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ALTERNATIVE AUCTION METHODS FOR LEASING OIL AND GAS RIGHTS ON MICHIGAN'S PUBLIC LANDS

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Preface

This report is drawn from a study by Douglas J.Krieger, supported by Michigan Agricultural Experiment Station, Michigan State University. The full study is an unpublished Masters thesis for the Department of Agricultural Economics. Assistance and cooperation by personnel of the Lands Division of the Michigan Department of Natural Resources were instrumental to completion of this study. Special thanks are due Mr. Roland Harms and Mr. David Freed of that Division.

The manuscript was reviewed by Dr. James Oehmke form the Department of Agricultural Economics and Dr. Peter Kakela from the Department of Resource Development, both at Michigan State University. Their comments and suggestions helped produce what is hopefully a useful report. The reviewers should not, however, be held accountable for the final product.

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Chapter One

Introduction

This report focuses on the transfer of exploration and development rights to oil and gas deposits on state owned lands in Michigan. Emphasis is on possible consequences of different mechanisms used to allocate these rights. Federal and state governments in the United States do not often engage directly in the exploration for or development of oil and gas resources. Exclusive rights to these resources are generally granted to private developers. The manner in which the transfer of rights from public to private hands takes place would be expected to have some effect on the way in which these rights are allocated between interested parties and on the way in which development takes place. Information about how different institutions governing these transactions affect government objectives and the satisfaction of public preferences will be important to government decision makers.

These issues are particularly relevant in Michigan for two reasons. First, the State of Michigan ranks twelfth in the nation in the production of both oil and gas with over 31 million barrels of oil and over 142 billion cubic feet of gas produced in 1984. Secondly, Michigan has more land under state jurisdiction than most states east of the Rocky Mountains. Revenues from oil and gas development in the state could contribute substantially to the state treasury. Diversification of the economic base is important in a state that is often seen as being too dependent on heavy industry. In 1984,

revenues to the state from bonus and royalty payments on oil and gas developments amounted to over 58 million dollars (Table 1-1).

Table 1-1

Revenues From Oil and Gas Production on State Owned Lands

Years	Royalty ($)	Rental ($)	Bonus ($)	Other* ($)	Total ($)
1927-1931	85,262	43,821	27,707	1,204	157,995
1932-1936	209,125	205,349	87,211	4,506	506,192
1937-1941	1,302,355	724,330	515,705	7,367	2,549,758
1942-1946	1,645,462	2,021,512	601,065	3,759	4,271,799
1947-1951	1,813,632	2,256,913	1,307,470	4,398	5,382,414
1952-1956	2,727,410	1,989,342	256,186	3,028	4,975,967
1957-1961	1,879,927	769,593	475,840	3,702	3,129,063
1962-1966	1,259,162	1,476,949	409,809	4,982	3,150,902
1967-1971	2,160,038	3,258,088	2,168,524	6,009	7,592,661
1972-1976	31,651,761	5,998,726	18,339,720	9,979	56,000,186
1977	13,327,908	1,190,619	357,005	3,069	14,878,602
1978	18,244,756	1,131,238	14,483	1,733	19,392,210
1979	24,269,564	1,100,306	1,414,667	1,047	26,785,584
1980-10/1	24,488,630	1,015,879	-2,982	1,679	25,503,206
10/80-10/81	44,912,755	1,216,258	32,277,235	1,860	78,408,109
10/81-10/82	45,802,471	908,025	10,304,780	17,715	57,032,992
10/82-10/83	49,142,835	790,225	630,029	21,759	50,584,849
10/83-10/84	49,978,858	1,215,116	7,513,180	33,099	58,740,225
Totals ($)	314,901,920	27,312,297	76,697,639	130,895	419,042,752

* This column is the sum of application and assignment fees

Source: Department of Natural Resources (1984)
Oil and Gas Leasing in Michigan

Further, Michigan gains from the development of privately held deposits through the payment of taxes. In 1982, production from private lands accounted for almost 23 million barrels of oil and 110 billion cubic feet of gas, accounting for 73% of the oil and 77% of the gas produced in the state (Department of Natural Resources, 1984). Severance tax payments on oil and gas development totaled over $75

million in 1984. [1] Choice of institutions to transfer publicly held resources to private hands will affect the manner in which private landholders bargain with developers.

The state of Michigan owns the surface and mineral rights to 3.8 million acres of land and the separate mineral rights to an additional 2.1 million acres. Although leasing of great lakes bottomland for oil and gas production is currently prohibited, the state also owns 25 million acres of such land that could become available for lease in the future.

The recovery of hydrocarbon resources from state lands in Michigan takes place under the provisions of Act 17, P.A. 1921, as amended, and Act 280, P.A. 1909 as amended. These acts provide for "... management of land and mineral resources to ensure protection and enhancement of the public trust". In addition, regulations have established the director of the DNR as the supervisor of wells whose duty it is to provide day to day enforcement of "...all matters relating to the prevention of waste...and to the conservation of oil and gas in the state" (Patric and Kakela, 1982a). The policy of the state in leasing oil and gas rights is specifically stated as follows.

> It shall be the policy of the Natural Resources Commission to provide for orderly development of state-owned hydrocarbon resources, to encourage the private sector rather than the state to risk capital in exploration and development, to optimize revenue from state-owned hydrocarbons consistent with other natural resource management objectives, and to provide for regular and systematic review of the oil and gas leasing program.
>
> Oil and gas leasing and development on public lands shall be established in a manner to assure (1) optimum economic return to the state, (2) competition for the acquisition for leases, (3) protection against drainage of hydrocarbons, and (4)

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[1] "Michigan's Oil Exploration-Production Industry at a Glance", Michigan's Oil and Gas News, May 24, 1985, pp. 24

> protection of the environmental, recreational and other uses of the land, including lakebottoms and connecting bays harbors and waterways. (Department of Natural Resources, 1982a)

Current Procedure

The leasing of oil and gas rights on state lands in Michigan falls under the jurisdiction of the Lands Division of the Department of Natural Resources (DNR) with lease sales held two or three times a year depending on demand. Tracts to be leased are nominated by interested parties. Nominations are reviewed by the DNR to determine the desirability of leasing and any lease restrictions that might apply. Leases are sold primarily through an auction method although provisions exist for direct sales under certain conditions. The auction specifies a reservation price, the minimum number of bidders required on a tract, the way in which bids are accepted and the object of the auction. The lease, once purchased by auction, further specifies the term of the lease, the conditions of reimbursement for resources actually recovered under the lease, regulations governing specific development practices and lease assignment regulations. Some in the DNR are concerned that the auction method and lease terms currently in use may not be suited to the attainment of leasing objectives. This report examines the possible consequences of alternative auction methods and lease terms.

