

Federal Trade Commission

**The ECONOMIC STRUCTURE
and BEHAVIOR in the
NATURAL GAS PRODUCTION INDUSTRY**

**Staff Report of the
Bureau of Economics**

February, 1979

ECONOMIC STRUCTURE AND BEHAVIOR IN
THE NATURAL GAS PRODUCTION INDUSTRY

by
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Staff Report of the Bureau of Economics to
the FEDERAL TRADE COMMISSION.

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This is a staff report prepared by the Commission's Bureau of Economics. The Commission has not adopted the report in whole or in part. Hence, all statements, conclusions, and recommendations contained herein are solely those of the staff responsible for its preparations.

PREFACE

This study was submitted to the Commission for approval prior to the Natural Gas Policy Act of 1978 and therefore does not take into account changes in natural gas regulation. This act, signed by the President on November 9, 1978, provides for a gradual phasing out of federal price controls on natural gas prices.

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Chapter I

Introduction and Summary

This report evaluates the competitive potential of the natural gas production industry. Attention focuses primarily on seller structure within the gas sector, on both a nationwide and a regional basis. In a behavioral context, charges of monopolistic supply restraint by the major producers are evaluated by examining the ownership pattern of nonproducing leases in the Federal offshore area. Since Federal price regulation has had a pervasive effect on the gas sector's performance up to the present time, the report's objective is not to evaluate the industry's past performance but, rather, to gauge its potential for workable competition in the absence of price regulation in the future.

The chief source of data for analysis is the set of producer responses to the Federal Trade Commission's Natural Gas Survey Questionnaire, issued March 31, 1975. The returns from this survey provide a profile of the largest producers and reserve holders of natural gas as of 1974 and for selected earlier years. Additional information on relevant aspects of the natural gas supply sector was obtained from hitherto confidential surveys conducted by the Federal Power Commission and from extensive reports on Federal offshore operations maintained by the Department of the Interior.

Summary of Findings

The chief findings of this report are the following:

- Seller concentration in the production sector is relatively moderate. Based on either production or reserves, the largest producer's output share ranges from 11 to 12 percent and the 8 largest producers account for approximately 45 percent of output. These figures are similar to the median for all manufacturing and below those levels most commonly identified with monopolistic behavior. Thus, the natural gas sector differs significantly from most industries subject to regulations

specifying a maximum price where technology dictates a highly concentrated seller structure.

- Integration between the production and interstate pipeline sectors is low. As a result, producers face the prospect of potentially strong bargaining pressure from purchasers whose extensive pipeline networks enable them to secure reserves from a variety of different fields. Also, pipelines constitute an important source of potential entry into the production sector. Integration is somewhat higher in the nonregulated (intrastate) sector although not of a level or nature to pose a competitive threat. A significant portion of vertical links in this latter market is accounted for by purchaser interests (primarily industrial and electric utility gas users) in production and transportation facilities.

- Joint venture activity within the industry is extensive and has been increasing. Although such activity is a potential threat to competition, its current level does not appear to create a competitive problem. In general, joint venture contracts among the largest producers have been diverse and of a temporary nature. Future problems in this area have been considerably mitigated by a recent Interior Department ruling which prohibits combinations among eight large producers in bids for Federal offshore leases.

- The Interior Department's influence over both gas supply and seller structure in the Federal offshore sector constitutes an important lever which can be used to stimulate competitive behavior. Interior plays an important role in the determination of gas supply through its formulation of lease sale schedules and through its regulation concerning the timing of development-production schedules for tracts issued in the Federal offshore area. The Department also has an impact on seller structure in the offshore sector through its ability to regulate the form of bidding combines eligible for ownership of Federal leases. The ban on joint ventures among eight large petroleum producers is one example of the form that this authority can take.

- An analysis of ownership patterns for nonproducing leases in the Federal offshore area indicates no evidence of attempts at monopolistic supply control by the major producers. As a group, the eight largest gas producers exhibited holdings of nonproducing leases similar to or less than that of the industry as a whole during the 1963-75 period.

The above findings suggest that the natural gas industry is capable of workably competitive performance in the absence of Federal price regulation. Monopolistic dislocations that may occur in such an unfettered environment appear amenable to antitrust action as well as to the growing influence of Interior Department oversight efforts in the offshore sector.

Plan of Research

Chapter II reviews the salient features of the gas supply sector and develops the analytic context within which it can be studied most fruitfully.

Chapter III surveys nationwide concentration ratios and also examines measures based on regional and jurisdictional considerations. Seller concentration is based on a number of different measurement units: production, proved reserves, new contract sales, and lease acquisition payments.

Chapter IV analyzes the effect of joint ventures on seller structure. Alternative concentration ratio formulas are developed in an attempt to account more realistically for the influence of such combines on seller structure.

Behavioral analysis of producer supply responses to FPC regulation is presented in Chapter V. In particular, allegations of monopolistic supply restraint are evaluated by investigating the ownership pattern of extended term nonproducing leases in the Federal offshore sector.

Chapter VI summarizes the report's chief findings and discusses their implications for public policy.

CHAPTER II

Approaches to the Analysis of Competition in the Natural Gas Sector

The competitive potential of the natural gas production sector is evaluated in this report by analyzing both the structure and the behavior of the industry during the 1955-74 period. A two-stage search for manifestations of monopoly power is utilized: Structural analysis searches for the causes of monopoly and behavioral tests search for evidence of its manifestation.

This chapter outlines the nature and scope of the empirical analysis employed. As with any industry study of this type, the operating environment of the gas sector largely determines the relevant analytical approach. To this end, the first section summarizes the chief characteristics of the gas sector. Succeeding sections then proceed to outline structural and behavioral tests deemed appropriate in such an environment.

1. Relevant Characteristics of the Industry

Exchange

The bulk of natural gas is sold via long-term contracts, typically 10 to 20 years in duration. ^{1/} Normally, a producer explores a lease and determines, by development drilling, the amount of reserves underlying it and the cost of extraction. A sales agreement between the producer and a pipeline company is then negotiated in which the producer agrees to deliver a per annum quantity of gas for the length of the contract. Price levels are usually specified for

^{1/} Federal Power Commission, Natural Gas Survey, Vol. 1 (Washington: U.S. Government Printing Office, 1975), p. 56. See, also, American Gas Association, Gas Rate Fundamentals (Arlington: American Gas Association, 1969), pp. 45, 46.

e length of the contract, typically allowing for fixed periodic increases. 1/
though yearly production volume and contract length are based on the reserves
timated by the producer (at times independently verified by the pipeline company),
e agreement usually entails dedication to the gas purchaser of all reserves
derlying the lease (at least up to a specified depth). A long-term contract
us constitutes sale of the entire gas deposit, the ex ante quantification of
ich is reflected in a reserves estimate mutually agreed upon by buyer and
ler. 2/

The current gas shortage has brought about some variations in these con-
tactual arrangements as buyers have become increasingly concerned about continuity
supply for their pipeline systems. In particular, there has been an increase
the frequency of exploration-financing agreements where gas customers (pipe-
es, utilities, industrial firms, etc.) finance the exploration efforts of
ducers in return for an option to purchase whatever gas is found. Such agree-
ts amount to the dedication (sale) of reserves not yet found.

Gas Production Process

The production of gas encompasses three stages: exploration, development,
extraction. The exploration stage entails the preliminary research designed
discover the marketable gas-bearing deposits. Typically, seismic tests are
formed, followed by geophysical analysis (based on drilling efforts) designed
evaluate the original test results. Once a commercially viable pool is located,
velopment drilling takes place in order to delineate the boundaries of the

For those contracts not regulated by the FPC (i.e., sales in the intra-
e market), there frequently occur "favored nation" clauses stipulating that
contract price be continually adjusted to the prevailing market level. The
utlaws such clauses for contracts under its supervision.

he reserve estimates utilized in gas contracts often vary in their degree
rtainty. See below, pp. 10-12.

gas deposit, its size, and cost of extraction. As the name implies, the extraction stage refers to the relatively straightforward process of extracting the gas from a reservoir at the rate specified by the contract between buyer and seller.

The time consumed by the three stages can vary considerably, depending on the geological characteristics of the area and the amount of activity that has taken place previously in surrounding areas. Lead times entailed in the exploration stage are especially variable since fields initially rejected may be subsequently developed due to new technology or more favorable market conditions. 1/ The development stage is subject to less variation: Production usually takes place within 1 to 6 years from the onset of developmental effort. The productive life of a reservoir typically ranges from 10 to 30 years. 2/

Historically, the direction of gas search efforts has been determined by expected price levels and by the nature of previous exploration and development efforts. The early postwar period, up to 1960, saw a significant expansion in gas demand and a concomitant rise in the finding of new gas fields. During the 1960's, as price regulation, prorationing, and the previous success rate tended to shift supply into the more intensive development of known fields, the discovery of new gas fields decreased significantly. 3/ This latter pattern

1/ M.A. Adelman, The Supply and Price of Natural Gas, supplement to Journal of Industrial Economics, 1962, p. 3. An example of the longrun nature of the petroleum exploration process is given by William Bazeley, "San Emidio Nose Oil Field, California," in Society of Exploration Geophysicists, Stratigraphic Oil and Gas Fields - Classification, Exploration Methods, and Case Histories, Special Pub. No. 10 (Tulsa, 1972).

2/ A more complete analysis of the gas production process is contained in Adelman, op. cit.; and E. Tiratsoo, Natural Gas (New York: Plenum Press, 1967).

3/ See especially research by Edward Erickson: Economic Incentives, Industrial Structure and the Supply of Crude Oil Discoveries in the U.S., 1946-1958/59 (Vanderbilt Ph.d. dissertation, 1968); and "Supply Response in a Regulated Industry, the Case of Natural Gas," Bell Journal, Spring 1971 (with R. Spann), pp. 94-121.

now in the process of reversing itself since the rapid increase in the price of oil and gas, coupled with the demise of prorationing, has significantly increased the expected profitability of extensive gas development. 1/

Relevant Time Period

The gas supply market primarily entails exchange between producers and pipeline transmission companies. In a nonregulated environment, the relevant time period for exchange has been estimated at approximately five years. This is because the prevalence of long-term contracts and the relative stability of demand factors allow the pipelines to estimate their needs well in advance. As a result, they have a number of years in which to satisfy their new supply commitments. 2/ Paul MacAvoy describes the pipeline contracting process as follows:

A new pipeline usually obtains the reserves necessary for certification within one to four years. . . . Once the original reserves are obtained, there is no urgent need for a transporter to purchase replacement reserves until 20 years have passed. Actually it may be least costly for the buyer to purchase reserves equal to 5 years' production every 5 years. (A pipeline usually has the opportunity to take fully explored reserves in its gathering region immediately, or to

^{1/} For a discussion of the nature and extent of future gas exploration, see Federal Energy Administration, U.S. Energy Outlook 1976 (Washington: U.S. Government Printing Office, 1976) pp. 128-159; Oil and Gas Journal, "Where Higher Gas Prices Could Boost U.S. Supply" (April 4, 1977), pp. 47-51.

^{2/} This description refers to an unregulated market situation where supply-demand equality prevails. The current gas shortage has shortened the time horizon of pipelines somewhat since they have been forced to enter into a number of short-term "emergency sale" contracts. On the other hand, pipelines have endeavored to improve their contracting flexibility by negotiating exploration-financing agreements with independent producers. See below, p. 29.

wait 5 years for newly discovered reserves to be ready for sale.) The buyer's market includes most reserves offered in a 5 year period in the established gathering region. 1/

The time perspective of producers, on the other hand, tends to be shorter owing to various pressures placed on them to produce from developed deposits. For example, producers typically are pressured to sell by landowners eager to receive their royalty payments. Such pressure is perhaps greatest in the Federal offshore area where Federal regulations require leaseholders to initiate production within five years of purchase. 2/

Regulation

The most important regulatory influence on the natural gas sector has been that of the Federal Power Commission which has set price ceilings on interstate wellhead gas transactions since 1955. 3/ During the 1955-60 period, the Commission attempted a cost-of-service type regulation that proved largely ineffective due to the large volume of individual gas transactions to be monitored. Effective price control began in 1960 when the Commission adopted an areawide pricing approach with maximum wellhead prices to be determined by rate proceedings conducted for a number of gas producing regions. The increasing complexity of these proceedings, in turn, led the FPC to institute

1/ Paul MacAvoy, Price Formation in Natural Gas Fields (New Haven: Yale University Press, 1962), pp. 54, 55.

2/ Extensions beyond the five-year term are granted if producers can demonstrate that the tract is capable of commercial production and that there are valid technological or marketing reasons for a delay.

3/ Under the Department of Energy Organization Act (PL 95-91, Stat. 565, August 1, 1977) pricing responsibilities of the FPC were transferred to the Federal Energy Regulatory Commission as of Oct. 1, 1977.

a nationwide rate-setting procedure in 1973. 1/ Throughout, the objective of FPC price regulation has been to set a "fair and equitable" price based on the historical record of costs entailed in the production of natural gas.

From 1960 onward, the FPC price ceiling in most instances effectively set the prevailing price in the interstate sector. Since the preliminary area prices set in 1960 were close to those specified after the area rate proceedings were completed, the price of interstate gas remained approximately constant throughout the 1960's. 2/ The first significant price rise allowed by the FPC came in 1971 in a series of area rate redeterminations and new decisions. These increases reflected the FPC's attempt to alleviate the worsening gas supply situation, first highlighted by a significant decline in reported proved reserves in 1968. The continuing deterioration of the gas supply situation has led to additional price rises in subsequent periods. The latest FPC ruling has set the wellhead price of newly discovered natural gas at \$1.42 per m.c.f. 3/

The FPC's pricing jurisdiction encompasses sales by producers to pipelines of gas destined for resale in interstate markets. Nonregulated transactions take place in the so-called intrastate market which primarily encompasses the sale of gas to purchasers who do not transport it across State boundaries. While the interstate sector has traditionally accounted for the bulk of well-head gas sales, it has experienced a significant decline in the past few years

1/ The historical development of wellhead price regulation by the FPC is covered in S. Breyer and P. MacAvoy, Energy Regulation by the Federal Power Commission, (Washington: Brookings Institution, 1974) pp. 56-59.

2/ The weighted average new contract price was 18.2 cents per m.c.f. in 1961 and 19.8 cents per m.c.f. in 1969. The price of alternative energy fuels rose 10 to 25 percent over the same period. P.S. MacAvoy and R.S. Pindyck, The Economics of the Natural Gas Shortage (1960-1980), (Amsterdam: North Holland Press, 1975), pp. 16, 17.

3/ FPC, Opinion 770-A.

due to the increasing relative attractiveness of the intrastate market. As the FPC price ceiling dropped below market levels prevailing in the intrastate sector, new gas supply has increasingly gravitated toward the latter. 1/ For new supplies, the interstate sector has become largely dependent on gas originating in the Federal offshore area; this region is always within FPC jurisdiction. 2/

In addition to the policies of the FPC, gas supply in the Federal offshore sector is significantly influenced by the Department of the Interior which determines the number of tracts to be leased and specifies the timing and manner in which they are to be developed. In particular, Interior regulations stipulate that tracts within its jurisdiction initiate production within five years of their sale. Any producer unable to meet this timetable is subject to forfeiture of the lease unless he obtains an extension. 3/

Resource Measures

The most important resource concept utilized in the natural gas industry is "proved recoverable reserves," defined as those gas deposits estimated to

1/ From 1973 to 1975, over 80 percent of new gas supply was committed to the intrastate sector. Executive Office of the President, Energy Policy and Planning, The National Energy Plan (Washington: U.S. Government Printing Office, 1977), p. 18.

2/ Ibid.

3/ No actual forfeitures have occurred so far. The influence of Federal production timetables in the OCS sector is discussed in chapter V.

be economically recoverable under current market conditions. 1/ This definition, while theoretically vague, has nonetheless become operationally meaningful as the basis for an estimate of gas resources expected to be recovered from fields that have undergone exploratory and developmental drilling. As such, the proved reserve concept is a relatively conservative measure that generally excludes those resource deposits identified by geophysical research that have not yet been subject to extensive drilling activity.

From the standpoint of measuring a producer's capacity to supply natural gas, proved reserves is essentially an ex post concept because the bulk of reserves so classified have already been dedicated to gas purchasers. FPC studies conducted during the 1970-73 period, for example, indicate that more than 95 percent of proved reserves stock in any period was committed via long-term contract and thus unavailable to prospective purchasers. 2/ This situation arises because a tract (especially in the offshore sector) is usually sold before development drilling is completed. Typically a producer's initial proved reserves estimate is used as the basis for the sale of the entire deposit, including those sections not yet drilled. As a result, proved reserves should be considered as a producer's "output"; i.e., those fully developed resources already dedicated to a purchaser via long-term contract.

1/ The American Gas Association definition of recoverable proved reserves is as follows:

". . . The current estimated quantity of natural gas and natural gas liquids which analysis of geologic and engineering data demonstrate with reasonable certainty to be recoverable in the future from known oil and gas reservoirs under existing economic and operating conditions. Reservoirs are considered proved that demonstrated the ability to produce by either actual production or conclusive formation test." American Petroleum Institute, American Gas Association, Canadian Petroleum Association, Reserves of Crude Oil Natural Gas Liquids, and Natural Gas, in the U.S. and Canada, Vol. 28, June 1974, p. 104.

2/ FPC; Uncommitted Reserves Survey, Docket No. R405, reported in FPC Press Release No. 20290, May 19, 1974.

They are, therefore, the end product of his development program, the aim of which is to prepare resources for production.

There does exist a broader class of reserves, generally termed "probable" (or "inferred"), that are intended to encompass partially developed resources not yet ready for production and, in part, not yet dedicated to a buyer. There are conceptual and pragmatic factors, however, which prevent utilization of these estimates in the study of seller market structure. The most immediate problem is that probable reserves are not defined consistently among producers and thus do not allow for interfirm comparison.^{1/} This situation is perhaps inevitable considering the limited information used to develop such estimates. Aside from the measurement problem, probable reserves are difficult to interpret in an economically meaningful fashion since they are part of a heterogeneous group that includes (a) expected low cost reserves which have not yet been developed and (b) partially developed reserves whose high cost has discouraged the producer from further drilling activities at the current time. In addition, sub-categories (a) and (b) are further divided into those resources that are already sold to a purchaser (i.e., reserves on tracts previously committed via long-term contract) and those that are not. 1/

1/ These problems were recognized by a National Gas Survey study group commissioned by the Federal Power Commission. The group's report noted that the term "probable reserves" contained a number of ambiguities and recommended against its inclusion in future resource estimation programs. Emphasis was placed instead on adoption of an indicated reserves concept which would refer to reserves "likely ... [to be]... added in future years to proved reserves in identified fields" (p. 13). A separate category, termed "identified-subeconomic resources" would refer to "known resources not economically producible on the date of estimation" (p. 14). Natural Gas Survey report to the FPC, Report of the Supply-Technical Advisory Subgroup on Gas Reserves and Resources Classifications (Washington, D.C.: U.S. Government Printing Office, 1976).

2. Structural Analysis

The task of structural analysis is to identify within an industry environmental conditions that can lead to monopolistic behavior. The two chief elements of seller structure in an industry are its seller concentration level and condition of entry. Seller concentration measures the degree to which a small number of firms control an industry's productive capacity. It may indicate the degree of interdependence perceived by the major producers among themselves and their possible influence on market price. Ceteris paribus, the higher the concentration level, the greater the expected degree of interdependency among the major producers which in turn can provide a means for them to engage in monopolistic pricing and output policies.

The condition of entry deals with the relative ability of both smaller firms and potential entrants to create new capacity in response to the setting of monopolistic price levels by the dominant firms in the industry. Entry conditions in effect define the longrun monopoly potential of an industry sufficiently concentrated to encourage attempts at monopolistic pricing. High concentration and impeded entry are thus complementary conditions that are necessary for the existence of longrun monopolistic performance.

Most empirical analyses of seller structure have focused on the manufacturing sector. The measurement of seller concentration in such studies is usually based on firms' sales volumes, figures presumed to be adequate proxies for their productive capacities. Determination of an industry's condition typically entails a separate analysis based on conditions, potential differentiation of the product, and the level of capital costs necessary to develop new plant capacity. 1/

1/ A useful summation of the theory and empirical application of seller structure analysis is contained in F. M. Scherer, Industrial Market Structure and Economic Performance (Chicago: Rand McNally, 1970).

Structural analyses in natural resource industries such as natural gas differ from those in manufacturing principally in that the empirical and theoretical dichotomization between seller concentration and condition of entry is less pronounced. This is so because resource control can be a key determinant of entry conditions. As a result, concentration indices based on reserve holdings and land acquisitions become important indicators of both entry barriers and the degree of probable interdependency among the major producers.

The interconnection between concentration and barriers to entry is shown in the static resource monopoly scenario described in figure II-I. DD is the industry demand curve and M is the marginal revenue curve of a monopolist who perceives the industry's demand as his own. C is a resource cost schedule indicating the extraction cost of different resource deposits arrayed in descending order of productivity. Under the assumption that each deposit has a fixed recovery factor, C is also the industry marginal cost curve and hence portrays a schedule of competitive supply response to varying levels of market price.

In this context, monopoly power entails the control of OB resources by a single producer (or a group of producers acting in concert). A producer with such control can recognize the industry demand curve as his own, select the profit-maximizing price of OP_1 , and sell OA units. His control of OB resources effectively blocks entry since the most efficient resource controlled by potential rivals can be sold only at a price higher than the market price OP_1 . The unutilized resource base AB represents the monopolist's entry deterrent as well as a manifestation of his supply restraint. The monopoly price of OP_1 contrasts with the lower competitive price of OP_2 that would prevail if the resource holdings were sufficiently dispersed so that each producer perceived he had no influence on market price. In the latter situation, each producer would accept the market price and adjust his supply accordingly.

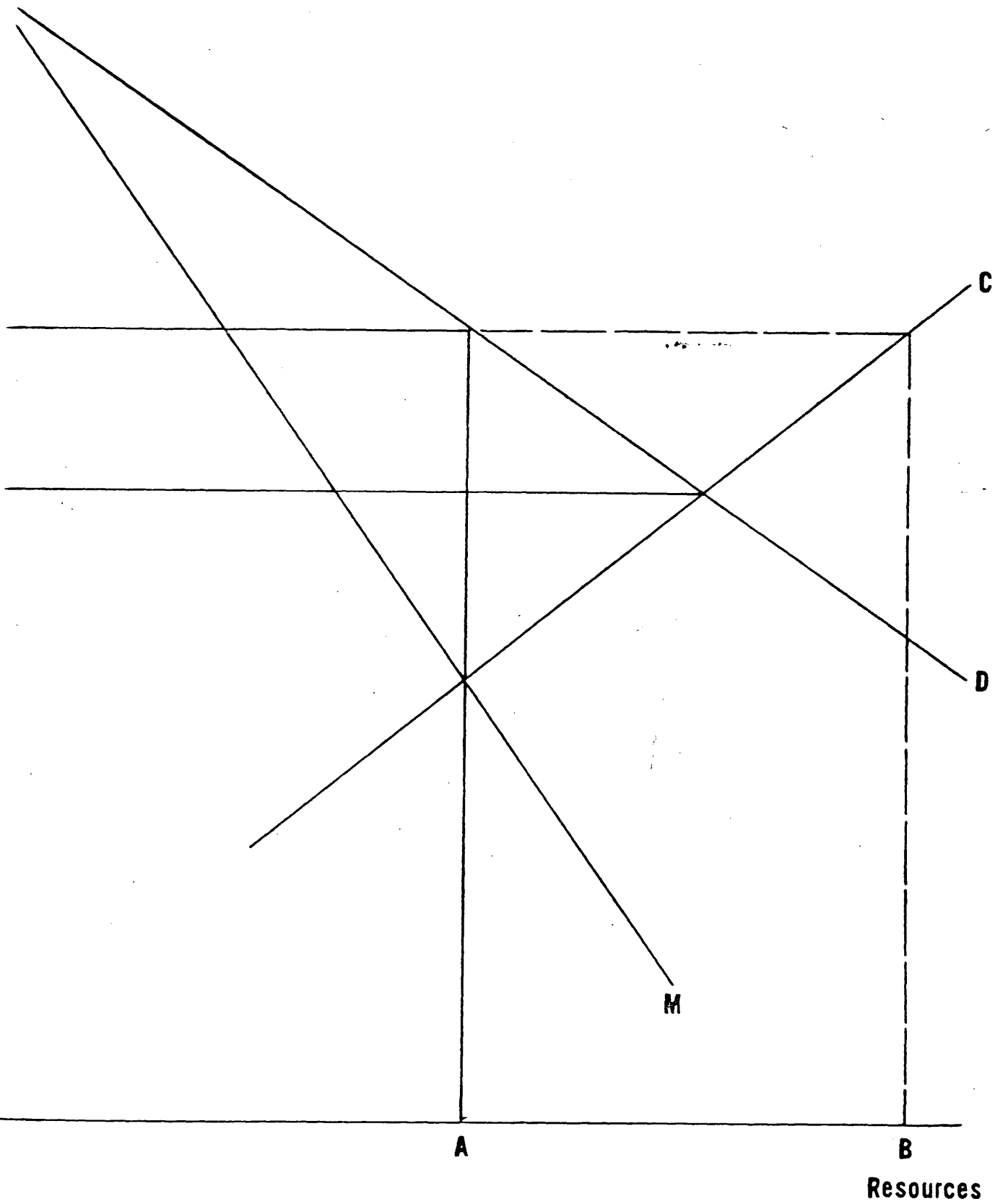


FIGURE II-1 RESOURCE MONOPOLY MODEL

Control of a substantial, but not complete, portion of the resource of base OB by a set of large producers can also result in monopolistic price levels. This would be the case, for example, if the major producers, either collectively or independently, attempted to influence price by their supply policies while allowing smaller producers to supply a portion of market demand. In this "dominant firm case," the major producers would set output based on a residual market demand schedule that incorporates the competitive supply response of smaller rivals. 1/ In this context, a mixture of monopoly and competitive behavior takes place: The smaller (fringe) firms respond competitively to price levels. The larger producers within the dominant firm group, on the other hand, act in a monopolistic fashion similar to that portrayed in figure II-1 by restricting their sales of gas resources. The end result is a price above the competitive level but below that which would prevail in a full monopoly situation. 2/

The monopoly models depicted above represent a useful starting point for structural analysis since they show the potential importance of concentration measures in assessing monopoly power. The characteristics of the natural gas market, however, rule out the feasibility of their literal application through the utilization of resource ownership patterns as direct measures of present and future monopoly power. This is so because the dynamic nature of the industry dictates that monopoly power cannot be based on control of the current resource base per se but, rather, must accrue from an ability to dominate the development of commercial resources in subsequent periods. This

1/ That is, the dominant firm(s) estimates the volume of resources he could sell at each price level by subtracting the fringe firms' supply response from the aggregate demand schedule.

2/ The dominant firm oligopoly model is developed in C. E. Ferguson, Microeconomic Theory (Homewood: Richard D. Irwin, 1966), pp. 292-294.

holds true whether attention is focused on (a) a shortrun resource measure such as proved reserves or (b) a longer-run, more broadly defined construct such as probable reserves:

(a) As noted above, proved reserves is an essentially ex post concept that refers to already developed resources that have, for the most part, been dedicated to purchasers via long-term contracts. A producer's share of the current stock of proved reserves thus has no direct bearing on the current market for gas supply. That market is based on partially developed resources not yet dedicated to purchasers.

(b) Extension of the time horizon to encompass resources more broadly defined than proved reserves does not represent an appropriate alternative. Monopolization based on control of the underlying resource base, out of which proved reserves are derived, is infeasible due to the geological uncertainty involved in petroleum exploration and to the extensive Government ownership of petroleum-bearing lands. The inexact nature of the petroleum exploration process 1/ implies that a producer desirous of monopoly control would be forced to acquire many times the number of tracts that ultimately prove commercially viable. Of greater importance, the significant magnitude of Federal and State Government ownership of gas-bearing lands acts to thwart any attempt at monopolistic resource control. Projections indicate, for example, that over 40 percent of new gas supply coming on stream in 1980 will originate from

1/ For example, the drilling success ratio for new field discoveries was less than 15 percent in 1973. The American Association of Petroleum Geologist Bulletin (August 1974), p. 1477.

Government lands. 1/ The bulk of this supply will come from Federal offshore lands not yet leased by the Federal Government.

The above factors imply that control of the undeveloped resource base is not a plausible monopoly situation in the natural gas sector. The relevant resource base is too large and too much of it is in Government hands for a program of monopolistic resource control to work. Instead, a dynamic longrun view of potential monopoly power must be adopted. The probability of monopolistic behavior depends on the degree to which the exploration-development capacity of the gas supply market is controlled by the largest producers. The relevant basis for concentration measurement in this context is a producer's capacity to create new gas supply that is commercially feasible at current or expected price levels. The greater the degree to which such capacity is centered in a relatively few firms, the greater their potential for affecting a monopolistic pricing and output strategy. Such an approach consists of controlling the pace of development activity so as to limit the volume of new gas supply in each period to the monopolistic optimum.

