Louisiana Coastal Resources Program

THE IMPACT OF OUTER CONTINENTAL SHELF DEVELOPMENT ON LOUISIANA

STATE PLANNING OFFICE

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The State Planning Office would appreciate any comments or questions you may have. Thank you.

Sincerely,

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THE IMPACT OF OIL AND GAS EXPLORATION, DEVELOPMENT, AND PRODUCTION ON THE OUTER CONTINENTAL SHELF ON LOUISIANA: BACKGROUND AND METHODOLOGY

By

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For

THE LOUISIANA DEPARTMENT OF CONSERVATION
and
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EXECUTIVE SUMMARY

Introduction

This report contains data on OCS development and some financial implications for the state. But the major portion of ths study is concerned with alternative methodologies, and their related evaluations, which can be applied to measuring the impact of petroleum and gas mining activity on the Outer Continental Shelf (OCS) adjacent to Louisiana. For purposes of this report the OCS extends seaward from the outer 3 mile limit of the state's jurdisiction to the limit of the continental margin. The OCS adjacent to Louisiana lies seaward between the extended state's boundary lines with Texas and Louisiana. After consultations with industry and government officials and after consulting USGS pipeline maps, we determined that virtually all of the oil and gas produced in the Louisiana OCS comes ashore in Louisiana. At the extreme boundaries of the Louisiana OCS a very small quantity of gas comes ashore in Texas and Mississippi but the amount is insignificant. Similarly, virtually no oil or gas produced in the offshore areas of Mississippi or Texas comes ashore in Louisiana. Thus, there is little justification for the concern that Louisiana OCS production is initially impacting other states, nor that their OCS production is initially impacting Louisiana. Of course, the distribution of OCS oil and gas after it comes ashore in Louisiana could not be determined.

Although this report was to contain only a methodology of OCS impact, we decided to include data and data sources, where available, and a discussion of a few salient features of the OCS not germane to a narrow methodological study. Most of these features are contained in the first chapter.

Chapter 2 contains a survey of the literature--except for specific fiscal impact literature and environmental impact literature which are presented in Chapters 6 and 7. Because the impact methodology proposed by us is based heavily on the input-output technique, Chapter 3 presents a summary of input-output technology. One cannot begin an OCS impact study unless he is reasonably familiar with the production and processes of the OCS industry. Chapter 4 summarizes these processes.

Chapter 5 presents the methodology for estimating OCS related expenditures and their impact on Louisiana. Chapter 6 is concerned with the methodology of estimating the fiscal impact on Louisiana's governments and Chapter 7 briefly discusses the environmental impact and literature. The major points of each chapter are summarized below.

Chapter 1: Louisiana OCS Activity: An Overview

- Although it is estimated that remaining reserves on the Louisiana OCS are 3.3 billion barrels of oil and 33 trillion cubic feet, the year of peak of crude oil production was 1970, and even with a national energy policy of accelerated development, many experts believe that future annual production will not surpass 1970. However, Louisiana OCS is expected to continue a major role in OCS development.

- The Federal government rebates to the states 37 1/2% of revenues obtained on Federal lands situated within the boundaries of these states. Although offshore as well as onshore development occasions similar impact burdens and similar absence of state taxing authority, states receive no Federal funds for offshore induced impacts.

- Over a period of 14 years (1960 to 1973), Louisiana--including the Louisiana OCS--provided an average of 60% of the Bureau of Land Management's mineral revenues but received an average of 3/10ths of one percent of BLM's allocations of mineral revenues to all states.

- Alaska, Montana, Oklahoma, and Wyoming are receiving $36,745, $9,677, $7,492, and $5,307, respectively, per employee on Federal lands, but, if one includes the Louisiana OCS, Louisiana is obtaining impact funds of $12 per employee on Federal lands.

- During FY1976 and FY1977 it is estimated that Louisiana severance tax revenue will be $505 million and $468 million or 25 percent and 23 percent of total state revenues.

- Total state oil and gas revenues--including royalties, bonsues, rentals and severance taxes will decrease from 35 percent of state revenues in FY1975 to 32 percent in FY1976.

- Five methods of estimating OCS direct employment are given in the report. The recommended one is a direct survey of the industry. One such survey taken in 1971 estimated 38,000 direct OCS employees. A less preferred method which is still better than other alternatives is to apply a crude oil production ratio to state oil and gas mining employment. (SIC Codes 131, 132, 138).

- Cameron, Plaquemines, and Terribonne parishes have 36%, 27%, and 24% of their total employment engaged in oil and gas extraction.

Chapter 2: Survey of the Literature

- Three studies have been done on the impact of the OCS on Louisiana. None of these studies present reliable estimates of the net impact costs.

- Numerous OCS impact studies for other regions have been completed but all of these studies attempt to predict the onshore impacts of future OCS development in their regions. It is very simple to criticize all impact studies but we thought the best studies were the Mid-Atlantic Regional Study (2.3.4.), OCS Oil and Gas--An Environmental Assessment (2.3.6.), and the Florida Coastal Policy Study (2.3.8.). This latter study estimated the predicted Florida OCS impact on Manatee County, Florida. The unique feature of the study was its use of detailed methodology and surveys rather than use of averages. We make a similar recommendation in Chapters 5 and 6 of this report.

Chapter 3: Impact Methodology--An Explanation of the Net Benefit Approach

- The basic methodology proposed for measuring Louisiana's net benefits from its OCS activity is the input-output (I-O) technique which is summarized in this chapter. We find the 83-sector Louisiana input-output table generally suitable for this analysis with a few alterations as follows:

  (1) the separate identification of the gas processing industry

  (2) the separate identification of the OCS oil and gas from the onshore oil and gas industry

  (3) the separate identification of the OCS oil industry from the OCS gas industry

  (4) additional data from direct surveys be integrated into the model to supplement currently available from location quotients.

Chapter 4: The Institutions and Procedures of the OCS Industry

- The major stages of OCS development are geophysical exploration, exploratory drilling, field development, production, transportation and storage. Each of these stages is discussed in the text.

- Within a few years water depth will be no technological constraint on OCS development. In fact, if the world price of oil permits, the major source of new oil on the Louisiana OCS will probably be beyond the 1000 feet depth.

Chapter 5: Measuring the Net Benefits of OCS Activity to Louisiana

- Firms directly engaged in OCS operations require labor, materials, equipment, supplies, and services produced on-shore in Louisiana and elsewhere. These expenditures in Louisiana are referred to as the direct demand-induced expenditures, which are classified as labor, capital, and supply expenditures. Direct-demand induced labor expenditures on the OCS can be estimated by applying a formula (provided in text) to the Census of Mineral Industries which is published every 5 years. An earnings index can be used for years within the five year interval. An alternative technique for estimating direct OCS labor expenditure utilizes data from BLM which shows the number of employees, and their average wages, per rig, per platform, service support, etc. These data can be converted to a common dimension and multiplied by the average number of wells drilled to obtain estimated labor expenditures.

- Direct capital expenditures are estimated by methods similar to those employed for estimating direct labor expenditures. Basic data from the Census of Mineral Industries are used. Direct supply expenditures cannot be estimated from the Census data. However, an independent study of non-labor operating and maintenance costs expenditures enabled us to calculate the per well costs and to multiply these unit costs by the number of producing wells.

- All of the direct, demand induced expenditures estimated above are total purchases from both Louisiana and non-Louisiana firms. The share of these non-labor expenditures which represent purchases from Louisiana firms can be obtained in two ways. First, major OCS firms can be surveyed to determine the percentage of their non-labor expenditures purchased from Louisiana. In order to be compatable with the input-output technique, these expenditures should be broken down by the 83 industries in the input-output model. Indeed, it would be helpful if the offshore state's input-output model separated offshore from onshore oil and gas production.

- An alternative approach is to take industry's casual estimate. In a study by Mid-Continent Oil and Gas Association it was estimated that 60% of all capital costs and 80% of all supply costs were incurred in Louisiana. Once the value of Louisiana purchases has been determined, it must be broken down by industry source for use in the input-output model. In the absence of survey information, the only technique for doing this is to assume that the input structure of OCS activities is the same as that of the "Crude Petroleum and Natural Gas" sector of Louisiana input-output model.

- Based on some simple empirical studies conducted by the authors, it was concluded that OCS production had relatively little effect on the location of refineries in Louisiana, but that it does not have an impact on the location of chemical plants and gas processing plants. The expected increments in output of these plants could be multiplied by the coefficients of these industries to yield the net increases in outputs of their supply industries. These estimated amounts must be added to the Louisiana input requirements necessary to satisfy OCS activities in order to obtain the final demand vector. Unfortunately, the gas processing industry is not separately identified in the state's input-output model.

- The OCS <u>indirect</u> effects are obtained from the state's input-output model as described in the text.

- After all of the above estimates have been calculated one will obtain the total OCS expenditure impact on Louisiana. However, this expenditure impact is not equal to the economic impact because some Louisiana residents will have moved into the state as a result of OCS activities and we believe that only the income increases of state residents prior to the increase in OCS activities should be included. Also, many of the Louisiana owned factors of production would have been otherwise employed if OCS activities did not exist. For example, if a Louisiana resident would have earned $1000 a month in the absence of OCS activities and he is currently earning $1500 a month in an OCS related occupation, only $500 a month should be included in the net-benefit calculations. Section 5.5. is devoted to estimating the net increase in labor, capital, and land income as a result of the OCS activity.

<u>Chapter 6: Procedures for Estimating Net Fiscal Impacts From OCS Activity</u>

- A brief review of other fiscal impact studies is presented in this chapter. Because these studies were directed at estimating the impact of future OCS developments, they did not attempt to estimate the actual fiscal costs of OCS development.

- One procedure employed in estimating OCS is to estimate tax payments by OCS related firms and individuals and then to compare these tax revenues to the average state-wide per capita revenues. In addition to other methodological problems, we argued in Chapter 5 that the use of average ratios tends to seriously underestimate the fiscal impact of OCS development. Other studies attempt to estimate separately the OCS related fiscal costs and benefits, but they extensively employ average ratios.

- A procedure for estimating fiscal impact utilizing average ratios is shown but, if funds are available for a more detailed study, we do not recommend their use.

- Based on a preliminary study, the 17 parishes located in coastal Louisiana have higher public service operating costs per capita than the average of other parishes in the state. This suggests that a future impact study might focus on particular parishes as well as on statewide impacts.

- OCS related cost impacts on the state are separated into population-created impacts and production-created impacts and into operating and capital costs. In order to be able to estimate the population-created impact, it is necessary to identify whether or not an OCS worker resides in Louisiana. This data is not currently available and, as suggested in Chapter 5, estimates will have to be obtained from the industry. Specific enumeration techniques are supplied for estimating population and production created demands. Although quite expensive, these techniques would yield more reliable estimates.

- OCS related tax revenues can be estimated through input-output techniques discussed in Chapter 5 or through specific enumeration techniques. The major flaw in the input-output approach is the assumption that tax revenues are proportional to the level of activity. This is particularly not true for property taxes, at least not in the short run.

Chapter 7: Environmental Costs and Benefits

- A model of estimating the net environmental impact of OCS development is beyond the scope of the report but this chapter is included because of the potential importance of such an analysis to the state. A brief summary of the nature of the problem is discussed below.

- Positive environmental benefits may accrue from the drilling platforms functioning as artificial reefs which attract and support marine life in the Gulf. Negative environmental benefits result primarily from damage to the life supporting functions of the wetlands by damaging the marsh grass which are an important food source for the fisheries and other wildlife. This is a particularly important impact for Louisiana because its coastal area is characterized by a mixture of brackish and saline water in approximately 4 million acres of estuarine marshland--one of the world's most extensive coastal wetland areas. Because of Louisiana's unique coastal area, the net environmental costs are important variables in any generalized benefit-cost study of OCS activity off Louisiana. But such costs are the most difficult to analyze because of the common property nature of the resources. To the extent that the private property owner captures all of the benefits from the productivity of his land, there is no environmental problem because the cost of these environmental impacts will be reflected in the price the landowner requires for the sale of, say, land for pipeline passage. The serious environmental problems arise when landowners do not capture all the social benefits provided by their lands. The landowner, for example, does not capture the food value of his marshland to numerous species of fish which migrate along wide sections of the Louisiana coast. Thus, the individual landowner would not consider the value of the decreased food production when selling his land.