Measures of performance of alternative auction procedures must be identified. The consequences of different auction methods are often stated only in terms of revenues to the seller. Auction methods also affect the distribution of leases between various types of prospective buyers, the manner of development or the distribution of risk and

benefits between the parties to the sale. This report considers a number of performance criteria in addition to returns to the seller. The choice of these criteria is based in part on concerns expressed the DNR in their leasing policy.

Chapter Two

A Conceptual Framework for Research

This study will employ the situation-structure-conduct-performance (SSCP) paradigm that was introduced in the field of industrial organization and adopted by the institutional economists. This framework suggests that there is a causal connection between the situation in which a market operates, the structure of the market, the conduct of market participants and subsequent performance. The purpose of this chapter is to adapt the SSCP paradigm to the leasing of rights to oil and gas resources. It is hypothesized that variations in the rules of leasing will affect the substantive performance of the leasing program in terms of the distribution of leases, the allocation of the benefits of hydrocarbon development and other performance variables.

Market Situation

The situation refers to the characteristics of oil and gas that create interdependence among users. Included are the current demand and supply conditions for oil and gas, certain characteristics of the resource itself and the technology available for its development and use.

The physical characteristics of oil and gas resources are particularly important for institutional design. Deposits of oil and gas lie underground, sometimes at considerable depth, and their fluid

nature allows them to migrate through the porous rock in which they occur. The technology of exploration is inadequate to detect deposits with any great degree of accuracy before actual drilling takes place. Since drilling is very expensive, and in most cases prohibited before the sale of the lease, information costs concerning the value of a lease are very high. High information costs contribute to a great deal of uncertainty about lease value for both the buyer and the seller.

There is also uncertainty caused by the time frame of oil and gas development. Once a sale is made it may take years (the state allows seven) to develop the lease and begin the recovery of oil or gas. Once production has begun it may take many more years to deplete the deposit. Purchasing decisions are made using an estimate of the value of the resource which incorporates the expected future value of any oil or gas recovered. The likelihood that actual prices will deviate from those expected adds to the uncertainty inherent in the purchasing decision.

Another important situational characteristic of oil and gas resources is the fluid nature of the deposits. The uncertainty involved in locating deposits creates problems in linking the rights to underground deposits to the surface rights in which leases are sold. If a deposit is found to lie under surface areas for which the development rights are held by two or more parties, the fluid nature of the resource can lead to problems in development. A party who pumps at a faster rate than others can draw oil from under adjacent claims. From an engineering standpoint, there is an optimal rate at which oil or gas can be extracted from a well to maximize total recovery. Too great an extraction rate will significantly reduce the

total resource recoverable. The fluid nature of the resource in effect creates non-exclusive rights to the deposits and, coupled with the engineering realities, can lead to a form of the "tragedy of the commons" (Hardin, 1977). The maximizing actions of each developer on the field will result in a substantially reduced total recovery from the deposit.

The situational variables define the environment within which structural alternatives must perform. The most important consideration from the standpoint of this study is the degree of uncertainty faced by both parties to the transaction. Most states, as sellers of rights to publicly held oil and gas resources, do not engage in activities to estimate the value of leases prior to sale. Louisiana is the only exception. The seller, therefore, faces more uncertainty than the buyer concerning the value of the lease and relies on the method of sale.

Institutional Structure

Given the interdependence described by the situation, the structure of institutions defines the property rights of individuals. It imposes some order on the interdependence. In the oil and gas lease market the rules that govern the leasing of rights to oil and gas resources define the property rights accruing to the parties with an interest in the lease.

The most common institutional arrangement for the allocation of property rights to oil and gas resources is the auction. This study distinguishes between two types of auctions, oral and sealed-bid. In a sealed bid auction all prospective buyers submit sealed bids which

are then opened simultaneously and the winner announced. The winning bidder pays the amount of his bid. In an oral auction progressively higher bids are accepted orally until only one bidder remains. An important difference between the two methods is that in an oral auction, bidders have the opportunity to alter bidding behavior in response to the actions of others. Auctions are also differentiated by the object of bidding and the method of payment, the most common for each being the bonus or royalty. These variables specify the units of bidding and how the seller is to be reimbursed for the object that is sold. While only one is usually the object of bidding, both can be used together for actual payment.

The bonus is an initial payment, made at the time of sale, for the right to develop a specified surface area and is usually defined as a price per surface acre. The bonus payment bears no relation to the actual amount of oil or gas that may be discovered under the surface leased. The royalty is specified as a percentage of the wellhead value of resources recovered under the lease. Total payment will depend on the amount of the resource recovered and its price. Although the bonus and royalty are often used separately, it is also common in oil and gas leasing to use both a bonus and a royalty, with the bonus being the object of bidding and the royalty set at a specified level as an additional payment vehicle. Since the bonus and the royalty are used as partial payment for the same object it would be expected that their ultimate magnitudes would be inversely related -- the higher the royalty rate specified in the lease the lower the expected bonus bid, other factors held equal.

The primary differences between the bonus and the royalty as objects of the bidding are in the timing of payments and the sharing

of risk. Payments under a bonus scheme are made in full at the time of sale. Royalty payments, on the other hand, are made only when and if actual recovery takes place.

When the bonus is the exclusive method of payment, the buyer assumes the risk of finding no recoverable deposits. Under this scheme the seller is paid the same amount regardless of whether oil or gas are discovered. The buyer, on the other hand, may pay the bonus and find no recoverable deposits. The buyer under a royalty payment bears less "dry hole" risk. If deposits are not discovered the buyer has still lost the cost of exploration but has paid nothing for the lease. A royalty is often seen as a way to shift the dry hole risk to the seller who bears a different sort of risk than the buyer. The risk to the seller with a royalty is that no payment will be received on an unproductive lease where a bonus payment would yield revenues. The most common case is a bonus bid with a specified royalty which shares the risk between the two parties, with the actual share borne by each determined by the relative size of the two payments.

Participant Conduct

Individual and group behavior provide the link between institutional structure and market performance. Knowledge of how economic actors usually behave when confronted with the incentives and penalties of institutional structure is essential to the accurate prediction of performance. The behavioral models of economics generally assume that individuals behave rationally. They act to maximize utility. While these models often assume perfect information the expected utility hypothesis (EUH) has been used to create a model

of rational decision making under uncertainty that has gained wide acceptance in economics and has been applied frequently to oil and gas markets.