No direct measure of the relative resource development ability of producers has proved feasible so far. 2/ Instead, the search for structural

1/ Federal Energy Administration, Project Independence Blueprint, Final Task Force Report, Natural Gas (Washington: U.S. Government Printing Office, 1974), Table III-12, p. III-18. For a more recent, although less detailed, projection of future gas supply originations, see FEA, National Energy Outlook, February 1976 (Washington: U.S. Government Printing Office, 1976), p. 143.

2/ For example, while the FPC since 1970 has maintained that the higher cost and risks of small producers entitles them to higher gas prices, it has been unable to quantify the magnitude of this difference. The Commission's latest attempt was the issuance of an arbitrary ruling that "small" producers (those with annual production of less than 10 bil. cu. ft.) are entitled to prices that yield a 20 percent rate of return vis-a-vis the prevailing 15 percent standard. No rationale based on cost data was provided. The Commission acknowledged that although the higher return was "amply justified," the level was "a matter of judgment." FPC, Opinion No. 742, Docket R-393, Small Producer Regulation (August 28, 1975), p. 5.

manifestations of monopoly power is best approached through the utilization of output measures, such as production and proved reserves, as proxies for exploration-development capacity. The reasoning here is that a firm's output reflects its past success at developing gas resources and hence may be interpreted as an indicator of its current and future capacity as well. Viewed from this perspective, conceptual differences between production and proved reserves narrow considerably since both are interpreted as ex post indicators of a producer's supply capability.

Based on the above conceptual approach, the analysis of ownership patterns will proceed along the following lines: (1) Chapter III surveys concentration levels for the gas sector viewed as a nationwide entity and on the level of relevant subsectors. (2) Chapter IV considers potential distortions in concentration levels created by the gas sector's extensive joint venture activity. This is necessary since conventional concentration measures, such as those constructed in Chapter III, allocate output from jointly owned tracts according to financial interest and thus do not take into account the corporate interaction that necessarily occurs under such arrangements. The principal objective of chapter IV is to evaluate the potential bias of this approach by constructing alternative concentration measures based on a number of assumed modes of joint venture interaction among partners.

3. Behavioral Analysis

The pervasive effect of FPC price regulation complicates attempts at behavioral analysis. Through the setting of price ceilings on gas entering the interstate market, the Commission plays a large part in determining the gas sector's conduct and performance. As a result, studies of competitive

pricing behavior become impossible, since price levels are in large part determined by FPC fiat and not through market forces. 1/

One possible area of behavioral analysis concerns the nature of supply responses by producers to the regulated price set by the FPC. In an ideal regulatory environment, seller supply adjustments to a price ceiling would be similar in both monopoly and competitive structures since the regulated price in each situation would not be determined by supply conditions and thus would be outside the influence of the regulated seller. 2/ The natural gas industry does not fit this regulatory ideal, however, since the FPC's price rulings have in fact been influenced by supply conditions. Beginning with the large drop in reserves in 1968, the regulated price has been continually adjusted upward in response to the worsening natural gas shortage. This pattern of events has led to charges that the major producers have engaged in a sophisticated form of monopoly pricing in which gas supply is withheld from the market so as to pressure the FPC into increases in wellhead gas price ceilings.

In simple form, the case of monopoly behavior under regulation is similar to the unfettered monopoly model described in figure II-1 above, where the industry is presumed to be dichotomized into a set of dominant firms and a group of smaller fringe firms. The dominant firms, recognizing their influence

1/ Based on data from the period just prior to the onset of FPC price regulation, Paul MacAvoy utilized the pricing approach in studying behavior in gas markets during the 1955-60 period. He found that price patterns corresponded in most instances to competitive predictions. Those noncompetitive cases observed indicated monopsonistic behavior where a dominant pipeline forced price below the competitive level. Paul MacAvoy, Price Behavior in Natural Gas Fields, op. cit..

2/ This "ideal" situation would be one in which the regulatory agency possessed an infallible cost-based pricing formula that set the regulated price at a level which would prevail in a competitive situation. In this case, even a monopolist concedes his power over price and thus acts as if he were a competitive firm by adjusting his supply to the regulated price level.

over the regulated price, hold back supply and create a "shortage" which in turn forces the regulator to raise the price in order to achieve supply-demand equality. The fringe firms, on the other hand, pursue a competitive supply response policy (since they are presumed too small to perceive their influence over price) and produce all commercial reserves available to them.

In a dynamic context, the monopoly strategy of the dominant firms translates into a delay of exploration-development timetables on certain tracts so as to keep gas supply below the competitive level. 1/ The chief testable prediction of this monopoly model is that the dominant firms will hold back commercial resources from the market (i.e., resources that could be provided profitably at the regulated price) while the smaller fringe firms will not. Chapter V will test this monopolization thesis by analyzing the patterns of producible shut-in leases (PSI's) in the offshore sector. PSI's are non-producing tracts that have been in existence for over five years and thus represent a potential manifestation of monopolistic supply reduction. The monopoly theory predicts that the major producers (acting as dominant firms) should control a disproportionately large share of these leases.

1/ Since natural gas is typically sold via long-term contract, producers have little scope for adjusting production levels from already dedicated tracts in order to achieve overall supply objectives. Hence, the analysis in this report will focus on the timing of lease development rather than attempts at fine-tuning production levels.

Chapter III

Seller Structure in the Gas Supply Market

1. National Seller Structure

Concentration Levels

While there are over 5,000 companies listed as natural gas producers, the bulk of activity in the gas sector is accounted for by a substantially fewer number. Census Bureau figures indicate that the 32 largest producers (ranked by lease revenue) accounted for approximately 70 percent of gas activity indices such as exploration expenditures, development costs, and sales revenues (table III-1). The remaining firms tend to be relatively insignificant entities specializing in one or two aspects of the gas production cycle. In light of such a skewed size distribution pattern, structural analysis in this chapter will focus primarily on the large producers, principally the 30 largest gas producing companies.

The two most useful productive capacity measures for assessing the relative size of the largest producers are annual production and proved reserves holdings. ^{1/} Table III-2 lists the 30 largest producers ranked on the basis of 1974 annual production and Table III-3 provides a similar listing based on proved reserves holdings as of December 31, 1974. A summary of concentration levels based on these two output measures is given in table III-4.

Although reserve concentration ratios are higher than their production counterparts, the difference is relatively small. The similarity between the two productive capacity measures reflects in large part the relative ownership

^{1/} While providing valuable indices of overall concentration levels, Census data are of limited usefulness for a more disaggregated analysis since individual company information is not reported.

TABLE III-1

Concentration Levels Based on Census Data for
the 32 Largest Petroleum Producers: 1972

Gas activity category	Value accounted for by the 32 largest producers (ranked by total lease revenues) (millions of dollars)	Top 32 value as percentage of total for all producers
natural gas sales	4,059.6	72.9
exploration expenditures	6,327.7	73.1
development expenditures	2,970.6	67.3
production expenditures	4,120.4	73.1

SOURCE: U.S. Department of Commerce, Bureau of the Census, Annual Survey of Oil and Gas, 1974 (Wash.: U.S. Government Printing Office, 1976), table 3, pp. 15,16.

TABLE III-2
Largest Natural Gas Producers: 1974

Rank	Producer	Production (mil. cu. ft.)	Market share (percent)
1	Exxon Corp.	2,298,597	10.8
2	Texaco, Inc.	1,649,929	7.7
3	Standard Oil Co. (Ind.)	1,195,606	5.6
4	Mobil Oil Corp.	964,390	4.5
5	Gulf Oil Corp.	949,100	4.5
6	Shell Oil Co.	754,788	3.5
7	Union Oil Co. Calif.	638,369	3.0
8	Atlantic Richfield Co.	632,362	3.0
9	Sun Oil Co.	602,315	2.8
10	Phillips Petroleum Co.	564,394	2.6
11	Standard Oil Co. of Calif.	558,672	2.6
12	Getty Oil Co.	509,594	2.4
13	Cities Service	453,893	2.1
14	Continental Oil Co.	399,916	1.9
15	Tenneco, Inc.	397,521	1.9
16	Superior Oil Co.	334,916	1.6
17	Pennzoil Co.	320,457	1.5
18	Coastal States Gas Corp.	221,661	1.0
19	El Paso Natural Gas Co.	202,650	1.0
20	Panhandle Eastern Pipe Line Co.	197,002	0.9
21	Marathon Oil Co.	175,410	0.8
22	Amerada-Hess Corp.	127,759	0.6
23	Kerr-McGee Corp.	127,039	0.6
24	Diamond Shamrock Corp.	115,043	0.5
25	Ashland Oil, Inc.	114,008	0.5
26	Columbia Gas System, Corp.	113,319	0.5
27	Lone Star Gas Co.	108,990	0.5
28	Consolidated Nat. Gas Co.	102,714	0.5
29	Hunt Oil Co. (Placid Oil Co.)	99,334	0.5
30	Champlin Petroleum Co.	96,917	0.5
Total U.S. Production		21,318,470	

Concentration Ratios: (percent)

4-firm	28.6
8-firm	42.6
20-firm	64.9
30-firm	70.4

Sources: Company data - Company responses to the FTC Natural Gas Survey.

U.S. total - API-AGA-ACA, Reserves of Crude Oil, Natural Gas Liquids, and Natural Gas in the U.S. as of Dec. 31, 1975, table VII p. 120.

TABLE III-3
Largest Holders of Natural Gas Reserves: 1974

Rank	Firm	Proved reserves (mil. cu. ft.)	Percent of total
1	Exxon Corp.	28,173,168	11.9
2	Texaco, Inc.	18,454,644	7.8
3	Atlantic Richfield	14,228,740	6.0
4	Standard Oil Co. (Ind.)	12,591,167	5.3
5	Mobil Oil Corp.	9,642,331	4.1
6	Gulf Oil Corp.	8,959,243	3.8
7	Standard Oil of Calif.	7,730,609	3.3
8	Standard Oil Co. (Ohio)	7,419,396	3.1
9	Union Oil Co. of Calif.	7,016,842	3.0
10	Shell Oil Co.	6,918,865	2.9
11	El Paso Natural Gas Co.	5,832,655	2.5
12	Phillips Petroleum Co.	4,931,371	2.1
13	Sun Oil Co.	4,881,812	2.1
14	Cities Service Co.	4,652,129	2.0
15	Getty Oil Co.	4,031,640	1.7
16	Tenneco, Inc.	3,906,069	1.6
17	Continental Oil Co.	3,209,738	1.4
18	Superior Oil Co.	2,823,682	1.2
19	Marathon Oil Co.	2,647,115	1.1
20	Panhandle Eastern Pipe Line Co.	2,226,936	0.9
21	Coastal States Gas Corp.	2,189,781	0.9
22	Pennzoil Co.	1,819,498	0.8
23	Hunt Oil Co.	1,746,681	0.7
24	Mesa Petroleum Co.	1,512,256	0.6
25	Diamond Shamrock Corp.	1,452,252	0.6
26	Amerada-Hess Corp.	1,377,190	0.6
27	Ashland Oil, Inc.	1,313,725	0.6
28	Consolidated Nat. Gas Co.	1,117,642	0.5
29	Kan.-Neb. Natural Gas Co.	1,084,076	0.5
30	Aztec Oil & Gas Co.	1,064,954	0.4
Total United States		237,132,497	

Concentration Ratios: (percent)

4-firm	31.0
8-firm	45.3
20-firm	67.8
30-firm	74.0

Sources: Company data - Company responses to the FTC Natural Gas Survey.

U.S. Total - API-AGA-ACA, Reserves of Crude Oil, Natural Gas Liquids, and Natural Gas in the U.S. as of Dec. 31, 1975, p. 92.

TABLE III-4

Concentration index	Production (percent)	Proved reserves (percent)
4-firm	28.6	31.0
8-firm	42.6	45.3
20-firm	64.9	67.8

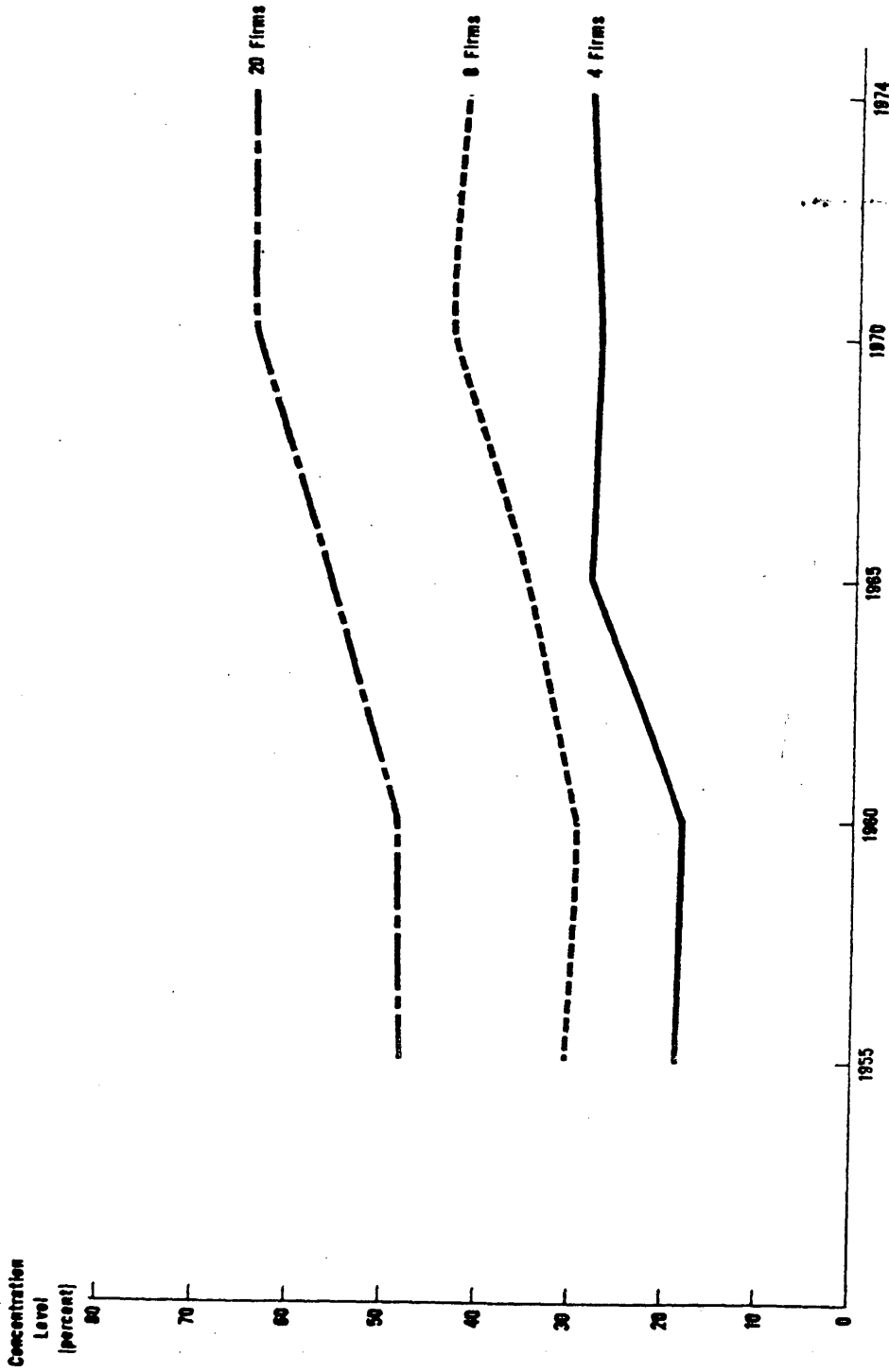
SOURCE: See Tables III-2 and III-3

constancy within the major producer group. Unlike other resource industries where de novo entry has been significant, the identity of the major producer group in the gas sector has remained stable. Fifteen of the 20 largest producers in 1974, for example, were included in the 1955 top 20 group. ^{1/} This pattern reflects the maturity of the gas production sector, an industry which has passed its period of greatest expansion. Another contributing element is the recent stability of concentration levels. After a period of sharp increases during the 1960's, concentration levels remained relatively constant during the 1970-74 period (fig. III-1).

The above factors combine to forge a close link between the production and reserves concentration measures. Owing to their greater accessibility, the remaining analysis in this chapter will be based primarily on production and sales as measures of exploratory-development capacity.

^{1/} The top 20 producer group in 1955 is tabulated in J. Mulholland and D. Webbink, Concentration Levels and Trends in the Energy Sector of the U.S. Economy (Wash: U.S. Government Printing Office, 1974), table C-8, p. 217. Four of the five new entrants for 1974 were pipeline concerns that have greatly expanded their production over the 1954-74 period.

FIGURE III-1 GAS PRODUCT CONCENTRATION LEVELS: 1955-74



SOURCES: 1955 - Joseph Mulholland and Douglas Weisbink, Concentration Levels and Trends in the U. S. Energy Sector
Reprint: U. S. Government Printing Office, 1974. P.
1960, 1965, 1970 - see Appendix Tables A-5, A-6, and A-7.
1974 - Table III-2.

Vertical Integration

The nature and extent of vertical links between the production and downstream stages of the gas sector differs between the interstate and intrastate markets. Vertical integration is lowest in the interstate market where the bulk of gas is sold to an independent interstate pipeline sector for resale. Integration appears to be somewhat higher in the intrastate market where the distance between production and consumption point is relatively small and the importance of direct sales to industry and power generation plants is high.

In 1975, production by interstate pipelines accounted for less than 6 percent of their total sales. 1/ Alternatively, few of the large gas producers maintain significant pipeline interests. Only 5 of the 20 largest gas producers (El Paso, Tenneco, Cities Service, Coastal States, and Panhandle Eastern) own subsidiaries ranked among the 20 largest interstate pipeline companies for 1972. 2/

The low degree of vertical integration in the interstate market is, due to a number of factors. Historically, the early postwar growth of the gas market allowed the pipeline companies to specialize in pipeline sales as large scale entry into the wellhead market by non-integrated producers took place. Between 1947 and 1953, for example, pipeline self-sufficiency fell from 40 to 20 percent. 3/ Also, FPC regulation of pipeline production throughout most of the post war period has discouraged their

1/ FPC, The Gas Supplies of Interstate Pipeline Companies 1975 (Washington: U.S. Government Printing Office, 1977), p. 10.

2/ FPC, Sales by Producers of Natural Gas to Interstate Pipeline Companies (Washington: U.S. Government Printing Office, 1972), table 5.

3/ Edward J. Neuner, The Natural Gas Industry (Norman: U. of Okla. Press, 1960), pp. 23-25.

participation in the gas supply market. Until 1969, pipeline owned gas was regulated on a cost of service basis by the FPC. The result in most cases was that pipeline gas was priced lower than the corresponding area rates allowed independent producers. 1/

The downward trend in vertical integration has been reversed in the past few years as pipelines and gas consumers have entered the gas production stage in an attempt to secure gas supplies not available at FPC mandated price levels. 2/ In addition to the development of in-house exploration-development programs, downstream companies have also financed the exploration efforts of independent producers in return for options to purchase gas supplies found under these programs. 3/ This backward movement into the gas production sector does not appear to be a longrun phenomenon, however, since it is largely stimulated by the disequilibrium created by FPC pricing policies. Pipeline and gas consumer entry into the gas production stage largely represents an attempt to circumvent FPC price regulation since their gas supply needs are not fully satisfied at existing price ceilings. Restoration of supply-demand equality would appear to limit the incentives for further entry in the future.

Smaller distances between field and consumption points, along with the greater importance of industrial sales, result in a higher frequency of vertical links in the intrastate market. In addition to petroleum refiner

1/ The FPC began to reverse its policy in 1969 as pipeline gas from new leases was placed under the area rate (Opinion No. 568, 42 FPC 738 (1969)). The current FPC policy is to place all pipeline production, irrespective of its vintage, under the applicable nationwide rate (Opinion 770-A).

2/ See Oil and Gas Journal, "U.S. interstate lines pour cash into search for gas," Dec. 27, 1976, pp. 73-77; FPC, Natural Gas Survey, vol. 1 (Washington: U.S. Government Printing Office, 1975), pp. 68-72.

3/ A major source of exploration financing was conducted by interstate pipelines under the FPC's "advance payments" program where pipelines were allowed to place advances to producers under their rate base. Initiated in 1970, this program was terminated by the FPC at the end of 1975. See FPC, Opinion 770-A, Nov. 5, 1976, p. 150.

purchasers, a number of gas users within the chemical and paper products industries maintain transportation and/or gas production facilities. 1/ Owing to the diffuse and unregulated nature of the intrastate market, definitive information regarding the degree of vertical integration is not available. It does appear, however, that direct links between the production and transportation stages for the largest gas producers is low. For example, a tabulation based on long-term 1975 intrastate contracts indicates that 5.3 percent of the annual volume of new contract sales transacted by the 20 largest intrastate sellers were accounted for by transfers to their pipeline or refinery-chemical affiliates. 2/

To summarize, vertical integration within the natural gas cycle is low; this is especially the case among large producers selling in the interstate market. There has been a recent trend toward increased integration but this has generally taken the form of a backward movement into production by gas purchasers such as pipelines and industrial gas consumers. It is questionable whether this latter tendency is sustainable in a nonregulated environment since its original development appears to have been stimulated largely by past regulatory actions.

1/ American Gas Association, The Intrastate Gas Markets in Texas, Louisiana, and Oklahoma, (April 1974); G. Donkin, "The Competitive Effects of Interdependent Actions Among Buyers and Sellers in the Natural Gas Producing Industry," British Columbia Energy Conference, 1974.

2/ The 1975 intrastate sales data base is described in appendix B. The integration index may be understated somewhat since it does not take into account direct sales to industrial customers where a producer's pipeline acts as a common carrier and thus does not obtain title to the gas. The frequency of such arrangements is unknown although the above noted AGA report stated that in many cases it is the industrial purchaser, not the producer, that will supply the transportation--in effect taking title to the gas at the wellhead. (American Gas Association, Intrastate Gas Markets..., op. cit. p. 16).

Horizontal Integration

In contrast to the relatively insignificant vertical contracts between gas sellers and purchasers, horizontal integration between gas and oil operations is high. This pattern is due to the technological and geological overlap between oil and gas production activities. As a result, similar ownership patterns exist for the two fuels. The major gas producers, for example, tend to hold similar market positions in crude oil production. The chief exceptions are producer-pipeline concerns such as Tenneco, Coastal States, El Paso, and Panhandle Eastern that tend to concentrate their production efforts in natural gas. Reflecting in part the output of such producer-purchasers, concentration levels are somewhat lower in gas than in oil. At the 8-firm level, concentration in oil is 46.9 percent versus 42.6 percent in natural gas (table III-5).

Overall, the major gas producers tend to be highly integrated into all stages of the crude oil cycle (refining, oil pipelines, and marketing). Fifteen of the 20 largest gas producers, for example, were included in a list of integrated petroleum "majors" identified in an earlier FTC study. ^{1/}

2. Regional and Jurisdictional Aspects of the Gas Supply Market

Regional and jurisdictional elements interact to form a complex network of subdivisions within the natural gas industry. On a regional basis, over 86 percent of gas supply is concentrated in four Southwestern States: Texas, Louisiana, Oklahoma, and New Mexico (table III-6). There are three geographically distinct gas-producing regions within this four-State area:

^{1/} Mulholland and Webbink, Concentration Levels, op. cit., table D-1, p. 236. The five gas producers not classified as majors are: Superior, Pennzoil, Coastal States, El Paso, and Panhandle Eastern.

TABLE III-5
Comparison of Oil and Gas
Production Rankings for the
20 Largest Gas Producers: 1974

<u>Producer</u>	<u>Natural gas production rank</u>	<u>Crude oil production rank</u>
Exxon Corp.	1	1
Texaco, Inc.	2	2
Standard Oil Co. (Ind.)	3	3
Mobil Oil Corp.	4	8
Gulf Oil Corp.	5	5
Shell Oil Co.	6	4
Union Oil Co. of Calif.	7	13
Atlantic Richfield Co.	8	7
Sun Oil Co.	9	12
Phillips Petroleum Co.	10	9
Standard Oil Co. of Calif.	11	6
Getty Oil Co.	12	11
Cities Service Co.	13	10
Continental Oil Co.	14	14
Tenneco, Inc.	15	19
Superior Oil Co.	16	18
Pennzoil Co.	17	22
Coastal States Gas Corp.	18	28
El Paso Natural Gas Co.	19	34
Panhandle Eastern Pipeline Co.	20	36

Concentration Levels: (percent)

	<u>Natural gas</u>	<u>Crude oil</u>
4-firm	28.6	28.8
8-firm	42.6	46.9
20-firm	64.9	73.3

Sources:

Gas rank - See table III-2
Oil rank - See table A-12

TABLE III-6

Natural Gas Production
By State for 1975

State	Market production (mil. cu. ft.)	State production as percent of total
Texas	7,485,764	37.2
Louisiana	7,090,645	35.3
Oklahoma	1,605,410	8.0
New Mexico	1,217,430	6.1
Kansas	843,625	4.2
California	318,308	1.6
Wyoming	316,123	1.6
Colorado	171,629	0.9
West Virginia	154,484	0.8
Other States	<u>905,243</u>	<u>4.5</u>
U.S. total production	20,108,661	100.0*

*Detail does not add to total due to rounding.

Source: U.S. Department of the Interior, Bureau of Mines, Mineral Industries Surveys: National Gas Production and Consumption 1975 (Washington: U.S. Government Printing Office, 1976), table 2.

Gulf Coast (encompassing the coastal portions of Texas and Louisiana), Hugoton-Anadarko (Kansas, Oklahoma, plus northern portions of Texas), and the Permian Basin (southeast New Mexico and northwest Texas). Together, these three regions accounted for approximately 85 percent of new contract sales during 1972 (table III-7). The Gulf Coast segment is by far the most important producing area, reflecting in large part the substantial gas reserves found in the Gulf of Mexico.

Ownership patterns vary among the major gas-producing regions. The major producers tend to predominate in the Permian and Gulf areas while smaller independent producers have traditionally accounted for a large part of Hugoton-Anadarko activity. Based on responses to the FTC's Natural Gas Survey, the eight major gas producers' aggregate market share in the Hugoton-Anadarko region was slightly over half their share in the Permian Basin and Gulf Coast areas. Overall concentration levels, however, tend to be similar in all three regions (table III-8). ^{1/}

At present, FPC regulation plays a more important role than geography in delineating relevant subsectors within the gas market. Since 1970, the increasing spread between FPC mandated price ceilings and the higher market levels prevailing for unregulated transactions has dichotomized the gas sector into jurisdictional (i.e., those wellhead transactions subject to FPC regulations) and nonjurisdictional segments. Jurisdictional sales have become

^{1/} The concentration levels in table III-8 are useful chiefly as indicators of variations in ownership patterns among the producing regions. As concentration measures, they are biased upward because the base used in calculating market share ratios include only producers canvassed by the FTC, not all producers in an area. (Regionwide production totals for all producers are not available.) Since 24 percent of nationwide production for 1974 was accounted for by producers not included in the FTC survey, the magnitude of this upward bias is significant.

TABLE III-7

Chief Natural Gas Production Regions
New Contract Sales: 1972

Area	Sales (bil cu. ft.)	Percent of total
Gulf Coast	481.8	55.7
Permian Basin	179.6	20.8
Hugoton-Anadarko	66.3	7.7
Remaining areas	<u>137.7</u>	<u>15.9</u>
TOTAL	865.4	100.0*

*Detail does not add to total due to rounding.

Note: Sales are 1973 volumes sold under contracts initiated in 1972. Both interstate and intrastate transactions are included.

Sources: Interstate - FPC contract data as compiled by Foster Associates.

Interstate - FPC interstate sales survey, Docket R 389A. Volumes cover the period 9-15-71 to 9-15-72.

TABLE III-8

Production Concentration
on a Regional Basis: 1974

Region	Concentration ratios (percent)			
	4-firm	8-firm	20-firm	8-majors
Gulf Coast	45.9	64.7	92.0	63.9
Hugoton-Anadrako	40.2	64.0	91.5	38.4
Permian Basin	43.0	67.0	95.5	65.2

Source: Responses to FTC Natural Gas Survey Questionnaire. See appendix tables A-13, A-14, and A-15.

increasingly limited to the Outer Continental Shelf (OCS) sector where all wellhead sales come under FPC regulation. Onshore gas, on the other hand, has gravitated toward intrastate transactions which are essentially unregulated. ^{1/} Due to the necessity of limiting transactions to intrastate purchasers (so as to avoid FPC regulation) the relevant market for nonjurisdictional gas has shrunk to that of the individual producing States. As a result, seller structure has become more concentrated since concentration on a State level is significantly higher than corresponding regional constructs. For example, on a new contract sales basis, the unweighted average 8-firm concentration ratio for the 4 major producing States is approximately 13 percent higher than the corresponding index for the 4-State region considered as a whole (table III-9).