  This problem of the commons is not automatically solved through regional planning, or coastal zone management because there is no readily apparent value one can assign to the common property, e.g., to salt water intrusion, the value of the food, or even to the value of a fish in the seas.* Values of fish catch are incorrect values to use because they will, in the long run, reflect the cost of resources, such as labor, boats, nets, etc., employed in catching the fish.

Thus, one of the more important OCS cost impacts on Louisiana citizens defies apparent measurement, Perhaps some very approximate estimates, which are beyond the scope of this study, could be made through more intensive research. In order to accomplish this research, we need the input of environmental scientists to determine the physical and biological cause and effect relationships. LSU's Center for Wetland Resources, and other environmental research organizations, have recently done considerable work in this area. Secondly, we need the input of economists who are able to grapple with problems of assigning values to common property resources and to make recommendations in the decision-making trade-off process between additional fish versus additional oil. Third, the environment should, as other resources, be incorporated into a state input-output table to determine the multiple generating or constraining effects of environmental change.

Concluding Recommendations

- The general methodology proposed in this report is based on the existence of the state's input-output table. Although this model was recently developed by using location quotients, these data should be supplemented by employing idustry survey techniques, especially in the oil and gas and chemical industries. Secondly, we would recommend that the offshore oil and gas industry be separated from the onshore oil and gas industry because their inputs vary considerably. It is also desirable to separate the offshore oil industry from the offshore gas industry, but their joint production may make this very difficult.

- We recommend that in developing the offshore oil and gas industry sector that special surveys be taken to determine the labor, capital, equipment, and supplies which the industry purchases from Louisiana. The residency of OCS workers would also have to be determined. Although this data would only have to be gathered every ten years, it will be an expensive undertaking. It is suggested that the Louisiana Department of Conservation which is sponsoring the state input-output model and the State Planning Office, which is heavily involved in coastal zone management, seek the financial and technical assistance of the Bureau of Land Management, and the U.S. Geological Survey in obtaining the basic data. Industry officials should be asked to participate, and financial or other assistance should be provided to industry to ease their investigating and reporting burdens. The Louisiana Department of Revenue should be requested to provide assistance on the fiscal impact section.

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*For a further discussion of the fish valuation problem see David B. Johnson, "Selected Data on Commercial Fisheries in the Superport Region," in Recommendations for the Environmental Protection, Report 3, Louisiana Superport Studies. Center for Wetland Resources, Louisiana State University, Baton Rouge, Louisiana, 1974.

There is no existing methodology which can be employed to integrate satisfactorily the environmental impact into a general economic impact methodology. A considerable number of studies have focused on the pollution outputs per unit of economic activity but there has been relatively little quantification beyond this. Most importantly, the economic value of these environmental effects are not well quantified, although economists have been able to assign some economic values to some effects. Much additional work needs to be done in this area. Finally, the interdependencies of the ecological and economic systems have been recognized in only a very elementary form. Hence, there are three stages of development critically needed in this area before a general impact analysis can be made:

(1) Quantification of physical ecological dose-response functions

(2) Determination of the economic value of these effects

(3) An integration of the ecological effects into the economic model. This suggests the development of some type of economic-ecological input-output model.

Even if technically feasible, the development of the three stages listed above would be very expensive and would require a number of years to complete. Without them, however, any impact analysis will be incomplete.

CHAPTER 1

LOUISIANA OCS ACTIVITY--AN OVERVIEW

1.1. Introduction

This chapter presents an overview of the Louisiana Outer Continental Shelf (OCS) problems and issues. It begins with a definition of the OCS, and continues with a discussion of the significance of OCS oil and gas production and a comparative analysis among major mineral producing states of Federal revenue sharing for mineral production on Federal lands. This is followed by an examination of the importance of oil and gas revenues in Louisiana's revenue structure. Finally, the importance of estimating employment on the OCS prompted the authors to present in this overview chapter several alternative estimating methods and to examine the distribution of OCS employment by parish.

1.2. The Outer Continental Shelf

The Outer Continental Shelf (OCS) is a subpart of the continental margin which is an extension of the continental land mass and extends out to sea to a depth of approximately 4000 meters. The extent of

U.S. legal control over natural resources on the continental margin is not clear. The Truman Proclamation (1945) unilaterally asserted U.S. jurisdiction and control over the natural resources located on the accessible subsoil and seabed of the U.S. Continental Shelf. In 1953, Congress ratified this proclamation by passing the Outer Continental Shelf Lands Act, establishing rules and procedures for the leasing of property on the U.S. Continental margin for purposes of mineral extraction. This Act of the U.S. Congress was internationalized in the 1958 Geneva Convention on the Outer Continental Shelf which stated that the coastal nations had jurisdiction over natural resources on the continental shelf to a depth of "200 meters or, beyond that limit, to where the depth of the superadjacent waters admits of the exploitation of the natural resources."

Because of the exploitability clause, there has been considerable controversy about the actual seaward boundary of the coastal nation's control. The Law of the Sea negotiations may possibly resolve this controversy by adopting some measure such as depth, gradient or distance from shore (e.g., 200 miles) to mark the seaward limit of the coastal nations' control of mineral resources.

According to recent Supreme Court decisions the State of Louisiana has jurisdiction to a three mile limit whereas, due to original grants to Texas and Florida (Gulf side) before they entered the union, their state territorial boundaries extend approximately 10.5 nautical miles.

This greater offshore area controlled by Texas partially explains the greater percentage of oil and gas produced within its state offshore area than is produced within Louisiana's offshore territory.

Although the structure of international law which might result from the Law of the Sea negotiations, or from independent bilateral or multilateral negotiations, could have significant effects on the development of the offshore oil and gas industries, these potential changes will not affect this study since its purpose is to develop the methodologies which can be employed to measure the impact of that oil and gas production which actually does occur.

1.3. Offshore Oil and Gas Production

The development of offshore petroleum production began on the United States Outer Continental Shelf (OCS) off the Louisiana coast during the late 1940's. The experience and technological advances made since that time have lead to extensive OCS production throughout the world. Due to the different nature of offshore production, a brief explanation of the exploratory and production capabilities of offshore petroleum mining may be helpful.

Petroleum search and recovery operations on the OCS are separated into a number of phases. First, geological and geographical surveys are conducted to identify areas favorable for the accumulation of hydrocarbons in the earth's rock structure. Second, exploratory wells must be drilled to determine the actual presence of oil or gas. Because offshore drilling equipment used in this exploratory phase must be moved frequently, they are typically mounted on a ship or other movable structure. Third, development wells used to extract oil or gas are typically drilled from fixed platforms which also serve as sites for the installation of equipment to control and measure fluids produced, to separate gas from the hydrocarbon liquids and treaters to remove water and impurities. Storage tanks and pumping or compression facilities must also be provided on the offshore facilities. At present, the conventional or fixed platform offers the best solution to offshore drilling and production operations. Although fixed platforms have not yet been installed in water depths exceeding 1,000 feet,[1] the technology exists to install fixed production platforms in such water depths. By 1980, it is expected that under water completion wells will be installed in water depths of 3,000 feet. Despite the energy crisis and the prominence OCS production is supposed to play in U.S. energy independence, the year of peak crude production for the United States OCS was 1970 when 1.15 million barrels per day or 12 percent of total U.S. crude production were produced. By 1974, total OCS crude oil production had decreased to 988 thousand barrels per day or 11 percent of U.S. total crude oil production. Natural gas production on the OCS increased every year between 1953 and 1974. In 1974, total natural gas production on the OCS was 3.5 trillion cubic feet, or 16 percent of total U.S. production. Chart 1-1 shows OCS production of crude oil and natural gas from 1955 through 1974 as a percentage of total U.S. production.

Any national energy policy which is designed to lessen United States dependency on foreign sources of crude oil will have to emphasize the development and acceleration of OCS production. Even if such a national energy policy emphasizes synthetic fuels, coal, nuclear, and the more exotic sources of energy, the projected critical liquid fuels gap[2] will

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[1]Shell Oil Company will shortly be constructing a platform in the Gulf of Mexico in water depths of 850 feet.

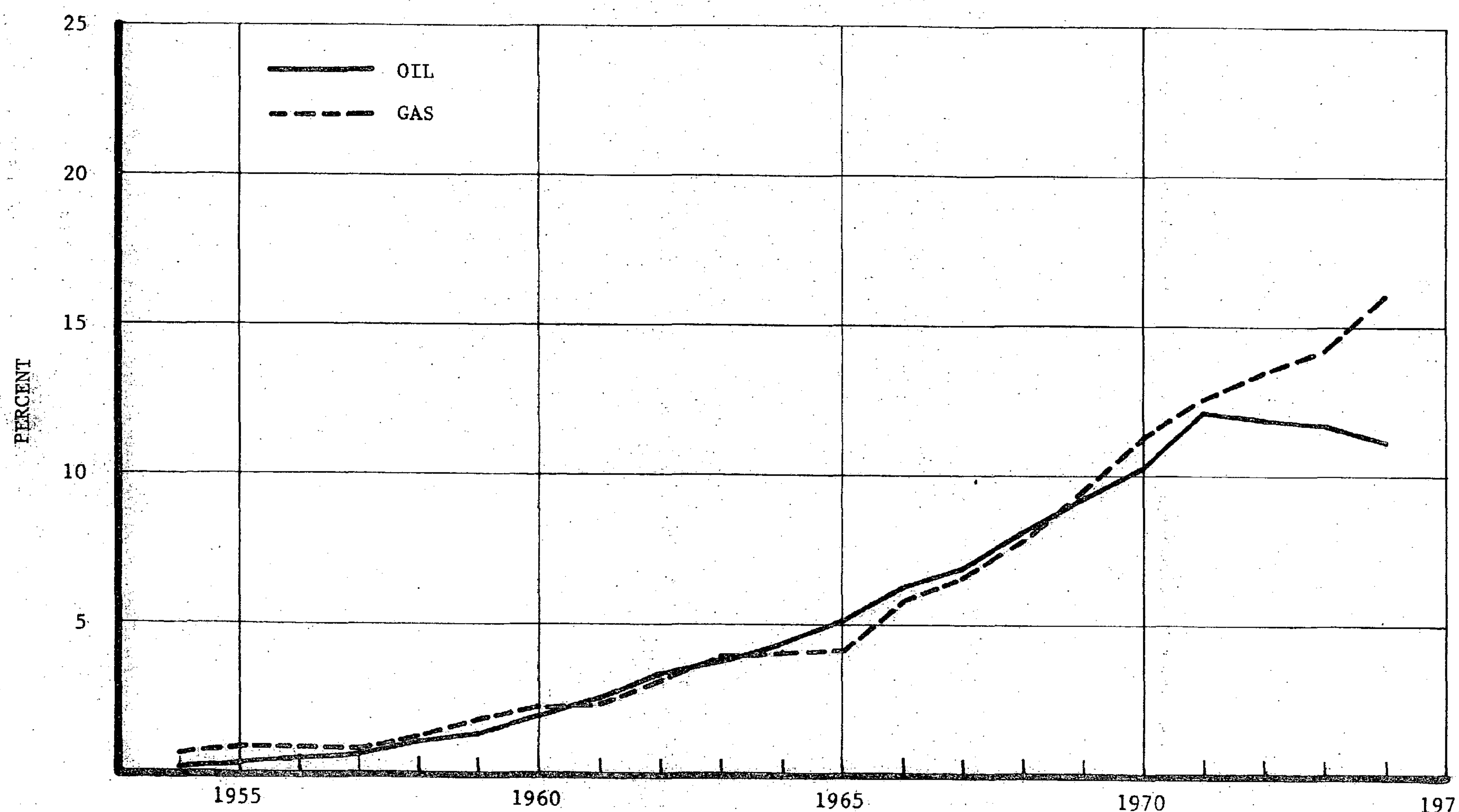
[2]See, for example, Energy Research and Development Plan, ERDA-48, A National Plan for Energy Research, Development, and Demonstration: Creating Energy Choices for the Future, 1975.