The development of the EUH is usually credited to Bernoulli who introduced the concept of utility and hypothesized that individuals make decisions based not on money but on the utility that they can obtain from it.

> "...in their theory mathematicians evaluate money in proportion to its quantity while, in practice, people with common sense evaluate money in proportion to the utility they can obtain from it." (Bernoulli, 1738, pp. 33)

Bernoulli goes on to propose a decision rule stating that individuals act so as to maximize the expectation of utility rather than income or profit.

If individuals make choices based on utility then individual reactions to risk can be explained in terms of the individual utility function and three separate cases can be explored -- risk aversion, risk neutrality and risk loving behavior. A risk averse individual is one who would have to be bribed to accept a fair gamble. To this person there is a cost associated with bearing risk. A risk loving individual, on the other hand, gains some utility from risk and will accept an unfair gamble without payment. The third type of individual is risk neutral and will accept a fair gamble, and any that are better than fair, prospects are evaluated on their mathematical expectation.

Chapter three of this report addresses the issue of behavior in auction markets.

Leasing Performance

The performance of leasing institutions has many aspects and measurement must facilitate the identification of real changes attributable to these institutions. Traditionally performance has been measured as revenue to the seller and the capture of economic rent while the distribution of leases among buyers received very little attention. Questions of distribution do not address final impacts but are related to broader issues of performance. It is conceivable, for instance, that the way in which leases are allocated among different types of buyers will affect the development of the lease or employment in the region.

From the seller's perspective, a relevant measure of the performance of auction alternatives is the capture of the economic rent associated with the oil and gas resource. Economic rent is defined as the surplus paid to a factor of production exceeding the minimum amount necessary to call forth its services. The economic rent associated with oil and gas resources would consist of any revenues from the lease that exceeded the amount necessary to produce and market the oil. Costs of exploration, development, risk bearing and a return to the developer on invested capital would be subtracted from revenues to determine rent.

Economic rent in oil and gas markets arises from differences in recovery costs of deposits (Howe, 1979). Demand may be sufficient to support the development of deposits with varying quality or recovery costs. Given perfect information the least expensive deposits will be the first to be developed with more expensive ones following. In this model the price of oil is the cost of recovery from the marginal

deposit, the one with the highest recovery cost. Developers of intra-marginal deposits earn economic rent because development costs are below price.

Perhaps a more significant source of rents in oil and gas markets arises from uncertainty. When location, size, quality and recovery costs are unknown a developer may pay less for a lease than it is ultimately worth and hence earn positive economic rent. The problem in institutional design for leasing under conditions of uncertainty is to extract the economic rent in spite of the uncertainty about its magnitude.

Specifics of the Leasing Procedure in Michigan

Oil and gas have been produced in Michigan for almost 100 years and have been part of a significant industry in the state since 1925, (Patric and Kakela, 1982b). The information in Table 2-1 illustrates the historic development of the oil and gas industry in the state for state lands. Referring to the map of Figure 2-1, the first phase of development was primarily in the Michigan Basin which covers the center of the lower peninsula. In recent years the primary producing area has become the Salina Niagaran trend which in 1980 yielded 73% of the state's oil and 85% of the natural gas. The Salina Niagaran trend, which runs northeast across the northern lower peninsula, is thought to have reached its production peak and some interest has shifted to the application of new extraction technologies in previously abandoned fields. In 1980 a large natural gas find was located in what is known as the Mid-Michigan Gravity High which is a formation at almost the 11,000 foot depth that runs from south of

Detroit to the Traverse City area. Figure 2-2 illustrates the location of oil and gas fields relative to land under state jurisdiction.

Table 2-1

Oil and Gas Production on State Lands

Years	Oil Production (barrels)	Gas Production (1,000) cubic ft.	Acreage Under Lease
1927-1931	555,101	----------	----------
1932-1936	1,665,578	220,620	27,120
1937-1941	9,810,671	732,423	160,473
1942-1946	8,270,928	2,315,755	291,644
1947-1951	5,277,096	5,085,920	446,021
1952-1956	7,272,536	5,161,244	933,531
1957-1961	4,543,205	8,354,698	264,725
1962-1966	3,146,716	6,974,406	438,539
1967-1971	5,337,231	6,497,155	284,651
1972-1976	21,324,223	91,132,019	1,563,465
1977	8,980,542	33,329,183	1,643,488
1978	7,936,277	41,310,258	1,535,088
1979	9,228,560	37,898,681	1,666,320
1980-10/1	1,185,380	29,786,521	1,584,850
10/80-10/81	8,229,847	39,188,686	1,707,986
10/81-10/82	8,450,258	32,296,848	1,888,286
10/82-10/83	8,901,078	18,298,733	1,841,761
10/83-10/84	8,488,415	39,343,217	1,693,189
Totals	128,674,097	397,926,372	

Source: Unpublished figures collected by Michigan Department of Natural Resources

There are currently about 490 companies or individuals that are active producers of oil or gas in Michigan, although an average lease sale draws thirty to fifty participants. Developers range from private individuals and small local firms to representatives of the major oil companies. In a sale held in December of 1984, for

instance, there were 75 registered bidders, 55 of which were from Michigan. Also among the bidders were representatives of such major out of state oil companies as Shell, Amoco and Atlantic Richfield. It might be expected that the ability to obtain a lease would differ among the various types of bidders and leasing institutions will need to account for this if allocation is important to the performance of the leasing program.

The Auction System in Michigan

The State of Michigan currently conducts two or three sales of oil and gas leases annually with the tracts offered chosen from lands nominated by the industry. Nominated lands are reviewed by the DNR in order to determine whether they will be offered for sale and if so under what conditions. The state distinguishes between development and non-development leases. The former are those that allow exploration and development activities on the surface of the land area covered by the lease. Non-development leases, on the other hand, restrict these activities because of environmental or other concerns. Leases are classified as non-development if they fall within parks, state forest campgrounds, natural or wilderness areas or areas with unusual natural or recreational values where these would be disturbed by oil and gas development.