The relevance of the above regional and jurisdictional factors for structural analysis depends on the time perspective and the regulatory environment considered appropriate. In a longrun context where FPC regulation is assumed absent, regional elements diminish in importance and the relevant market for gas can be considered a national one. This is so because of the adaptive capabilities of both sellers and purchasers to inter-regional price variations. Of most importance, the extensive pipeline network allows transmission companies leverage in choosing among different areas for their gas supplies. This leveraging potential of pipelines is described well by Phillips:

^{1/} The nature of FPC regulatory authority is discussed in chapter II. The bulk of gas produced and consumed within a State's boundary is outside the scope of FPC pricing regulation. (The relatively minor exceptions are discussed in J. Tiano, "Federal Jurisdiction over Producer Sales in the State of Production," National Resources Journal, vol. 17, January 1977, pp. 97-111.) Through 1976, such intrastate gas was unregulated since no State pricing authority existed. However, the rising price of intrastate gas has recently stimulated attempts to initiate price regulation in a number of producing States.

TABLE III-9

Intrastate Concentration Levels
Based on New Contract Filings During 1968-70 Period
(percent)

State	Concentration level		
	4-Firm	8-Firm	20-Firm
Louisiana	70.9	92.1	99.8
Texas	57.7	82.0	96.7
Oklahoma	54.6	86.1	100.0
New Mexico	95.5	100.0	100.0
Unweighted average for the four states	69.7	90.1	99.1
Aggregate for the four states	55.7	79.7	96.1

SOURCE: FTC tabulation based on FPC Intrastate Sales Survey,
Docket 389A.

The various gas-producing fields are in competition for markets. Natural gas pipelines once laid down cannot be easily moved, but extensions and branches can be built to other fields and to other pipelines (interconnections) if a supplier or group of suppliers attempts to control the supply in any field. Consequently, the concentration ratio for a gas-producing field does not indicate a corresponding degree of control over supply. 1/

Regional mobility by sellers is also important since they can shift their capital resources to whatever area promises the greatest financial return. As a result, localized monopolies in the gas supply market are improbable and, where they exist, short-lived. 2/

Regional subsectors have their greatest influence under a continuation of the current regulatory scheme whereby FPC price levels remain below market clearing levels in the nonregulated sector. Even in a longrun context, where sellers shift to areas with the highest expected return, some regional effects will be present because of the restricted mobility of purchasers in searching for the lowest price. Viewed from this perspective, concentration levels calculated on a statewide basis become a relevant element of market structure for gas supply in the nonregulated interstate market.

Since the principal aim of this report is to evaluate the competitive viability of the gas sector in an unregulated environment, the most important analytical dichotomy is between offshore and onshore gas. While onshore and offshore sectors are not valid economic submarkets, they do display significant differences in important structural characteristics such as concentration levels,

1/ Charles Phillips, The Economics of Regulation, (Homewood: Richard D. Irwin, 1969), pp. 618, 619.

2/ For further analysis and references to the relevant literature see: Mulholland and Webbink, Concentration Levels . . ., op. cit., pp. 57, 58, 163-169.

dition of entry, and joint venture activity. An assessment of the differences becomes important in light of the ongoing shift in gas supply to the offshore segment. To this end, the major features of the offshore and onshore sectors respectively are outlined in the following two sections.

3. Offshore

The offshore sector is increasingly becoming the dominant source of new supply. By 1980, offshore's share of new reserve additions is expected to account for over 40 percent of the U.S. total. ^{1/} The bulk of offshore production is currently centered in the Gulf Coast area (Louisiana and Texas) which accounted for over 97 percent of total offshore output in 1975 (table III-10). Most of the Gulf Coast fields, however, have already been developed. As a result, future offshore supply will in large part come from virgin provinces such as the Atlantic Coast and Alaska Gulf where initial exploration activity has recently taken place.

Within the offshore sector, Federal activity is dominant, accounting for over 80 percent of total gas production in 1975 (table III-10). As development activity proceeds farther offshore, the Federal segment (termed the Outer Continental Shelf or OCS) will continue to increase in significance since the majority of gas-bearing State lands have already been leased. Due to its relative importance and the greater data accessibility, the OCS sector will be the primary point of analysis in this section.

^{1/} Federal Energy Administration, Project Independence Blueprint, Final Task Report, Natural Gas, (Washington: U.S. Government Printing Office, 1974) III-12, p. III-18.

TABLE III-10

Distribution of Offshore Gas Production: 1975

<u>Offshore gas production (mil. cu. ft.)</u>				
State	State	Federal	Total offshore	Offshore production as percent of total offshore production for U.S.
Louisiana	489,577	3,332,169	3,821,746	89.8
Texas	210,289	122,573	332,862	7.8
Alaska	75,581	0	75,581	1.8
California	23,320	3,952	27,272	0.6
Total	798,767	3,458,694	4,257,461	100.0

SOURCE: U.S. Geological Survey, OCS Statistics, 1975 (Wash: U.S. Government Printing Office, 1976), p. 90.

nt Seller Structure

The chief distinguishing characteristic of the offshore sector vis-a-vis of the national market outlined in section 1 is that its size distribution of firms is skewed more toward the largest producers. There are fewer than 100 producers participating in the OCS sector compared to over 5,000 national producers (see III-11).
1/ Also, concentration ratios range from 16 to 43 percent higher offshore than onshore (see III-11).

In addition, joint venture (JV) activity among the major producers appears to be more predominant offshore. During the 1971-74 period, joint bids accounted for over 80 percent of total OCS tract acquisitions. 2/ In contrast, a major portion of onshore joint activity revolves around "farm out" agreements where a larger producer provides land and a smaller independent producer supplies the drilling and production effort. 3/

The relatively high concentration and joint venture activity offshore are explained in part by the substantial capital costs and risks associated with the activity. 4/ Typically, high initial capital investments are required before production revenues are received. In addition to substantial bonus payments (the auction payment to the Government for the lease), exploration and development expenditures for an offshore tract can be extremely high.

Department of Commerce, Bureau of the Census, Census of Mineral Resources, 1972. Industry Series: Oil and Gas Field Operations (Washington: Government Printing Office, 1975), tables 1 and 2A.

Calculations based on U.S. Department of the Interior files.

See below, p. 53.

A detailed analysis of the operating environment in the offshore sector, see W. H. Kash et al., Energy Under the Ocean (Norman: U. of Oklahoma Press, 1974) and Federal Trade Commission, Federal Energy Land Policy: Efficiency, Allocation, and Competition (Washington: U.S. Government Printing Office, 1975), p. 50.

TABLE III-11

Comparison of Onshore and Offshore
Concentration Levels: 1974

Area	Concentration level (percent)		
	4-Firm	8-Firm	20-Firm
Offshore (OCS)	29.7	51.3	85.3
Onshore	28.8	42.3	61.3
National	28.6	42.6	64.9

Sources:

Offshore - U.S. Dept. of the Interior; see appendix table D-6

Onshore - FTC Natural Gas Survey Questionnaire; see appendix table A-11.

National - FTC Natural Gas Survey Questionnaire; see table III-2.

high. Firms also must be prepared to bear the significant risk that a lease, once purchased, will prove unproductive. 1/ Apparently as a consequence of these factors, OCS producers have increasingly turned to JV's in an attempt to spread the costs and risks of OCS activity. While JV's have served to facilitate entry by smaller producers (see below), there are still many producers who find the costs and risks prohibitive. 2/ This capital requirements entry barrier in turn places upward pressure on offshore concentration levels.

Barriers to entry are not the sole, or possibly even the major, cause of relatively high concentration levels offshore, however. A profile of the largest OCS gas producers in table III-12 shows, in a number of instances, substantial divergence between firm size (measured in terms of either nationwide production or asset value) and OCS production. For example, the 2 largest nationwide producers, Exxon and Texaco, are ranked below the top 4 in OCS production. Phillips, the 10th largest national producer, ranks only 18th in OCS production. Overall the 8 largest national producers account for

Through 1974, 55 percent of all tracts five years of age or older had been relinquished to the Government with no recorded production. Possibly the most notable case of unproductive leases is the east Gulf of Mexico offshore tracts leased in 1973 at a total bonus value of \$1.4 billion. None of these tracts has so far proved productive with the prognosis in the Destin Dome area being particularly pessimistic. "Oil Drilling in E. Gulf Fails," Washington Post, June 24, 1975, p. A-1.

The recent Interior Department experiment with royalty bidding (where firms compete for tracts on the basis of royalty payments rather than bonus bids) provides some evidence on the capital barrier posed by high bonus payments. The eight tracts leased via royalty bidding attracted relatively more bids, and new companies, than were observed on tracts issued via bonus bids. Interior's staff cautioned, however, that the increased company participation created by royalty bidding may be achieved at the cost of lower petroleum recovery. This is so since the winning royalty rates, which represent an operating cost to producers, can be so high as to induce premature abandonment of a lease. (Interior memo from Asst. Sec. for Program Development and Budget to the Secretary, January 28, 1975.)

TABLE III-12

Profile of Largest OCS Gas Producers: 1974

OCS prod. rank	Producer Name	OCS production		National production		Asset size		Percent of natl. pro- duction accounted for by OCS production
		Mkt. share (percent)	Rank	Mkt. share (percent)	Rank	Value of assets (millions of dollars)	Rank among all petro. firms	
1	Tenneco	9.4	1	1.9	15	\$ 6,339	7	65.2
2	Union Oil Co. of Calif.	7.2	2	2.5	7	3,459	16	36.9
3	Shell Oil Co.	6.9	3	3.5	6	6,129	9	25.3
4	Mobil Oil Corp.	6.2	4	4.6	4	14,074	3	17.5
5	Exxon Corp.	6.0	5	9.1	1	31,154	1	8.5
6	Getty Oil Co.	5.5	6	2.4	12	2,964	21	29.7
7	Gulf Oil Corp.	5.3	7	4.4	5	12,503	4	15.3
8	Standard Oil Co. (Ind.)	4.8	8	5.0	3	8,915	6	12.6
9	Standard Oil Co. of Calif.	4.8	9	2.2	11	11,608	5	27.9
10	Cities Service Co.	4.4	10	2.1	13	2,898	23	26.4
11	Texaco, Inc.	4.0	11	8.0	2	16,122	2	6.4
12	Continental Oil Co.	3.5	12	1.9	14	4,635	12	23.9
13	Superior Oil Co.	3.2	13	1.5	16	822	53	27.1
14	Pennzoil Co.	3.2	14	1.5	17	1,798	34	27.4
15	Atlantic Richfield Co.	3.2	15	3.0	8	6,152	8	13.8
16	Kerr-McGee Corp.	1.6	16	0.6	23	1,164	45	34.5
17	Hunt Oil Co.	1.6	17	0.5	29	N.A.	N.A.	43.7
18	Phillips Petroleum Co.	1.6	18	2.6	10	4,028	15	7.7
19	Forest Oil Corp.	1.5	19	0.4	32	207	77	49.1
20	Consolidated Natural Gas Co.	1.4	20	0.5	28	1,636	40	38.5

TABLE III-12 (continued)

OCS prod. rank	Producer name	OCS production		National production rank	Asset size		Percent of natl. pro- duction accounted for by OCS production
		Mkt. share (percent)	rank (percent)		Value of assets (millions of dollars)	Rank among all petro. firms	
21	General Crude Oil Co.	1.0	21	0.1	N.A.	N.A.	88.1
22	Esmark, Inc.	1.0	22	N.A.	1,266	43	N.A.
23	Sun Oil Co.	0.9	23	2.8	4,063	14	3.9
24	Southern Natural Resources, Inc.	0.8	24	0.3	1,066	47	38.1
25	Amerada-Hess Corp.	0.8	25	0.6	2,255	29	17.9
26	Burmah Oil, Inc.	0.8	26	0.2	1,216	44	64.7
27	Louisiana Land & Expl. Co.	0.8	27	0.3	533	58	28.3
28	Ashland Oil Inc.	0.7	28	0.5	1,746	37	16.0
29	Marathon Oil Co.	0.6	29	0.8	1,800	33	10.0
30	Hamilton Bros. Oil Co.	0.9	30	.001	79	87	93.8

N.A. - Not available

SOURCE: FIC tabulation based on U.S. Department of Interior files, FTC Gas Survey, and Moody's Industrial Manuals.

44 percent of OCS production, a figure significantly below the OCS 8-firm concentration level of 51 percent.

This under-representation of the majors may be explained in part by the emergence of a number of smaller nationwide producers who have chosen to concentrate their efforts on the offshore sector. Foremost among these is Tenneco, the largest OCS producer in contrast to its 15th place ranking in national production. While Tenneco does exhibit a significant asset base, the top 20 offshore producer group in the OCS also contains a number of relatively small producers such as Forest Oil and Hunt Oil.

The above factors suggest that the relatively high OCS concentration levels cannot be explained exclusively by cost and risk obstacles to small firm entry. Another important element is that, by framing the comparison in terms of offshore versus onshore, relative concentration in the offshore segment is somewhat exaggerated due to the former's smaller size. Irrespective of the magnitude of entry barriers created by capital requirements and risk, the smaller size of the OCS sector, in terms of both areal extent and volume of production, leads to higher concentration due to the greater effect of scale economies in exploration and development: The smaller the volume of activity in a region, the greater the relative importance of fixed capital outlays entailed in exploration-development operation and thus the more important are scale related efficiencies.

Concentration Trends

Concentration in production, especially at the 4- and 8-firm level, has been declining steadily since 1960. The market share held by the 8 major producers group has exhibited a similar downward movement (table III-13). This trend reflects a gradual widening of the OCS ownership base as reflected in

TABLE III-13

Gas Production Concentration Levels
in the OCS Sector: 1960-74
(percent)

Year	<u>Concentration Levels</u>			Eight Major Gas Producers
	4-Firm	8-Firm	20-Firm	
1960	90.7	99.8	100.0	78.8
1965	58.8	80.6	99.6	73.8
1970	47.4	70.1	95.2	56.2
1974	29.7	51.3	85.3	43.6

SOURCE: FTC tabulation based on U.S. Dept. of the Interior files. See appendix tables D-3 through D-6.

the concentration patterns for OCS lease sales. The 8-firm lease acquisition concentration level, for example, has shown a downward trend over the 1954-74 period. The percentage of leases acquired by the 8-firm major group also exhibits a downward, albeit erratic, movement (table III-14). New entrants into the OCS sector have increased significantly, especially since 1970. During the 1971-74 period, there were 53 new companies participating in OCS lease sales. Of these, 29 acquired tracts during the period (see table III-16, below).

The downward trend in concentration reflects in large part three developments: (1) the rise in the number of tracts leased by Interior, (2) the increasing utilization of joint ventures, and (3) purchaser adaptations to the natural gas shortage.

(1) The rising cumulative total of tracts leased by Interior over time presents an obvious opportunity for more participants in the OCS. Scale economies (in both exploration and production) for the original set of producers become exhausted, allowing new companies to enter and compete. Of particular importance, the increasing level of OCS activity encourages the emergence of specialized agents (e.g., those that conduct "group shoots" for geophysical exploration) which reduce the initial capital expenditures required of new entrants and decrease the scope of scale economies in pre-sale exploratory research for individual firms. Likewise, the tendency toward issuance of more tracts on a per sale basis tends to encourage diversity among winning bidders. 1/

1/ This is true in a probabilistic sense, abstracting from entry considerations or scale economies. Assuming that each firm has an equal chance of winning every tract, an increase in the number of tracts issued will reduce the variance of its success ratio and hence, in the aggregate, more evenly distribute tracts among all competing firms.

TABLE III-14

Lease Acquisition Concentration Levels
 For OCS Lease Sales: Selected Years,
 1954-74

8-Firm concentration ratio: percent of
 total bonus payment accounted for by:

Year	Eight largest bidders per year	Eight largest gas producers nationwide*
1954	79.9	52.5
1955	68.8	32.2
1959	97.5	73.3
1960	65.5	48.8
1962	74.9	65.2
1963	100.0	95.0
1964	89.7	51.7
1966	78.9	50.8
1967	65.5	44.7
1968	77.8	74.4
1969	94.1	52.5
1970	61.5	18.4
1971	95.9	46.9
1972	42.4	34.9
1973	58.1	40.0
1974	57.8	56.1

*Exxon Corp., Texaco Inc., Mobil Oil Corp., Gulf Oil Corp., Standard Oil Co. (Ind.), Shell Oil Co., Atlantic Richfield Co., and Union Oil Co. Ranking based on 1974 national production.

SOURCE: FTC tabulation based on U.S. Dept. of the Interior files.

(2) There has been significant rise in joint venture frequency in the OCS sector. JV's rose from 9 percent of the value of all winning bids during 1954-58 to over 80 percent by 1971-74 (table III-15). JV's increase the diversity of the OCS ownership base by facilitating entry among producers whose small size and/or lack of exploration capacity makes solo bidding unprofitable. The importance of JV's in this regard appears significant. During the 1960-74 period, 49 of the 57 new producers that acquired OCS leases (86 percent) did so via JV bid (table III-16).

(3) Pressures of the natural gas shortage, especially since 1970, have stimulated gas purchasers to strive for greater supply security by entering into gas production. Frequently, this backward integration has been accomplished through JV agreements with established producers. 1/ Also, gas purchasers have financed exploration efforts of producers in exchange for a committed supply portion of those gas reserves to be found. Such exploration financing agreements have increased the viability of the smaller producers' exploration efforts in both onshore and offshore sectors. 2/

In regard to future trends, the current evidence points to a continued decline in concentration, albeit at a slower rate than in the past. The concentration levels for 1971-74 OCS leases, for instance, are slightly

1/ Offshore acquisition by pipelines reached a peak in the December 19, 1972, Louisiana OCS sale. See "Stampede for Gulf Blocks Smashes all Bonus Records" (Oil and Gas Journal, December 25, 1972, pp. 27-41). Pipeline purchases at this sale reduced to 21.3 percent the share of leases purchased by the eight major gas producers. Subsequent activities by pipelines have subsided due to the FPC's limitation on their ability to place lease acquisition costs into the rate base. See FTC, Federal Energy Land Policy, op. cit., pp. 371-2.

2/ The nature and extent of exploration financing agreements are discussed in chapter II.

TABLE III-15

OCS Joint Venture Indices
for Selected Periods: 1954-74

Period	Value of total bonus payment on all tracts (dollars)	Value of bonus payments on JV tracts (dollars)	JV bonus value as percent of total bonus payment
1954-58	248,264,227	23,061,686	9.3
1959-62	861,869,861	338,929,879	39.3
1963-66	296,692,805	135,611,953	45.7
1967-70	2,912,576,339	1,507,996,800	51.8
1971-74	10,452,970,782	8,414,065,490	80.5

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

TABLE III-16

New Entrants in Gulf Coast
Lease Sales: 1960-74

Year	Number of Bidders		
	New bidders	Successful new bidders	Successful new bidders that participated in joint ventures
1960	4	3	3
1962	11	9	7
1964	2	0	0
1966	9	0	0
1967	4	2	0
1968	14	11	11
1969	1	0	0
1970	7	3	1
1971	0	0	0
1972	16	11	11
1973	12	8	7
1974	25	10	9
Total	105	57	49

Note: A new bidder in a year is defined as a company that had no record of participation in OCS lease sales prior to that time. Successful bidders are those that acquire at least one lease.

SOURCE: FTC tabulations based on U.S. Dept. of the Interior files.

lower than current production concentration levels (table III-17). 1/

Over a longer time frame, a key factor will be the nature and scope of the Interior Department's leasing agenda.

4. Onshore

As noted above, seller structure is significantly more diffused onshore than in the offshore area. In addition to the larger area, measured either by areal extent or volume of output, the larger number of onshore producers reflects a favorable operating environment for the small producer. The initial capital investment necessary for onshore activity tends to be substantially smaller than that required offshore. Lease bonus payments tend to be lower, and there are numerous financing arrangements that reduce the initial investment required by smaller producers. Also, farm-out agreements are sometimes initiated by major producers who provide land to the small producer in exchange for information generated by the latter's wildcat exploration efforts. 2/

Onshore concentration levels have exhibited a number of varying movements during the 1955-74 period. Based on annual production, concentration levels remained constant between 1955 and 1960 then rose significantly during the 1960's. There has been a relatively small increase in concentration during the 1970's (table III-18).

1/ Leases sold during this period had little or no production in 1974, the latest date for which concentration levels are calculated. Hence, they represent a new element in the gas supply picture, one that is not reflected in 1974 production data.

2/ J. McKie, "Market Structure and Uncertainty in Oil and Gas Exploration," Quarterly Journal of Economics (February 1962), pp. 98-121; Federal Power Commission, Natural Gas Survey, vol. 1 (Washington: U.S. Government Printing Office, 1975) p. 60.

TABLE III-17

Concentration Levels Based
on 1971-74 OCS Lease Sales
(percent)

	Concentration Levels (based on working interest share of total bonus payments)
4-firm	30.1
8-firm	49.6
20-firm	79.9

Source: FTC tabulation based on U.S. Dept. of the Interior files. See appendix table D-7.

TABLE III-18

Concentration Levels for the Onshore Sector:
Selected Years, 1955-74
(percent)

Year	Concentration Levels		
	4-firm	8-firm	20-firm
1955	18.6	30.4	48.1
1960	18.8	29.6	48.2
1965	21.7	33.7	53.9
1970	27.5	41.4	60.5
1974	28.8	42.3	61.3

Sources: Concentration levels for 1955 derived from J. Mulholland and D. Webbink, Concentration Levels and Trends on the Energy Sector of the U.S. Economy (Washington: U.S. Govt. Printing Office, 1974), table C-8, p. 217. Concentration levels for remaining years tabulated from FTC's Natural Gas Survey Questionnaire (see appendix tables A-8 through A-11).

The concentration increase during the 1960's was influenced partly by the FPC's price regulation policies which tended to discourage production by smaller producers. This effect was most prominent during the 1960's when FPC price ceilings, set below market equilibrium levels, shifted supply efforts toward the more intensive development of existing (known) gas fields at the expense of new field development. 1/ This policy had a disproportionately harmful effect on smaller producers who traditionally operated smaller tracts and pursued riskier, wildcat exploration (often with financial assistance from the major petroleum producers). 2/

The negative effect of FPC policies appears to have been moderated somewhat in the 1970's as gas supply shifted to intrastate markets in response to higher selling prices in those areas. As a result, the expanding market for new gas supply in the chief producing States tended to reduce seller concentration levels. For example, the market share of intrastate new contract sales for the major producer group declined approximately 20 percent between 1970 and 1975 (see appendix tables B-5 and B-6).

1/ E. Erickson and R. Spann ("Supply Response in a Regulated Industry, The Case of Natural Gas," Bell Journal, V, Spring 1971) document the effect of FPC regulation on exploration and development strategy.

2/ The adverse effect of price controls was acknowledged by both the FPC and the courts during the 1960's. The hearing examiner's decision in the original Permian rate case recommended the exemption of small producers from the proposed price ceilings. The Commission agreed that unique characteristics of the small producers rendered them vulnerable to price regulation but concluded, nevertheless, that outright exemption would not be in the best interests of the consumer (34 FPC 159, Opinion No. 468, Permian). Supreme Court decisions concurred with the FPC's reasoning here, although there was a minority position (espoused principally by Justices Douglas and Clark) which posited that area rate regulation amounted to confiscation of small producers' property and, hence, was unconstitutional.

Under most possible scenarios, onshore concentration levels can be expected to continue their decline. A continuation of the present regulatory situation should stimulate further expansion of onshore production in the nonjurisdictional market. Deregulation would tend to expand the demand for onshore gas even further, especially in those onshore areas (such as northern Louisiana) where the predominance of interstate pipelines has restricted the market for nonregulated gas. 1/ Under either situation, the expected higher gas prices will encourage the search for gas in high cost areas such as Hugoton-Anadarko that have traditionally been the preserve of the independent producer. On the other hand, expansion of FPC jurisdiction to include the intrastate market may lead to a repeat of the 1960's experience of rising concentration levels if price ceilings are again set below market clearing levels.

5. Conclusions

In a longrun context, where FPC regulation is assumed absent, the relevant market for natural gas supply is national in scope. 2/ The flexibility of the pipeline system and the mobility of sellers discourage the emergence of a sustained regional monopoly. Seller concentration levels (based on production) in this national market are moderate to low depending on the frame of reference.

1/ American Gas Association, The Interstate Gas Markets in Texas, Louisiana, and Oklahoma (Washington: 1974), p. 21.

2/ Submarkets within the gas sector become relevant chiefly when the current regulatory situation is considered. Due to the segmentation of areas created by FPC price regulation policies, relevant submarkets in the non-jurisdictional sector are drawn along State lines. In this situation the extensive gas pipeline system is of limited usefulness in offsetting potential monopolistic pricing efforts by dominant producers in an area since purchasers cannot cross State lines to secure their supplies. Based on new contract sales, concentration levels on a statewide basis do appear to be significantly higher.

A comparison of natural gas concentration to corresponding levels in the manufacturing and mineral sector is presented in table III-19. The 8-firm gas production concentration ratio of 42.6, is similar to the weighted average concentration for all manufacturing of 39.0. ^{1/} Gas concentration levels are typically lower than those in most extractive industries. The average 8-firm concentration level for a sample of non-energy extractive industries, for example, is 60.5. Concentration levels in the other energy resource industries are also typically higher than those in natural gas. The one exception is coal, but this sector contains some regional markets that exhibit significantly higher concentration levels than the aggregate national figure.

Natural gas concentration levels are also below the threshold levels hypothesized by industrial organization economists and legislators as signifying the onset on monopolistic pricing behavior. On a 4-firm basis, such pivotal indices range from 40 to 50, as compared with the gas production level of 28.6. ^{2/} The 8-firm concentration ratio of 42.6 in gas production

^{1/} A more representative concentration index for manufacturing may be significantly higher, however. Shepherd, for example, calculated an average 4-firm CR of 60.3 after adjusting the Census industries by taking into account regional aspects and correcting for Census misclassifications. (William Shepherd, Market Power and Economic Welfare (New York: Random House, 1970), pp. 105-108.

^{2/} Both Scherer and Shepherd posit a 4-firm concentration level of 40 as a minimum oligopoly index. (Shepherd, ibid., p. 105; Frederic Scherer, Industrial Structure and Market Performance (Chicago: Rand McNally, 1970), p. 60. Concentration levels suggested in proposed industrial deconcentration schemes are higher. The Neal Report defined an oligopolistic industry as one where the 4-firm concentration level exceeds 70 percent. The Industrial Reorganization Act (the Hart Bill) proposes breakup of the leading firms in industries where the 4-firm concentration ratio exceeds 50 percent. Texts of these proposals, are reprinted in H. Goldschmid et al., Industrial Concentration: The New Learning (Boston: Little, Brown and Company 1974), pp. 445-451.

TABLE III-19

Comparison of Industry and Sector
Concentration Levels: Selected Years
(percent)

<u>Industry or Sector</u>	<u>Concentration Ratios</u>		
	<u>4-firm</u>	<u>8-firm</u>	<u>20-firm</u>
1. <u>Natural gas</u>			
1974 production	28.6	42.6	64.9
2. <u>Manufacturing sector</u> - weighted average			
Concentration level based on 1966 value of shipments	N.A.	39.0	N.A.
3. <u>Extractive sector</u> - non-energy			
Unweighted average based on 1963 value of shipments	50.4	60.5	N.A.
4. <u>Energy sector</u> - 1974 production			
Crude oil	28.8	49.6	73.3
Coal	25.0	34.8	48.2
Uranium	61.3	86.1	100.0

N.A. - Not available

Source:

Natural gas - See Table III-2, above

Manufacturing - Census 4-firm concentration ratio for 1966 as cited in F.M. Scherer, Industrial Market Structure and Market Performance (Chicago: Rand McNally, 1970), p. 63

Extractive Industries - Census concentration ratios compiled by D. Klyce and Sullentrop, U.S. Dept. of Commerce Impact of Corporate Diversification in the Mineral Industry, Bureau of Mines, open file report.

Crude Oil - See table A - 1

Coal and Uranium - FTC tabulation based on surveys of uranium and coal producers.

is also below Kaysen and Turner's oligopoly level (where "the recognition of interdependence by the leading firm is extremely high") of 50. 1/

The near future (up to 5 years) should show no significant change in concentration levels. In particular, sharp upward movements appear unlikely due to the increased exploration activity of middle-sized and small producers stimulated by higher petroleum prices. Over a longer period, some upward pressure on concentration may take place due to the shift in gas supply to the more highly concentrated offshore sector. The Gulf Coast experience indicates, however, that the effect on concentration up to the 20-firm level will not be very large since there exist at least this number of firms capable of efficient offshore operation.

The most important structural effect of the shift to offshore will be to increase the already heavy dependency placed on joint ventures by the petroleum industry. This organizational form represents an aspect of the competitive equation not directly taken into account by conventional concentration measures. Chapter IV analyzes the competitive impact of joint ventures by assessing their influence on seller structure in the offshore sector.

1/ C. Kaysen and D. Turner, Antitrust Policy (Cambridge: Harvard University Press, 1959), p. 27.