CHART 1-1

OUTER CONTINENTAL SHELF PRODUCTION OF CRUDE OIL[1] AND NATURAL GAS AS A PERCENTAGE OF TOTAL U.S. PRODUCTION

1954 - 1974

[1] Includes Condensate



SOURCE: Outer Continental Shelf Statistics, United States Department of the Interior, Geological Survey.

necessitate accelerated OCS development.

Although the peak year of OCS production has been passed and resources are dwindling, the relatively large quantity of remaining reserves located on the OCS adjacent to Louisiana will insure that this state will have a vital role to play in any national energy plan. In 1974, crude production on the state and federal offshore areas located adjacent to Louisiana accounted for 74 percent of total crude produced offshore in the United States, and 10 percent of total United States production in 1974. Natural gas production on the state and Federal offshore area to Louisiana accounted for 92 percent of total U.S. offshore natural gas and 15 percent of the natural gas produced in the country.

According to the latest U.S. Geological Survey estimates (December, 1975), estimated ultimate reserves on the OCS (Federal area only) off the coast of Louisiana are 6 1/2 billion barrels of oil and 56.8 trillion cubic feet of gas. The estimate for Texas is 64 million barrels of oil and 2.2 trillion cubic feet of natural gas.[3] Thus, when one is speaking of current offshore drilling activity in the United States, he is speaking primarily of activity off the coast of Louisiana.

Unlike other states in which a large proportion of offshore production occurs within state boundaries, in 1974, 88 percent of Louisiana offshore crude production and 86 percent of offshore natural gas production were located on the Federal OCS. In contrast, all of Alaska's, 37 percent of Texas', and 82 percent of California's offshore production occurred within the state offshore area. Charts 1-2 and 1-3 show the rapid deterioration in the percentage of offshore crude oil and gas production

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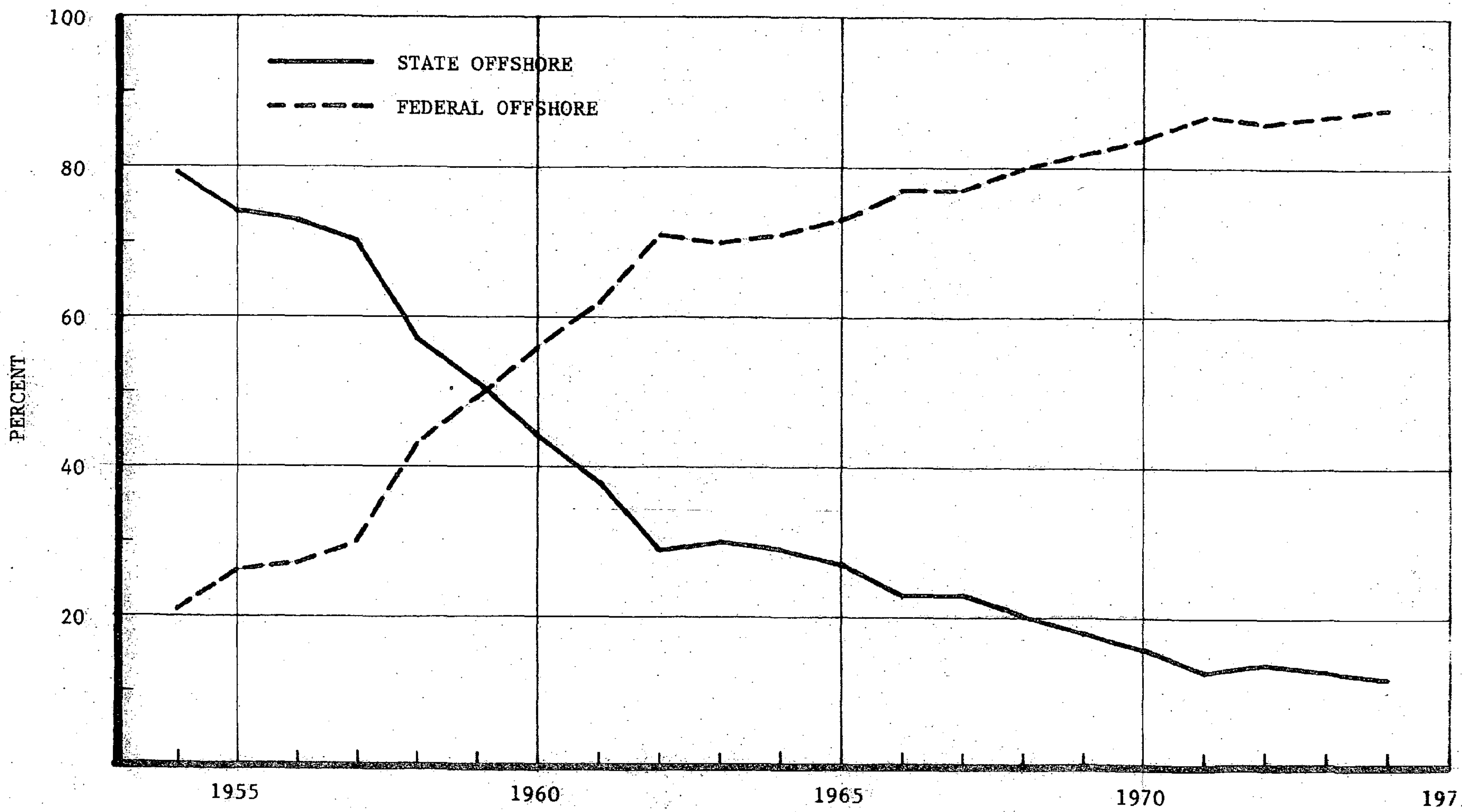
[3]According to a 1974 U.S. Geological Survey data the Louisiana OCS had produced 3 billion barrels of oil and 18.3 trillion cubic feet of gas through 1973. It had 3.3 billion of oil reserves and 33 trillion cubic feet of gas yet in place. Texas OCS had produced 23.2 million barrels of oil and .8 trillion cubic feet and had 41 billion barrels of oil and 1.3 trillion cubic feet of gas in place. Reserves are a much "harder" concept than ultimately recoverable resources.

CHART 1-2

LOUISIANA OFFSHORE CRUDE OIL PRODUCTION: PERCENTAGE OF TOTAL PRODUCED IN STATE AND FEDERAL AREAS

1954 - 1974

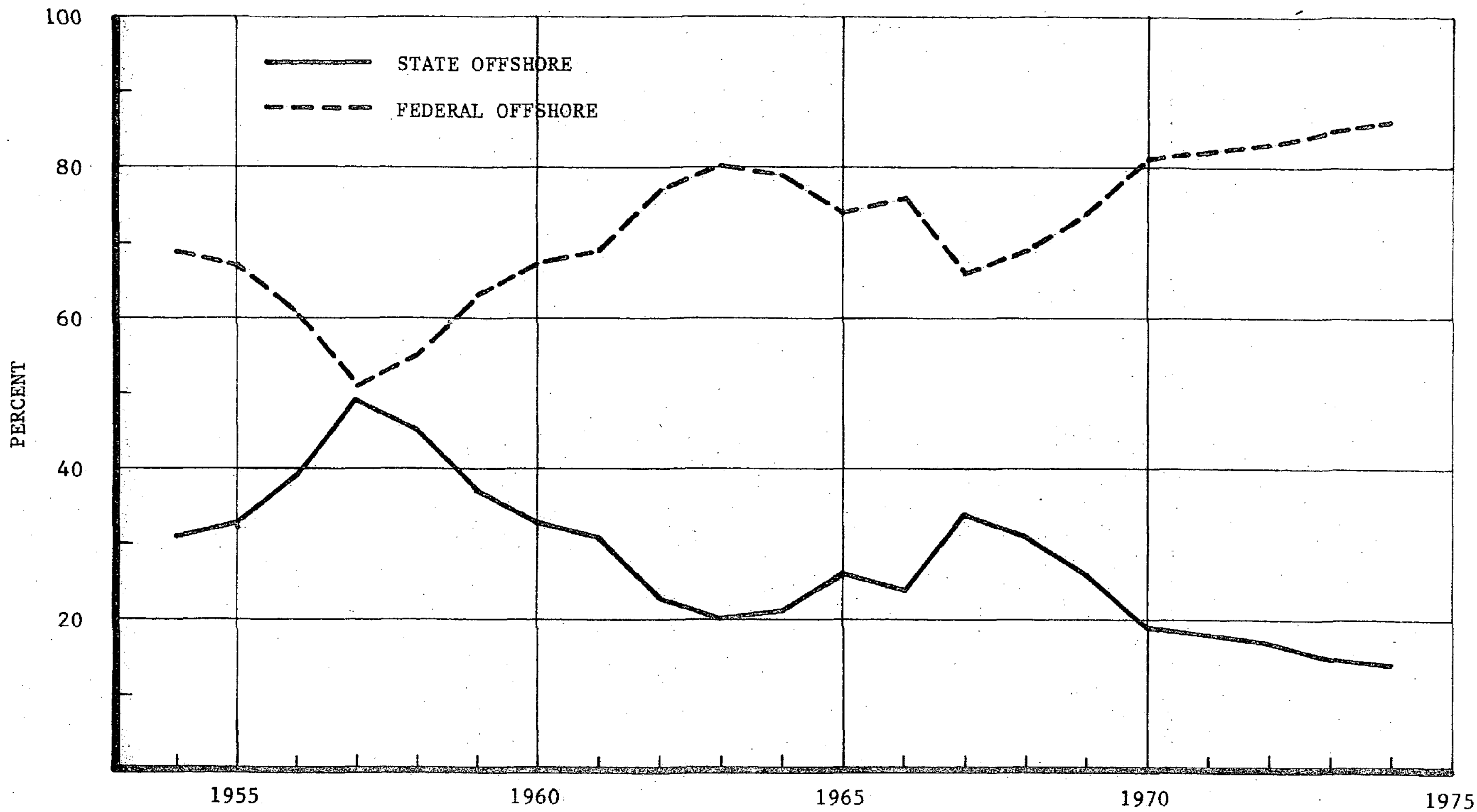


SOURCE: Outer Continental Shelf Statistics, United States Department of the Interior, Geological Survey.

CHART 1-3

LOUISIANA OFFSHORE NATURAL GAS PRODUCTION: PERCENTAGE OF TOTAL PRODUCED IN STATE AND FEDERAL AREAS

1954 - 1974



SOURCE: Outer Continental Shelf Statistics, United States Department of the Interior, Geological Survey.

occuring within Louisiana waters. Charts 1-4, 1-5, and 1-6 present the number of active gas and oil wells active on the Louisiana OCS[4] and the quantity and value of oil and gas produced on OCS off the coast of Louisiana.