Lease sales in Michigan are held by oral auction with a bonus as the object of bidding and a specified royalty. Professional auctioneers are hired by the state and, starting at the reservation price of ten dollars per acre, they elicit progressively higher bids until only one bidder remains who pays the amount of his bid. If

Figure 2-1

Oil and Gas Producing Areas in Michigan

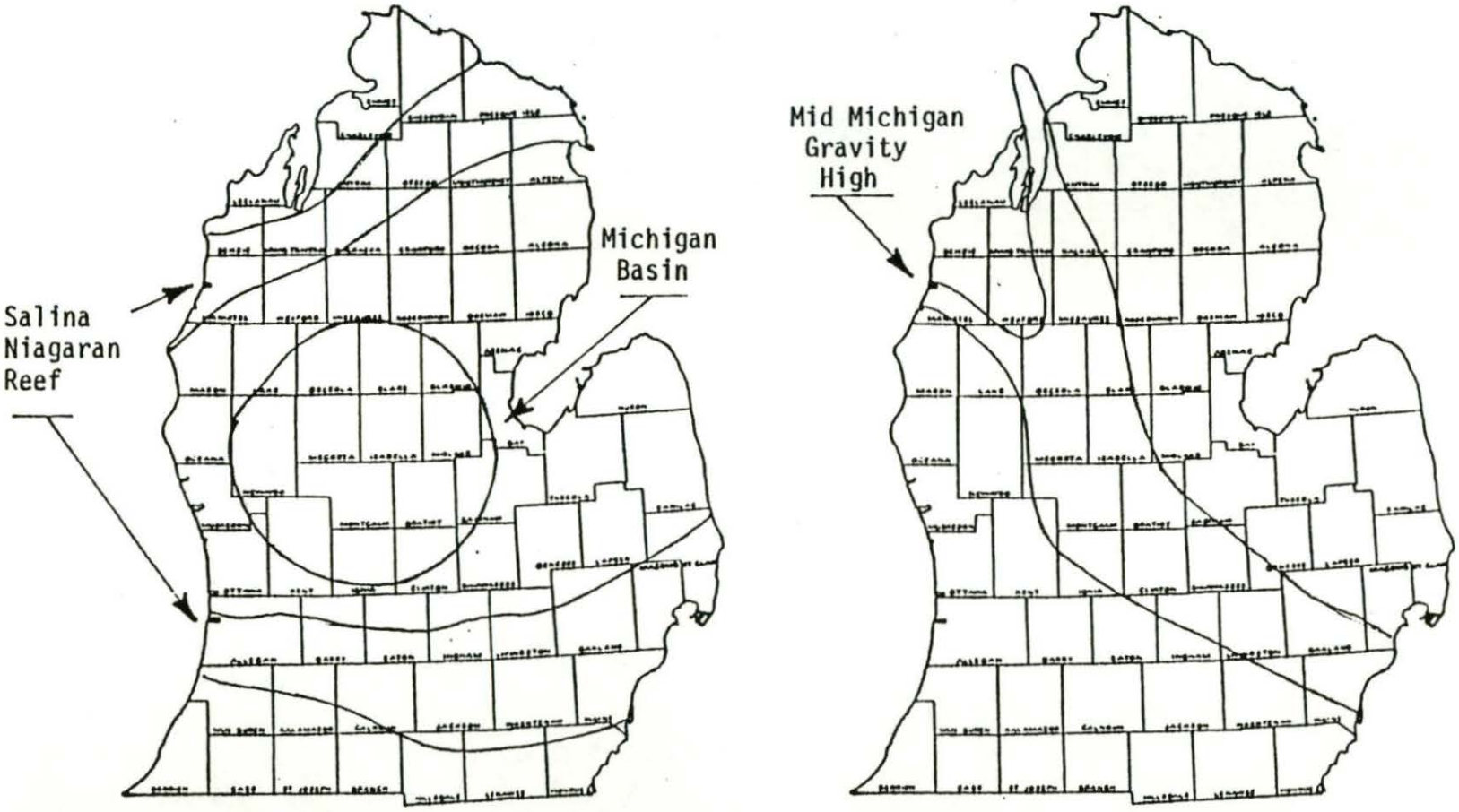

Figure 2-2

State Lands and Oil and Gas Fields --
Michigan's Lower Peninsula

there are no bidders willing to offer the reservation price the tract is not sold.

The lease specifies further conditions of the sale and reimbursement to the state for oil and gas recovered. The lease currently in use in Michigan specifies a term of seven years during which oil and gas must be found if the lease is not to revert to the state. If oil and gas are found within the seven year period the lease extends for as long as oil or gas are recovered in paying quantities. The lease specifies a royalty rate of 16.66% (1/6) of the wellhead value of oil or gas produced. Beginning in the third year of the lease term a rental of two dollars per acre will be required. Once a producing well of oil or gas is established the rental is no longer required.

Michigan Leasing Objectives

Specific objectives of the leasing program are stated as being, (1) optimum economic return to the state and, (2) competition for the acquisition of leases. These stated objectives are too vague to be operational measures of performance and may confuse intermediate objectives with ultimate goals. Discussions with managers of the state leasing program have refined these objectives and turned up other concerns that will be reflected in the measures of performance used in this study.

The concern with an optimum economic return to the state is primarily aimed at the concept of economic rent or a "fair" price for the lease. Auction models generally imply that competition is a necessary condition for the capture of the full economic rent and the

concerns of the DNR in this area again seem motivated by the concept of a fair price. One component of performance that will be used in this study will be the capture of economic rent. Due to difficulty in the measurement of economic rent, the analysis of this component of performance will rely on theoretical models in describing the link between institutional structure and rent capture given the situation in Michigan.

Oil and gas development is big business in Michigan and is an important aspect of the state economy (Patric and Kakela, 1982b). Oil and gas activities brought around $494 million to the state in 1984 in the form of bonus payments, royalties and severance taxes. Further, oil and gas development creates employment opportunities. It is estimated that approximately 21,000 individuals in Michigan depend on the oil and gas industry for their livelihood.[1] It is conceivable that the allocation of leases between different types of firms (local, national or international) may affect the employment of Michigan residents in the industry and the tax revenue and other benefits to the state.

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[1] "Michigan's Oil Exploration-Production Industry at a Glance", Michigan's Oil and Gas News, May 24, 1985, pp. 24

Chapter Three

Bidding and Auction Theory

In general the theory of auction markets focuses on the structural characteristics of markets and the preferences of participants and how these affect performance given the assumption of rational economic behavior. The distinguishing characteristics addressed in this report have been chosen to reflect the emphasis of the literature and the interests of the DNR. The issues addressed here are auction method (oral vs. sealed-bid), auction objects (bonus and royalty), multiple object auctions, asymmetric information, reservation price and risk aversion.