CHAPTER IV

Joint Ventures

Joint operations between independent companies are found in all phases of the petroleum production process, from initial exploratory efforts to the final extraction of crude oil and natural gas. Nationwide, approximately 60 percent of all oil and gas wells are jointly owned. 1/ Joint operations are especially prominent in the Federal offshore sector where joint bids accounted for 80 percent of total bonus payments recorded in OCS sales during the 1971-74 period. 2/

The pervasive nature of joint operations in the gas production sector complicates evaluation of its seller structure since joint ventures (JV's) can encompass both pro- and anti-competitive elements. The chief competitive attribute of JV's is their tendency to foster a more diversified ownership base. As noted in chapter III, the rise in JV activity influenced the downward trend in OCS bid and production concentration ratios by allowing participation of a greater number of firms than possible through solo bids. In the onshore sector, joint exploratory projects between majors and independents have provided significant financial assistance to smaller firms with limited capital funds. 3/

On the other hand, the high incidence of JV's in the petroleum sector can also generate anti-competitive effects. There are, in particular, two

1/ The Structure of the U.S. Petroleum Industry, U.S. Senate, Committee on Interior and Insular Affairs (Washington, 1976), pp. 41-45. The study was based on a survey of 12 major and 25 nonmajor producers. On some producer returns, wells on utilized leases were incorrectly classified as "jointly owned". Thus the degree of joint ownership is biased upward by some undetermined amount.

2/ See table III-15.

3/ J. McKie, "Market Structure and Uncertainty in Oil and Gas Exploration," Quarterly Journal of Economics (February 1962), pp. 98-121.

circumstances in which JV's significantly increase the monopolistic potential of the gas sector beyond that indicated by conventionally defined CR levels:

(a) JV's can raise the effective seller concentration level through de facto consolidations at either the firm or tract level. These consolidations are ignored in conventional concentration measures which presume each JV partner can, and does, operate his share of the tract in an autonomous manner.

(b) JV's may create a "community of interests" among major producers that results in an interdependent seller structure characteristic of industries with substantially higher concentration levels.

These two factors, it has been argued, lead to a highly oligopolistic seller structure sufficient to render the petroleum sector incapable of performing in a workably competitive manner. The validity of this position as it relates to the natural gas sector is evaluated in the following sections.

Analysis of the alleged monopolistic nature of JV's will utilize two approaches. First, the relationship between firm size and JV activity will be analyzed in an effort to discern anti-competitive effects through monopolistic intent (section 1). Since the usual nonmonopoly explanation of JV's emphasizes the desire by producers to exploit scale economies related to exploration costs and risk, a non-negative relationship between firm size and JV intensity (i.e., one in which JV intensity does not decrease with increases in firm size) may indicate attempts by the larger producers to capture monopoly returns alleged to accrue from JV activity.

The second approach will entail direct analysis of the purported monopolistic effects of JV's regardless of the motivation which originally brought them into being. Section 2 estimates concentration levels based

on formulas that explicitly take into account potential consolidation effects created by JV's. Section 3 analyzes the degree to which JV's can increase interdependent behavior in the gas sector.

Bidding and production activity in the OCS sector for the 1954-74 period will form the principal data base for analysis. The OCS was chosen because of the accessibility of its data and its high frequency of JV's. It should be noted, however, that the OCS sector does not represent a valid longrun economic market; it is, rather, a rapidly growing part of a larger whole, the national gas market.

1. Joint Venture Motivation: Theory and Statistical Evidence

Theories of Joint Venture Motivation

The nonmonopoly explanation of OCS JV's centers on their cost saving attributes. By allowing producers to spread their funds over a greater number of tracts, JV's create the potential for two classes of scale related cost savings: (1) savings on exploration expenditures, and (2) risk reduction.

In regard to scale economies, JV's allow producers to exploit size related efficiencies not available to them if they acted individually. The nature and magnitude of these exploration cost savings depends on the extent of cooperation between partners in the JV. If the partners decide to coordinate their exploration activities from the outset, they can share the total costs necessary in such programs. Or, firms may initiate separate exploration programs but, prior to an OCS sale, discover that the information each has accumulated proves complementary and thus can be usefully combined. 1/

1/ The pre-sale workings of joint venture organizations are described in Charles Gremillion, "Offshore Leases in the Gulf of Mexico - JV Agreements and Related Matters," 25 The Oil and Gas Institute (Matthew Bender, 1974).

JV's reduce the riskiness of OCS operations by allowing producers to diversify a fixed investment budget over a larger number of tracts, thus creating the potential for reduced variation in income flows. This attribute of JV's is of greatest importance to firms whose asset position is small relative to the considerable capital investment required for OCS activity. Solo bidding by such firms may be infeasible in that failure of a tract can lead to significant disruptions within the company (and, at the extreme, bankruptcy). By spreading their investment over a greater number of tracts, small producers reduce their financial commitment per tract and thus lower the probability of drastic income shortfalls. As a result, their prospects for funding in the capital market increase. On a more general level, the ability to spread investment funds over a larger number of tracts through JV's can serve to stabilize a company's operations by reducing the variance of its share of tracts purchased and petroleum discovered. Through this effect the uncertainty surrounding a producer's planning decisions involving exploration and development expenditures can be reduced.

The costs of JV's in a nonmonopoly context stem chiefly from potential decisionmaking conflicts among partners. Participation in OCS lease production represents a sequential decision process encompassing the choice of bid price, the timing and magnitude of exploration and development programs and, finally, marketing arrangements for the natural gas output. By joining in a JV, a producer significantly reduces his flexibility in dealing with these issues since he must engage in joint decisionmaking with partners. Disagreements over policy can thus be more costly to resolve than if the producer had sole control over a lease

and could resolve internal disagreements by fiat. 1/ Perhaps the most significant potential source of costly disagreements concerns the extent and timing of development efforts. The usual nonconsent clause in a JV contract assesses significant penalties to a producer unwilling to proceed with development as quickly or on as large a scale as his partners. 2/ A company may also be limited with regard to participation in leasing activity made outside of the JV combine. Typically, a JV agreement specifies a geographical area within which a partner cannot bid independently unless he allows the combine's remaining members the option to purchase shares in any tract subsequently purchased. 3/

It is difficult to estimate a priori the importance of these JV costs and the nature of their possible association with firm size. To the extent that the decisionmaking process becomes more awkward as the number of partners in a JV increases, smaller firms may be more affected in that they tend to associate with more JV partners than do larger producers. These costs can be minimized, however, by specifying efficient conflict resolution rules in the initial JV agreement. 4/ Also, each producer can be expected to gravitate toward the combine whose operating approach best suits his interest. On the

1/ The reduced flexibility created by JV's is somewhat analogous to the transactions costs incurred by producers choosing to purchase inputs via long-term contracts instead of having them supplied internally. In both instances, costs are incurred by the necessity of dealing with independent concerns in an uncertain environment. Alternatively, the choice to integrate backward into the input stage is similar to that of a solo venture in that they both allow the firm to resolve disputes without resort to costly arbitration. For a discussion of the transactions costs involved in market participation, see Oliver Williamson, "The Economics of Anti-Trust: Transactions Cost Consideration," University of Pennsylvania Law Review, (May 1974), pp. 1439-1496.

2/ See W.J. Stewart, "Important Features of Joint Operating Agreements," 1972 Institute of Petroleum Landmen (Matthew Bender 1972).

3/ Gremillion, op. cit., pp. 210, 211.

4/ For example, it may be decided to let the operator firm make the final decision concerning development plans.

other hand, large firms may find the restriction on independent bidding outside the combine more binding than smaller producers who have smaller exploration budgets and perhaps less extensive information on tracts available for sale.

In a monopoly context, JV's can prove valuable in the formulation and implementation of a supply reduction strategy by the major producers. By joining together in JV's, they can more effectively assess the costs and benefits of any monopolization strategy. Also, JV's provide a convenient monitoring device for detection of "cheaters" from any collusive arrangement. From this monopolistic viewpoint, the benefits of JV participation are significantly higher for those major producers intent on formulating a joint profit-maximizing strategy. Also, the transactions costs of JV participation noted above should be minimal for a set of colluding firms sharing a common aim.

Statistical Analysis

Attempts to identify monopolistic intent in the utilization of JV's have focused chiefly on the analysis of the relationship between JV intensity and firm size. Researchers have hypothesized that the monopoly motive theory of JV activity implies a positive association between JV intensity and firm size, whereas the competitive motive implies a negative relationship. The monopoly result stems from the added incentive to participate in JV's by monopolistically inclined large producers, while the competitive scenario is based on the cost reduction advantages of JV's (such as scale economies and risk reduction) which are inversely related to firm size. 1/

1/ See, for example, the empirical analysis of Edward Erickson, "An Analysis of the Competitive Structure of the Domestic Natural Supply Market," a report submitted to the Department of the Interior, 1975, pp. 41-43. See, also, John W. Wilson, "Market Structure and Interfirm Integration in the Petroleum Industry," Journal of Economic Issues (June 1975), pp. 330-333.

While providing a useful focus for empirical analysis, these predictions do not follow inevitably from the theory. Rather, they rest on two restrictive assumptions:

(a) In the monopoly case, it is presumed that the gains from the monopolistic use of JV's are greater than the scale related efficiencies such combines provide to smaller producers. Otherwise, a monopoly scenario is conceivable in which the JV intensity for the major producers is less than that for smaller firms yet greater than that expected for cost reduction reasons alone. In this case, some monopolistic motivation would be consistent with a negative relationship between firm size and JV activity.

(b) The predicted competitive result rests on the assumption that the potential cost of JV participation facing smaller producers is relatively insignificant. As noted above, however, costs faced by such firms in negotiating with a relatively large number of JV partners may be substantial, thus leading to lower perceived rates of return for small producers vis-a vis large ones. Such a situation would in turn suggest a positive relationship between firm size and JV intensity.

Notwithstanding the above problems, analysis of JV-firm patterns can prove useful as a test of one important version of the monopoly motivation hypothesis where monopoly gains via JV's are so great that they create a greater emphasis on JV's by larger firms than by smaller ones. 1/ To this end, the OCS bidding activities of 32 petroleum producers were tabulated for the 1965-74 period. A producer's JV intensity index is defined as the firm's number of bids submitted

1/ See especially the allegations of John Wilson, ibid.

through a JV divided by its total number of bids. The principal measure of firm size is a producer's domestic oil production for 1970. 1/

The resulting firm size-JV patterns shows a mild negative association. As indicated in the scatter diagram (figure IV-1) and frequency distribution (table IV-1), there is a weak but discernible negative relationship between firm size and JV intensity. Regression analysis yields similar results. In a simple linear equation, estimated from the data, there is a significant negative relationship between JV intensity and firm size. 2/

$$(1) \text{ JV intensity} = 95.3 - .0014 \text{ Firm Size}$$
$$t \text{ value} = (4.90)$$

$$R^2 = .45 \quad F = 24.1$$

By contrast, a quadratic equation suggested by the monopoly hypothesis (where size bears a U-shaped relationship to JV intensity as the degree of JV activity is lowest for middle-sized producers too large to enjoy the cost reducing benefits of JV's and too small to participate in the monopolistic utilization of them) proved insignificant:

$$(2) \text{ JV intensity} = 93.78 - .0001 \text{ Firm Size} - .00001 \text{ Firm Size}^2$$
$$t \text{ value} = (1.00) \quad t \text{ value} = (0.63)$$

$$R^2 = .45 \quad F = 12.0$$

1/ Oil output rather than gas production is used since oil revenues greatly exceed gas revenues both in the OCS sector and nationwide during the 1965-74 period. A firm's oil production thus would appear to be the size variable relevant to its decisions under the cost reduction theory. Domestic rather than worldwide production was used since it more directly relates to both the scale economy and monopoly factors. Alternative size measures--international oil production, domestic gas production and asset value--were also utilized in regression analyses with approximately the same results as domestic oil production. See appendix C, table C-2.

2/ The regression estimates are based on a cross-sectional analysis of a firm's total JV activity during the 1965-74 period and its size as of 1970. There are 32 observations, one for each producer in the sample. A listing of the producers utilized in the above statistical analysis is supplied in appendix C.

Table IV-1

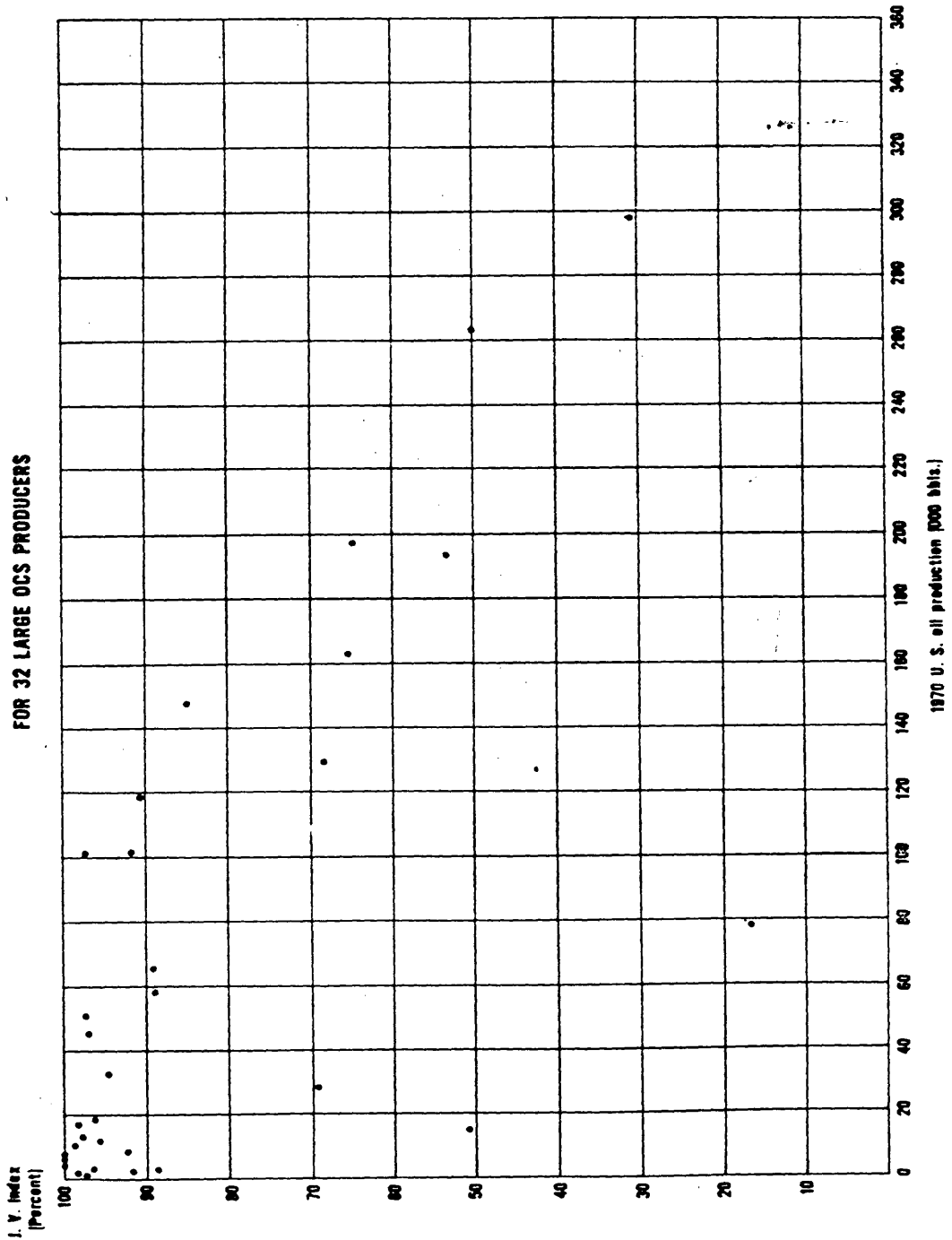
Distribution of OCS Producer JV
Indices by Production Rank: 1965-74

Size group-ranked by 1970 domestic oil production	Average JV index for the group *
1-4	49.6
5-8	77.2
9-12	73.9
13-16	94.7
17-20	79.8
21-24	96.6
25-28	99.1
29-32	94.8

*JV index is the number of a firm's joint bids divided by the number of its total bids.

Sources: JV indices - FTC tabulations based on U.S. Dept. of the Interior files. Producer Size - 1970 U.S. crude oil production as reported in Moody's Industrial Manual, 1971.

FIGURE IV-1 JOINT VENTURE INTENSITY VERSUS FIRM SIZE
FOR 32 LARGE OCS PRODUCERS



Source: Appendix Table C-1

Neither size variable in equation (2) is significant and the size squared term coefficient exhibits the wrong sign. (The monopoly hypothesis predicts a positive coefficient; i.e., JV intensity should increase with firm size for the larger producers).

To conclude, firm size patterns of JV intensity in the OCS sector cannot be used to infer monopolistic intent by the major producers. Although the largest producers' JV activity rate is high, their reliance on joint associations is somewhat lower than smaller firms—a result inconsistent with the strong monopoly hypothesis posited by a number of petroleum industry observers. This finding does not rule out conclusively the possibility of monopolistic motivation for large producers. Nevertheless, it appears more useful to concentrate the search for anti-competitive aspects of JV's on their effects rather than on the motivations that bring them about.

2. Consolidation Effects of Joint Ventures

The necessary interaction among partners in a JV can create consolidation effects not measured in conventional concentration ratios. These can serve to increase significantly the major producers' control of gas supply. Such a result can occur under either of the following circumstances:

- (a) Extensive JV interlinks among a set of large firms creates a de facto merger among them. In such a case, concentration levels need to be adjusted upward since the set of JV related producers should be considered one consolidated entity.
- (b) Development and marketing policies of JV leases are controlled primarily by a group of major producers with smaller partners playing primarily an investor role. As a result, conventional concentration measures under-estimate the control over gas supply exerted by the

major producers. The quantitative importance that should be attached to each of these possibilities is estimated below.

(1) De Facto Merger Via JV

The most likely sources of de facto merger via JV are organizations designed specifically for joint operation on an ongoing basis. In the OCS sector, CAGC (Continental Oil, Atlantic Richfield, Getty, and Cities Service) and SLAM (Signal, Louisiana Land, Amerada, and Marathon) are the most important examples of these groups. Each represents a permanent organization formed to coordinate bids and subsequent exploration and development plans among the member firms. Within designated areas, partners agree to bid collectively and to refrain from submitting independent bids that do not allow for subsequent participation by other members of the combine. ^{1/}

CAGC and SLAM are for the most part collections of middle-sized producers. Only one CAGC member, Atlantic Richfield, ranks within the top 8 national gas producers. None of SLAM's members rank within the top 20. Members of both combines together accounted for approximately 11 percent of total gas production in 1974 (table IV-2).

Although both of these JV organizations display a significant degree of coordinated action, the available evidence cannot be used to infer that their activity is equivalent to outright merger:

(a) A tabulation of successful bidding patterns over the 1965-74 period shows a high diversity of pairwise associations within the two combines (table IV-3). For CAGC, the importance of intra-combine associations ranges

^{1/} The SLAM ownership is as of the end of 1973. During 1974 two ownership changes took place: Texas Eastern Pipeline joined the combine and Signal sold its interest to Burmah. In 1975, R. J. Reynolds acquired Burmah's OCS properties and set up a subsidiary, Aminoil, to manage them.

Table IV-2
Membership of CAGC and
SLAM Joint Ventures

Joint venture	Member firms	1974 Production rank	Percentage share of total 1974 gas production
CAGC	Continental Oil Co.	14	1.9
	Atlantic Richfield Co.	8	3.0
	Getty Oil Co.	12	2.4
	Cities Service Co.	13	2.1
			<u>9.4</u>
SLAM	Signal Oil and Gas Co.*	46	0.2
	Louisiana Land & Explo- ration Co.	33	0.3
	Amerada-Hess Corp.	22	0.6
	Marathon Oil Co.	21	0.8
			<u>1.9</u>

*Signal's oil and gas properties were acquired by Burmah Oil in 1975.

Source: See Table III-2.

TABLE IV-3

Partnership Patterns Among Partners in the CAGC
and SLAM Joint Ventures: 1965-74 OCS Lease Sales

(Percentage of A's Total Winning Bids made with B)

Partner A	Partner B			
	<u>Continental</u>	<u>1-CAGC</u> <u>Atlantic Richfield</u>	<u>Getty</u>	<u>Cities Service</u>
Continental Oil Co.	-	29.6	53.1	53.2
Atlantic Richfield Co.	18.0	-	14.0	16.5
Getty Oil Co.	25.0	17.1	-	66.4
Cities Service Co.	42.1	21.7	71.4	-
	<u>Signal</u>	<u>2-SLAM</u> <u>Louisiana Land</u>	<u>Marathon</u>	<u>Amerada-Hess</u>
Continental Oil and Gas Co.	-	21.1	21.0	20.6
Louisiana Land & Exploration Co.	44.2	-	71.3	53.2
Marathon Oil Co.	33.7	61.6	-	69.8
Amerada-Hess Corp.	44.8	56.7	95.2	-

Source: FTC tabulations based on U.S. Dept. of the Interior files.

from less than 50 percent of total bids for Atlantic Richfield to a range of 21 to 71 percent for Cities Service. A similar diversity is found within SLAM. For both combines, the majority of pairwise associations was less than 50 percent of a producer's total successful bids during the period.

(b) The Gulf Coast ties formed within CAGC and SLAM have not carried over into recent OCS sales outside that area. For example, members of CAGC and SLAM bid relatively little with each other in the 1976 Alaska and Atlantic OCS sales. CAGC partners bid less than 20 percent with each other and the corresponding ratio for SLAM partners was approximately 8 percent (table IV-4).

The remaining OCS JV's are mostly ad hoc associations among producers in which no formal structure, such as CAGC or SLAM, has evolved. These are temporary combinations in which member firms coordinate their bidding for tracts in particular areas but are then free to seek out different associations in subsequent lease sales or even in different areas within the current sale. In order to gauge the nature of corporate associations that have been created by JV's, bidding patterns among the 20 largest OCS producers were tabulated for the 1965-74 period. In table IV-5, the most important bidding partner for each producer is listed, along with the percentage of that producer's total value of successful bids made in association with that partner. As expected, the most important JV pairings were found among members of the CAGC and SLAM combines. Outside of these cases the most prominent bid associations concerned Kerr-McGee, Hunt, and General Crude:

TABLE IV-4

Partnership Patterns Among Partners in the
CAGC and SLAM Joint Ventures for the 1976
Alaska and Mid-Atlantic OCS Lease Sales

JV organization and member firms	Working interest value of winning bids made with other member firms (dollars)	Total working interest value of winning bids made by member firms (dollars)	Percentage of total winning bids made with member firms
<u>CAGC</u>			
Continental Oil Co.	39,576,159	86,335,839	45.8
Atlantic Richfield Co.	0	164,276,399	0.0
Getty Oil Co.	0	53,545,966	0.0
Cities Services Co.	22,494,991	40,487,765	55.6
Total	62,071,150	344,645,969	18.0
<u>SLAM</u>			
Burmah Oil, Inc.	0	0	0.0
Louisiana Land & Exploration Co.	2,426,112	13,854,300	17.5
Marathon Oil Co.	4,003,085	4,003,085	100.0
Amerada Hess Corp.	0	62,454,706	0.0
Total	6,429,197	80,312,091	8.0

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

TABLE IV-5

Highest Pairwise Bidding Associations
Among the 20 Largest OCS Producers:
1965-74 OCS Sales

1974 OCS gas production rank	Most Frequent Bidding Partner (B)		Percentage of the total value of A's successful bids made in JV's with B
	Producer A	Producer B	
1	Tenneco, Inc.	Texaco, Inc.	40.1
2	Union Oil Co. of Calif.	Mobil Oil Corp.	54.0
3	Shell Oil Co.	Transcontinental Oil Co.	37.2
4	Mobil Oil Corp.	Gulf Oil Corp.	30.6
5	Exxon Corp.	Champlin Petroleum Co.	27.2
6	Getty Oil Co.	Cities Service Co.	75.6
7	Gulf Oil Corp.	Mobil Oil Corp.	43.9
8	Standard Oil Co. (Ind.)	Union Oil Co. of Calif.	54.9
9	Standard Oil Co. of Calif.	General American Oil Co. of Texas	20.4
10	Cities Service Co.	Getty Oil Co.	71.4
11	Texaco, Inc.	Columbia Gas System, Inc.	22.2
12	Continental Oil Co.	Cities Service Co.	53.2
13	Superior Oil Co.	General American Oil Co. of Texas	32.0
14	Pennzoil Co.	Cockrell, E., Co.	46.3
15	Atlantic Richfield Co.	Continental Oil Co.	18.0
16	Kerr-McGee Corp.	Essex Royalty Co.	85.0
17	Hunt Oil Co.	Hamilton Bros. Oil Co.	74.5
18	Forest Oil Corp.	Columbia Gas System, Inc.	37.1
19	Consolidated Natural Gas Co.	General American Oil Co. of Texas	26.9
20	General Crude Oil Co.	Kewanee Oil Co.	91.3

Source: FTC tabulations based on U.S. Dept. of the Interior files.

Producer A	Producer B	Percentage of A's total successful bids made with B	Percentage of B's total successful bids made with A
Kerr-McGee Corp.	Essex Royalty Co.	85.0	99.6
Hunt Oil Co.	Hamilton Bros. Oil Co.	74.5	96.1
General Crude Oil Co.	Kewanee Oil Co.	91.3	52.5

In all three cases, the bidding partner is relatively small so that consolidation with the large producer would have little effect on market share indices. Hamilton Brothers' share of 1974 OCS gas production is 0.9 percent, Essex Royalty's is less than 0.5 percent, and Kewanee's is 0.3 percent.

To conclude, the available evidence on inter-corporate bidding associations indicates a sufficient diversity to rule out the significance of quasi-formal linkages as a source of downward bias in conventional concentration level measures.

(2) Leverage Control by the Major Producers

Under the conventional formula for deriving concentration ratios, output from a jointly-owned lease is allocated among partners in proportion to their financial share in that lease. This "working interest" 1/ allocation rule in effect treats each partner's share as physically and contractually distinct, as if each were a small solo venture. In fact, this implied dichotomization of a jointly-owned tract is generally not valid. Especially in the OCS area, efficiency dictates that each petroleum tract be developed as a unit, regardless of the number of partners involved. As a result, concentration levels

1/ So-called since the partners share in costs and revenues in proportion to their financial interest in the lease. In contrast, a royalty interest entitles one, usually the landowner, to a straight percentage share in total revenue from the lease. Outside of specifying time limits for the development of a lease, such royalty holders typically have no decisionmaking role.

which purport to indicate the percentage of output controlled by a specified number of sellers will be inaccurate if the producers' lease control patterns differ from their financial interest record. In these types of situations, conventional concentration measures can impart either a negative or positive bias, depending on the extent of control maintained by the major producers. ^{1/}

In regard to the JV monopoly theory, the relevant question is whether the major producers' control of joint venture leases is such that their working interest market share ratios are significantly understated. The monopoly hypothesis to be tested posits that effective control of JV leases resides in the hands of a group of major producers to the extent that they are able to pursue a monopolistic supply strategy. Since such a strategy dictates a reduction in gas supply below the competitive norm, lease control for monopolistic purposes translates into the ability to delay tract development.

A priori, such monopoly control is difficult in the OCS sector since the typical JV agreement contains a "non-consent" clause stipulating that any

^{1/} For example, consider a hypothetical lease sale where 30 tracts are sold at \$10 million each for a total bonus payment of \$300 million. The aim is to estimate a relevant market share ratio for producer A who makes \$100 million in lease purchases. On a working interest basis, A's market share is 33 percent regardless of the lease ownership arrangements he enters into (\$100 mil./\$300 mil.). Yet the nature of these arrangements can significantly affect the degree of control he exercises over the development and marketing plans of the leased tracts.

Consider, for example, two alternative allocations of A's \$100 million: (1) He purchases two-thirds interest in each of 15 tracts; or (2) he purchases one-third interest in each of the 30 tracts sold at the lease sale. Now, although the working interest share of total bonus payments is the same in both cases (33 percent), the control exercised by A can differ considerably. If it is assumed that development and marketing strategy in a joint venture is decided by majority vote, producer A attains greatest control in case 1 where his two-thirds interest gives him control over 15 leases with a total bonus value of \$150 million, or 50 percent of the total bonus payment for the lease sale. At the other extreme, case 2 gives A an interest in every tract sold at the lease sale but effective control in none owing to his minority financial interest in each lease. In comparison with the working interest share ratio of 33 percent, the "true" concentration level (based on control of tract development) for A would be 50 percent in the first case and zero in the second.

member company, regardless of its financial interest, can proceed with development alone if its partners choose to delay. Such a maverick incurs all development costs but then can recoup them, plus a premium, through initial revenues from the tract's output. 1/ As a result, lease control, in theory, resides with that producer intent on the fastest rate of development.