1.4. Federal Impact Payments to Other States

If one examines relative impact costs among states Federal policy on sharing mineral revenues obtained from Federal lands located in states is characterized by significant asymmetries. Louisiana and other coastal states presently receive no payments from the Federal Government for the potential costs they may have to bear for the development of the Outer Continental Shelf adjacent to their areas. This is unlike the Federal sharing of revenues obtained from mineral extraction on Federal lands within the states in which these Federal lands are located. Based on the provisions of the Mineral Leasing Act of 1920 the Federal Government must rebate to the states 37 1/2% of the revenues obtained from royalties, leases, and bonuses from mineral production on Federal lands situated within the boundaries of these states. The funds "are to be used by such State or subdivisions thereof for the construction and maintenance of public roads or for the support of public schools or other public educational institutions, as the legislature may direct."[5] Because Alaska received 90 percent of Federal revenue from mineral production on Federal lands when it was a territory, it retained this privilege when it became a state.[6]

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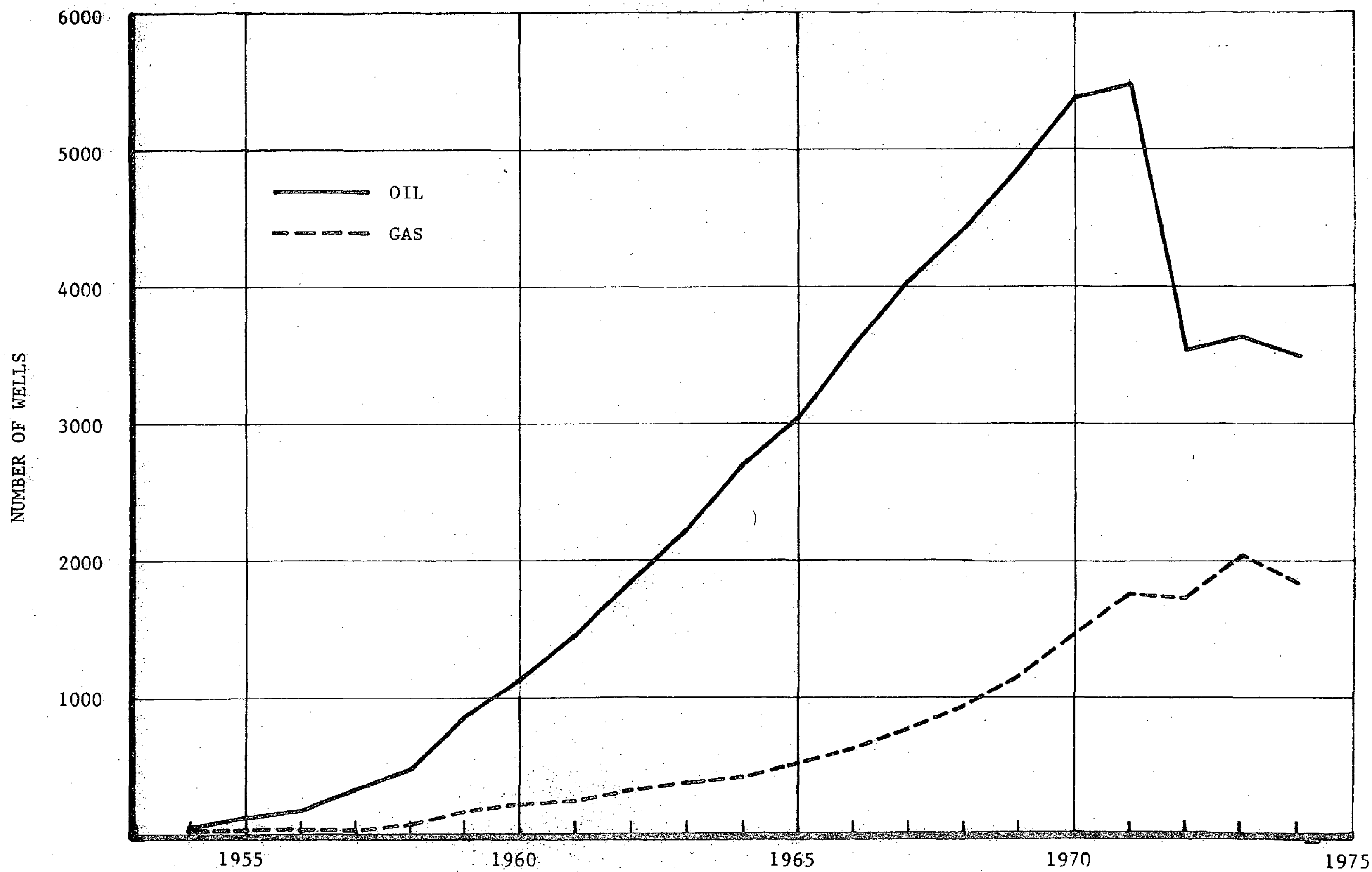
[4]The Louisiana OCS is defined as that area seaward of the three mile state limit which is adjacent to the State of Louisiana and which is within an area determined by the extensions of the state's boundaries with Texas and Mississippi. It includes the Federal but not the state controlled waters.

[5]30 U.S.C. 191.

[6]48 U.S.C. 439 amended.

CHART 1-4

ACTIVE OIL AND GAS WELLS ON THE OUTER CONTINENTAL SHELF OFF THE COAST OF LOUISIANA
1954 - 1974

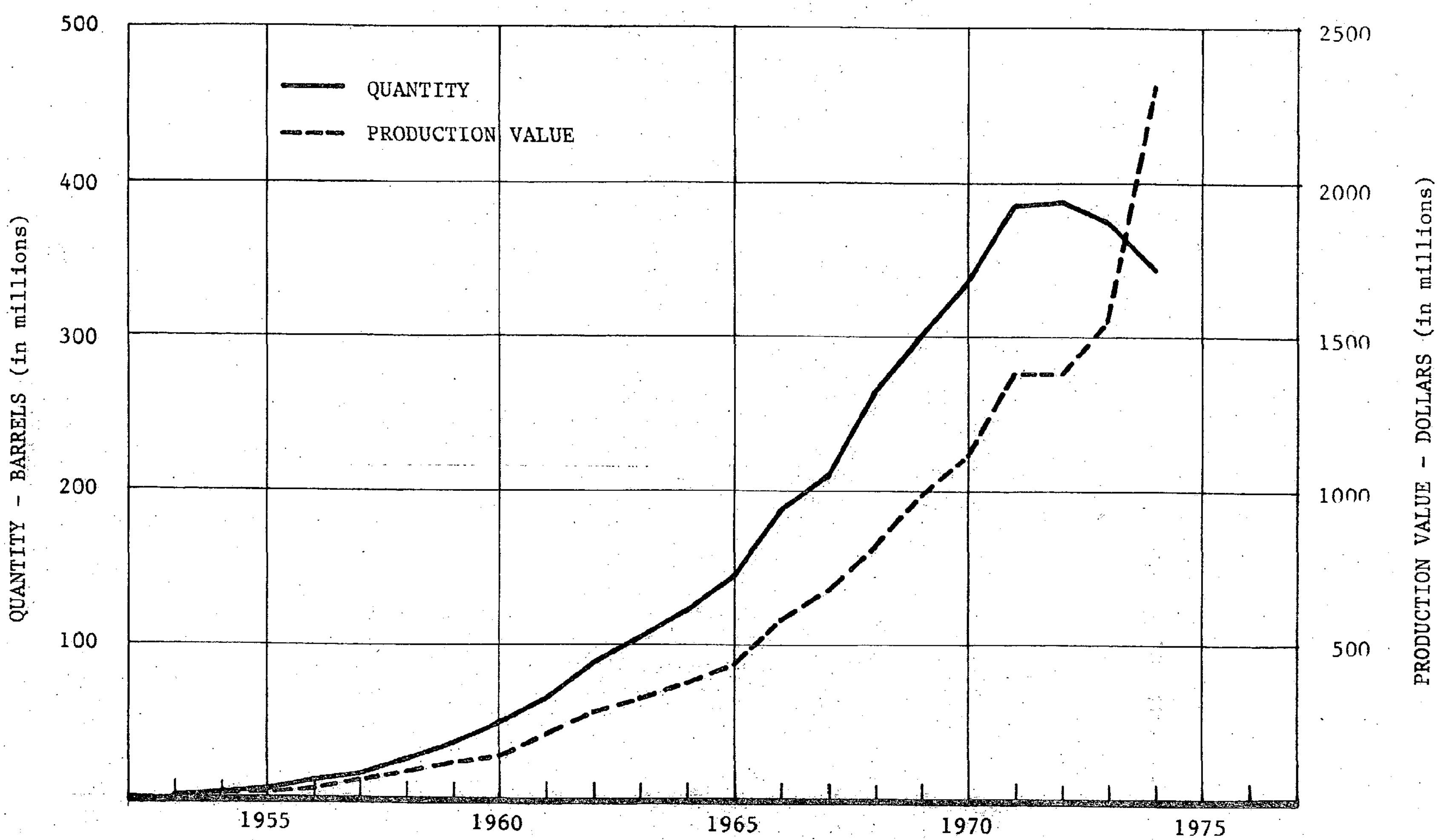


SOURCE: Outer Continental Shelf Statistics, United States Department of the Interior, Geological Survey.

CHART 1-5

OIL AND CONDENSATE PRODUCTION ON THE OUTER CONTINENTAL SHELF OFF THE COAST OF LOUISIANA

1953 - 1974

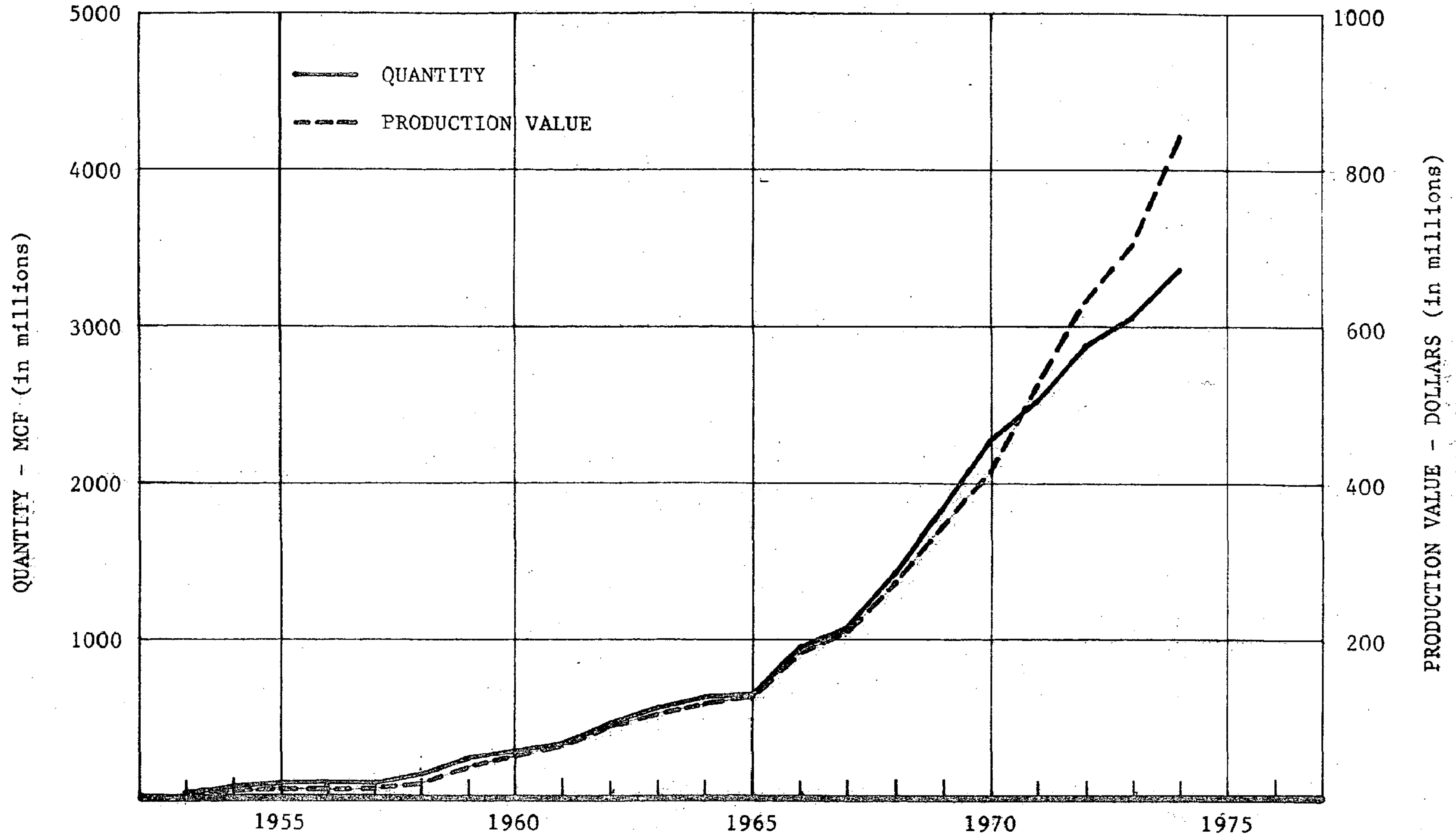


SOURCE: Outer Continental Shelf Statistics, United States Department of the Interior, Geological Survey.