The Common Values Model

The model most applicable to the analysis of markets in mineral leases is the common values model. This model assumes that the object of the auction has a common, although unknown, value to all bidders where each bidder may have a different estimate of this value. In addition the model usually assumes that bidders make independent and unbiased estimates of the value of the object of the auction. This means that the valuation of one bidder is not related to the valuation of others and the expected value of a bid is equal to the true value of the object.

In the common values model with an oral auction and the assumption of symmetry, in which all bidders have equal costs and can be

considered identical, the winning bidder will be the one with the highest value estimate (Rothkopf, 1969). The actual amount bid will depend on the bidding strategy chosen which is a function of the number of bidders. In this case the bidding strategy is to bid a fraction of the estimated value of the object. An additional result is that the expected selling price converges to the true value of the object as the number of bidders becomes large (Wilson, 1977).

One result of the symmetric common values model described above is what has been referred to as the "winner's curse", (Capen, Clapp and Campbell, 1971). Bidders value estimates in this model are assumed to be independently drawn from a common known distribution. The resulting valuations are unbiased estimates of the true value of the object, implying that some estimates are higher than the actual value and some lower. Since the winner is the one with the highest valuation he is the one who overestimates the true value by the greatest amount. Consequently the winning bidder would be expected to pay more than the object is worth.

The winner's curse result illustrates the importance of information in auction markets. Winning an auction is an informative event in itself and when this source of information is accounted for in the context of the sealed-bid auction bidders will revise their bidding strategies and eliminate the winner's curse (Reece, 1978). Such strategies lead to non-aggressive bidding behavior where optimal bids fall as the expected number of bidders increases. This is an intuitive result, if a bid wins against a large number of competitors it is more likely that the object has been overvalued.

In the common values model the oral auction generally leads to higher prices than the sealed-bid auction (Milgrom and Weber, 1982).

This result stems from the information about other bidder's valuations that a bidder can gain in the course of an oral auction. This type of information weakens the winner's curse and can lead to more aggressive bidding in the oral auction. The structure of the auction can enhance or impede the transmission of information among bidders and this is the major reason why the distinction between oral and sealed bidding is a useful one. In terms of expected prices the auction methods can be ranked with the oral auction first followed by the sealed-bid auction (Milgrom and Weber, 1982).

The above ordering of auction methods in terms of expected prices depends on the assumption of competitive behavior among bidders. Collusion in auction markets will tend to depress prices. The choice of auction method can facilitate the policing of collusive behavior by the bidders and, if collusion is present, can affect the level of prices received by the seller. In an oral auction bidders can observe who is bidding and can identify, and later punish, cheaters on a collusive agreement. In a sealed bid auction, on the other hand, the identity of bidders is not known and collusive agreements will be more difficult to police.[1] In the presence of collusion the auctions can be ranked in the reverse order, the sealed-bid followed by the oral auction (Mead, 1977).

Alternative Auction Objects

In terms of a symmetric common values model the amount of rent

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[1] This result assumes a single sale, with repeated sales including the same bidders a cheater on a collusive agreement can be identified once sale results are announced and can be "punished" at a future sale.

captured by the seller is, in part, a function of the uncertainty associated with the value information of the bidders. Regardless of the level of uncertainty, however, the royalty dominates the bonus as an auction object in terms of rent capture (Reece, 1979). The comparative advantage of the royalty is greater when the number of bidders is low and the uncertainty high.

The royalty as the method of payment, however, leads to a host of inefficient production decisions. The physical characteristics of oil and gas wells dictate that production costs rise as the age of the well increases. In the context of the discussion of economic rent as presented by Howe (1979), as production costs rise the amount of rent falls. At the point that rent becomes negative, when marginal extraction costs exceed marginal revenues, the rational developer will cease production. A royalty payment acts as a tax or a deduction from marginal revenue. The larger the amount of the royalty the greater the deduction from marginal revenue and the earlier abandonment will occur. A lower royalty, or a form of payment that does not affect marginal revenues, such as a bonus, will result in greater recovery from each well.

While the literature addresses the bonus versus royalty question in terms of the optimal sharing of risk between the two parties to a lease the concept of time preference is not introduced. Time preference refers to the preference of an individual for consumption (money) in the present as opposed to the future. The time preference of an individual may depend on a number of factors such as current wealth or expectations. The higher a person's time preference the higher current consumption is valued relative to the future. The choice between a bonus or a royalty affects the time of payment,

either in the present or in the future. A buyer of leases with a high time preference may prefer to delay payment through a royalty payment scheme. Similarly, the time preference of the seller will affect his preference for payment forms.

Multiple Object Auctions

Most auction models consider the auction of a single object while the common practice in many auction situations, including oil and gas leases is to auction a number of objects at a sale. Very little work has been done on the theory of multiple-object auctions but some results are available.

There are two types of multiple-object auctions that are important in the context of this study -- the simultaneous-independent auction and the sequential auction (Weber, 1983). A simultaneous-independent auction describes the case where the bidders must act simultaneously in a number of auctions where the outcome of each sale is independent of the outcomes of the others. The sealed bid auctions of mineral rights are a good example of this sort of auction. The the sequential auction is one in which the multiple objects are sold sequentially with each sale concluded before another is begun as in the sale of mineral leases by oral auction.

The simultaneous-independent auction is the one that most closely corresponds to the typical sealed-bid oil and gas rights auction. An important consideration is that bidders risk winning more objects than they desire. Since the sales are simultaneous a bidder does not have the choice of submitting contingent bids with the condition that winning a particular object negates all other bids. This is a major

drawback of sealed-bid auctions of multiple objects and particularly when bidders face budget constraints (Rothkopf, 1977). With a sequential auction, because bids are made with full knowledge of the outcome of the sales of previous items, a bidder always knows the extent of his commitments. Bidders would likely prefer to sequential to simultaneous and oral to sealed bid, auctions if they face constraints on the size of their bidding budget.

Asymmetric Information

A common assumption in many bidding models is that all bidders have access to the same information concerning the value of the object of the auction. Different valuations and bids in this case are a result of differences in interpretation of the available information. It seems reasonable to assume that in most cases bidders do not have access to the same information about lease values because of the cost of such information or because of information monopolies (Reece, 1978). Furthermore, the results of seismic tests are very sensitive to the procedure used. Two firms could carry out tests on the same tract and obtain very different results. Information monopolies may occur when a firm develops tracts already under lease. The information gathered from these leases may yield significant information regarding adjacent tracts that may be offered at a later sale. Since this information is proprietary to the firm it may result in an informational advantage in the future sale.