Notwithstanding the obstacle to monopolistic supply control placed by the non-consent clause, the major producers may succeed in achieving control of JV leases through two possible routes:

(a) Operator status - Operators in the OCS sector can have a significant influence on the nature and pace of exploration and development activity. 2/ While it does not appear that they have absolute control over development policy, it is likely that their recommendations have a significant influence on its direction and timing. Hence, it is possible that the major producers can exercise significant control over gas supply via operator status in a disproportionate number of JV leases.

(b) Ownership status - The majors can increase their control leverage by engaging only in JV's where their partners are relegated to a passive, investor-type role. One indication of this would be a pattern where the majors maintain a dominant financial interest in the bulk of their JV leases.

To gauge the importance of these potential monopoly scenarios, concentration ratios are re-estimated using control definitions based on operator and ownership allocation rules.

1/ See W. J. Stewart, "Important Features of Joint Operating Agreements," 1972 Institute of Petroleum Landmen (Matthew Bender, 1972), pp. 139-169.

2/ The role played by operators in offshore joint ventures is discussed in Gremillion, op. cit.

Operator status

The operator's identity for each producing lease in the Gulf Coast OCS sector was recorded. Operator based market share ratios were derived by assigning all of a lease's output to its operator. The resulting tabulation indicates that the major gas producers' share is actually somewhat less than their share based on the working interest formula -- 41.0 percent vs. 43.6 percent (table IV-6). ^{1/} While overall operator concentration levels are significantly higher than corresponding measures based on working interest, this result is due to specialization in operator roles by smaller firms. Operator specialists, as indicated in table IV-6 by an operator rank higher than working interest rank, include Continental (ranked 14th nationally), Forest (33rd), Hunt (29th), and Marathon (21st). Continental is the principal operator for the CAGC group and Marathon is principal operator for the SLAM group.

Maintenance of a significant financial share in a lease appeared to be the main reason for the bulk of the major producers' operator roles. In less than 20 percent of the cases did a major operate a 1974 producing lease in which it had a minority or zero financial interest (table IV-7).

Ownership Control

Another possible indication of JV lease control is the financial interest patterns of the respective partners. For some leases, control may reside in the hands of the producer with a dominant financial interest. In such cases, the remaining partners are relegated to the role of investor with little or no control over lease development. To evaluate the effect of this possibility on

^{1/} The major gas producers are: Exxon, Texaco, Standard (Ind.), Gulf, Mobil, Shell, Atlantic Richfield, and Union. These are the eight largest producers of natural gas, ranked on a nationwide basis for 1974.

OCS Sector: 1974 Natural Gas Production

Production rank	Operator	Working interest	Producer	1974 gas production on leases operated by producer	Market share-producers' production as percentage of total 1974 Gulf Coast OCS production
1	Continental Oil Co.	12		322,158,510	11.8
2	Tenneco, Inc.	1		274,041,011	10.0
3	Union Oil Co. of Calif.	2		256,411,043	9.4
4	Shell Oil Co.	3		216,853,872	7.9
5	Gulf Oil Corp.	7		191,121,839	7.0
6	Forest Oil Corp.	18		166,693,360	6.1
7	Hunt Oil Co.	17		146,078,531	5.4
8	Exxon Corp.	5		143,258,564	5.3
9	Standard Oil Co. of Calif.	9		129,413,975	4.7
10	Mobil Oil Corp.	4		124,178,277	4.6
11	Pennzoil Co.	13		123,636,082	4.5
12	Standard Oil Co. (Ind.)	8		85,938,117	3.1
13	Texaco, Inc.	11		85,000,597	3.1
14	Southern Natural Resources, Inc.	22		65,853,802	2.4
15	Kerr-McGee Corp.	16		63,945,521	2.3
16	Marathon Oil Co.	28		46,499,889	1.7
17	Getty Oil Co.	6		46,352,848	1.7
18	Cities Service Co.	10		46,122,890	1.7
19	Esmark, Inc.	21		39,785,662	1.5
20	Phillips Petroleum Co.	36		36,652,464	1.3

Concentration levels	Concentration (percent) operator	Working interest
4-firm	39.1	29.5
8-firm	62.9	51.0
20-firm	95.5	84.2
8 majors*	41.0	43.6

*Atlantic Richfield Co. (0.6 operator market share), Exxon Corp., Standard Oil Co. (Ind.), Gulf Oil Corp., Mobil Oil Corp., Shell Oil Co., Texaco, Inc., Union Oil Co.

SOURCE: Lease production - U.S. Dept. of the Interior, Geological Survey, computer tape
Operator status - U.S. Dept. of the Interior, Bureau of the Land Management, files.

TABLE IV-7

Distribution of Operators in Gulf Coast OCS
Producing Leases by Ownership Status: 1974

Ownership characteristic of lease in which firm is operator	All leases		Leases operated by major gas producer group 1/	
	Number	Percentage of all leases total	Number	Percentage of total leases operated by majors
A - Solo	171	49.1	107	60.5
B - Majority share	17	4.9	8	4.5
C - Plurality	14	4.0	7	4.0
D - 50% Share	37	10.6	25	14.1
E - Minority interest	54	15.5	10	5.6
F - No financial interest	<u>55</u>	<u>15.8</u>	<u>20</u>	<u>11.3</u>
Totals	348	100.0 <u>2/</u>	177	100.0

Note: Lease sample consists of all non-unitized OCS tracts that listed gas production in 1974.

1/ Exxon, Texaco, Standard Oil (Ind.), Gulf, Mobil, Shell, Atlantic Richfield, and Union Oil.

2/ Detail does not add to total because of rounding.

SOURCE: FTC tabulation based on Dept. of Interior files.

concentration levels, outputs from JV leases were allocated to firms within the major producer group displaying the following ownership characteristics:

- (1) Majority interest - Firm has a greater than 50 percent financial interest in the lease.
- (2) Plurality interest - Firm has largest financial share (but less than 50 percent) and its partners are relatively small producers or have no production expertise at all.

In either of the above allocations, the probability of a minority partner's invoking the non-consent clause is presumed low due to his relatively small ownership interest. In cases of plurality interest, the relatively small size of the minority producers is assumed to limit their ability to undertake solo development in the face of the major producer's reluctance to proceed.

A third control category to be used is based on the stronger assumption that the eight major gas producers collude in lease development policy, or at least have a common motivation to avoid excessive gas supply levels:

- (3) Shared dominance - For those JV leases, not controlled by a single firm with majority or plurality interest, where the combined financial interest of two or more majors exceeds 50 percent.

In this case, the participating majors are presumed to control the lease. Output from the tract is thus allocated to them in proportion to their financial interest.

Concentration ratios based on financial control categories were calculated for 1971-74 OCS lease sales. The lease bonus was used as an output index under the assumption that it reflected expected future production, as estimated by the winning bidder. The most straight forward control category refers to solo leases where the individual producer can make his own decision regarding lease development (subject to Interior Department approval). For

JV leases, control concentration ratios based on the majority, plurality, and shared dominance categories were estimated. Under the majority and plurality groupings, the entire lease bonus was assigned to that producer defined as being in control. In the case of a shared dominance lease, the bonus was allocated among the relevant major producers in proportion to their financial interest.

Table IV-8 lists concentration ratios for the eight major producers under the alternative allocation rules described above.

On an individual firm basis, the major group control concentration ranges from 12.2 percent for solo leases to 25.2 percent for the financial control category encompassing solo leases, majority and plurality JV leases. The latter financial control concentration ratio is significantly lower than the corresponding working interest level of 46.6 percent. This result reflects the tendency of the individual major producers to avoid concentrating their investment funds in leases where they have a dominant financial interest. The major group as a whole, for example, maintained a dominant financial interest in approximately 17 percent of the JV's acquired over the 1971-74 period. The one exception to this pattern is Shell Oil who maintained a majority interest in over 80 percent of its JV leases (table IV-10).

On the other hand, JV links among the major gas producers do increase their control market share measure under the assumption that they act as a collective unit. The "shared dominance" control category, where lease control was assigned to two or more majors when their respective financial shares together accounted for over 50 percent of a lease, raised the control concentration ratios for the majors to 47.9 percent, slightly above their working interest total of 46.6 percent. The key factor here is the high intra-group JV activity between Standard (Ind.), Gulf, and Mobil (table IV-11).

TABLE IV-8

Summary of Control Concentration
Ratios for the Major Gas Producer
Groups: 1971-74 OCS Lease Sale

<u>Control Category</u>	<u>Percent Share</u>	<u>Cumulative Share (percent)</u>
Solo lease	12.2	12.2
Dominant leases:		
Majority	12.0	24.2
Plurality	1.0	25.2
Shared dominance	22.7	47.9
Working interest market share:		46.6

Source: See table IV-9.

TABLE IV-9

Composition of Market Share Levels for
the Eight Major Gas Producers Based on Financial
Control Categories: 1971-74 OCS Lease Sales

(percent)

Producer	Solo leases	Dominant leases		Shared dominance leases	Working interest share
		Majority	Plurality		
Exxon Corp.	3.7	2.9	0	2.4	7.7
Texaco, Inc.	1.9	2.6	0	1.3	6.8
Standard Oil Co. (Ind.)	0.6	1.1	0.9	3.9	5.3
Gulf Oil Corp.	1.3	0.8	0	4.2	6.4
Mobil Oil Corp.	0.8	0.7	0.1	8.4	9.2
Shell Oil Corp.	0.9	3.9	0	0	4.6
Atlantic Richfield Co.	3.0	0	0	0.3	3.8
Union Oil Co. of Calif.	0	0	0	2.2	2.8
Total	12.2	12.0	1.0	22.7	46.6

Definitions of Control Categories:

Solo leases - Producer has 100 percent interest in lease.

Dominant lease - Producer has either (a) majority interest in lease or (b) plurality interest where remaining partners are ranked below 20th largest in nationwide gas production.

Shared dominance leases - Leases in which two or more majors combine to have a majority financial interest. Lease bonus assigned to relevant majors in proportion to their respective financial shares.

Source: FTC tabulations based on U.S. Dept. of the Interior files.

TABLE IV-10

Frequency Distribution of Major Producer
 Joint Venture Leases According
 to Ownership Category: 1971-74 OCS Lease Sales

Producer	Total number of joint venture leases	Financial dominance leases	
		Number of leases	Number as percent of all JV leases acquired by producer
Exxon Corp.	15	5	33.3
Texaco, Inc.	39	8	20.5
Standard Oil Co. (Ind.)	89	20	22.5
Gulf Oil Corp.	55	3	5.5
Mobil Oil Corp.	80	5	6.3
Shell Oil Co.	37	30	81.1
Atlantic Richfield Co.	36	0	0.0
Union Oil Co. of Calif.	79	0	0.0
Total	430	71	16.5

NOTE: Dominant leases are those in which producer maintained either majority (over 50 percent) financial interest or where he had a plurality interest and the remaining partners were ranked below the 20th largest as producer on a national basis.

SOURCE: FTC tabulation based on Department of Interior files.

TABLE IV-11

Joint Venture Associations Among the
Eight Major Gas Producers: 1971-74 OCS Lease Sales

(Percent of Total Value of Firm A's Winning Bids Accounted for by Joint Bids with Firm B)

Firm A	Firm B							
	Exxon	Texaco	Std. Oil (Ind.)	Gulf	Mobil	Shell	Atl.-Richfield	Union Oil
Exxon Corp.	-	0.0	0.0	0.0	52.3	0.0	0.0	0.0
Texaco, Inc.	0.0	-	0.0	20.1	7.6	0.0	0.1	0.0
Std. Oil Co. (Ind.)	0.0	0.0	-	3.6	50.0	0.0	0.0	0.0
Gulf Oil Corp.	0.0	28.3	5.5	-	41.5	0.0	3.8	0.0
Mobil Oil Corp.	24.0	7.6	30.2	28.4	-	0.0	0.0	0.0
Shell Oil Co.	0.0	0.0	0.0	0.0	0.0	-	0.0	1.2
Atlantic Richfield Co.	0.0	0.1	0.0	6.5	0.0	0.0	-	0.0
Union Oil Co. of Calif.	0.0	0.0	76.7	0.0	51.1	4.3	0.0	-

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

The current importance of the shared dominance concentration category is minimal due to a 1975 Interior Department ruling that bans joint bids among six of the eight major gas producers. ^{1/} One of the two majors not affected by the ban, Atlantic-Richfield, had no significant JV associations with other major producers during the 1971-74 period. Union, the other exempted company, did have significant JV associations with both Standard Oil (Ind.) and Mobil, yet the bulk of these ventures did not result in a combined majority interest with the included majors (table IV-11).

To summarize, the above analysis indicates that the working interest concentration ratio serves fairly well as an upper bound estimate for market share indices based on lease control. Compared to the working interest concentration ratio of 46.6 for the eight largest national producers, alternative control indices for this group range from 12.2 percent for solo leases to 7.9 for the dominance control index based on a strong collusive assumption.

3. Monopolistic Interaction Effects Created by JV's

A frequent argument leveled against JV's is that the multitude of interfirm contracts necessitated by such associations creates an interdependent environment among the major producers characteristic of industries with substantially higher concentration levels. Supporters of this position argue that petroleum JV's, viewed from an aggregative perspective, produce a synergistic anti-competitive effect not evident at a micro level. From such

^{1/} The Interior Department joint venture ban applies to producers with international petroleum production greater than 1.6 million barrels per day. Present the ban applies to the following producers: British-Petroleum, Exxon, Gulf, Mobil, Shell, Standard Oil (Ind.), Texaco, and Standard Oil (Cal.).

a holistic viewpoint, a number of commentators conclude that JV's are "anti-
thetical to any potential rivalry or competition". 1/

Under this interaction theory, JV's are viewed as fostering oligopolistic behavior among the major producers by providing both the atmosphere for interdependent action and the wherewithal to bring it about successfully. These two elements can be represented as follows:

(a) The frequent intercorporate contacts occasioned by JV's leads to a "spirit of cooperation" among the major producers. Such an environment encourages the formulation of nonrivalrous patterns of conduct designed to maximize joint profits.

(b) On a functional level, JV's provide a means of effectively carrying out such a joint maximizing policy through the sharing of information regarding supply decisions among the major group. Such a transmittal of information allows each producer to adapt his actions to that of the group. 2/

Evaluation of the interaction theory's relevance to the natural gas sector must necessarily be tentative since it has not been developed into an empirically testable construct. In general, the theory's key predictions are behavioral: The gas market should exhibit monopolistic patterns of conduct similar to industries with significantly higher concentration levels. This aspect will be investigated in chapter V where ownership patterns among shut-in leases are analyzed in search of a collusive supply reduction strategy by the major

1/ Statement of David Schwartz before the Subcommittee on Activities of Regulatory Agencies of the House Select Committee on Small Business, March 26, 1975, p. 11. See also, U.S. Senate, Committee on the Judiciary, Petroleum Industry Competition Act of 1976, Part I (Washington, 1976), esp. pp. 28-35.

2/ "They (the majors) don't have to collude. It is obvious what the facts are, and each one can take his own individual action, but it is generally the same action." Robert Yancy, testimony reprinted in The Industrial Reorganization Act, Part 8, U.S. Senate, Committee on the Judiciary, Subcommittee on Antitrust and Monopoly, 93d Cong., 1974, p. 5921.

producers. The one piece of behavioral evidence so far reviewed concerns bidding patterns for OCS leases. The general diversity of JV associations, both as to time and location, appears to conflict with the monopoly interaction theory where more consistent relationships would be expected. Also, a wide variety of independent research so far has found no evidence of collusion among the majors in rigging bid offers for OCS tracts. 1/

The absence of an operational theory of interaction through JV's makes it difficult to analyze structural evidence in a definitive fashion. Advocates of the interaction position appear at times to infer its validity simply by documenting the large number of JV's that take place in the gas sector. 2/ Such evidence is not sufficient, however, since there are a number of institutional factors that may limit the uniqueness as well as the efficiency of JV's as monopoly instruments:

(a) While JV's no doubt occasion contact and cooperation among established rivals, the petroleum industry contains numerous other institutions, such as trade associations and Government regulation, that allow the majors ample opportunity to communicate their desires and problems. The role of Government regulation appears to be especially pervasive in this regard. Through established trade associations such as the American Petroleum Institute and the American Gas Association, petroleum firms formulate policy on OCS leasing policy, FPC regulation, imports, etc. Major producer contacts outside the trade groups also arise. The FPC, for example, has encouraged producers with "like interests" concerning rate regulation levels to join together in common

1/ See Erickson, op. cit.; Susan Wilcox, Entry and Joint Venture Bidding in the Offshore Petroleum Industry, Ph.D. dissertation, U. of California, Santa Barbara, 1974; statement of Walter Mead, Hearings on Market Performance and Competition in the Petroleum Industry, pt. 3, pp. 1005-1014.

2/ See especially John Wilson, "Market Structure and Interfirm Integration...", op. cit., and references to his earlier work cited therein.

submissions to that agency. Representatives of the major producers are frequently subpoenaed en masse before congressional committees. Communication among the majors at these policy levels may very well be more important in the formulation of oligopolistic strategy than JV's since higher management echelons are more apt to be involved. In contrast, the day-to-day management of JV's usually entails more decentralized management participation carried on by engineers and geologists relatively low in the corporate hierarchy.

(b) On a functional level, the disaggregated nature of domestic gas production, as reflected in the large number of both JV combines and gas tracts, tends to reduce the anti-competitive impact of JV's as an information transmittal system among the major producers. In contrast to the Middle East where each JV combine controls a large percentage of a region's total petroleum output, JV's in the gas sector are highly fragmented. The largest permanent JV combine, GAGC, accounted for only 12 percent of the total value of OCS leases acquired during 1971-74, for example. As the number of distinct JV's rise, each one's relative importance declines, thus creating incentives for corporate decisions to be decentralized so that an individual optimization strategy is pursued for each tract. 1/

To conclude, the relatively large number of JV's in the gas sector does not constitute per se evidence of noncompetitiveness under the interaction

1/ The importance of the number of JV combines in determining their monopolistic potential is stressed by Morris Adelman. In regard to the domestic petroleum market Adelman posits "...the amount of production that (the major producers) can develop, even in the biggest lease, is tiny relative to the market. In their own interest, the owners must operate the leases as though they were a single independent firm, unable to influence price." ("Splitting the Oil Companies Won't Help," Washington Post, May 1, 1976.) On the other hand, Adelman does view the Middle East JV's as potentially monopolistic because of their large relative size. He posits that their combined effect is "...to reduce the independence forced on each participant, who knows the investment and output plans of his rival." Industrial Organizational and Economic Development, Markham and Papanek, eds., (Boston: Houghton Mifflin Co., 1970), p. 145.

theory. While JV activity no doubt creates some measure of a cooperative spirit among producers, institutional factors act to limit the ability of such attitudes to be translated into an effective monopolistic strategy. As a result, the net effect of these contrasting forces cannot be inferred a priori from structural evidence but must, instead, be found in actual behavioral patterns.

4. Conclusions

The aim of this chapter was to evaluate the alleged anti-competitive effects of JV's, stressing in particular their effect on seller structure in the OCS sector. The resulting analysis does not support assertions that JV's create a unique structural environment that renders the gas sector incapable of effective competition:

(1) The negative relationship between firm size and JV intensity among OCS producers is inconsistent with a frequently advanced monopoly hypothesis based on anti-competitive intent by the major producers. While this finding does not rule out such a possibility, it does suggest that demonstrating monopoly through intent is not a particularly fruitful approach.

(2) An analysis of JV bidding patterns does not reveal significant instances of de facto merger among OCS producers. For the most likely candidates, the permanent JV combines CAGC and SLAM, member firms exhibit a wide range of bidding associations both within and outside of the joint association. The remaining JV's are temporary associations that also show wide diversity of partnership patterns.

(3) Alternative concentration measures based on the assumption of single firm control of JV's resulted in major producer market share levels generally lower than those based on the conventional working interest index. During the 1965-74 period, the major producer group as a whole did not exhibit a

disproportionate tendency to control JV leases by becoming operators or by maintaining a dominant financial share.

(4) A number of institutional characteristics of the gas sector discourage the monopolistic utilization of JV's. First, the large number of individual JV's limits the effectiveness of JV's as a vehicle for coordinating a monopoly strategy among the producers. Second, the non-consent clause of the typical JV agreement hinders the ability of a major to delay development in a lease since smaller partners have the right to proceed with the tract's development if it is considered a profitable undertaking.

The lack of incriminating evidence concerning JV's does not imply blanket approval of them. These joint associations do represent a cooperative effort among ostensible rivals and therefore should be monitored closely. Of particular interest on antitrust grounds are JV combines among large producers. Such activity was especially prominent during the 1971-74 period when JV associations among the major gas producers resulted in a significant "shared dominance" category of leases where two or more majors combined to maintain greater than 50 percent financial interest in a JV lease. In the absence of evidence showing the necessity of intra-major JV's on efficiency grounds, 1/ an appropriate public policy may be to discourage JV's among the largest producers. The recent Interior Department prohibition of JV's among certain large producers is a useful policy initiative in this regard.

1/ In the process of formulating its OCS JV ban, Interior's staff did not find evidence of important efficiencies derived from intra-major JV's. See Department of the Interior report, Joint Bidding for Federal Offshore Oil and Gas Lands, and Coal and Oil Shale Lands, U.S. Senate, Committee on Interior and Insular Affairs (Washington, 1976).

CHAPTER V

Nonproducing Leases in the OCS Sector - Behavioral Tests of Alleged Monopolistic Behavior

1. Introduction

Nonproducing leases in the Federal offshore area have been a continuing source of controversy. Of particular concern have been the so-called extended term producible shut-in leases (PSI's). These are nonproducing tracts that have been in existence for over five years. While the petroleum companies state that development delay on these tracts is unavoidable, ^{1/} such leases nonetheless represent a potential form of monopolistic supply restriction. As noted in chapter II, development delay through the utilization of PSI status can be viewed as an attempt by the major producers to create an artificial gas shortage designed to force the FPC to raise its ceiling price on interstate gas. This chapter evaluates the validity of such a monopoly thesis by analyzing ownership patterns of PSI holdings in the Gulf Coast OCS sector.

Attention will focus on the prediction of the monopoly hypothesis that the major producers hold a disproportionately large share of PSI tracts. This expected pattern follows from the postulate that a group of the largest producers, acting as dominant firms, seek to influence FPC price ceilings by withholding commercial gas deposits from the market by placing them in PSI status. Smaller producers, on the other hand, have less incentive to hold back supply since their perceived effect on market supply is relatively inconsequential. As a result, their PSI holdings should be low relative to that of the major producers.

^{1/} The chief reasons given by producers for delay are (1) geological and technological problems connected with development of the tract, (2) lack of pipeline facilities to carry the petroleum onshore, and (3) delays in attaining FPC certification for the sale of natural gas. Federal Power Commission, Offshore Investigations: Producible Shut-in Leases (First Phase) (Washington: U.S. Government Printing Office, 1974), p. 2.

By contrast, no significant association between producer size and relative PSI share should emerge in a nonmonopoly situation. In this context each producer, regardless of size, does not attempt to influence price but, rather, adjusts his supply to the price level set by the FPC. Hence, no positive association between firm size and PSI share should emerge.

The search for monopolistic patterns of PSI holdings utilizes two approaches. First, the ownership distribution of all leases classified PSI in certain years is analyzed. Second, on a more disaggregated basis, the ownership of PSI tracts from selected lease sales is compared to the set of all leases issued at those sales. This latter approach allows for a more specific comparison of relative PSI levels since the lease age factor can be held constant. In both cases, statistical research evaluates whether the ownership distribution of PSI leases deviates significantly from that pattern expected if such tracts were allocated randomly among all producers.

PSI tabulations for individual producers will focus on the years 1970 and 1974 since both periods coincided with charges that the major producers were contriving to create a shortage by holding back on gas supply. The year 1970 marked the beginning of curtailments by gas distributors which in turn led to pressure on the FPC to increase gas price ceilings. The National Rate Proceeding (Docket No. RM 75-14), which led ultimately to the latest FPC price rise in 1976 (Opinion No. 770), was initiated in 1974 amid charges that the producers deliberately created a crisis atmosphere in order to increase price ceilings.

The primary measure of producer size is nationwide production in 1974. As noted in chapter II, production market share (along with the closely associated proved reserves market share index) serves as a measure of a

company's exploration-developmental capacity and thus may be indicative of its perceived effect on market supply. In this regard, particular attention focuses on the eight largest natural gas producers. ^{1/} It is within this group that instances of dominant firm behavior are most likely to be found since these companies have a greater probability of perceiving their influence on market supply. The companies within this size group also stand to receive a commensurately higher reward (in the form of an appreciation in the value of their uncommitted resources) from a successful monopoly supply strategy than would be the case with smaller producers.

Company market shares based on the value of leases purchased at 1971-74 OCS lease sales are also utilized as a producer size measure in evaluating the pattern of 1974 PSI holdings. Tracts purchased during this period were likely to be uncommitted by the beginning of 1974; hence, they represent the principal reserve stock to benefit from a subsequent price rise by the FPC. An expected monopoly pattern thus would be a positive association between PSI share and 1971-74 lease ownership: the larger a producer's stock of uncommitted reserves, the greater his incentive for holding back older tracts (i.e., those past five years of age) in an attempt to raise FPC ceiling prices.

2. Statistical Analysis

PSI Holdings on a Yearly Basis:

Analysis of PSI ownership patterns focuses on those leases so classified in a particular year. Due to differences in the time sequence of purchases among producers, interfirm comparisons based on their respective shares of the total PSI's may not be valid; e.g., a seller with no lease over five years

^{1/} The eight largest producers on a nationwide basis for 1974 are: Exxon, Texaco, Standard Oil (Ind.), Gulf Oil, Mobil Oil, Shell Oil, Atlantic Richfield, and Union.

of age cannot by definition have any PSI tracts. 1/ A more relevant measure for comparison purposes is thus the ratio of a producer's PSI holdings to the set of all leases owned by him that are greater than five years of age:

$$P_t^* = \frac{X_t^*}{\bar{X}_t}$$

where:

X_t^* = leases that have been issued earlier than $t-5$ that have not yet initiated production

\bar{X}_t = the set of all leases (producing and nonproducing) issued earlier than $t - 5$

t = current time period

A producer's PSI index is based on its working share interest of bonus payments originally paid for each lease. 2/

The expected pattern of P^* index among producers is as follows: In the nonmonopoly case, PSI's are presumed to be distributed randomly among producers in proportion to their purchases. Hence, the PSI index P^* should display no size pattern among producers; i.e., the expected value of P^* should be the same for all producers, regardless of size. Under the monopoly hypothesis, the major producers are expected to control a disproportionately large share of PSI tracts; hence, they should display P^* levels significantly higher than those of small producers.

The resulting statistical analysis does not support the monopoly hypothesis. As a group, the majors' PSI index (P^*) has generally been below that

1/ The "age" of a lease refers to the elapsed time between its issuance in a lease sale and the current time period being considered. PSI leases are defined as nonproducing tracts that have been in existence for over five years.

2/ That is, a producer's lease holding totals, X^* and \bar{X} , are weighted by its working interest share of the total value of bonus payments originally paid for the tracts.

of the industry average. For the 13 years during the 1963-76 period where calculations could be made, the PSI index of the major group was lower than that of the OCS total in every year except 1974 when the major producer index was higher (table V-1). ^{1/} Also, individual comparisons among the major group for 1970 and 1974 indicate a diversity of PSI rates inconsistent with a collusive withholding scheme. PSI indices in 1974 range from Shell Oil's 13.9 percent to Union's 50.9 percent. The 1970 range is considerably greater: 2.6 percent to 66.0 percent (table V-2).

A final test of the monopoly hypothesis is to search for a positive relationship between producer size and PSI rate among all OCS operators. The resulting tabulation is shown in table V-3 where PSI indices are averaged for companies grouped by two size indices--1974 nationwide gas production and 1971-74 OCS lease purchases. Beyond the two smallest size groupings, no evidence of a positive PSI-size of firm relationship is apparent.

1974 PSI Leases Issued at the 1962 and 1967 OCS Lease Sales

Lease sales from two years, 1962 and 1967, accounted for the bulk of PSI tracts in 1974. Sixty-nine of the 94 leases classified as PSI in 1974 originated from these lease sales. This section summarizes the ownership pattern for this important subset of PSI tracts. The information developed shows a relatively low level of PSI holdings for the major group.

The top eight producers' share of PSI leases was 40 percent compared to their 54 percent share of original purchases. Two of the majors (Mobil and Union) had no PSI holdings at all, despite their original acquisition share of 7.7 percent (table V-4).

^{1/} The higher major group total for 1974 is due chiefly to Union, the second smallest company within the major group. Union's PSI index (value of PSI tracts as percent of total value of all tracts over 5 years of age) rose to 51 percent in 1974 from 5.3 percent in 1973. By 1975, however, its PSI index had declined to 31.8 percent as the total value of its PSI holdings dropped from \$22.6 million to \$10.3 million.