CHART 1-6

NATURAL GAS PRODUCTION ON THE OUTER CONTINENTAL SHELF OFF THE COAST OF LOUISIANA

1953 - 1974



SOURCE: Outer Continental Shelf Statistics, United States Department of the Interior, Geological Survey.

It is true that the OCS is not precisely analogous to the Federal lands provision, because the OCS is located outside the territorial control of the state. But Federal lands onshore or beyond the control of state and local governments are similar in terms of the states' inability to tax the mining activity. They are also similar in the fact that the development of these Federal lands, both onshore and offshore, result in greater state and local expenditures for public support facilities, such as roads, fire and police protection, and education.

It appears clear that the intent of onshore revenue sharing was to provide states with "in-lieu" or impact funds because the states were burdened with these additional expenditures but could not tax the Federal land or the activities thereon which were the cause of the additional public expenditures. Both offshore, as well as onshore, Federal land development occasion similar burdens and similar absence of state taxing authority. However, those states with onshore Federal development receive mineral revenue sharing funds whereas those with offshore development do not.

Although the following statistics are not directly relevant to the methodology of determining OCS impact, the authors thought some statistical comparisons among those states which are major recipients of Federal mineral revenue sharing might be interesting.[7] Chart 1-7 shows the Federal Government's mineral receipts from Louisiana as a percentage of the Bureau of Land Management's (BLM) total mineral receipts from all states and BLM's mineral revenue sharing allocations to Louisiana. For purposes of this comparison, BLM's receipts from the Outer Continental Shelf have been allocated to the adjacent coastal state. As shown in Chart 1-7, the per-

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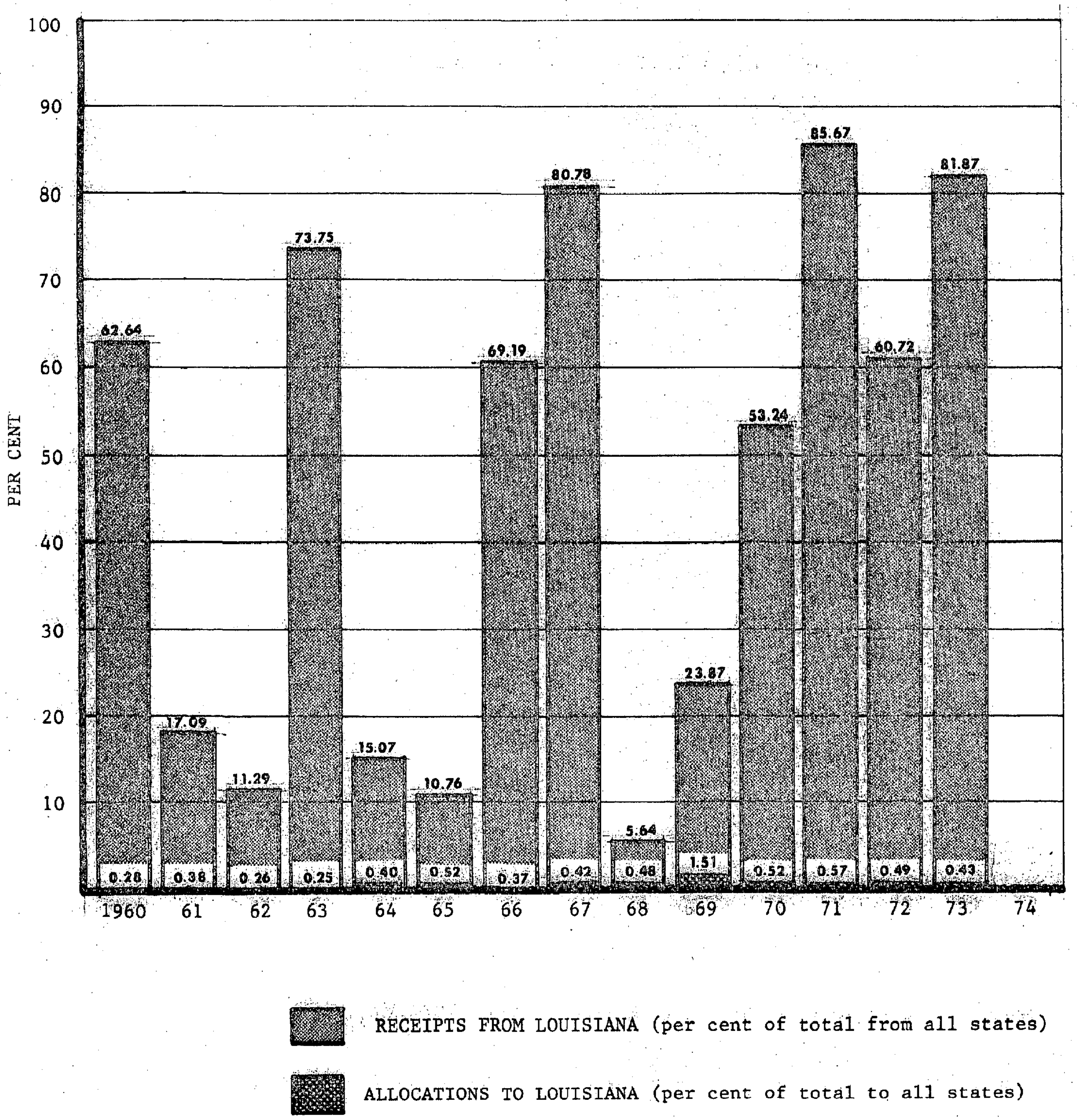
[7]These states are Alaska, California, Colorado, Kansas, Louisiana, Mississippi, Montana, Nevada, New Mexico, North Dakota, Oklahoma, Utah, and Wyoming.

CHART 1-7

FEDERAL GOVERNMENT'S RECEIPTS/ALLOCATIONS
FROM/TO LOUISIANA AS A PERCENTAGE OF
RECEIPTS/ALLOCATIONS FROM/TO ALL STATES
1960 - 1973



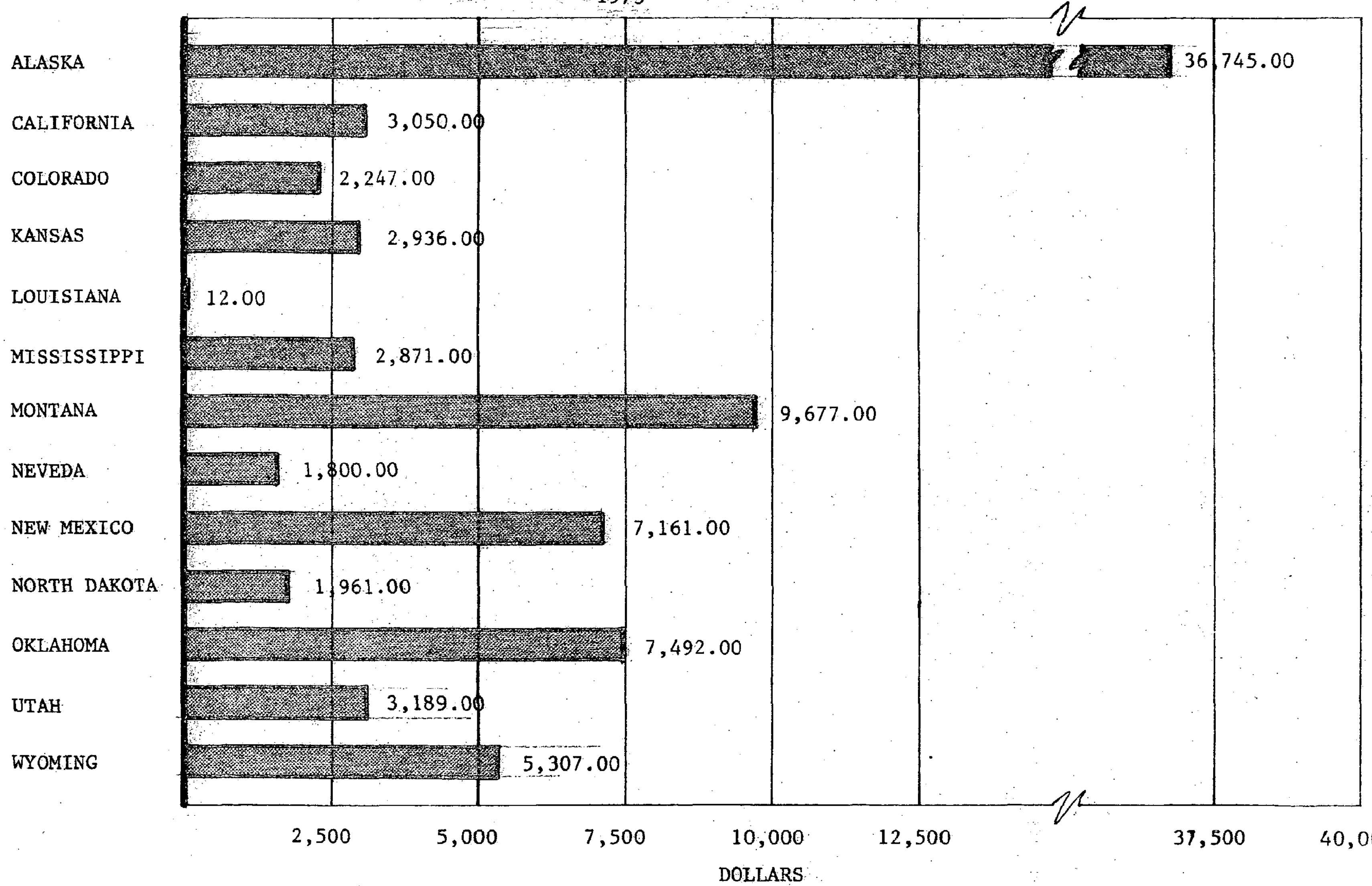
centage of BLM's receipts from Louisiana vary widely from year to year, but over the 14 year period of 1960 to 1973 Federal lands located in or adjacent to Louisiana have provided a significant portion of Federal mineral revenue. Over this period, Louisiana provided an average of 60 percent of BLM's mineral revenues, and received an average of 3/10ths of one percent of BLM's allocations of mineral revenues to all states.

Although the differential magnitudes of revenue from Louisiana's Federal land and the allocations received from such revenues are rather sharp, the result is obviously caused by the inclusion of adjacent OCS revenues. Although the OCS land is not legally within the state's territory its impacts are approximately the same. A mining employee in Montana who works on Federal lands provides the same additional burden to Montana's local and state governments as an employee on the OCS causes Louisiana local and state governments. Thus, if revenues obtained on Federal lands are a reasonable proxy for the relative magnitudes of impacted costs--say impacted costs are some fixed percentage of Federal revenues for all states--then Louisiana is bearing 60 percent of the impacted costs of all states but is receiving only 3/10ths of one percent of Federal revenues which supposedly are to be used to offset these impact costs.

Chart 1-8 presents some related statistics. We calculated the number of employees working on Federal lands, including the OCS for major producing states. Employees on Federal lands was calculated by determining the proportion of mineral production on Federal lands to total production within the state. Alaska received from the BLM, $36,745 per employee on its Federal lands and Montana received $9,677, but Louisiana received only $12 per employee on Federal lands. Thus, Louisiana is receiving mineral sharing impact funds of approximately $12 per employee on Federal lands, including the OCS, whereas Alaska, Montana, Oklahoma, and Wyoming are receiving $36,745, $9,677, $7,492, and $5,307, respectively, per

CHART 1-8

MINERAL REVENUE SHARING FROM FEDERAL LANDS RECEIVED
BY STATES WITH SIGNIFICANT FEDERAL MINERAL LANDS,
PER MINING EMPLOYEE ON FEDERAL LANDS
1973



employee on Federal lands.