In the context of the sealed-bid auction with asymmetric information a bidder with private information can obtain positive expected profits while restricting the expected profits of less

informed bidders to zero (Milgrom and Weber, 1982; Hughart, 1975). Both of these results, however, depend on a sealed-bid auction that offers no possibility of a less informed bidder learning from the bids of a more informed one. If the auction structure is changed to one in which a bidder is able to revise his bids upward in response to the bids of others, very different results are obtained. In an oral auction, assuming that the less informed bidder knows the strategy of the more informed bidder and that the less informed bidder is risk neutral, there is no strategy available to the informed bidder by which he can profit from his superior information (Hughart, 1975). The two assumptions of the model are crucial to the result. If either is violated the more informed bidder is able to make positive expected profits.

Reservation Price

In many auction situations the seller will specify a reservation price, a price below which the object will not be sold. A reservation price assures that the object does not sell for less than the seller's valuation of that object. While the use of the reservation price protects the seller from loss, some recent studies indicate that the choice of a reservation price may affect not only the minimum price but the maximum as well.

The reservation price represents the lower bound on bids and, in an oral auction, is the level at which the auctioneer begins the bidding. With a reservation price set higher than the seller's valuation there is a chance that the seller will retain an object that a bidder values more highly. While this represents a risk of loss to

the seller it may be optimal, under certain conditions, to bear this risk (Meyerson, 1983; Robinson, 1984; Riley and Samuelson, 1981).

In the common values model the expected value of the object to a bidder will depend on the number of bidders and their value estimates since the "winner's curse" must be considered. In this model the optimal reservation price depends on the expected value of the object to the winning bidder given the information available to him (Robinson, 1984). Since some auction methods convey more information than others, the optimal reservation price depends on both the number of bidders and the auction type. As the number of bidders increases the expected high bid also increases and the potential gains from a high reservation price are reduced while the potential losses are unaffected. The optimal reservation price is, therefore, inversely related to the number of bidders.

The results given so far depend on the assumptions of symmetry and non-cooperative bidder behavior. In the common values model, the optimal reservation price increases with an increase in the probability of a stable bidder cartel. The logic behind this result is that collusion reduces effective competition and decreases the expected level of a lone high bid. In the extreme case of perfect collusion, there is only one bidder and the reservation price should be set quite high. Similar results would be expected to apply in other cases of reduced effective competition such as the case of informational asymmetry. In an auction where one bidder is thought to have better information than others the optimal reservation price is higher than in the symmetric case (Robinson, 1984).

Risk Aversion

Most auction models consider only the case of risk neutral bidders. Results are modified significantly, however, if risk aversion is considered. A risk averse bidder who faces uncertainty as to the value of an object in an auction would likely discount his bid as the uncertainty increased. If two bidders placed the same value on the object the less risk averse bidder would make the highest bid. To the extent that the choice of auction structure can affect the uncertainty associated with the value of the object it could also influence the bidding behavior of bidders who are not risk neutral.

When risk averse bidders are uncertain of the value of the object of the auction, as in the common values model, additional information may affect their bid. Unless some restrictions are placed on the form of the utility function, however, it is not possible to determine whether expected prices will rise or fall when additional information about the value of the object is made available.

Summary

A wide variety of models of auction markets have been introduced in this chapter. In using the results of these models to prescribe actions in actual auction situations it is important to bear in mind the assumptions that have been made. Actual auction markets will never conform fully to the requirements of a particular model and the results of such a model should not be expected to apply exactly to a real situation. Where actual conditions deviate from model assumptions it is often possible to estimate the probable affect of

these differences on theoretical predictions and hence to provide some guide to actual market outcomes.

Chapter Four

Oil and Gas Leasing in Michigan

Most theoretical models of auctions define performance quite narrowly, almost exclusively in terms of expected revenues to the seller of the lease. Further, bidder behavior is described only in terms of such rational economic behavior as the maximation of expected utility or profit. While these simplifications are understandable in the development of theory it is necessary to go beyond these models in applied work. The purpose of this chapter is to adapt the results of these models to the concerns of the DNR with the oil and gas leasing program in the State of Michigan.

The analysis will focus an specific questions of auction structure that have been raised as concerns by the Department of Natural Resources. Measures of performance will include such variables as the distribution of leases among bidders and the development consequences of structural alternatives.

Auction Method

Some concern has been raised within the DNR that the oral auction method currently in use does not capture the economic rent associated with a lease and that a sealed bid auction should be adopted. The alternative to the oral auction considered for use in the state has been the sealed-bid auction and several bidding experiments have been conducted using this method.

In the context of the common values model auction methods can be ranked in terms of expected revenue with the oral auction first followed by the sealed-bid auction (Milgrom and Weber, 1982). This ranking is a direct result of the oral nature of the sale. When bidders are uncertain of the value of the object they can gain useful information by observing the bidding behavior of others during the course of an oral auction. Extra information weakens the winner's curse and leads to more aggressive bidding in the oral auction. More aggressive bidding leads, in turn, to higher expected prices. The added information also implies a decrease in value uncertainty which would lead risk averse bidders to enter higher bids.

While information about valuation can lead to more aggressive bidding and higher prices it also introduces the possibility that some bidders will act as "free riders". Some bidders may not invest in information but will enter bids based entirely on other's bidding behavior. The money saved on geophysical tests and other information gathering techniques could be used to outbid the competition. This would be more of a problem where exploration costs were very high, as in the offshore markets.

The primary argument against oral auction methods also stems from the accessibility of information. Bidders gain not only information about other's valuation of the lease but also discover who is bidding and the amount of their bid. In an oral auction collusive practices become more easily policed by the coalition. Collusion would tend to decrease effective competition and lower expected prices. In addition to outright collusion, where agreements are made before the sale, the oral auction method allows the possibility of implicit signaling during the sale. A bidder may signal, by his bidding behavior, his

determination to gain a particular lease and other bidders may not compete on the implicit condition that they will receive similar treatment on "their" lease. Discussions with both bidders and auctioneers at Michigan's lease sales indicate that collusive behavior is not perceived as a problem.

Mead (1967) suggests that industry characteristics can influence auction preferences. Resource and industry characteristics may dictate that a firm have access to a reliable source of specific raw materials if it is to generate revenues to cover investments in production facilities. An auction method that provides the opportunity to react to the bidding behavior of competitors gives the bidder greater control over auction outcomes for specific sales and provides greater assurance that he can obtain the needed resource. In the sealed bid setting, as opposed to oral bidding, it is difficult to guarantee that an object will be won and this may cause planning problems for some bidders.