TABLE V-1

PSI Holdings of the Eight Major
Gas Producers: 1963-76

PSI index -- value of PSI holdings as percent of total leases in existence for over 5 years			
Year	(1) Major producers*	(2) All producers	(3) Major producers index divided by all producers index = (1)/(2)
1963	18.2	29.3	.62
1964	N.A.	N.A.	N.A.
1965	17.4	31.8	.55
1966	27.3	37.1	.74
1967	35.4	44.7	.79
1968	31.3	40.2	.78
1969	28.0	36.5	.77
1970	22.2	24.9	.89
1971	12.9	15.4	.84
1972	18.3	23.1	.79
1973	16.6	20.6	.81
1974	23.9	21.6	1.11
1975	16.8	17.2	.98
1976	11.2	21.0	.53

*Major producer groups: Exxon, Texaco, Standard Oil (Ind.), Gulf, Mobil, Shell, Atlantic Richfield, and Union Oil.

N.A. - Not Available

SOURCE: FTC tabulation based on Dept. of the Interior files.

TABLE V-2

PSI Holdings for the Eight Largest Gas
Producers: 1970 and 1974

Producer	1970		1974	
	Number of PSI leases	PSI index*	Number of PSI leases	PSI index*
on Corp.	15	22.1	7	27.5
aco, Inc.	38	66.0	10	26.2
andard Oil Co. (Ind.)	34	48.5	8	18.5
l Oil Corp.	4	9.7	7	30.8
e Oil Corp.	8	14.2	8	18.7
l Oil Co.	16	9.7	5	13.9
m Oil Co. of Calif.	5	22.7	6	50.9
ntic Richfield Co.	4	2.6	9	25.7
al - major group		22.2		23.9
al - all firms		24.9		21.6

*Value of a producer's PSI leases as a percent of its leases over 5 years in age.

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

TABLE V-3

Distribution of 1974 PSI Share Indices Grouped by
Selected Company Size Indices

Size categories ranked high to low	1974 nationwide production	Average PSI index* for producers grouped by:	1971-74 OCS lease sale acquisitions
1-4	25.8		28.8
5-8	14.6		12.7
9-12	23.0		24.7
13-16	20.5		64.9
17-20	50.0		37.2
21-24	5.6		9.1
25-29	9.0		0.1

*Unweighted average PSI index for companies in each size group. A company's PSI index is the ratio of the value of its PSI leases to the value of all of its leases that are over five years of age.

SOURCE: FTC tabulation based on Dept. of the Interior files.

TABLE V-4

Major Gas Producer Market Share Ratios for 1974 PSI
Leases Issued at the 1962 and 1967 OCS Lease Sales

Producer market share based on bonus value
of tracts purchased
(percent)

Producer	(1) Share of leases pur- chased at 1962 and 1967 lease sales classified PSI in 1974	(2) Share of all leases pur- chased at 1962 and 1967 lease sales	(3) PSI share minus total lease share =(1) - (2)
Exxon Corp.	3.5	8.8	-5.3
Gulf Oil Corp.	7.9	10.3	-2.4
Shell Oil Co.	12.7	15.0	-2.3
Texaco, Inc.	11.0	8.4	2.6
Standard Oil Co. (Ind.)	0.8	1.6	-0.8
Atlantic Richfield Co.	4.2	2.6	1.6
Mobil Oil Corp.	0	5.1	-5.1
Union Oil Co. of Calif.	0	2.6	-2.6
Total - Majors	40.1	54.4	-14.3

NOTE: Market share ratio is a producer's working interest of its leases as a percentage of the industry total.

SOURCE: FTC tabulation based on Dept. of the Interior files.

The majors' reliance on joint ventures was also relatively low (table V-5). While 20 percent of their original 1962 and 1967 purchases were acquired jointly, the corresponding figure for PSI leases acquired at these sales was less than 15 percent. It is also important to note that none of the joint ventures involving PSI tracts combined more than one major. Hence, it does not appear that joint ventures were used by the majors as a vehicle for coordinating a joint PSI holding strategy for leases issued in 1962 and 1967.

Trends in PSI Holdings

The magnitude of PSI holdings, in both an absolute and a relative sense, reached a peak in 1967 and has declined steadily in subsequent periods. The 1976 total of 80 PSI's represents a 70 percent drop from the high of 275 in 1967. A similar reduction is found for PSI's expressed as a percentage of all tracts greater than 5 years of age (table V-6).

Part of this decline is attributable to governmental responses to the increasing scarcity of domestic petroleum supply. The Department of the Interior has placed heightened pressure on producers to develop within the five-year period and thus to reduce their inventory of PSI leases. The FPC has attempted to speed up its pipeline certification procedures. Also the Commission's adoption of an optional pricing scheme in 1973 allowed some producers to bring high cost reservoirs into production at prices higher than prevailing FPC ceiling levels. 1/

In addition, the post-1967 decline appears to reflect the increased ability of producers to develop expeditiously the volume of tracts issued by Interior. In this regard, the peak year of PSI activity in 1967 was influenced

1/ Optional Procedure for Certificating New Producer Sales of Natural Gas, 48 FPC 218.

TABLE V-5

PSI Profile for Top Eight Producers: Tracts Purchased at 1962 and 1967 OCS Lease Sales

	A - PSI tracts				B - Total tracts purchased at the leased sales			
	All leases		JV leases		All leases		JV leases	
	Number	Bonus value (dollars)	Number	Bonus value (dollars)	Number	Bonus value (dollars)	Number	Bonus value (dollars)
Exxon Corp.	5	6,467,320	0	0	61	87,506,885	3	9,619,900
Texaco, Inc.	7	20,657,193	3	961,035	38	84,275,695	23	6,413,363
Standard Oil Co. (Ind.)	5	1,577,609	4	1,467,609	37	16,233,041	26	8,662,828
Gulf Oil Corp.	5	14,852,879	0	0	41	102,848,051	8	19,935,275
Mobil Oil Corp.	0	0	0	0	35	50,822,480	20	32,592,720
Shell Oil Co.	5	23,795,214	2	813,500	77	149,938,751	2	813,500
Atlantic Richfield Co.	7	7,810,557	5	7,592,819	39	26,027,748	34	15,896,666
Union Oil Co. of Calif.	0	0	0	0	28	26,367,965	16	14,980,525
Total								
Majors		75,160,772		10,834,963		544,020,616		108,914,777
All Firms		187,204,887		95,676,859		999,560,289		
Majors as percentage of all firms		40.1		11.3		54.4		

Source: FTC tabulation based on Dept. of the Interior files.

TABLE V-6

PSI Leases in the Gulf
Coast OCS Sector: 1963-76

Year	Number of PSI leases	PSI leases expressed as percentage of total number of leases in existence for over 5 years
1963	34	35.4
1964	N.A.	N.A.
1965	45	42.5
1966	82	44.1
1967	275	63.1
1968	238	57.3
1969	221	53.0
1970	183	43.6
1971	109	27.1
1972	122	25.3
1973	107	22.8
1974	94	19.5
1975	80	16.8
1976	80	15.2

N.A.- Not Available

Source: FTC tabulation based on Dept. of the Interior files.

by the extraordinary OCS leasing activity in 1962. In that year, Interior issued 420 tracts, one more than the cumulative total issued in the previous history of OCS leasing. Not coincidentally, the peak PSI year of 1967 marked the first year past the primary (5-year) term for the 1962 tracts. Over 50 percent of the PSI tracts as of 1967 were issued at 1962 lease sales. ^{1/}

The large number of leases issued in 1962 appeared to have taxed the capacity of producers to develop them within the 5-year primary term. In addition to high volume of leases, 1962 marked the first significant issuance of deep water tracts (greater than 240 feet) for which new drilling techniques were required. ^{2/} Viewed in this perspective, the subsequent decline in PSI holdings may reflect the improved adaptation of the petroleum industry to offshore leasing activity. Factors that have facilitated this trend include advances in the technology of offshore exploration and development and a less erratic leasing policy pursued by the Department of the Interior.

3. Concluding Remarks

To summarize, analysis of PSI holdings over the 1963-75 period does not support allegations that they have been utilized in a collusive attempt to restrict natural gas supply. The PSI indices of the eight largest gas producers--those most likely to pursue a monopoly supply strategy--were lower than the OCS sector as a whole for most of the period examined. Overall, it appears that the major producers, to the extent that they have generally exhibited a lower than average PSI index, initiate production on their leases at a somewhat faster rate than smaller producers. This pattern may be due to

^{1/} Of the 275 leases classified PSI in 1967, 158 were issued in 1962 lease sales.

^{2/} See Oil and Gas Journal, March 26, 1962, pp. 79-83.

the possibly superior exploration development ability of the majors or it may simply reflect the type of tracts they purchase.

The apparent nonmonopolistic nature of PSI holdings does not necessarily imply that the existence of such tracts is as inevitable as members of the petroleum industry may claim. There remains the possibility of speculative withholding on the part of producers anticipating (rather than causing) higher FPC ceiling prices in subsequent years. Speculative withholding results when producers anticipate that additional revenues from a price rise in a subsequent period will more than offset the opportunity cost of delayed revenues in the present period. The significant upward movement of FPC price ceilings, plus the perennial expectation of deregulation, no doubt may encourage such attempts.

Speculative withholding does not directly relate to the competitiveness of the gas sector, however. It concerns instead the behavior of regulatory agencies and their ability to formulate pricing policies that result in a stable demand-supply equilibrium over time. Since at least 1970, the FPC has been unable to achieve such a result because the increasing shortfall of gas supplies has placed continued pressure on that agency to revise its price ceiling upward. In such a regulatory environment, speculative withholding is a rational response of profit maximizing firms and does not depend on perceived market power. As a consequence, the existence and magnitude of speculative withholding is both difficult to quantify and not germane to the search for manifestations of monopoly power.

Chapter VI

Conclusions

The aim of this study has been to evaluate the gas supply industry's competitive potential in an environment where Federal price regulation is absent. Although conclusions must be considered tentative due to the extensive influence of FPC regulation on both structure and behavior, the evidence developed suggests that the gas industry is capable of workably competitive performance. The principal findings germane to this evaluation are as follows:

Seller concentration in the production sector is relatively moderate. Based on either production or reserves, the largest producer's output share ranges from 11 to 12 percent while the eight largest producers account for approximately 45 percent of output. These figures are similar to the median levels for the manufacturing sector and are below those threshold levels most commonly identified with monopolistic behavior. Of greater consequence, there exists a large number of producers of moderate size that possess adequate capacity to develop resources on a scale sufficient to frustrate any monopolistic supply restriction scheme of the larger producers. This supply potential is greatest in the onshore sector where relatively small tract sizes and lower capital requirements are particularly conducive to small producer participation. High initial capital outlays have prevented the participation of many small producers in the offshore area, yet there remains in that sector a nucleus of producers that appear sufficiently large in number to frustrate attempts at a collusive development strategy.

Exchange characteristics of the gas sector tend to limit the scope of monopolistic behavior since the prevalence of longterm contracts creates a dynamic situation in which industry capacity is constantly turning over at a rapid rate. Producers are thus limited in their ability to fine-tune supply

levels on a year-to-year basis in accordance with joint profit maximizing aspirations. Since production from existing tracts is set by long-term contract, output variations have to be coordinated by reductions in the development of leases, a more difficult and less exact process. 1/

Integration between the production and transportation stages does not appear to pose a competitive threat. Integration is quite low in the interstate market where gas producers sell to a largely independent pipeline sector. Vertical links appear somewhat higher in the interstate sector but are not of a nature to create significant competitive problems. In both markets the recent increase in vertical integration has pro-competitive overtones since it has generally taken the form of backward movements by gas purchasers into the production stage. The potential for such activity in the future can be expected to limit the ability of major gas producers to pursue a monopolistic supply strategy.

Joint venture activity within the industry is extensive and has been increasing. Although such activity is a potential threat to competition, its current level does not appear to create a competitive problem. In general, joint venture contacts among the largest producers have been diverse and of a temporary nature. Future problems in this area have been considerably mitigated by a recent Interior Department ruling which forbids combinations among the eight large producers in bids for Federal offshore leases.

The Interior Department's influence over both gas supply and seller structure in the Federal offshore sector constitutes an important lever

1/ In contrast, the prevalence of spot market transactions in crude oil provides a more favorable environment for output manipulation. The classic example here, of course, is the prorationing scheme devised by the Texas Railroad Commission whereby well output levels were varied on a monthly basis in order to support prices at predetermined levels.

can be used to stimulate competitive behavior. Interior plays an important role in the determination of Federal offshore gas supply through manipulation of lease sale schedules and its influence on the timing of development. The Department also has an impact on seller structure in the offshore sector through its ability to regulate the form of bidding and which companies are eligible for ownership of Federal leases. The ban on joint ventures among eight large petroleum producers is one example of the form this authority can take.

An analysis of ownership patterns for nonproducing leases in the Federal offshore areas indicates no evidence of attempts at monopolistic supply control by the major producers. As a group, the eight largest gas producers exhibited ownership patterns of nonproducing leases similar to or less than that of the industry as a whole during the 1963-75 period.

The above findings suggest that Federal price regulation is not necessary to control monopolistic tendencies in the gas sector. The industry's structure distinguishes it from the bulk of industries subject to maximum price regulation (such as electric utilities) where technology dictates significant entry barriers and a consequent highly concentrated seller structure. While the occurrence of monopolistic dislocations in a nonregulated situation cannot be completely ruled out, such cases should be amenable to antitrust action and to the countervailing influence of Interior Department oversight efforts in the offshore gas sector.

APPENDIX A

Production and Proved Reserves Statistics

The FTC's Natural Gas Survey Questionnaire (Gas Survey) formed the primary data source for individual company production and proved reserves figures. The questionnaire was sent to 59 large natural gas producers. These companies are listed in table A-1. In 1974, the 59 respondents accounted for 76 percent of total production and 79 percent of proved reserves.

The Gas Survey consisted of five questions. The first three sought information on company production and reserves levels on both a nationwide and an area basis. Relevant company figures were requested for the years 1960, 1965, and 1970 through 1974. Question number four concerned contractual relations between the surveyed producers and their customers during the 1973-74 period. It requested price and sales information on an individual contract basis along with identity of firms participating in joint venture combines. The fifth question dealt with producible shut-in leases in the onshore and offshore areas. The present report is based on responses to the first three questions. This information allowed for the construction of concentration ratios, based on production and proved reserves, for the nationwide market as well as for selected regional sectors.

Definitions of production and proved reserves in the survey are those utilized by the American Petroleum Association and the American Gas Association (table A-2). These definitions were chosen because of their wide utilization in the petroleum sector and because they are available in aggregate form, thus providing a consistent basis for concentration measurement. 1/ Conversely,

1/ Utilization of the API-AGA production and reserves aggregate totals thus should not be construed as an endorsement by the FTC of their veracity. The choice was rather a pragmatic one dictated by industry usage.

TABLE A-1
Natural Gas Producers Surveyed by
The Federal Trade Commission

Producer

Amerada-Hess Corp.
Amarex, Inc.
American Petrofina, Inc.
Arkansas Louisiana Gas Co.
Ashland Oil, Inc.
Atlantic Richfield Co.
Austral Oil Co., Inc.
Aztec Oil & Gas Co.
Belco Petroleum Corp.
Burmah Oil, Inc. (Signal Petroleum Co.)
Cities Service Co.
Coastal States Gas Corp.
Columbia Gas System, Inc.
Consolidated Natural Gas Co.
Continental Oil Co.
Cox, Edwin L.
Diamond Shamrock Corp.
El Paso Natural Gas Co. 1/
Exxon Corp.
Forest Oil Corp.
General American Oil Co. of Texas
Getty Oil Co. 2/
Gulf Oil Corp.
Hamilton Bros. Oil Co.
Hunt Oil Co.
Husky Oil Co.
Kansas-Nebraska Natural Gas Co.
Kerr-McGee Corp.
Kewanee Oil Co.
Lone Star Gas Co.
Louisiana Land & Exploration Co.
Mapco, Inc.
Marathon Oil Co.
Mesa Petroleum Co.
Mitchell Energy & Development Corp.
Mobil Oil Corp.
Murphy Oil Corp.
Occidental Petroleum Corp.
Panhandle Eastern Pipe Line Co.
Pennzoil Co.
Phillips Petroleum Co.
Pioneer Natural Gas Co.
Placid Oil Co.
Shell Oil Co.
Southern Natural Resources, Inc.
Southern Union Gas Co. (Western Gas Interstate)

TABLE A-1
Producers Surveyed by
The Federal Trade Commission
(Continued)

Producer

Southland Royalty Co.
Standard Oil Co. of Calif.
Standard Oil Co. (Ind.)
Standard Oil Co. (Ohio)
Sun Oil Co.
Superior Oil Co.
Tenneco, Inc.
Texaco, Inc.
Texas Eastern Transmission Corp.
Texas Gas Transmission Corp. 3/
Texas Oil & Gas Corp.
Union Oil Co. of Calif.
Union Pacific Corp.

1/ Companies included with El Paso Natural Gas are: Northwest Production Corp., Pecos Co., El Paso Products Co., Odessa Natural Gas Co.

2/ Companies included with Getty Oil Co. are: Mission Corp., Skelly Oil Co.

3/ Included with Texas Gas Transmission Corp. is Texas Gas Exploration Corp.

TABLE A-2
Instructions to Gas Survey Respondents
Regarding the Definition of Production
and Proved Reserves

Company Consolidation:

1. For purposes of this Special Report the "reporting company" refers to any company to which this questionnaire is addressed and includes any subsidiary owned or controlled directly or indirectly by the addressee. "Control" means the power to determine basic business policies such as investment in plant and equipment, price policies, and product development and can be based upon ownership of less than a majority stock interest. The reporting company must also include any joint venture or partnership in which the addressee and any subsidiary, owned or controlled directly or indirectly by the addressee, has an ownership interest.

Proved Reserves Definition:

1. For purposes of this report, the definition of proved reserves adopted by the American Gas Association in its annual publication, "Reserves of Crude Oil, Natural Gas Liquids, and Natural Gas in the United States and Canada and United States Productive Capacity," Volume 28, June 1974, and the accompanying instructions are to be used. The first two paragraphs of the following definition appear on page 103 of this publication, the third paragraph is derived from page 99, and the last paragraph is derived from pages 96 and 97.

Proved Reserves are the estimated quantity of natural gas which analysis of geologic and engineering data demonstrate with reasonable certainty to be recoverable in the future from known oil and gas reservoirs under existing economic and operating conditions. Reservoirs are considered proved that have demonstrated the ability to produce by either actual production or conclusive formation test.

The area of a reservoir considered proved is that portion delineated by drilling and defined by gas-oil, gas-water contacts or limited to the structural deformation or lenticularity of the reservoir. In the absence of fluid contacts, the lowest known structural occurrence of hydrocarbons controls the proved limits of the reservoir. The proved area of a reservoir may also include the adjoining portions not delineated by drilling but which can be evaluated as economically productive on the basis of geological and engineering data available at the time the estimate is made. Therefore, the reserves reported should include total proved reserves which may be in either the drilled or the undrilled portions of the field or reservoir.

Natural gas reserves take into account the shrinkage of the reservoir gas volume resulting from the removal of the liquefiable portions of the hydrocarbon gases and the reduction of volume due to the exclusion of non-hydrocarbon gases where they occur in sufficient quantity to render the gas unmarketable.

TABLE A-2 (con't)

2. The term "Gross Company Proved Reserves" refers to the reporting company's owned interest in proved reserves plus its proportionate part of any royalty or other noncost-bearing interest in proved reserves owed to others.

Production Definition:

1. Production refers to the total volume of natural gas withdrawn from producing reservoirs less the volume returned to such reservoirs in cycling, re-pressurizing of oil reservoirs and conservation operations. Production also should be corrected for shrinkage resulting from the removal of the liquefiable portions of the gas and excludes non-hydrocarbon gases where they occur in sufficient quantity to render the gas unmarketable.

2. The term "Gross Company Production" refers to the reporting company's owned interest in production plus its proportionate part of any royalty or other noncost-bearing interest in production owed to others.

Source: Federal Trade Commission, Special Report, Natural Gas Survey, issued March 14, 1975, pp. 2-4.

more liberal definitions of reserves were not requested because of the lack of an acceptable definition and the unavailability of empirical aggregates.

Companies were instructed to report production and proved reserves on a gross consolidated basis; i.e., company totals included the share of natural gas nominally owned by royalty owners.

For the top 30 producer and proved reserves groups, comparisons were made between each company's Gas Survey submission for 1974 and corresponding data available from public sources. Table A-3 compares production figures while table A-4 compares proved reserves estimates. 1/ In the majority of cases, the Gas Survey figures tended to be higher than the public ones. Overall, Gas Survey totals for the respondent firms were 9.5 percent higher than corresponding public figures for production and 6 percent higher for proved reserves (in each case the difference is expressed as a percentage of the relevant Gas Survey total).

The differences between the public and Gas Survey figures are not surprising in light of the wide variation in definitions that producers choose to present their production and reserves statistics. Of particular relevance for the comparisons made in tables A-3 and A-4 is the omission by most companies of royalty interest in either their production or proved reserves statistics. This factor can be substantial since royalty interests in petroleum properties typically range from 12 to 20 percent.

1/ Three companies were not included in the comparison because of unavailable public figures: Hunt Oil, Panhandle Eastern, and Consolidated Natural Gas.

TABLE A-3

Comparison of Public and Gas Survey 1974 Production Figures for Respondent
Companies Ranked Within the Top 30 Nationwide Producers
(All volumes in mil. cu. ft.)

National rank	Company	Gas survey production	Public production	Percent difference*	Definition of public production
1	Exxon Corp.	2,298,597	1,938,880	-15.6	Natural Gas Sales - United States
2	Texaco, Inc.	1,649,929	1,710,000	3.6	Gross U.S. Production
3	Standard Oil Co. (Ind.)	1,195,606	1,055,945	-11.7	Net Production - United States
4	Mobil Oil Corp.	964,390	974,185	1.0	Gross Production - United States
5	Gulf Oil Corp.	949,100	796,758	-16.1	Net Natural Gas Produced - United States
6	Shell Oil Co.	754,788	748,250	-0.9	Net Natural Gas Produced
7	Union Oil Co. of Calif.	638,369	534,104	-16.3	Net Production - United States
8	Atlantic Richfield Co.	632,362	634,735	0.4	Net Production of Natural Gas - United States
9	Sun Oil Co.	602,315	477,055	-20.8	Natural Gas Sales - United States
10	Phillips Petroleum Co.	564,394	523,045	-7.3	Net Natural Gas Production - United States
11	Standard Oil Co. of Calif.	558,672	470,000	-15.9	Approximate Net Production
12	Getty Oil Co.				Net Domestic and Canadian Production of Natural Gas for Co. and Subs.
13	(Skelly Oil Co.)	509,594	434,173	-14.8	
14	Cities Service	453,893	406,975	-10.3	Net Natural Gas Production - United States
15	Continental Oil	399,916	327,551	-18.1	Net Natural Gas Deliveries - United States
15	Tenneco, Inc.	397,521	297,750	-25.1	Production: Natural Gas - U.S. and Canada-Net to Tenneco
16	Superior Oil Co.	334,916	325,048	-2.9	Gross Sales - United States
17	Pennzoil Co.	320,457	273,020	-14.8	Production: Net Natural Gas - U.S. & Canada-Pennzoil and Pxygo
18	Coastal States Gas Corp.	221,661	189,222	-14.6	Production: Gas - United States
19	El Paso Natural Gas Co.	202,650	258,115	27.4	Produced - Dry Gas
20	Panhandle Eastern Pipe Line Co.	197,022	191,000	-3.0	Gas Production by Subsidiaries - United States

TABLE A-3 (Continued)

National rank	Company	Gas survey production	Public production	Percent difference*	Definition of public production
21	Marathon Oil Co.	175,410	149,066	-15.0	Net Production-Natural Gas - Total United States
22	Amerada-Hess Corp.	127,759	130,347	2.0	Net Natural Gas Production - Total United States
23	Kerr-McGee Corp.	127,039	105,265	-17.1	Natural Gas Delivered from Leases (Production)
24	Diamond Shamrock Corp.	115,043	93,615	-18.6	Net Natural Gas Produced
25	Ashland Oil, Inc.	114,008	99,444	-12.8	Net Gas Production - Domestic
26	Columbia Gas System, Inc.	113,319	103,898	- 8.3	Natural Gas Produced
27	Lone Star Gas Co.	108,990	99,057	- 9.1	Natural Gas Produced and sold
28	Consolidated Nat. Gas Co.	102,714	101,055	- 1.6	Gas Produced - United States
30	Champlin Petroleum Co.	96,917	89,425	- 7.7	Net Interest in Gas from all sources (Substantially all properties in U.S.)
	Total	14,927,331	13,536,983	-9.3	

*Public minus Gas Survey divided by Gas Survey.

Source: Gas Survey production figures from Federal Trade Commission Natural Gas Survey Questionnaire.
 Public production figures derived from company annual reports, SEC Forms 10-K and Moody's Industrial and Public Utility Manuals.

TABLE A-4

Comparison of Public and Gas Survey 1974 Reserve Figures for Respondent
Companies Ranked Within the Top 30 Nationwide Reserve Holders
(All volumes in mil. cu. ft.)

National rank	Company	Gas survey reserves	Public reserves	Percent difference*	Definition of public reserves
1	Exxon Corp.	28,173,168	24,100,000	-14.5	Gas Reserves
2	Texaco, Inc.	18,454,644	15,500,000	-16.0	Gas Reserve - No. America
3	Atlantic Richfield Co.	14,228,740	12,990,000	-8.7	Net Proved Reserves incl. No. Slope Alaska-United States
4	Standard Oil Co. (Ind.)	12,591,167	14,788,000	17.4	Net Proved Reserves (U.S. and Canada)
5	Mobil Oil Corp.	9,642,331	8,200,000	-15.0	Net Proved Reserves - U.S.
6	Gulf Oil Co.	8,959,243	7,741,000	-13.6	Net Proven U.S. Natural Gas Reserves
7	Standard Oil Co. of Calif.	7,730,609	7,859,000	1.7	Total Proved Reserves (U.S. and Canada)
8	Standard Oil Co. (Ohio)	7,419,396	7,375,900	- 0.6	Gross (Alaska), Net (Other U.S.)-Proved Reserves of Natural Gas
9	Union Oil Co. of Calif.	7,016,842	7,387,600	5.3	Net Proved Reserves (U.S. and Foreign)
10	Shell Oil Co.	6,918,865	7,400,000	7.0	Net Proved U.S. Natural Gas Reserves
11	El Paso Natural Gas Co.	5,832,655	5,527,200	- 5.2	Natural Gas Reserves Owned by Company
12	Phillips Petroleum	4,931,371	5,617,000	13.9	Owned Recoverable Reserves of Gas Excl. The No. Slope of Alaska
13	Sun Oil Co.	4,881,812	4,400,000	- 9.9	Net Proved Reserves-Natural Gas-United States
14	Cities Service Co.	4,652,129	4,900,000	5.3	Net Reserves-Natural Gas (U.S. and Canada)
15	Getty Oil Co.	4,031,640	3,583,146	-11.1	Net Domestic Reserves (Getty); Net Proved Reserves (Skelly)
16	Tenneco, Inc.	3,906,069	3,838,505	- 1.7	Net Proved Reserves of Natural Gas
17	Continental Oil Co.	3,209,738	3,267,000	1.8	Net Proved Reserves-United States
18	Superior Oil Co.	2,823,682	3,200,000	13.3	Net U.S. Reserves (estimated by John Herold Service)
19	Marathon Oil Co.	2,647,115	2,290,000	-13.5	Reserves of Natural Gas in the United States
		2,100,781	1,860,000	-15.1	Company-Owned Proved Reserves

TABLE A-4 (Continued)

National rank	Company	Gas survey reserves	Public reserves	Percent difference*	Definition of public reserves
22	Pennzoil Co.	1,819,498	1,826,953	0.4	Net Gas Reserves
24	Mesa Petroleum Co.	1,512,256	1,695,739	12.1	Net Proved Reserves-Natural Gas (83.2% located in U.S.)
25	Diamond Shamrock Corp.	1,452,252	1,100,000	-24.3	Net Proved Natural Gas Reserves
26	Amerada-Hess Corp.	1,377,190	1,320,000	- 4.2	Net Reserves-U.S. Natural Gas
27	Ashland Oil, Inc.	1,313,725	1,049,306	-20.1	Net Natural Reserves-United States
29	Kansas-Nebraska Natural Gas Co.	1,084,076	816,280	-24.7	Gas Reserves Owned by the company and contracted to it by Subs.
30	Aztec Oil & Gas Co.	1,064,954	928,042	-12.9	Net Proved Gas Reserves
	Total	169,864,948	160,560,671	-5.5	

* Public minus Gas Survey divided by Gas Survey.

Source: Gas Survey Figures from Federal Trade Commission Natural Gas Survey.
 Public reserves figures from company annual reports, SEC Forms 10-K,
 and Moody's Industrial and Public Utility Manuals.