Another question that might be raised is: What is the relationship between the percentage of a state's employees working on Federal lands and the percentage of each state's revenue obtained from Federal land revenues? As shown in Chart 1-9 Wyoming obtained nearly 18 percent of its state's revenues from Federal mineral land funds but it had only 4 percent of its employees working on Federal lands. Alaska's mineral land revenues account for 5.2 percent of its state revenues but employment on Federal land is only 3/10ths of one percent of Alaska's total employment. All states, except Louisiana, receive a greater percentage of their revenue from BLM than the percentage of the state's employees working on Federal land. Louisiana had 2.22 percent of its work force employed on Federal lands but received only 2/10ths of one percent of state revenues from BLM.

1.5. Oil and Gas Revenues in Louisiana's Revenue Structure

In recent history Louisiana's revenue structure has been heavily dependent upon oil and gas severance taxes as well as on bonuses, rentals, and royalties from production and leasing of state lands. Table 1-1 shows royalties, bonuses, rentals, and severance taxes for fiscal years 1973, 1974, and 1975.

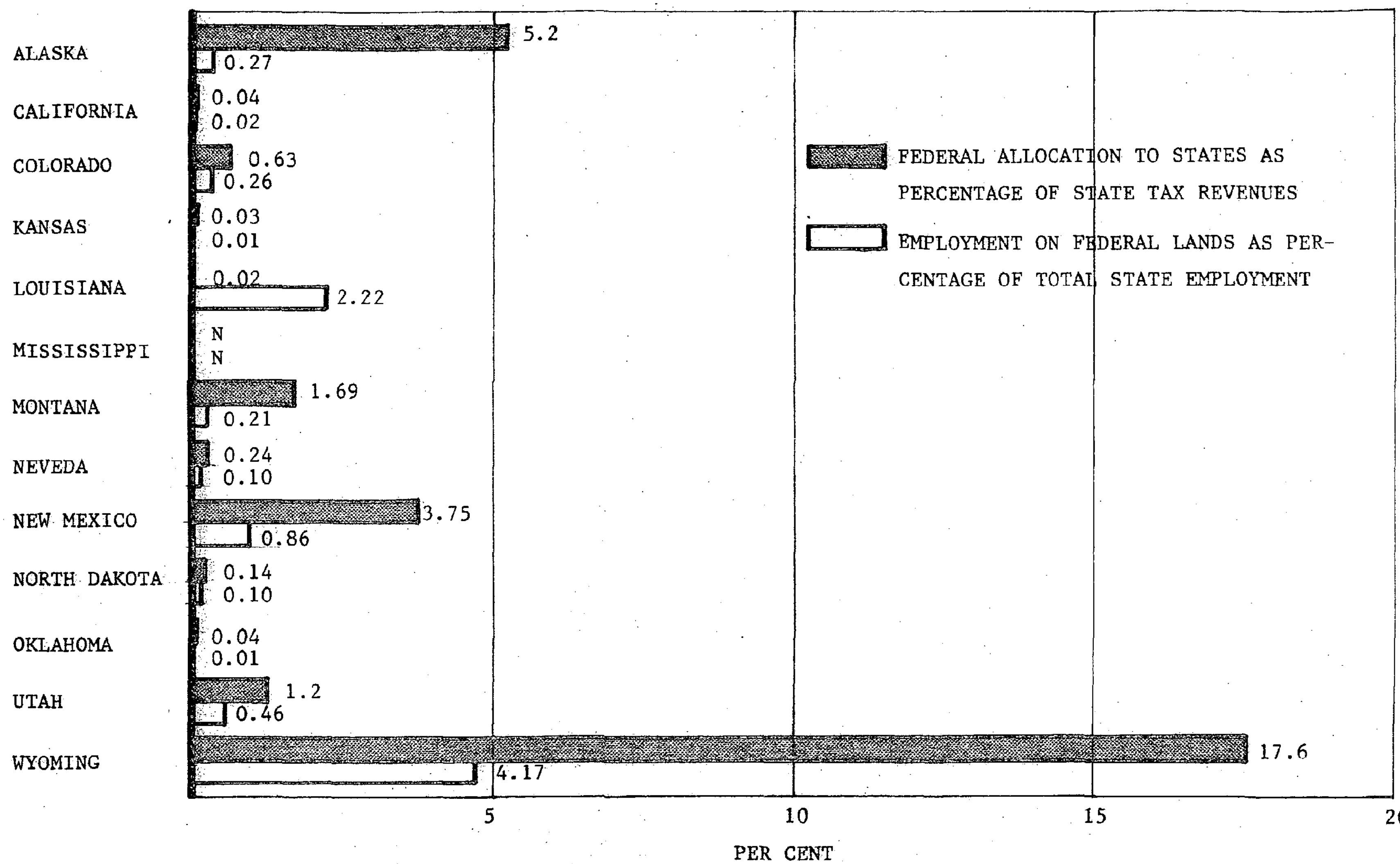
TABLE 1-1

	FY1973	FY1974	FY1975
Rentals, Bonuses, and Royalties	$141,909,247	$185,651,643	$185,204,459
Severance Taxes	$259,454,515	$380,767,316	$539,571,517
TOTAL	$401,363,762	$566,418,959	$724,775,966

CHART 1-9

COMPARISON OF ALLOCATION OF FEDERAL LAND REVENUES TO STATES AS PERCENTAGE OF STATE TAX REVENUES WITH RATIO OF EMPLOYMENT ON FEDERAL LANDS TO TOTAL STATE EMPLOYMENT

1973



Severance taxes increased significantly in FY1975 and moderately in FY1974, because of the change in state severance tax rates which became effective on January 1, 1974. The severance tax rate on oil and condensate was changed from 18¢-26¢ per barrel to 12 1/2 percent of value at the wellhead, except for oil produced from wells producing less than 25 barrels per day (6 1/4 percent). Chart 1-10 shows Louisiana severance tax revenue as a percent of state generated revenue between FY1954 and FY1975. It is obvious that the relative importance of the severance tax has been decreasing since FY1968 and that only the changes in tax rates provided a one time increase to a new plateau of severance tax revenue.

It is estimated that in FY1976 and FY1977 severance tax revenue will amount to $505 million and $468 million respectively.[8] For these two years severance tax revenue would amount to 25 percent and 23 percent of total state revenues.

Total state oil and gas revenues--including royalties, bonuses, rentals, and severance taxes--as a percent of state generated revenue is shown in Chart 1-11. The peak year once again was FY1968 with a steady decrease from that year until FY1974 and FY1975 when the severance tax change became effective. This percentage is forecasted to decrease to 35 percent in FY1975 and to 32 percent in FY1976.

Mineral related revenues have always compensated for the thin manufacturing base in Louisiana and for the accompanying low state revenue from the corporate income tax. Corporate income taxes accounted for only four percent of total state revenue in fiscal years 1974 and 1975.[9]

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[8] James A. Richardson, "Louisiana's Revenue Outlook," in Louisiana Business Review, Division of Research, Louisiana State University, March, 1976.

[9] Above a small exemption, the corporate income tax rate is 4 percent.

CHART 1-10

STATE OIL AND GAS SEVERANCE TAX REVENUE AS A PERCENT OF STATE GENERATED REVENUE*

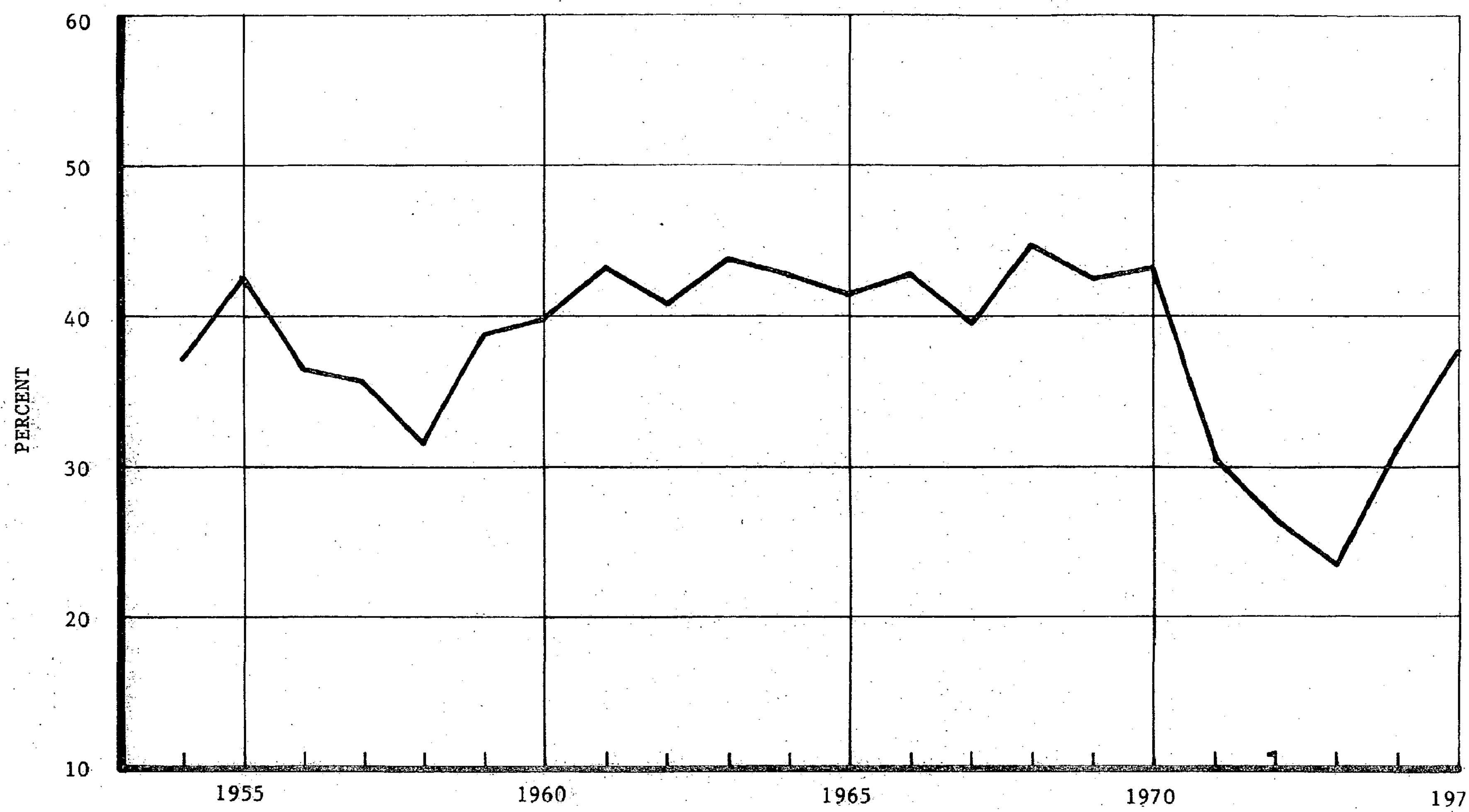
FISCAL YEARS 1954 - 1975

*State generated revenue excludes federal revenues, medicare payments, and receipts from bond sales.

CHART 1-11

STATE REVENUES FROM ROYALTIES, RENTALS, BONUSES AND OIL AND GAS SEVERANCE TAXES AS A PERCENT OF STATE GENERATED REVENUE*

FISCAL YEARS 1954 - 1975



*Royalties, rentals, and bonuses includes Rockefeller, Russell Sage, and Marsh Island refuge funds. Total state generated revenues includes total state revenues, less federal grants, medicare, and bond proceeds.

1.6. Estimates of Louisiana Employment in OCS Mining

In 1975, 58,842 individuals were employed in mining in Louisiana, of which 92 percent were employed in oil and gas extraction (SIC Codes 131, 132, 138). Approximately 24,200 individuals, or 41 percent of the state's total in mining were employed in the nine parishes adjacent to the Gulf of Mexico.

