11-14-76	MT	10	22	
10-20-76	WY	18	54	

Summary of Low, Noise Bids Received for Bonus Bid Leases

SALE DATE	STATE	NUMBER OF BONUS BID LEASES RECEIVING BIDS	NUMBER OF BIDS RECEIVED	NUMBER OF LOW, NOISE BIDS
10-21-76	ND	1	6	
01-18-77	NM	26	108	
01-19-77	WY	20	47	
02-15-77	OK	2	4	
03-08-77	MT	2	6	
03-09-77	OK	21	76	4
03-23-77	WY	32	149	2
04-06-77	AK	1	1	
04-06-77	CO	17	75	
04-06-77	LA	2	4	
05-18-77	KS	1	2	1
05-18-77	WY	19	86	
06-15-77	UT	8	8	
08-09-77	OK	23	101	12
08-17-77	KS	3	6	
08-17-77	WY	21	77	
09-13-77	UT	25	54	
09-20-77	MT	22	37	
09-20-77	ND	4	10	
09-20-77	UT	42	165	
10-19-77	KS	7	11	
10-19-77	WY	15	60	
12-14-77	NE	23	91	

APPENDIX D

POOLED STANDARD DEVIATIONS OF BIDS

BY SALE DATE

(3 pages)

Sale Date	State	No. of Leases Receiving 2 or More Bids	No. of Bids on Leases Receiving 2 or More Bids	Sale Pooled Standard Deviation σ_s
8-15-72	OK	2	4	1.206
8-30-72	KS	2	5	.8103
8-30-72	WY	8	17	.6831
9-27-72	AK	8	24	.7277
9-27-72	CO	8	16	.9442
12-04-72	UT	33	112	.6970
12-20-72	CO	8	18	.5274
12-27-72	WY	10	28	1.116
1-16-73	OK	6	19	.5738
3-20-73	NM	46	302	1.091
4-10-73	OK	11	32	.6840
4-14-73	LA	1	3	.2646
4-18-73	WY	11	38	.7671
5-23-73	WY	14	28	.7001
6-05-73	NM	3	38	.6731
6-13-73	CO	1	2	.3486
6-20-73	WY	15	57	.8276
7-11-73	CO	1	2	.8974
8-15-73	CO	5	12	.9147
8-22-73	WY	8	31	1.121
8-29-73	LA	2	4	1.648
9-05-73	CO	1	2	1.770
9-11-73	OK	5	13	.7182
9-19-73	CO	9	23	.5881
10-16-73	NM	18	115	1.323
10-17-73	WY	7	15	.5013
10-30-73	MT	8	20	.9822
11-21-73	CO	2	6	.7351
12-19-73	WY	12	33	1.115
1-15-74	OK	4	12	1.143
1-24-74	UT	1	3	1.035
2-06-74	CO	7	22	.8213
2-20-74	WY	28	97	1.093
3-06-74	CO	3	8	.5884
4-10-74	CO	6	21	.7022
4-16-74	MT	35	83	.8545
4-17-74	WY	20	40	.4162
5-15-74	CO	2	7	1.270
5-22-74	WY	9	20	1.133

Sale Date	State	No. of Leases Receiving 2 or More Bids	No. of Bids on Leases Receiving 2 or More Bids	Sale Pooled Standard Deviation σ_s
6-26-74	UT	2	4	.7638
7-10-74	MT	3	8	.6756
7-17-74	KS	2	4	.8425
7-17-74	WY	10	25	1.126
8-15-74	OK	5	16	.7471
8-21-74	KS	1	5	.9590
8-21-74	WY	15	47	1.327
8-22-74	NM	70	291	1.265
8-27-74	ND	3	23	1.095
9-17-74	TX	1	3	.7036
10-23-74	WY	17	68	1.310
11-06-74	CO	6	18	.9432
11-18-74	ND	2	6	2.463
12-04-74	CO	9	39	1.355
12-17-74	MT	5	20	.6509
12-17-74	SD	4	8	1.232
1-08-75	LA	1	2	.3352
3-05-75	CO	8	23	.8007
3-11-75	UT	7	18	.7795
3-19-75	WY	27	135	.9465
4-22-75	NM	58	260	1.075
4-23-75	WY	9	24	1.017
4-30-75	AK	4	9	.4427
5-20-75	OK	4	9	.5178
5-21-75	WY	6	15	1.192
6-25-75	WY	18	64	1.264
7-08-75	MT	2	7	.7300
7-09-75	AK	17	97	.8603
8-19-75	ND	4	10	1.817
8-20-75	WY	13	27	.9560
10-08-75	CO	14	37	.6528
10-21-75	MT	3	11	1.825
10-21-75	OK	17	66	1.339
11-18-75	ND	3	15	1.872
12-09-75	UT	8	29	1.046
12-17-75	WY	8	27	.8992
1-27-76	MT	1	2	1.466
2-26-76	OK	4	10	1.690
3-10-76	AK	1	5	1.870

Sale Date	State	No. of Leases Receiving 2 or More Bids	No. of Bids on Leases Receiving 2 or More Bids	Sale Pooled Standard Deviation σ_S
3-10-76	LA	4	13	3.072
3-16-76	MT	1	2	.4630
3-23-76	ND	4	22	1.334
3-30-76	NM	70	334	1.228
4-14-76	KS	1	2	1.768
4-14-76	WY	15	49	1.137
6-08-76	MT	15	42	.6835
6-23-76	UT	1	2	.1425
6-23-76	WY	16	52	1.204
7-21-76	WY	24	79	1.214
7-27-76	OK	6	27	.8526
8-04-76	CO	14	48	1.040
8-18-76	WY	23	63	1.628
10-13-76	LA	1	5	1.303
10-14-76	MT	5	17	.5816
10-20-76	WY	15	51	1.486
10-21-76	ND	1	6	.4986
1-18-77	NM	25	107	1.086
1-19-77	WY	12	39	1.163
2-15-77	OK	2	4	.6946
3-08-77	ND	2	6	1.648
3-09-77	OK	19	70	1.653
3-23-77	WY	27	142	1.194
4-06-77	CO	8	66	1.020
4-06-77	LA	1	3	.7793
5-18-77	KS	1	2	.0150
5-18-77	WY	19	85	.9789
8-09-77	OK	19	85	1.413
8-17-77	KS	2	5	1.238
8-17-77	WY	18	74	1.312
9-13-77	UT	17	46	1.488
9-20-77	MT	9	24	1.579
9-20-77	ND	4	10	1.443
9-20-77	UT	40	163	1.182
10-19-77	KS	3	7	1.365
10-19-77	WY	14	59	1.485
12-14-77	NE	20	78	1.350
All Sales		1250	4708	1.156