TABLE A-5
Largest Natural Gas Producers: 1960

Production rank	Producer	Gas production (mil. cu. ft.)	Percent of U.S. total
1	Exxon Corp.	751,450	5.8
2	Standard Oil Co. (Ind.)	626,281	4.8
3	Phillips Petroleum Co.	511,730* <u>1/</u>	3.9
4	Texaco, Inc.	510,183	3.9
5	Mobil Oil Corp.	399,000	3.1
6	Shell Oil Co.	367,306	2.8
7	Gulf Oil Corp.	365,000*	2.8
8	Cities Service Co.	311,340	2.4
9	Standard Oil Co. of Calif.	283,993	2.2
10	Getty Oil Co.	288,532	2.2
11	Sun Oil Co.	273,694* <u>1/</u>	2.1
12	Union Oil Co. of Calif.	271,304	2.1
13	Superior Oil Co.	225,372	1.7
14	Pennzoil Co.	209,210	1.6
15	Atlantic Richfield Co.	186,054* <u>2/</u>	1.4
16	Continental Oil Co.	178,572	1.4
17	El Paso Natural Gas Co.	162,915	1.3
18	Sinclair Oil Corp.	157,176* <u>2/</u>	1.2
19	Sunray Mid-Continent Oil Co.	151,663* <u>2/</u>	1.2
20	Marathon Oil Co.	120,694	0.9
21	Champlin Petroleum Co.	115,870	0.9
22	Pure Oil Co.	114,614* <u>2/</u>	0.9
23	Amerada-Hess Corp.	110,559	0.8
24	Panhandle Eastern Pipeline Co.	105,963	0.8
25	Diamond Shamrock Corp.	87,181	0.7
26	Lone Star Gas Co.	83,710	0.6
27	Columbia Gas System, Inc.	72,817	0.6
28	Consolidated Natural Gas Co.	69,355	0.5
29	Hunt Oil Co.	67,276	0.5
30	Tenneco, Inc.	56,494	0.4

Total United States net production: 13,019,356

Concentration Ratios: (percent)

4-firm	18.4
8-firm	29.5
20-firm	48.8
30-firm	55.5

Table A-5 (continued)

1/ U.S. & Foreign

2/ U.S. & Canada

Source: Company data - FTC Natural Gas Survey where available.
Those figures noted by an asterisk (*) obtained
from J. Mulholland and D. Webbink, Concentration
Levels and Trends in the Energy Sector of the U.S. Economy,
(Washington: U.S. Government Printing Office, 1974).

U.S. Total - AGA, API, CPA, Reserves of Crude Oil, Natural Gas
Liquids and Natural Gas in the U.S. and Canada as of
Dec. 31, 1973 Vol. 28, June 1974, table VII. p. 120.

TABLE A-6
Largest Natural Gas Producers: 1965

Production rank	Producer	Gas production (mil. cu. ft.)	Percent of U.S. total
1	Exxon Corp.	1,260,582	7.8
2	Standard Oil Co. (Ind.)	866,674	5.3
3	Texaco Inc.	751,208	4.6
4	Mobil Oil Corp.	665,000	4.1
5	Gulf Oil	597,140*	3.7
6	Shell Oil Co.	584,913*	3.6
7	Union Oil Co. of Calif.	498,944	3.1
8	Phillips Petroleum Co.	485,450*	3.0
9	Standard Oil Co. of Calif.	444,821	2.7
10	Continental Oil Co.	402,471	2.5
11	Cities Service Co.	361,616	2.2
12	Getty Oil Co.	347,897	2.1
13	Sun Oil Co.	329,854* <u>1/</u>	2.0
14	Superior Oil Co.	277,243	1.7
15	Atlantic Richfield Co.	261,538* <u>2/</u>	1.6
16	Sinclair Oil Corp.	257,182* <u>1/</u>	1.6
17	Pennzoil Co.	193,807	1.2
18	United Gas Pipeline Co.	185,055* <u>3/</u>	1.1
19	El Paso Natural Gas Co.	171,979	1.1
20	Amerada-Hess Corp.	170,906	1.1
21	Panhandle Eastern Pipeline Co.	155,339	1.0
22	Sunray DX Oil Co.	135,591*	0.8
23	Marathon Oil Co.	133,846	0.8
24	Diamond Shamrock Corp.	109,739	0.7
25	Champlin Petroleum Co.	107,404	0.7
26	Lone Star Gas Co.	99,681	0.6
27	Columbia Gas System, Inc.	80,410	0.5
28	Kerr-McGee Corp.	77,379	0.5
29	Tenneco, Inc.	75,071	0.5
30	Hunt Oil Co.	65,727	0.4

Total United States: 16,252,293

Concentration Ratios: (percent)

4-firm	21.8
8-firm	35.2
20-firm	56.1
30-firm	62.6

TABLE A-6 (continued)

1/ U.S. & Canada

2/ North America

3/ U.S. plus Foreign

Source: Company data - FTC Natural Gas Survey where available. Those figures noted by an asterisk(*) obtained from J. Mulholland and D. Webbink, Concentration Levels and Trends in the Energy Sector of the U.S. Economy, (Washington: U.S. Government Printing Office, 1974).

U.S. total - AGA, API, CPA, Reserves of Crude Oil, Natural Gas Liquids and Natural Gas in the U.S. and Canada as of Dec. 31, 1973, Vol. 28, June 1974, table VII, p. 120.

TABLE A-7

Largest Natural Gas Producers: 1970

Production rank	Producer	Gas production (mil. cu. ft.)	Percent of U.S. total
1	Exxon Corp.	2,242,920	10.2
2	Texaco Inc.	1,552,749	7.1
3	Standard Oil Co. (Ind.)	1,208,300	5.5
4	Mobil Oil Corp.	1,030,003	4.7
5	Gulf Oil Corp.	1,006,305*	4.6
6	Shell Oil Co.	934,596	4.3
7	Atlantic Richfield Co.	748,294	3.4
8	Union Oil Co. of Calif.	685,248	3.1
9	Standard Oil Co. of Calif.	651,897	3.0
10	Sun Oil Co.	647,139	2.9
11	Phillips Petroleum Co.	604,990	2.8
12	Getty Oil Co.	518,270	2.4
13	Cities Service Co.	424,440	1.9
14	Continental Oil Co.	393,449*	1.8
15	Superior Oil Co.	340,144	1.5
16	Tenneco, Inc.	326,779	1.5
17	Pennzoil-United, Inc.	251,439	1.1
18	Marathon Oil	187,381	0.9
19	El Paso Natural Gas	179,101	0.8
20	Panhandle Eastern Pipeline Co.	167,428	0.8
21	Amerada-Hess Corp.	163,000	0.7
22	Champlin Petroleum Co.	141,487	0.6
23	Lone Star Gas Co.	133,562	0.6
24	Kerr-McGee Corp.	119,481	0.5
25	Diamond Shamrock Corp.	112,915	0.5
26	Hunt Oil Co.	99,970	0.5
27	Columbia Gas System, Inc.	90,003	0.4
28	Consolidated Natural Gas Co.	88,199	0.4
29	Mitchell Energy & Devel. Corp.	76,055	0.3
30	Standard Oil Co. (Ohio)	70,075	0.3

Total United States: 21,960,804

Concentration Ratios: (percent)

4-firm	27.5
8-firm	42.9
20-firm	64.3
30-firm	69.1

TABLE A-7 (continued)

Source: Company data - FTC Natural Gas Survey where available. Those figures noted by an asterisk(*) obtained from J. Mulholland and D. Webbink, Concentration Levels and Trends in the Energy Sector of the U.S. Economy, (Washington: U.S. Government Printing Office, 1974).

U.S. Total - AGA, API, CPA, Reserves of Crude Oil, Natural Gas Liquids and Natural Gas in the U.S. and Canada as of Dec. 31, 1973, Vol. 28, June 1974, table VII, p. 120.

TABLE A-8

Largest Onshore Producers of Natural Gas: 1960

Onshore rank	Producer	Onshore production (mil. cu. ft.)	Percent of U.S. total
1	Exxon Corp.	741,343	5.9
2	Standard Oil Co. (Ind.)	620,757	4.9
3	Phillips Petroleum Co.	506,751*	4.0
4	Texaco Inc.	505,297	4.0
5	Mobil Oil Co.	387,406	3.1
6	Gulf Oil Corp.	360,307	2.9
7	Shell Oil Co.	311,696	2.5
8	Cities Service Co.	294,612	2.3
9	Sun Oil Co.	273,694	2.2
10	Getty Oil Co.	269,960	2.1
11	Standard Oil Co. of Calif.	261,973	2.1
12	Superior Oil Co.	211,470	1.7
13	Pennzoil Co.	209,210	1.7
14	Union Oil Co. of Calif.	205,187	1.6
15	Atlantic Richfield Co.	186,039*	1.5
16	Sinclair Oil Co.	157,176*	1.2
17	Sunray Midcontinent Oil Co.	155,663*	1.2
18	Continental Oil Co.	150,399	1.2
19	El Paso Natural Gas Co.	148,304	1.2
20	Marathon Oil Co.	119,284	0.9

Total U.S. Onshore Production 12,578,895

Concentration Ratios (percent):

4-Firm	18.8
8-Firm	29.6
20-Firm	48.2

Source: Those marked by asterisk(*) were obtained from public sources. All others derived from FTC Natural Gas Survey Questionnaire.

TABLE A-9

Largest Onshore Producers of Natural Gas: 1965

Onshore rank		Onshore production (mil. cu. ft.)	Percent of U.S. total
1	Exxon Corp.	1,182,772	7.7
2	Standard Oil Co. (Ind.)	815,580	5.3
3	Texaco, Inc.	724,614	4.7
4	Mobil Oil Corp.	612,262	4.0
5	Shell Oil Co.	498,812	3.3
6	Gulf Oil Corp.	489,519	3.2
7	Phillips Petroleum Co.	481,507*	3.1
8	Standard Oil Co. of Calif.	369,972	2.4
9	Continental Oil Co.	349,353	2.3
10	Cities Service Co.	330,226	2.2
11	Sun Oil Co.	329,854	2.2
12	Getty Oil Co.	316,259	2.1
13	Union Oil Co. of Calif.	276,087	1.8
14	Sinclair Oil Co.	257,182*	1.7
15	Atlantic Richfield Co.	254,479*	1.7
16	Superior Oil Co.	239,133	1.6
17	Pennzoil Co.	192,622	1.3
18	United Gas Pipeline Co.	185,055*	1.2
19	Amerada-Hess Corp.	170,238	1.1
20	El Paso Natural Gas Co.	156,424	1.0
Total U.S. Onshore Production		15,312,869	
Concentration Ratios (percent):			
	4-Firm	21.7	
	8-Firm	33.7	
	20-Firm	53.9	

Source: Those marked by asterisk(*) were obtained from public sources. All others derived from FTC Natural Gas Survey Questionnaire.

TABLE A-10

Largest Onshore Producers of Natural Gas: 1970

Onshore rank	Producer	Onshore production (mil. cu. ft.)	Percent of U.S. total
1	Exxon Corp.	2,035,842	10.9
2	Texaco, Inc.	1,208,816	6.4
3	Standard Oil Co. (Ind.)	1,072,443	5.7
4	Mobil Oil Corp.	847,670	4.5
5	Gulf Oil Corp.	686,412	3.7
6	Sun Oil Co.	647,006	3.5
7	Atlantic Richfield Co.	637,714	3.4
8	Shell Oil Co.	619,204	3.3
9	Phillips Petroleum Co.	496,233	2.6
10	Standard Oil Co. of Calif.	442,250	2.4
11	Union Oil Co. of Calif.	416,177	2.2
12	Getty Oil Co.	415,239	2.2
13	Cities Service Co.	336,240	1.8
14	Continental Oil Co.	284,811	1.5
15	Superior Oil Co.	278,621	1.5
16	Pennzoil-United, Inc.	249,782	1.3
17	Marathon Oil Co.	183,513	1.0
18	El Paso Natural Gas Co.	171,058	0.9
19	Panhandle Eastern Co.	167,428	0.9
20	Amerada-Hess Corp.	153,995	0.8
Total U.S. Onshore Production		18,742,686	
Concentration Ratios (percent):			
	4-Firm	27.5	
	8-Firm	41.4	
	20-Firm	60.5	

Source: FTC Natural Gas Survey Questionnaire.

TABLE A-11

Largest Onshore Producers of Natural Gas: 1974

Onshore rank	Producer	Onshore production (mil. cu. ft.)	Percent of U.S. total
1	Exxon Corp.	2,050,865	12.0
2	Texaco, Inc.	1,146,538	6.7
3	Standard Oil Co. (Ind.)	998,997	5.8
4	Gulf Oil Corp.	741,236	4.3
5	Mobil Oil Corp.	721,820	4.2
6	Sun Oil Co.	578,606	3.4
7	Atlantic Richfield Co.	504,527	3.0
8	Shell Oil Co.	489,117	2.9
9	Phillips Petroleum Co.	457,461	2.7
10	Union Oil Co. of Calif.	382,919	2.2
11	Getty Oil Co.	339,558	2.0
12	Standard Oil Co. of Calif.	323,170	1.9
13	Cities Service Co.	308,224	1.8
14	Superior Oil Co.	258,687	1.5
15	Continental Oil Co.	252,805	1.5
16	Pennzoil Co.	208,376	1.2
17	Coastal States Gas Corp.	207,551	1.2
18	Panhandle Eastern Pipeline Co.	196,103	1.1
19	El Paso Natural Gas Co.	176,949	1.0
20	Marathon Oil Co.	153,200	0.9
Total U.S. Onshore Production		17,088,717	
Concentration Ratios (percent):			
	4-Firm	28.8	
	8-Firm	42.3	
	20-Firm	61.3	

Source: FTC Natural Gas Survey Questionnaire.

Table A-12
Largest Crude Oil Producers: 1974

Crude production rank		Net production of crude oil, condensate and natural gas liquids	Percent of U.S. total
1	Exxon Corp.	324,850*	8.5
2	Texaco, Inc.	257,325*	6.7
3	Standard Oil Co. (Ind.)	196,735	5.2
4	Shell Oil Co.	184,020	4.8
5	Gulf Oil Corp.	173,849	4.6
6	Standard Oil Co. of Calif.	150,745*	4.0
7	Atlantic Richfield Co.	139,832	3.7
8	Mobil Oil Corp.	132,495	3.5
9	Phillips Petroleum Co.	131,765	3.4
10	Cities Service Co.	115,048 <u>1/</u>	3.0
11	Getty Oil Co.	111,800	2.9
12	Sun Oil Co.	99,331	2.6
13	Union Oil of Calif.	98,404	2.6
14	Continental Oil	79,570	2.1
15	Marathon Oil Co.	63,525	1.7
16	City of Long Beach	46,100*	1.2
17	Amerada-Hess Corp.	42,600 <u>2/</u>	1.1
18	Superior Oil Co.	39,561	1.0
19	Tenneco, Inc.	31,317*	0.8
20	Louisiana Land & Expl. Co.	28,194	0.7
21	Murphy Oil Corp.	21,194	0.6
22	Pennzoil Co.	19,821	0.5
23	Ashland Oil, Inc.	17,944	0.5
24	Kerr-McGee Corp.	13,400	0.4
25	Standard Oil Co. (Ohio)	10,821	0.3
26	General Amer. Oil Co. of Texas	10,200	0.3
27	American Petrofina, Corp.	7,438	0.2
28	Coastal States Gas Corp.	5,376	0.1
29	Mesa Petroleum Co.	3,345	0.1
30	Occidental Petroleum Corp.	3,157	0.1
	Total United States	3,818,683	

Concentration Ratios: (percent)

	Net	Adjusted gross <u>3/</u>
4-firm	25.2	28.8
8-firm	41.0	46.9
20-firm	64.1	73.3
30-firm	67.2	76.8

TABLE A-12 (continued)

Source: Company data obtained from the following sources:
API, U.S. Petroleum Market Volumes and Market
Shares: 1950-1975, Individual Company Data
(Wash. 1976); Moody's Industrial Manuals; and
J. Herold Service.

Notes: 1/ U.S. and Canada

2/ North America

3/ Estimated gross concentration calculated by
multiplying net concentration by 1.143. See
J. Mulholland and D. Webbink, Concentration
Levels and Trends in the Energy Sector of the
U.S. Economy (Wash: U.S. Government Printing
Office, 1974) p. 35.

TABLE A-13
Largest Producers of Natural Gas
in the Gulf Coast Region: 1974

Rank	Producer	Production (mil. cu. ft.)	Market share (percent)
1	Exxon Corp.	1,780,878	19.6
2	Texaco, Inc.	1,356,084	14.9
3	Standard Oil Co. (Ind.)	563,463	6.2
4	Mobil Oil Corp.	472,381	5.2
5	Shell Oil Co.	472,357	5.2
6	Union Oil Co. of Calif.	430,066	4.7
7	Gulf Oil Corp.	410,320	4.5
8	Sun Oil Corp.	397,069	4.4
9	Standard Oil Co. of Calif.	346,469	3.8
10	Atlantic-Richfield Co.	331,097	3.6
11	Tenneco, Inc.	318,314	3.5
12	Getty Oil Co.	309,527	3.4
13	Pennzoil Co.	260,439	2.9
14	Superior Oil Co.	230,854	2.5
15	Continental Oil Co.	208,694	2.3
16	Cities Service Co.	180,733	2.0
17	Phillips Petroleum Co.	106,360	1.2
18	Kerr-McGee Corp.	83,633	0.9
19	Louisiana Land & Exploration Co.	56,918	0.6
20	Columbia Gas System, Inc.	54,501	0.6
Total Production of all Surveyed Producers		9,080,319	
Concentration Ratios: (percent)			
	4-firm	45.9	
	8-firm	64.7	
	20-firm	92.0	

Source: FTC Natural Gas Survey Questionnaire

TABLE A-14
Largest Producers of Natural Gas
in the Permian Basin Region: 1974

Rank	Producer	Production (mil. cu. ft.)	Market share (percent)
1	Gulf Oil Corp.	384,306	15.9
2	Exxon Corp.	322,274	13.3
3	Standard Oil Co. (Ind.)	169,228	7.0
4	Mobil Oil Corp.	164,618	6.8
5	Atlantic-Richfield Co.	163,678	6.8
6	Texaco, Inc.	148,831	6.1
7	Shell Oil Co.	145,801	6.0
8	Phillips Petroleum Co.	124,528	5.1
9	Getty Oil Co.	99,143	4.1
10	Sun Oil Co.	80,978	3.3
11	Union Oil Co. of Calif.	79,104	3.3
12	Standard Oil Co. of Calif.	77,378	3.2
13	Superior Oil Co.	77,284	3.2
14	Cities Service Co.	72,889	3.0
15	Continental Oil Co.	56,370	2.3
16	Forest Oil Corp.	45,164	1.9
17	Marathon Oil Corp.	40,584	1.7
18	Amerada-Hess Corp.	23,725	1.0
19	El Paso Natural Gas Co.	18,645	0.8
20	Pennzoil Co.	17,633	0.7
Total Production of all Surveyed Producers		2,422,075	
Concentration Ratios: (percent)			
	4-firm	43.0	
	8-firm	67.0	
	20-firm	95.5	

Source: FTC Natural Gas Survey Questionnaire

TABLE A-15
Largest Producers of Natural Gas
in the Hugoton-Anadarko Region: 1974

Rank	Producer	Production (mil. cu. ft.)	Market share (percent)
1	Standard Oil Co. (Ind.)	249,324	11.1
2	Mobil Oil Corp.	239,425	10.7
3	Phillips Petroleum Co.	228,349	10.2
4	Panhandle Eastern Pipeline Co.	184,711	8.2
5	Coastal States Gas Corp.	162,880	7.3
6	Cities Service Co.	162,294	7.2
7	Gulf Oil Corp.	106,027	4.7
8	Diamond Shamrock Corp.	104,239	4.6
9	Continental Oil Co.	75,899	3.4
10	Mesa Petroleum Co.	74,197	3.3
11	Sun Oil Co.	66,479	3.0
12	Shell Oil Co.	61,602	2.7
13	Exxon Corp.	59,719	2.7
14	Atlantic-Richfield Co.	55,277	2.5
15	Texaco, Inc.	55,267	2.5
16	Kansas-Nebraska Natural Gas Co.	39,311	1.8
17	Kerr-McGee Corp.	34,261	1.5
18	Getty Oil Co.	33,646	1.5
19	Union Oil Co. of Calif.	33,087	1.5
20	El Paso Natural Gas Co.	24,319	1.1
Total Production of all Surveyed Producers		2,243,216	
Concentration Ratios: (percent)			
	4-firm	40.2	
	8-firm	64.0	
	20-firm	91.5	

Source: FTC Natural Gas Survey Questionnaire

Appendix B

New Contract Sales Concentration Ratios

New contract concentration ratios presented in Chapter III are tabulated from gas sales based on contracts negotiated during specified time periods. In order to avoid distortions created by variations in the contract signing dates, sales are measured for the first full year after the contracts are negotiated. Thus, for example, a new contract concentration ratio for 1975 is based on 1976 sales emanating from contracts signed in 1975.

The Federal Power Commission was the source of both interstate and intrastate new contract information.

Interstate Contracts

Sales and ownership information on interstate contracts initiated during the 1968-70 period were compiled by Paul MacAvoy from records on file at the FPC. Further adjustments of the data were performed by the FTC in order to reflect corporate consolidations.

Intrastate Contracts

Intrastate contract information was obtained from the results of FPC surveys conducted for 1966-72 and 1975 periods. The 1966-72 survey was initiated under Docket Nos. R389 and R389A and consisted of questionnaires sent to producers with jurisdictional sales in excess

of 10 million cubic feet per year. Surveys were issued June 26 and July 24, 1970; September 8, 1971, and September 14, 1972. 1/ The 1975 data were obtained from copies of FPC form 45. This form is sent to all producers with jurisdictional gas sales in excess of 1 million cubic feet. 2/ There were no surveys for the intervening years between 1972 and 1975.

1/ The FTC gained access to the intrastate contract information through an April 23, 1976 FPC order issued under Docket No. R175-147.

2/ Form 45 was established under FPC order 521, issued January 7, 1975.

TABLE B-1

Largest Gas Suppliers, Based on 1968-70 New
Contract Sales - Nationwide

Rank	Seller	1968-70 New contract sales volume (mil. cu. ft.)	Market share (percent)
1	Exxon Corp.	313,000,204	17.7
2	Gulf Oil Corp.	144,456,942	8.1
3	Superior Oil Co.	129,008,335	7.3
4	Standard Oil Co. (Ind.)	111,901,713	6.3
5	Texaco, Inc.	110,686,457	6.2
6	Atlantic-Richfield Co.	94,012,625	5.3
7	Mobil Oil Corp.	80,444,464	4.5
8	Phillips Petroleum Co.	80,042,790	4.5
9	Getty Oil Co.	64,571,070	3.6
10	Union Oil of Calif.	59,234,061	3.3
11	Sun Oil Co.	54,969,753	3.1
12	Shell Oil Co.	45,119,715	2.5
13	Kansas-Nebraska Natural Gas Co.	42,845,000	2.4
14	Continental Oil Co.	38,631,981	2.2
15	Forest Oil Corp.	37,069,876	2.1
16	Louisiana Land & Exploration Co.	29,736,000	1.7
17	Standard Oil Co. of Calif.	29,549,953	1.7
18	Pennzoil Co.	28,379,000	1.6
19	Texas Oil & Gas Corp.	22,827,135	1.3
20	Lone Star Gas Co.	20,247,264	1.1
21	Columbia Gas System, Inc.	17,315,000	1.0
22	E. Cockrell Co.	15,431,554	.9
23	King Co.	13,687,000	.8
24	Cox, Edwin L.	10,827,000	.6
25	Hunt Oil Co.	10,165,532	.6
26	Southern Union Gas Co.	9,924,000	.6
27	Adobe Oil Co.	8,513,000	.5
28	IMP Amer. Mgt.	8,247,000	.5
29	Union Pacific Corp.	7,747,604	.4
30	Union Carbide Corp.	7,499,000	.4
	Total	1,773,067,265	

Sources: Intra-sales - FPC Intra-state Sales Survey. Docket nos. R389 and R389A.
Interstate sales - Contract information on file at the FPC.

TABLE B-2

Largest Seller in the Gulf Coast Region Based on
New Contract Sales During the 1968-70 Period

Rank	Seller	1968-70 New contract sales volume (mil. cu. ft.)	Sales volume percent of 1
1	Exxon Corp.	191,964,116	19.9
2	Standard Oil Co. (Ind.)	98,142,199	10.2
3	Texaco, Inc.	70,896,394	7.4
4	Mobil Oil Corp.	62,294,771	6.5
5	Getty Oil Co.	59,159,104	6.1
6	Atlantic-Richfield Co.	58,176,287	6.0
7	Union Oil Co. of Calif.	36,792,061	3.8
8	Shell Oil Co.	35,863,000	3.7
9	Sun Oil Co.	33,564,811	3.5
10	Louisiana Land & Exploration Co.	29,564,811	3.5
11	Pennzoil Co.	28,179,000	2.9
12	Continental Oil Co.	27,339,781	2.8
13	Standard Oil Co. of Calif.	21,725,953	2.3
14	Gulf Oil Corp.	19,271,642	2.0
15	Forest Oil Corp.	17,578,000	1.8
16	Columbia Gas System, Inc.	17,315,000	1.8
17	E. Cockrell Co.	15,431,554	1.6
18	Superior Oil Co.	13,296,297	1.4
19	King Co.	11,776,000	1.2
20	Cox, Edwin L.	10,827,000	1.1
21	Lone Star Gas Co.	9,779,976	1.0
22	Hunt Oil Co.	9,091,000	.9
23	Union Pacific Corp.	7,747,604	.8
24	Union Carbide Corp.	7,499,000	.8
25	Texas Oil & Gas Corp.	7,016,146	.7
26	Exchange Oil & Gas Co.	6,814,000	.7
27	IMP-Amer. Mgt.	6,210,000	.6
28	Phillips Petroleum Co.	5,512,507	.6
29	Trans Ocean Oil, Inc.	4,614,000	.5
30	Lo-Vaca Gathering Co.	4,474,000	.5
	Total	962,925,352	

Sources: Intrastate sales - FPC Intrastate Sales Survey. Docket nos. R38
and R389A.

Interstate sales - Contract information on file at the FPC.

TABLE B-3

Largest Sellers in the Permian Basin Region Based on
New Contract Sales During the 1968-70 Period

Rank	Seller	Sales volume (mil. cu. ft.)	Market share (percent)
1	Superior Oil Co.	115,037,038	21.0
2	Gulf Oil Corp.	111,047,000	20.3
3	Exxon Corp.	103,794,373	19.0
4	Atlantic Richfield Co.	32,746,789	6.0
5	Texaco, Inc.	32,593,586	6.0
6	Forest Oil Corp.	19,491,867	3.6
7	Sun Oil Co.	16,450,380	3.0
8	Mobil Oil Corp.	13,857,388	2.5
9	Phillips Petroleum Co.	12,955,715	2.4
10	Union Oil Co. of Calif.	12,000,000	2.2
11	Standard Oil Co. (Ind.)	11,575,000	2.1
12	Southern Union Gas Co.	9,379,000	1.7
13	Texas Oil & Gas Corp.	9,282,791	1.7
14	Adobe Oil Co.	8,513,000	1.6
15	Tenneco, Inc.	6,581,000	1.3
16	Continental Oil Co.	6,051,805	1.1
17	Texas American Oil Corp.	4,763,000	.9
18	Standard Oil Co. of Calif.	2,500,000	.5
19	Getty Oil Co.	2,335,500	.4
20	Mitchell Energy & Devel. Corp.	2,278,000	.4
21	Marathon Oil Co.	1,943,000	.4
22	Cities Service Co.	1,923,715	.4
23	Faskin, David	1,170,000	.2
24	Union Texas Petroleum Co.	1,117,000	.2
25	Hunt Oil Co.	1,074,532	.2
26	Crown Central Petroleum Corp.	1,046,000	.2
27	Southwestern Natural Gas Co.	929,000	.2
28	IMP Amer. Mgt.	663,286	.2
29	J.M. Huber Corp.	834,000	.1
30	Aztec Oil & Gas Co.	628,000	.1
	Total	546,560,369	

SOURCES: Intrastates sales - FPC intrastate Sales Survey. Docket
Nos. R389 and R389A

Interstate sales - Contract information on file at the FPC.