Because these employment data include those who work in onshore mining, or state owned offshore, some estimate must be made of the OCS employment. There are five reasonable, but approximate, methods that can be used to estimate direct OCS employment:

METHOD A:

$$\frac{\text{OCS Production of Crude Oil \& Condensate}}{\text{Total State \& OCS Production of Crude Oil and Condensate}} \times \left(\text{State Employment in SIC 131, 132,138}\right) =$$

Estimated OCS Employment

1974 Data: $\frac{342,435,496^{10}}{728,266,045^{11}} \times 55,606 = \underline{\underline{26,146}}$

METHOD B:

$$\frac{\text{OCS Production of Natural Gas}}{\text{Total State \& OCS Production of Natural Gas}} \times (\text{State Employment in SIC 131,132,138}) =$$

Estimated OCS Employment

1974 Data: $\frac{3,349,170,864^{12}}{7,643,408,783^{13}} \times 55,606 = \underline{\underline{24,365}}$

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[10] Oil is in units of barrels. Source: Outer-Continental Shelf Statistics, Department of the Interior, Geological Survey, June, 1975.

[11] 1974 State Crude Production Estimated by Louisiana Department of Conservation.

[12] Gas is in units of million cubic feet. Source: Outer-Continental Shelf Statistics, 1975.

[13] 1974 State Natural Gas Production estimated by Louisiana Department of Conservation.

METHOD C:

$$\frac{\text{Number of Active Oil and Gas Wells on OCS}}{\text{Number of Active Oil \& Gas Wells in State and OCS}} \times (\text{State Employment in SIC 131, 132,138}) =$$

Estimated OCS Employment

1974 Data: $\frac{5,337^{14}}{30,896^{15}} \times 55,606 = \underline{9,604}$

METHOD D:

Industry Surveys. One widely held industry view is that OCS employment is approximately 60 percent of the 55,000 individuals employed in state mining.

The GSRI study[16] reported the results of a survey of five oil and gas firms in Louisiana which responded that 31 percent of their employees classified in SIC codes 131, 132, and 138 were employed in the OCS.

A 1971 study by the Louisiana Offshore Operators Committee entitled "The Economic Impact of the Louisiana Offshore Oil Industry on the State of Louisiana" estimated that 38,000 oil and gas operating and service personnel were employed on the Louisiana offshore (state and Federal) industry.

In the spring of 1976, the oil and gas industry initiated a survey to determine the number of OCS employees. This survey should be completed by Fall, 1976.[17]

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[14] Source: Outer Continental Shelf Statistics.

[15] Source: Louisiana Department of Conservation.

[16] See Summary and analysis on pages 29-32.

[17] Bill Bailey at Mid Continental Oil and Gas Association, Baton Rouge, Louisiana.

METHOD E:

The 1972 Census of Mineral Industries reports a total of 12,000 employees working on offshore oil and gas extraction of which 9,800 are engaged in production, development, and exploration.[18]

This latter estimate which appears to be rather low, might be the result of the quirks in the design of the Census Bureau questionnaire mailed to the oil and gas companies. Companies were asked to list their employees in offshore locations and these offshore employees were then assigned to the area adjacent to the state in which the establishment was located. Thus, it is possible that an establishment located in Houston but engaged in activities off the coast of Louisiana would have its offshore employees assigned to Texas. Also, establishments may have reported only those employees directly working offshore without considering office, support, and administrative personnel.

Method C seriously underestimates the number of OCS employment according to industry sources and the alternative methods and probably should be disregarded. However, Methods A and B may provide rough approximations of direct OCS employment until more definitive survey results are available.

1.7. Employment Distribution by Parish

Chart 1-12 shows mining employment in each parish as a percent of total covered employment in each parish. These ratios tend to exaggerate the importance of mining employment because total employment includes only those employees subject to the Louisiana Employment Security Law. Excluded from this coverage are Federal employees, most municipal employees, and employees in agriculture, domestic services, railroad industry, most non-profit firms, and the self-employed.

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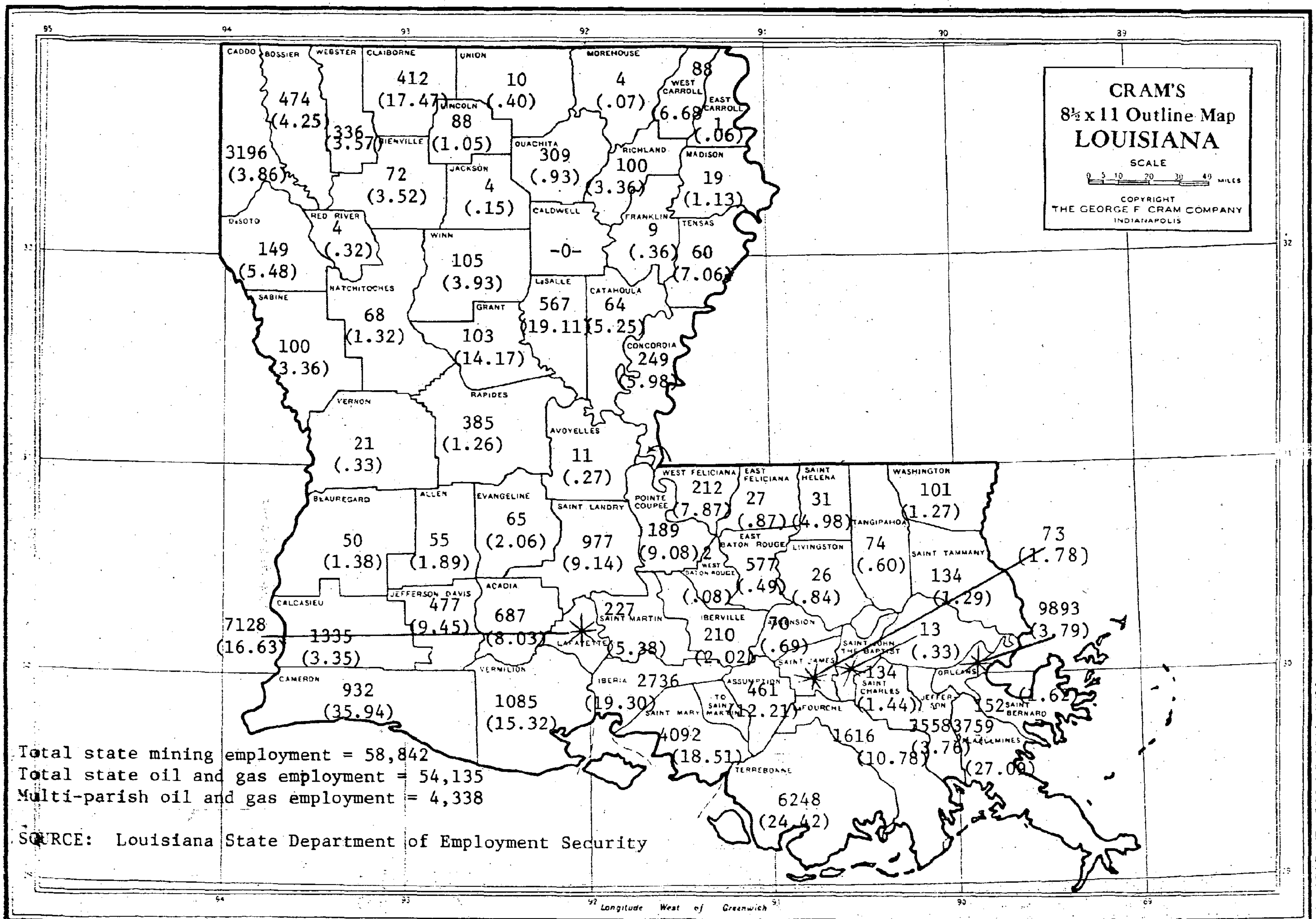
[18] 1972 Census of Mineral Industries, West South Central States, Bureau of the Census, pp. 7-25.

CHART 1-12

MINING EMPLOYMENT, BY NUMBER AND PERCENTAGE OF TOTAL COVERED EMPLOYMENT IN EACH PARISH

1975



Total state mining employment = 58,842
Total state oil and gas employment = 54,135
Multi-parish oil and gas employment = 4,338

SOURCE: Louisiana State Department of Employment Security

The location of employment is determined by the location of the reporting firm, unless the firm voluntarily agrees to allocate its workers by their place of actual employment. In their reporting responses, some firms, particularly the larger ones, do attempt to allocate workers according to the parish in which they are actually employed but many other firms do not. OCS workers are either allocated according to the location of the firm which employs them, or to the coastal parishes. Theoretically, OCS workers could be allocated to any parish in the state, but practically one would expect them to be allocated proportionally more to the coastal states. Total mining employment in the nine parishes adjacent to the Gulf of Mexico was 24,178 in 1975 and 20,176 in 1971.[19] The GSRI study includes a state map similar to our Chart 1-12, which shows mining as a percent of "total parish employment" (SIC) for 1971 for the 38 southern parishes. A comparison of mining employment percentages in our table with those shown in the GSRI study shows that the percentages of mining employment to total employment in almost all parishes were higher in 1971 than in 1975. This might lead one to reach the possibly erroneous conclusion that mining employment is decreasing relative to other employment in these parishes. The reason this conclusion might be erroneous is that in 1972, the Department of Employment Security changed their reporting requirements to conform to Federal regulations. This change broadened the statistical coverage which increased total covered employment, thus, producing distortions in temporal comparisons. These changes generally added to covered employment small firms which were not previously required to report. Because industries such as oil and gas industry, are characterized by large firms, the result was to decrease the relative size of their work force in relation to the total work force in each parish.

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[19] An average annual increase of 1000 mining employees in the 9 coastal parishes alone. Between 1971 and 1974, total oil and gas employment in the state grew from 45,993 to 55,606 so that statewide employment in oil and gas appears to have grown about as rapidly as oil and gas employment in the nine

CHAPTER 2

REVIEW OF THE LITERATURE--OTHER OCS IMPACT STUDIES

2.1. Introduction

The onshore effects of OCS petroleum mining have been estimated for several regions of the U.S. These studies have consisted primarily of hypothetical estimates of future OCS activity on the East Coast. However, several studies of actual OCS impacts on Louisiana have been undertaken. This review will describe and critique the Louisiana studies and analyze the East Coast studies. The latter studies are more useful for their methodology than their results.

2.2. OCS Impact Studies for Louisiana

2.2.1. Impact Costs to the State of Louisiana and Political Subdivisions Resulting from Federal Offshore Production, by Dr. David B. Johnson and Dr. G. Randolph Rice, Department of Economics, Louisiana State University.

This study was prepared in a three week period during June, 1972, for the Louisiana Attorney General's office. This study made no attempt to measure the benefits. Only the public sector costs of Outer Continental Shelf activity were included.

It was estimated that in 1970, 12,500 employees worked directly on the OCS, to which were added 750 employees who worked for Petroleum Helicopters providing shuttle service to the offshore area. All other direct and indirect employees were excluded. This employment figure of 13,250 was related to total employment in 12 coastal parishes to yield a basic OCS employment ratio (.0436) which could then be applied to the public service revenues.

Parish revenues were obtained from audits taken by the Louisiana Legislative Auditor. All user charges, utility receipts, fees, fines, tuition payments, and federal grants of all types were excluded. Fees and payments were excluded because they represent a payment for clerical services performed for the individual and such revenues increase in direct relation to the number of individuals demanding such services. Thus, additional OCS related employment could pay "its own way" for these services. Funds for certain purposes, such as education, for which parish data could be obtained from other state offices were also excluded from the data obtained from the Legislative Auditor. Those remaining revenues for each of the 12 coastal parishes were summed and multiplied by .0436 to obtain OCS impact cost. Special taxing districts were also icnluded. Expenditures for primary and secondary education, highways, public works, hospitals, and clinics, conservation and state police which were directly identified within the 12 coastal parishes were summed and multiplied by the OCS employment ratio. Funds for higher education were apportioned on the basis of OCS employment to total employment in the state.

It was estimated that the total costs to the coastal parish governments and to the state government from OCS activity were $13 million in 1970. This is very much a lower bound estimate because of the very conservative nature of the assumptions: the focus on only 12 parishes, the exclusion of all employees but those working directly on the OCS and those employed by Petroleum Helicopters, and the exclusion of municipality costs.