The preference for oral auctions may be weakened somewhat by the presence of alternative sources for the resource. Acquisition of the resource in a public auction will not be as critical if the opportunity exists to purchase from private landowners or from other sources. In Michigan there is a large market in oil and gas leases on private lands and this provides an alternative source of resources for the oil and gas industry in the state.

In certain types of markets the sealed bid auction could reduce the number of bidders for a given lease and reduce the final selling price. In an oral auction bidders can respond immediately to bids offered by competitors and know at any given time during the auction how much money has been spent and which leases acquired. If a desired

lease is not acquired the bidder can reallocate money to the purchase of another lease and be more certain of winning a lease even if not the most desired. Since most bidders do not win every lease that they bid on, bidders will participate in the auction on more tracts than they actually purchase. In a sealed bid auction, on the other hand, once bids are submitted there is no chance to change bidding strategy in response to the number of leases won or the behavior of others.

In a sealed bid situation a prospective buyer will be able to submit bids on a number of tracts, limited by his budget. He will not know until the sale is concluded which leases were won and how much of the budget was actually spent. The effect of this characteristic of sealed bid auctions will depend on the capital limitations faced by the bidder. A small firm would be more constrained in bidding than a larger one with a larger budget and would submit fewer bids. If the number of leases won depends in part on the number of bids submitted on different tracts, which is a reasonable assumption, then limiting the number of different leases on which a buyer can submit a bid reduces his chances of winning a lease. A buyer could, of course, bid on any number of leases in a sealed bid auction and simply default an any unwanted leases so obtained. Since the DNR would take such behavior into account in evaluating the buyer's bids in future sales, however, such a strategy may not be in the buyer's best interest in the long run.

This analysis suggests that if a market exhibits a disparity in size and capital levels among bidders a sealed bid auction would tend to yield an allocation of leases that was biased in favor of the wealthier bidders who could submit a larger number of bids. The market in Michigan consists of large national firms, smaller local

firms, speculators and some individuals or private investment clubs. There is wide disparity among bidders in capital available for the purchase of leases. In terms of an "equitable" allocation of available leases among the prospective buyers in this market it would appear that an oral auction would be preferred. Furthermore an oral auction will allow more bids to be submitted and would be expected to raise the overall level of competition and the level of the winning bids.

While the allocation of leases among bidders is not listed as a specific performance measure by the state, it may be that this allocation will affect other measures of performance. Some types of firms might be more likely to develop a lease in accordance with the state's leasing objectives than would others. Some firms may provide more employment for state residents than others or it may be politically desirable to favor certain firms. If the allocation of leases among different types of bidders is important to the performance of the leasing program then the choice of auction method given the market in the State of Michigan could have significant consequences.

A final consideration in the choice of auction method is the ease of application. An oral auction requires the physical assembly of all prospective buyers and can take a substantial period of time. The oil and gas lease sales in Michigan typically take between two and three days to conduct. Simultaneous sealed bid auctions, on the other hand, do not require the presence of the bidders and the opening of bids and awarding of leases can be accomplished in much less time and at much less expense.

Bidding Objects and Payment Method

The choice of payment method determines, in part, the shares of risk borne by the buyer and by the seller of a lease. When buyers and sellers are risk averse their attitudes towards bearing risk will affect the relative outcomes of alternative payment forms. Payment methods can also affect development of a lease and this may have consequences for the performance of a particular auction market.

Michigan specifically states in selecting the auction method that the development risk be borne by the buyer. While this supports the current use of a bonus as the object of the bid it contradicts the inclusion of the royalty as an additional payment. The use of both a bonus and a royalty achieves a level of risk sharing that is intermediate between either one used alone and the adjustment of the royalty rate can further fine tune the risk sharing. The expected amounts of each of the two forms of payment will be inversely related when the two are used together.

In addition to risk attitudes the relative time preference of the buyer and the seller must be considered when deciding on a payment method. If the seller has a greater preference for current consumption than does the buyer, the seller will prefer a bonus payment method. In a manner analogous to the sharing of risk an "optimal" auction should consider the relative time preference of the two parties.

Besides affecting the sharing of risk between the two parties to a lease sale the choice of payment method may affect some aspects of lease development. The royalty payment acts as a tax on production and will influence the abandonment decision. The higher the royalty

rate the greater the incentive for early abandonment. The affect of the royalty payment on the abandonment decision can be ameliorated through the use of a sliding scale royalty. With this scheme the royalty rate is tied to the amount produced. As a well ages and production drops the royalty rate also falls and premature abandonment is avoided. The time of abandonment will also affect the total revenue ultimately recovered from a lease through royalty payments as it affects the physical output from the well.

The expected price to the seller of a lease would be expected to increase as the share of risk borne by the buyer falls if buyers are risk averse. The seller, in choosing a payment method, must decide on the amount of risk he or she is willing to bear. Other considerations include the cost of monitoring any payment method to insure that the proper payments are being made and the ability to meaningfully compare bids when the payment method is the object of bidding.

Discounting for risk involves applying a discount rate to the expected revenue from a lease. When only a few leases are being developed a firm may not be able to afford to "play the averages" and may be risk averse. Governments, however, that sells thousands of leases can diversify very effectively and would probably increase expected and actual revenues by increasing the amount of risk borne. Increasing the royalty seems an effective way to accomplish this. When using a royalty, however, a sliding scale should be considered to avoid the negative effects on well abandonment and subsequent royalty revenue.

In the case of drainage leases the uncertainty concerning tract value is considerably reduced because of the presence of an adjacent

producing well. The above argument could be used to justify a higher royalty rate on such leases.

Reservation Prices

In setting a higher reservation price, the seller risks not selling an object that a prospective buyer values more highly. While this represents a loss to the seller it may be recovered when a lone bidder places a value on the object that is higher than the reservation price. When several bidders place a value on the object that is greater than the reservation price competition among them will result in a price higher than the minimum. When only one bidder has a value at least as high as the reservation price, however, the seller must rely on the reservation price to increase the bid.

As the number of bidders increases so does the expected level of the high bid. Potential gains from a high reservation price are reduced while the potential losses are unaffected. The optimal reservation price, therefore, is negatively related to the number of bidders. In Michigan's lease sales many leases are sold with only a few, and in many cases only one, bidder active. Few bidders on many sales would indicate that a reservation price should be set that is substantially higher than the state's valuation.