TABLE B-4

Largest Sellers in The Hugoton-Anadarko Region Based
on New Contract Sales During the 1968-70 Period

Rank	Seller	Sales volume (mil. cu. ft.)	Market share (percent)
1	Phillips Petroleum Co.	61,574,568	23.4
2	Kansas-Nebraska Natural Gas Co.	42,845,000	16.3
3	Exxon Corp.	17,241,715	6.5
4	Gulf Oil Corp.	14,138,300	5.4
5	Union Oil Co. of Calif.	10,442,000	4.0
6	Lone Star Gas Co.	10,224,869	3.9
7	Shell Oil Co.	8,672,715	3.3
8	Texaco, Inc.	7,196,477	2.7
9	Texas Oil & Gas Corp.	6,528,198	2.5
10	Diamond Shamrock Corp.	6,278,000	2.4
11	Woods Petroleum Corp.	5,552,000	2.1
12	Standard Oil Co. of Calif.	5,324,000	2.0
13	Continental Oil Co.	5,290,395	2.0
14	Sun Oil Co.	4,954,562	1.9
15	Mobil Oil Corp.	4,292,305	1.6
16	Rooman	4,215,000	1.6
17	Cabot Corp.	3,600,000	1.4
18	Monsanto Chemical CO.	3,215,000	1.2
19	Apache Corp.	3,139,000	1.2
20	Atlantic Richfield Co.	3,089,549	1.2
21	Getty Oil Co.	3,076,466	1.2
22	Cleary Petro. Co.	2,595,000	1.0
23	Samedan Oil Corp.	2,425,000	.9
24	Hill Oil Co.	2,416,000	.9
25	Nielson Ent.	2,358,000	.9
26	Western States Prod.	2,204,000	.8
27	Standard Oil Co. (Ind.)	2,184,514	.8
28	Wessely Petroleum	2,155,000	.8
29	Petro, Inc.	2,130,000	.8
30	Union Texas Petroleum Div.	2,064,000	.8
	Total	263,581,544	

SOURCES: Intrastate sales - FPC Intrastate Sales Survey. Docket Nos. R389
and R389A
Interstate sales - Contract information on file at the FPC.

TABLE B-5

Largest Gas Suppliers Based on 1972
Intrastate New Contract Sales - Nationwide

Rank	Seller	1972 New contract sales volume (mil. cu. ft.)	Market share (percent)
1	Mobil Oil Corp.	46,101,000	18.3
2	Texaco, Inc.	26,504,500	10.5
3	Houston Natural Gas Corp.	24,670,000	9.8
4	Shell Oil Co.	21,156,314	8.4
5	Texas Oil & Gas Corp.	20,368,881	8.1
6	Atlantic-Richfield Co.	19,586,000	7.8
7	Standard Oil Co. (Ind.)	18,368,470	7.3
8	Gulf Oil Corp.	17,379,242	6.9
9	Coastal States Gas Corp.	8,655,245	3.4
10	Standard Oil Co. of Calif.	7,690,000	3.1
11	Exxon Corp.	6,050,055	2.4
12	Phillips Petroleum Co.	5,887,158	2.3
13	Sun Oil Co.	4,906,750	1.9
14	Tenneco, Inc.	3,668,672	1.5
15	Continental Oil Co.	2,061,830	0.8
16	Pennzoil Co.	1,960,000	0.8
17	Monsanto Co.	1,938,000	0.8
18	Getty Oil Co.	1,804,000	0.7
19	Cox, Edwin L.	1,680,000	0.7
20	Cities Service Co.	1,527,500	0.6
	Total - all sales	251,835,464	

Concentration levels (percent):

4-firm	47.0
8-firm	77.1
20-firm	96.1

Source: FPC Intrastate Sales Survey, Docket 389A

TABLE B-6

Largest Gas Suppliers Based on 1975
Intrastate New Contract Sales-Nationwide

Rank	Seller	1975 new contract sales volume (mil. cu. ft.)	Market share (percent)
1	Texaco, Inc.	68,814,840	17.7
2	Shell Oil Co.	45,891,090	11.8
3	Mobil Oil Corp.	36,005,450	9.2
4	Union Oil Co. of Calif.	24,548,195	6.3
5	Exxon Corp.	17,261,146	4.4
6	Standard Oil Co. (Ind.)	17,120,178	4.4
7	Continental Oil Co.	16,541,603	4.2
8	Gulf Oil Corp.	15,528,500	4.0
9	Southland Royalty	13,024,000	3.3
10	Sun Oil Co.	12,278,325	3.2
11	Diamond Shamrock Corp.	11,830,000	3.0
12	Pennzoil Co.	11,632,500	3.0
13	Coastal States Gas Co.	11,314,500	2.9
14	Texas Oil & Gas Corp.	10,841,142	2.8
15	Atlantic Richfield Co.	10,441,495	2.7
16	Tenneco, Inc.	10,050,393	2.6
17	Cities Service Co.	6,806,776	1.7
18	Hunt Oil Co.	6,203,962	1.6
19	Phillips Petroleum Co.	6,010,250	1.5
20	Standard Oil Co. of Calif.	4,750,000	1.2
	Total - all sales	389,235,337	

Concentration levels (percent):

4 firm	45.0
8 firm	62.0
20 firm	91.7

Source: Federal Power Commission, Form 45

Appendix C

Data Base for Size of Firm - Joint Venture Intensity Comparisons

Table C-1 lists the 32 producers utilized in the firm size-JV intensity regression analysis presented in chapter IV. It also includes each firm's 1970 oil production total and JV intensity ratio. The company selection process was based on the availability of size information for a producer and its participation in at least one OCS sale during the 1965-74 period. One qualifying firm, Forest Oil, was excluded because it subsequently sold off a large portion of leases originally obtained at the lease sales (see appendix D).

Table C-2 lists regression results based on the following alternative indicators of producer size: value of assets, international oil production, and OCS oil production. Definitions and sources of the variables utilized in the regression analysis are explained in table C-3.

Table C-1

Data Base for JV Intensity Regressions
Reported in Chapter IV

Producers included in the JV intensity regressions	1970 U.S. oil production (thousands of bbls.)	JV intensity - No. of JV bids as percent of total bids - 1965-74
Atlantic Richfield Co.	129,260	68.4
Exxon Corp.	299,139	30.2
Gulf Oil Corp.	198,524	64.8
Mobil Oil Corp.	119,873	90.1
Shell Oil Co.	194,023	53.3
Standard Oil Co. of Calif.	162,425	65.4
Standard Oil Co. (Ind.)	147,000	85.0
Texaco, Inc.	262,800	50.0
Continental Oil Co.	64,240	89.6
Tenneco, Inc.	27,255	69.8
Phillips Petroleum Co.	50,699	97.5
Union Oil Co. of Calif.	101,069	91.8
Sun Oil Co.	78,441	16.7
Amerada-Hess Corp.	32,861	94.8
Ashland Oil, Inc.	4,043	100.0
Marathon Oil Co.	59,624	89.1
Cities Service Co.	43,764	97.3
Getty Oil Co.	100,901	97.4
Burmah Oil, Inc.	2,900	96.2
Champlin Petroleum Co.	18,338	98.8
Superior Oil Co.	19,801	96.7
Kerr-McGee Corp.	10,147	99.0
Murphy Oil Corp.	15,750	50.5
Pennzoil Co.	12,601	97.5
General Crude Oil Co.	8,614	92.7
Hamilton Bros. Oil Co.	1,081	98.3
Kewanee Oil Co.	7,900	100.0
Louisiana Land and Exploration Co.	11,714	96.8
Mesa Petroleum Co.	1,900	91.6
Consolidated Natural Gas Co.	256	97.8
El Paso Natural Gas Co.	2,832	100.0
Southern National Resources, Inc.	2,400	88.8

TABLE C-2
 Regression Equation Explaining Joint Venture
 Intensity by Alternative Measures of Producer Size

Equation	Intercept	Asset value (millions of dollars)	Regression coefficient (t values in parentheses)		R ² /F statistic
			International oil production	OCS oil production	
1	93.98	-.003 (3.6)			.38/18.32
2	98.30		-.00003 (4.1)		.36/16.89
3	89.44			-.001 (3.17)	.25/10.4

Note - For description of variables, see table C-3.

TABLE C-3

Description of Variables
Used in the JV Intensity
Regression Equation

Variable	Definition	Data source
JV intensity	Percent of a producer's total bids over the 1965-74 period accounted for by JV bids	FTC tabulation based on U.S. Dept. of the Interior files.
Asset value	Value of a producer's total assets (including non-petroleum interests) as of 1970	<u>Moody's Industrial Manuals</u>
Domestic oil production	Total U.S. oil production in 1970	<u>Moody's Industrial Manuals</u>
International oil production	Total international oil production in 1970	<u>Moody's Industrial Manuals</u>
OCS oil production	OCS oil production in 1970	FTC tabulation based on U.S. Dept. of the Interior files.

APPENDIX D

Outer Continental Shelf Statistics

Data pertaining to OCS lease ownership bidding patterns and production volumes, as reported in chapters III and IV, are derived from records supplied by the U.S. Department of the Interior. The primary data source is a computerized record of lease ownership and production maintained by the Geological Survey. This data base encompasses all leases issued by the Federal Government during the 1954-74 period. It does not include so-called "section 6 leases," tracts originally leased by State Government but subsequently placed under Federal Government supervision. In 1974, these tracts accounted for approximately 25 percent of total OCS petroleum production.

The Interior Department lease ownership records are maintained on an unconsolidated basis; i.e., subsidiary rather than parent identification is given. As a result, adjustments to the data base were made to reflect corporate interconnection. Table D-1 lists the consolidations and associated name changes for the larger leaseholders in the OCS sector. In most cases, corporate control was inferred when one company owned more than 50 percent of the voting stock of another. In the case of Hunt Industries, the extensive family and financial interconnections were deemed sufficient to consolidate the indicated companies.

TABLE D-1

Company Consolidations
for OCS Lease Ownership

Parent firm	Subsidiary
Consolidated Natural Gas Co.	Peoples Natural Gas Co. Consolidated Gas Supply Corp. CNG Producing Co.
Exxon Corp.	Humble Oil and Refining Co.
Gulf Oil Corp.	British Oil and Gas Corp.
Hunt Industries, Inc.	Margaret Hunt Trust William Hunt Trust H.L. Hunt Hunt Petroleum Caroline Hunt Placid Oil Co. Hunt Oil Co.
Louisiana Land and Exploration Co.	Louisiana Land Offshore Exploration Co.
Marathon Oil Co.	Ohio Oil Co.
Mobil Oil Corp.	Magnolia Petroleum Corp.
Murphy Oil Corp.	Ocean Oil and Gas Corp. Ocean Drilling and Exploration Co.
Occidental Petroleum Corp.	Canadian Occidental Co., Inc. Oxy Petroleum Co.
Panhandle Eastern Pipeline Co.	Pan Eastern Exploration Co. Pan Canadian Petroleum Co.

TABLE D-1 (continued)

Parent firm	Subsidiary
Pennzoil Co.	Union Producing Co. Pennzoil United Inc. Pennzoil Offshore Gas Co. Pennzoil L and T Offshore
Standard Oil Co. of California	Standard Oil Co. (Texas) California Oil Co. California Co.
Standard Oil Co. (Ind.)	Stanolind Oil and Gas Co. Amoco Production Co. Midwest Oil Corp.
Sun Oil Co.	Sunray DX Oil Co.
Tenneco, Inc.	Tennessee Gas Transmission Co.
Texaco, Inc.	Seaboard Oil Co.
Texas Eastern Transmission Corp.	Texas Gas Exploration Corp.
Union Oil Co. of California	Barber Oil Corp.

Post-lease Sale Ownership Changes

Changes in tract ownership frequently occur after the initial OCS lease sale. These changes are not reflected in the original OCS data set maintained by the Geological Survey but, instead, are noted in the Bureau of Land Management file termed "Serial Register Pages."

In order to gauge the relative importance of post-sale ownership transactions, current ownership for 1974 producing leases was obtained by tracing ownership changes through 1974 as listed in the Serial Register Pages. Table D-2 compares the market share ratios for the largest 30 OCS producers based on original and current ownership patterns. Overall, there is very little difference in concentration levels for the two series: Current ownership concentration is 0.7 percentage points higher at the 8-firm level and 1.0 point lower at the 20-firm level. Among individual producers, the one significant difference is found for Forest Oil which sold off a significant portion of its original leases. As a result, Forest's market share dropped from 6.1 on an original ownership basis to 1.5 on a current ownership basis.

The 1974 OCS market share levels utilized in text are based on the current ownership shares listed in table D-2. For earlier years, the original ownership information was used except in the case of Forest Oil where that firm's large lease sell-off was accounted for by adjustments to Forest production total and to that of the producers who purchased leases from Forest.

TABLE D-2

Top 30 Gulf Coast Gas Producers for 1974 -
Comparison of Market Shares Before and After
Post-Lease Sale Ownership Changes

Production rank		Producer	Firm production as percent of total OCS Gulf Coast production		Net change in market share (current ownership-original ownership)
Current ownership	Original ownership		Current ownership	Original ownership	
1	1	Tenneco, Inc.	9.4	10.4	-1.0
2	6	Union Oil Co. of Calif.	7.2	6.0	+1.2
3	2	Shell Oil Co.	6.9	7.2	-0.3
4	4	Mobil Oil Corp.	6.2	6.3	-0.1
5	3	Exxon Corp.	6.0	6.3	-0.3
6	7	Getty Oil Co.	5.5	5.4	+0.1
7	8	Gulf Oil Corp.	5.3	5.2	+0.1
8	12	Standard Oil Co. (Ind.)	4.8	3.5	+1.3
9	9	Standard Oil Co. of Calif.	4.8	4.8	0.0
10	10	Cities Service Co.	4.4	4.2	+0.2
11	13	Texaco, Inc.	4.0	3.2	+0.8
12	11	Continental Oil Co.	3.5	3.7	-0.2
13	14	Superior Oil Co.	3.2	2.9	+0.3
14	16	Pennzoil Co.	3.2	2.6	+0.6
15	15	Atlantic Richfield Co.	3.2	2.8	+0.4
16	20	Kerr-McGee Corp.	1.6	1.6	0.0
17	17	Hunt Industries, Inc.	1.6	2.5	-0.9
18	19	Phillips Petroleum Co.	1.6	1.6	0.0
19	5	Forest Oil Corp.	1.0	6.1	-5.1
20	44	Consolidated Natural Gas Co.	1.4	0.1	+1.3
21	34	General Crude Oil Co.	1.0	0.4	+0.6
22	21	Esmark, Inc.	1.0	1.3	-0.3
23	28	Sun Oil Co.	0.9	0.6	+0.3
24	26	Hamilton Bros. Oil Co.	0.9	0.7	+0.2
25	18	Southern Natural Resources, Inc.	0.8	2.4	-1.6

TABLE D-2 (continued)

Top 30 Gulf Coast Gas Producers for 1974 -
Comparison of Market Shares Before and After
Post-Lease Sale Ownership Changes

Production rank		Producer	Firm production as percent of total OCS Gulf Coast production		Net change in market share (current ownership-original ownership)
Current ownership	Original ownership		Current ownership	Original ownership	
26	24	Amerada-Hess Corp.	0.8	0.8	0.0
27	30	Burmah Oil, Inc.	0.8	0.5	+0.3
28	25	Louisiana Land & Exploration	0.8	0.7	+0.1
29	45	Ashland Oil, Inc.	0.7	0.0	+0.7
30	27	Marathon Oil Co.	0.6	0.6	0.0

Concentration levels	Current ownership	Original ownership	Net change in market share: (current ownership share minus original ownership share)
4-Firm	29.7	29.9	-0.2
8-Firm	51.3	50.3	+1.0
20-Firm	84.8	86.4	-1.6
Major Producer Group	43.6	40.5	+3.1

NOTE: Original ownership refers to company holdings at the time of the lease sale. Current ownership refers to company holdings as of September 1974.

SOURCE: FTC tabulations based on U.S. Dept. of the Interior files.

TABLE D-3

Largest OCS Producer of Natural Gas: 1960

OCS rank	Producer	OCS natural gas production (mil. cu. ft.)	Percent of total
1	Shell Oil Co.	15,784	38.2
2	Union Oil Co. of Calif.	13,757	33.3
3	Phillips Petroleum Co.	4,979	12.0
4	Gulf Oil Corp.	2,985	7.2
5	Marathon Oil Co.	1,241	3.0
6	Sun Oil Co.	1,241	3.0
7	Pure Oil Co.	1,241	3.0
8	Standard Oil Co. (Ind.)	33	0.1
9	Standard Oil Co. of Calif.	21	0.05
10	Continental Oil Co.	15	0.04
11	Getty Oil Co.	15	0.04
12	Cities Service Co.	15	0.04
13	Atlantic Richfield Co.	15	0.04
14	Pennzoil Co.	1	0.002
Total OCS Production		41,344	

Concentration Ratios: (percent)

4-Firm	90.7
8-Firm	99.8
20-Firm	100.0

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

TABLE D-4

Largest OCS Producers of Natural Gas: 1965

OCS rank	Producer	OCS natural gas production (mil. cu. ft.)	Percent of total
1	Gulf Oil Corp.	38,923	20.6
2	Shell Oil Co.	28,571	15.1
3	Union Oil Co. of Calif.	23,730	12.6
4	Mobil Oil Corp.	19,884	10.5
5	Exxon Corp.	19,465	10.3
6	Superior Oil Co.	7,820	4.1
7	Getty Oil Co.	7,059	3.7
8	Cities Service Co.	7,059	3.7
9	Atlantic Richfield Co.	7,059	3.7
10	Continental Oil Co.	7,059	3.7
11	Phillips Petroleum	3,943	2.1
12	Marathon Oil Co.	3,664	1.9
13	Sun Oil Co.	3,664	1.9
14	Pure Oil Co.	3,664	1.9
15	Standard Oil Co. (Ind.)	1,948	1.0
16	Forest Oil Corp.	1,810	1.0
17	Standard Oil Co. of Calif.	1,547	0.8
18	Pennzoil Co.	1,098	0.6
19	Tenneco Inc.	437	0.2
20	J. Ray McDermott & Co.	289	0.2
Total OCS Production		188,947	

Concentration Ratios: (percent)

4-Firm	58.8
8-Firm	80.6
20-Firm	99.6

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

TABLE D-5

Largest OCS Producers of Natural Gas: 1970

OCS rank	Producer	OCS natural gas production (mil. cu. ft.)	Percent of total
1	Shell Oil Co.	247,338	15.6
2	Gulf Oil Corp.	183,771	11.6
3	Tenneco, Inc.	161,087	10.2
4	Union Oil Co. of Calif.	157,958	10.0
5	Mobil Oil Corp.	115,492	7.3
6	Exxon Corp.	99,841	6.3
7	Standard Oil Co. of Calif.	76,204	4.8
8	Getty Oil Co.	68,350	4.3
9	Forest Oil Co.	67,659	4.3
10	Cities Service Co.	48,910	3.1
11	Superior Oil Co.	46,470	2.9
12	Phillips Petroleum Co.	44,608	2.8
13	Atlantic Richfield Co.	41,975	2.6
14	Continental Oil Co.	40,611	2.6
15	Standard Oil Co. (Ind.)	37,336	2.4
16	Kerr-McGee Corp.	23,840	1.5
17	Hunt Industries, Inc.	16,688	1.1
18	Union Carbide Corp.	11,435	0.7
19	Amerada-Hess Corp.	9,425	0.6
20	Louisiana Land & Exploration Co.	8,426	0.5
Total OCS Production		1,585,500	

Concentration Ratios: (percent)

4-Firm	47.4
8-Firm	70.1
20-Firm	95.2

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

TABLE D-6

Largest OCS Producers of Natural Gas: 1974

OCS rank	Firm	OCS natural gas production (mil. cu. ft.)	Percent of total
1	Tenneco, Inc.	259,189	9.4
2	Union Oil Co. of Calif.	197,135	7.2
3	Shell Oil Co.	189,381	6.9
4	Mobil Oil Corp.	170,176	6.2
5	Exxon Corp.	165,378	6.0
6	Getty Oil Co.	151,239	5.5
7	Gulf Oil Corp.	145,224	5.3
8	Standard Oil Co. (Ind.)	132,960	4.8
9	Standard Oil Co. of Calif.	131,255	4.8
10	Cities Service Co.	120,024	4.4
11	Texaco, Inc.	109,003	4.0
12	Continental Oil Co.	95,491	3.5
13	Superior Oil Co.	88,140	3.2
14	Pennzoil Co.	87,732	3.2
15	Atlantic Richfield Co.	87,248	3.2
16	Kerr-McGee Corp.	43,875	1.6
17	Hunt Industries, Inc.	43,457	1.6
18	Phillips Petroleum Co.	43,394	1.6
19	Forest Oil Corp.	41,426	1.5
20	Consolidated Natural Gas Co.	39,539	1.4
21	General Crude Oil Co.	26,987	1.0
22	Esmark, Inc.	26,781	1.0
23	Sun Oil Co.	23,721	0.9
24	Hamilton Bros. Oil Co.	23,606	0.9
25	Southern Natural Resources, Inc.	23,163	0.8
26	Amerada-Hess Corp.	22,930	0.8
27	Burmah Oil, Inc.	21,411	0.8
28	Louisiana Land & Exploration Co.	21,014	0.8
29	Ashland Oil, Inc.	18,253	0.7
30	Marathon Oil Co.	17,572	0.6
Total OCS Production		2,754,733	

Concentration Ratios: (percent)

4-firm	29.7
8-firm	51.3
20-firm	85.3
30-firm	93.6

SOURCE: FTC tabulation based on U.S. Dept. of the Interior Geological Survey and Bureau of Land Management files.

TABLE D-7

Largest Leaseholders Based on
1971-74 OCS Lease Sales

Rank	Producer	Bonus value of acquired leases	Bonus value as percent of total
1	Mobil Oil Corp.	959,328,040	9.2
2	Exxon Corp.	802,750,025	7.7
3	Texaco, Inc.	712,548,075	6.8
4	Gulf Oil Corp.	671,921,821	6.4
5	Standard Oil Co. (Ind.)	556,388,940	5.3
6	Standard Oil Co. of Calif.	523,771,788	5.0
7	Pennzoil Co.	478,541,937	4.6
8	Shell Oil Co.	478,023,880	4.6
9	Sun Oil Co.	434,723,170	4.2
10	Getty Oil Co.	419,553,520	4.0
11	Atlantic Richfield Co.	398,379,629	3.8
12	Union Oil Co. of Calif.	292,301,834	2.8
13	Tenneco, Inc.	283,625,859	2.7
14	Cities Service Co.	244,776,406	2.3
15	Mesa Petroleum Co.	214,745,786	2.1
16	Hunt Oil Co. (Placid Oil Co.)	202,111,447	1.9
17	Continental Oil Co.	197,601,738	1.9
18	Columbia Gas System, Inc.	189,525,555	1.8
19	Marathon Oil Co.	163,841,070	1.6
20	Occidental Petroleum Co.	140,855,926	1.3
21	Burmah Oil Co.	129,064,790	1.2
22	Champlin Petroleum Co.	124,147,772	1.2
23	Louisiana Land & Exploration Co.	121,611,439	1.2
24	Amerada-Hess Corp.	110,137,676	1.1
25	Signal Oil & Gas Co.	88,997,104	0.9
26	Energy Ventures Inc.	76,014,520	0.7
27	Quintana Offshore Inc.	72,515,880	0.7
28	The NW Mutual Life Ins.	70,878,520	0.7
29	Kerr-McGee Corp.	66,827,015	0.6
30	Transcontinental Prod. Co.	57,518,768	0.6
	Total OCS Lease Sales	10,452,970,782	

Concentration Ratios: (percent)

4-Firm	30.1
8-Firm	49.6
20-Firm	80.0
30-Firm	88.9

Source: U.S. Dept. of the Interior

Appendix E

Producible Shut-in Lease (PSI) Data

The producible shut-in lease (PSI) information reported in chapter V is based on yearly lease status reports supplied by the Department of the Interior. These list the current status of each Gulf Coast OCS lease in existence as of the report's issuance date. The following are the dates of the reports utilized along with the corresponding year referred to in the text:

<u>Date of Interior lease status report</u>	<u>Year reported in the text</u>
5/1/63	1963
4/1/65	1965
11/1/66	1966
6/27/67	1967
9/1/68	1968
5/1/69	1969
5/1/70	1970
7/1/71	1971
8/1/72	1972
4/1/73	1973
9/12/74	1974
7/1/75	1975
12/31/76	1976

In order to conform with the OCS data base (see appendix D) only Section 8 leases (i.e., those tracts originally issued by Interior) were tabulated. Thus, Section 6 leases, tracts issued by State Government but subsequently placed under Federal control, were not included in the PSI data base.

The remainder of the appendix will consider the potential for bias created by two factors: (1) post-lease sale ownership changes and (2) the inclusion of oil tracts in the PSI data base.

Ownership Changes:

As noted in appendix D, post-lease sales exchanges alter the ownership patterns of tracts over time. In the case of a PSI lease, selection of a date upon which to determine ownership is difficult since the exploration and development decisions which led to production delay may have taken place in a number of different time periods. The least ambiguous route, that followed in the text, is to base PSI ownership on the original purchasers of the tracts. In this way, arbitrary decisions concerning the developmental influence of subsequent owners of a tract (if any) are avoided.

Since the text's analysis finds that the major gas producers do not maintain a disproportionately large share of PSI tracts, it is important to determine whether subsequent ownership changes would alter this conclusion. To this end, post-lease sale ownership changes were recorded for PSI tracts sold at the 1962 and 1967 lease sales. Comparisons were then made between original and 1974 ownership of PSI leases for the eight major gas producers. The resulting tabulation indicates that as a group, the majors were net sellers of PSI tracts. For both the 1962 and 1967 leases there was a slight reduction in the majors' current ownership PSI share compared to their original

acquisition record at the respective lease sales (table E-1). Thus post-sale ownership changes have not created a larger PSI share for the majors but have in fact reduced it.

Hydrocarbon Content of PSI Tracts:

Based on Department of the Interior classifications, the majority of PSI tracts contain potentially marketable gas deposits. In 1976, for example, gas tracts (including those classified as combination oil-gas leases) accounted for over 85 percent of total PSI leases (table E-2). An FPC investigation found a similar distribution for 1974. 1/

Interior's hydrocarbon designations are tentative, however, since they are based on the initial tests that secured PSI status for the shut-in tracts. These designations thus may change over time as new exploratory efforts indicate additional reservoirs as well as the unprofitability of some originally discovered ones. This tentative nature of the classification system precluded limiting the PSI sample to gas-only tracts.

Although the relative number of non-gas tracts appears to be small (less than 12 percent based on Interior's classification scheme), their inclusion in the PSI sample can be a potential source of bias since the monopoly hypothesis tested related to gas withholding, not to that of crude

1/ Federal Power Commission, Offshore Investigation: Producible Shut-in Leases (First Phase) (Washington: 1974), p. 38.

Table E-1

Current Versus Original Ownership of 1974 PSI Leases
 Issued in the 1962 and 1967 OCS Lease Sales:
 Major Gas Producers

	Producer	Original Ownership Number of leases	Bonus value (dollars)	Current Ownership Number of leases	Bonus value (dollars)	Change minus original bonus value (dollars)
1	Exxon Corp.	5	6,467,320	2	4,202,396	-2,264,924
2	Texaco, Inc.	7	20,657,193	8	20,814,305	157,112
3	Standard Oil Co. (Ind.)	5	1,577,609	4	1,637,324	59,715
4	Gulf Oil Corp.	5	14,852,879	3	13,264,879	-1,588,000
5	Mobil Oil Corp.	0	0	0	0	0
6	Shell Oil Co.	5	23,795,214	5	23,795,214	0
7	Atlantic Richfield Co.	7	7,810,657	7	8,444,758	634,101
8	Union Oil Co. of Calif.	0	0	1	91,800	91,800
	Major Group Total		75,160,872		72,250,676	-2,910,196-

SOURCE: FTC tabulation based on Dept. of the Interior files.

TABLE E-2

Classification of
1976 PSI Leases
by Hydrocarbon Content

Hydrocarbon	Number of PSI leases	Percent of total
Oil	9	11.1
Gas	48	59.3
Oil and gas	16	20.0
N.A.	8	9.9
Total	81	100.0*

N.A. - Not available

* Detail does not add to total due to rounding.

Source: FTC tabulation based on Dept. of the Interior files.

oil. Considering that text's results indicate no disproportionately large holdings of PSI's by the major producers, it is important to determine whether the distribution of oil and gas leases contributes to this result. In particular, the most relevant bias scenario would be one in which the bulk of the major PSI's were concentrated in gas leases. In such a case, PSI indices based on oil and gas leases would tend to underestimate the major's relevant gas withholding potential.

A test of this bias hypothesis was made by calculating the percentage of the major's PSI leases in 1976 that were classified as gas-bearing by Interior. The resulting distribution does not indicate a tendency for the majors as a group to specialize in gas tracts: The percentage of the major PSI tracts classified as gas-bearing was 77.6 vis-a-vis 88.9 for the OCS sector as a whole (table E-3).

TABLE E-3

Gas Bearing PSI Leases Held by
the Major Gas Producers: 1976

Producer	Percent of producer's total value of PSI tracts classified as gas-bearing
Gulf Oil Corp.	57.6
Shell Oil Co.	82.6
Texaco, Inc.	0.0
Mobil Oil Corp.	92.5
Standard Oil Co. (Ind.)	98.6
Atlantic Richfield Co.	0.0
Exxon Corp.	0.0
Union Oil Co. of Calif.	0.0
Total weighted average for major group	77.6
Total for OCS	88.9

SOURCE: FTC tabulations based on Dept. of Interior