Since bidder's valuations will be affected by auction type and the optimal reservation price is a function of bidder's valuations, the choice of a reservation price will depend on the type of auction. The English, or oral, auction conveys more value information than other auction types, weakens the winner's curse and leads to more aggressive bidding and higher expected prices. The optimal reservation price in

the English auction would be expected to be lower than with the other auction methods.

Summary

The purpose of this chapter has been to suggest some performance outcomes of alternative institutional structures in Michigan's oil and gas leasing program. The analysis has applied the results of the theoretical models of auctions and bidding behavior to the situational characteristics of the State of Michigan. Results of this study can assist the DNR in designing the state's auction market so that the desired performance can be obtained.

Given the nature of the market for oil and gas leases in Michigan the oral auction has some advantages over the sealed bid methods. First, the expected revenue from the oral auction exceeds that from the sealed bid auction when bidder's valuations are dependent, which is a reasonable assumption in mineral lease markets. This is a result of the additional value information provided in the oral auction and the comparative advantage will be even greater when bidders are risk averse. Secondly, in a market characterized by a disparity in firm size and bidding budgets, which is the case in Michigan, the oral auction eliminates much of the advantage of the larger, wealthier firms in winning leases. The allocation of leases among bidders may not be a performance end in itself but may have consequences for other performance measures. The primary disadvantage of the oral auction is that collusive behavior, which can result in reduced revenue to the seller, is difficult to control. Collusion is not seen as a problem in Michigan's sales but is often difficult to detect and the possi-

bility should not be ignored. The oral auction can also encourage free riders but this would be a greater problem when exploration costs are high or where the object of bidding makes up a large share of the total payment. Neither is the case in Michigan.

The choice of payment method determines the shares of risk borne by the two parties to a lease. The optimal sharing of risk will depend on the relative risk aversion of the buyer and seller. When the buyer is more risk averse than the seller the largest expected revenues will result from those payment methods that shift risk to the landowner, the royalty as opposed to the bonus. It seems reasonable to assume, when the seller is a government agency that sells many leases, that the risk aversion of the buyer exceeds that of the seller.

The royalty payment can affect development of a lease through the abandonment decision and this may affect other performance measures used by the state. Sliding scale royalties should perhaps be explored as a means of dealing with these production distortions. In Michigan the bonus is the object of bidding while the royalty, on a producing lease, makes up the majority of the actual payment. Furthermore, when uncertainty is reduced, as in the case of drainage sales, the royalty is increased. This behavior is consistent with the goal of increasing revenue when the seller is less risk averse than the buyer.

Finally the choice of an appropriate reservation price is important to market performance in terms of expected revenue. The setting of a reservation price above the seller's valuation in a mineral leasing model would be expected to increase revenue to the seller. The optimal reservation price will depend both on the number

of bidders and the auction type. The advantages of a high reservation price are most pronounced when competition is least effective which may be the result of few bidders and different levels of information or collusive behavior. In any of these cases a relatively high reservation price would be expected to increase revenue. The optimal reservation price would be smaller in the oral auction than the sealed bid auctions but is still greater than the seller's valuation. While theory suggests that reservation prices should be greater than the seller's valuation, the optimal level must be empirically determined. Results of past sales in the state could be used to determine whether the change in the reservation price has affected revenues.

In conclusion it seems as though the auction structure currently in use in the State of Michigan is well tailored to the market situation to obtain the desired performance. The oral auction is expected to generate a greater revenue than sealed bid methods and yield a less biased allocation of leases. These results are especially relevant in a market, such as that in Michigan, where there is a large difference in bidder size and wealth. A question that needs more attention in this context is the possible performance consequences of the distribution of leases among different types of firms. The use of a royalty in addition to a bonus payment shifts some of the risk of development to the state. Since it seems that the state should be less risk averse than most of the buyers this is consistent with theory.

A Note on Empirical Work

The results of this study suggest that small firms may face

constraints in sealed bidding relative to larger firms. In a market where large and small firms compete for leases these constraints would imply (1) greater competition for leases under the oral bidding structure, (2) higher prices with oral bids and, (3) a different distribution of leases among bidders under the two bidding structures. Given the proper data these should be testable hypotheses concerning the difference between oral and sealed bidding.

Empirical testing of the differences between oral and sealed bidding may encounter several problems. First, because the oil and gas market, and hence the situation under which leases are sold, can change considerably from one sale to the next it would be desirable to collect data on both oral and sealed bids at the same sale. Secondly, the buyers should be familiar with both methods.

The DNR conducted sealed bid experiments in five lease sales. In these experiments fifty leases were sold through sealed bids which were opened at the start of the regular oral sale. Several attempts were made to compare the results of the oral and sealed bids. First an attempt was made to compare the mean prices of the sealed bid group with the leases sold by oral bidding. Bid prices in both groups, however, exhibited considerable variation and it was not possible to draw any statistically significant conclusions from the data. Casual observation suggests that tracts that are geographically close to each other have similar sale prices. The second test compared the selling prices of tracts sold by oral bids with adjacent tracts sold through sealed bids. Again significant results were not obtained.

One possible solution to the difficulty in comparing oral and sealed bidding in terms of the capture of rent may be to examine the historical record of leases that have been sold and developed. Given

the selling price of a lease that has already been developed it may be possible to determine whether the state has captured the economic rent associated with the lease. This could be accomplished by comparing the selling price with the eventual revenues. Unless different auction methods were used in the initial sale, however, the comparison of auction structures in terms of rent capture would not be possible. The historical comparison method described above could also be used to compare the bonus and royalty as methods of payment. To yield useful results, however, there would have to be some variation in actual methods of payment.

While this method may hold some promise it too has limitations. Probably the greatest obstacle to implementation will be the data requirements. In addition to original selling price, historical data on development costs, production, and firm revenues will be required. Since the development takes place over time it will also be necessary to discount revenues and expenditures and the question of an appropriate discount rate will have to be addressed. Finally, the calculation of rent must account for the cost of risk bearing to the developer and a normal return to his investment. These may be difficult to determine.

Given the proper data it may also be possible to test the hypotheses concerning competition and lease distribution. In the sealed bid setting, the collection of information on the number and identity of bidders on each lease is straightforward. If similar information could be generated from the oral auctions it might be possible to determine whether there is a difference between the two methods. The nature of the oral auction, however, makes it difficult to count and identify bidders.

While there are difficult problems associated with empirical tests of these hypotheses, the information gained from such tests could be very useful. Feasible empirical tests of auction markets may provide a fruitful area for future research.

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