If time had permitted, the study would have benefited from the following:

(1) An OCS employment ratio for each parish

(2) The inclusion of additional parishes and all municipalities within these parishes

(3) Secondary employment from suppliers of services to the OCS area and downstream fabrication

(4) More explicit recognition of large scale public projects built primarily to service the OCS, e.g., highways or ports.

The methodology of determining the additional employment within each municipality and parish and then using data from the Legislative Auditor or from the local governments is preferable, if time and money permit, to using nationally published data, such as the Census of Governments which hides many of the details and can result in double counting of data from different levels of government.

2.2.2. Offshore Revenue Sharing: An Analysis of Offshore Operations on Coastal States, by Gulf South Research Institute, undated.

This report, probably prepared in 1973, was done for the Governor's Offshore Revenue Sharing Committee. This study estimates that the number of persons employed directly in OCS activity in 1971 was 15,000. This estimate was based on interviews with five oil and gas firms and from data on mining production in 1971. Secondary employment generated in construction is estimated to be 4,700; in manufacturing 10,500; in chemicals and allied products, 7,300; and in refining 2,800. Supporting employment is estimated to be 84,100. Total employment generated by the OCS activity is estimated to be 124,400. Total estimated employment related to OCS activity is 390,990 employees.

Construction employment as a result of OCS activity was estimated by assuming that the share of total annual construction employment attributable to oil and gas mining equalled the ratio of oil and gas mining employment to total employment in agriculture, forestry and fisheries, mining and manufacturing. This ratio was multiplied by construction employment to obtain total construction employment allocated to mining. Since 29 percent of total oil and gas production was obtained from OCS, this percentage was multiplied by estimated oil and gas construction employment to obtain the final estimate of 4,700 employed in construction as a result of OCS activity.

A similar methodology was employed to estimate OCS generated employment in manufacturing, chemicals and allied products, and refining. None of the employment in the category of agriculture, forestry, and fisheries was related to OCS production.

GSRI estimated the costs of state and local governmental services arising as a result of OCS activity by:

(1) Taking the number of employees related to OCS, as shown above, and multiplying by 3.14 to obtain total OCS related employees and dependents.[1]

(2) Census of Government data shows that expenditures by state and local governments in Louisiana were $677.88 per capita (1970).[2] Multiplying the number of OCS employees (390,990) by $677.88 equals $265,044,000.

(3) Forty percent of the taxes needed to provide government service is estimated to be paid by individuals ($106,018,000) and sixty percent is estimated to be paid by corporations ($159,026,000).

At this point GSRI is ready to make their estimate of the net impact of OCS activity on Louisiana but, unfortunately, there is no information on how they do this. They merely list percentage allocations of total corporate taxes needed to finance public services and then take variable percentages of these amounts to obtain net uncompensated taxes. Their only salient reference to data supporting these percentages is: "These percentages allocations are based on information contained in the questionnaires and information supplied by the Department of Revenue. It is important to note that these figures apply only to those firms which are engaged in OCS activities and make no allowances for taxes paid for onshore activities by the same firms except those which support OCS activities."

The percentage allocations are shown below:

1. Ninety percent of the cost of governmental services provided mining corporation operating in the OCS are uncompensated for due to the tax jurisdiction $17,259,300

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[1]A multiplier of 3.14 is used because 1970 Census data indicates that there are 2.14 additional persons for every employed individual.

[2]This is not the appropriate number to use because it includes expenditures financed by Federal revenues. For example, during FY1971 nearly 26% of total Louisiana state and local expenditures were financed by the Federal government.

2.	Fifty percent of the cost of governmental services provided manufacturing firms servicing the OCS are uncompensated	6,711,000
3.	Fifty percent of the cost of governmental services provided construction firms serving the OCS are uncompensated	3,003,500
4.	Ten percent of the cost of governmental services provided supporting firms serving the OCS are uncompensated	10,751,000
	TOTAL NET IMPACT	$37,724,800

No supporting information for these percentage allocations is given in the GSRI report.

GSRI relied on the Louisiana Department of Revenue (DOR) to estimate the state taxes foregone. The tax category and the DOR estimates are:

STATE TAXES FOREGONE

Tax Category	Amount Foregone (Millions of dollars)
Severance	127.2
Income	17.1
Corporate Franchise	12.0
Sales and Use	10.0
Occupational License	0.1
Ad Valorem	9.8
Miscellaneous	7.3
	$183.5

For parishes and municipalities, GSRI assumed that the applicable sales tax rate is 2%, or two-thirds of the state 3% rate. This, it is estimated that parishes and municipalities lost $6.7 million of sales tax. For every dollar of state ad valorem (property) taxes collected, approximately $7.86 is collected on the local level (1970). Thus, local property taxes foregone are estimated to be $77.1 million. Total taxes foregone by local governments in Louisiana are estimated to be $83.8 million.

The calculation of state and local taxes foregone should not be part of the net impact study because taxes foregone have nothing to do with the net impacted cost of the OCS activity. Although, it appears that GSRI did not use taxes foregone in their calculation of net impact, the study does not state the purpose for its inclusion.

A major flaw in GSRI's estimate of OCS related employment is their implicit assumption that employment in construction, manufacturing, chemicals and allied products, and refining would fall in proportion to OCS activity. This is an incorrect assumption. In the absence of OCS production, crude oil would be imported from Venezeula and the Middle East. The resulting higher price of crude, in turn, might discourage refining and petrochemical capacity, in general, but employment in these industries would not fall in proportion to the decline in OCS activity.

Other methodological problems related to their employment estimates is the assumption that mining, agriculture, forestry and fisheries, and manufacturing are the only industries in Louisiana. More significant from a viewpoint of net impact analysis is that no benefits are assigned to OCS employment. Thus, the $37.7 million impact figure derived by GSRI is based on some unexplained methodology. Furthermore, it measures only the additional public service costs required by the additional OCS related employees. Additional production related costs, such as ports, are not included. Tax revenues are not estimated. Finally, it assumes all OCS related employees reside in Louisiana.

2.2.3. The Economic Impact of the Louisiana Offshore Oil Industry on the State of Louisiana, by Committee of Offshore Oil Industry Operators, undated.

This report contains information for 1971 and for the cumulative impact from 1948 to 1971. Only 1971 data are summarized in this report, which was probably released in 1973. This study is concerned with the impact of the Louisiana offshore industry, including state offshore activity, and not exclusively with the OCS impact. The following methodology was employed in the report.

(1) Oil and gas producing company personnel. A telephone survey was made of six major offshore producers which account for 75 percent of the offshore oil and 50 percent of the offshore gas. The total personnel of these companies who were employed in offshore activities and who were living in Louisiana was 5414. This was factored up by 1.5 and rounded to yield 8000 employees for all offshore producers. County Business Patterns, 1971, shows that the average annual taxable income for employees in "Crude Petroleum and Natural Gas" was $10,900 for the State of Louisiana. This was increased by 10 percent to $12,000 for the higher wages of offshore workers and the higher technical personnel mix required. The employees working in oil and gas service companies were estimated by unknown methods. Total number of employees of offshore producing and service companies was 38,000 employees with an annual total payroll of $381 million.

(2) The study estimated indirect employment by using a local employment multiplier of 1.86 mentioned in the April, 1972, issues of the Louisiana Business Survey. This multiplier was "rounded up" to 2.0 on the basis that the industry will have a greater effect on smaller communities than on a metropolitan area.[3] Thus, indirect employment was estimated to be 76,000. To obtain payroll estimates for these employees, the authors calculated a weighted average annual wage for transportation, wholesale trade, retail trade, finance, insurance, banking, real estate, and services. This weighted average annual wage was $5500. Total payroll was then calculated to be $418 million.

(3) By using industry data, including the "Joint Association of the U.S. Oil and Gas Producing Industry Data" published jointly by American Petroleum Institute. Independent Petroleum Association of America, and Mid-Continent Oil and Gas Association, it was estimated that in 1971, $807 million of capital expenditures were utilized to find, develop, produce, transport, and process offshore oil and gas. It was further estimated, without supportive data, that approximately 60 percent, or $482 million, of these capital expenditures stayed in Louisiana.

(4) Based on telephone surveys of the six major offshore operators, operating andmaintenance costs were estimated to be 55 cents per barrel. Multiplying by offshore production yields $356 million, of which, according to their judgment, 80 percent, or $285 million stayed in Louisiana. Capital expenditures by oil and gas pipeline companies offshore Louisiana was estimated at $23 million by the Oil and Gas Journal of which $14 million are estimated to have been spent in Louisiana.

(5) Other expenses for which the methodology is not clearly detailed are:

(a) Operating expenses of oil and gas pipeline companies offshore Louisiana: $5.0 million.

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[3]Actually, a metropolitan employment multiplier should be rounded down for a small community. The larger the area the greater the multiplier because fewer services and products have to be "imported".

(b) Operating expenses by oil and gas pipeline companies onshore to export gas and crude from Louisiana: $4.6 million.

(c) Capital expenditures for natural gas processing plants to process offshore gas: $4.0 million.

(d) Operating expenses for natural gas processing plants which process offshore gas: $6.0 million.

The total impact of the offshore oil industry on the State of Louisiana for 1971 is estimated to be nearly 1.6 million but because of double counting, the study estimated that the direct impact on the economy of Louisiana was $783 million and that the indirect expenditure was $418 million for a total of $1.2 billion. That is, they used the direct capital and operating costs which stayed in Louisiana, as estimated by them, for the direct impact estimate. For an estimate of the indirect impact they used the estimated indirect annual payroll of $418 million. This represents about 11 percent of personal income payments to Louisiana residents in 1971. Excluding income received from farm and government, this amount represents 20 percent of all Louisiana wages and salaries received in 1971.

This study measured the expenditure impact of all offshore production, not just the impact from OCS activity. In 1971, 87 percent of Louisiana offshore crude production occured in the Federal area. Applying this ratio to the $1.2 billion estimate results in total 1971 expenditures in the State of Louisiana of $1.04 billion. These estimates exclude royalties, bonuses or rentals paid to the state for leases and production in state controlled waters, so, in that sense, they underestimate offshore benefits in the state.

These estimates cannot be utilized to determine the net benefits of OCS production. First, the multiplier they used to determine the indirect expenses is probably too high. Second, their estimates of payments made to Louisiana residents, especially for capital construction appear to be unusually high in view of the small capital goods manufacturing industry in the State. Third, and most important, in the absence of OCS activity, all of the indirect and some of the direct benefits would not be lost because imported oil would substitute for OCS production. In other words, factors of production currently being paid as a result of OCS activities may either remain employed in their current positions in the absence of OCS activity or find alternative employment.

2.3. East Coast Studies

As one would expect, all the East Coast studies attempt to predict the onshore impacts of future OCS development. All of the studies assume various development scenarios. With the exception of one study, they all assume "best guess" primary impact areas. Since this study deals with actual impacts, the estimation of development scenarios will not be discussed. The following is a discussion of the impact measurement methodologies used by these studies, given whatever development scenarios are assumed.

2.3.1. The Georges Bank Petroleum Study, Offshore Oil Task Group, (Massachusetts Institute of Technology, February 1, 1973).

This was one of the first significant OCS impact studies of the East Coast. It attempted to measure the net effect on New England real regional income of OCS development. Their assumption is that in assessing any two alternative developments in a region, the only thing that counts is the net difference in regional income between the two. The study suggested that attention be focused on:

(1) The difference in the cost of outputs to regional consumers,

(2) The difference in private profits to regional investors,

(3) The difference in public profits (additional tax revenues minus additional cost of services occasioned by the developments under consideration) to the affected regional public bodies,

(4) The difference in take-home pay to all the regional labor affected,

(5) The net effect due to responding of all the above differences.

The study emphasized that the well-being of individuals who were residents of the affected region prior to the hypothesized development is the only relevant well-being. The study also emphasized that regional resources have opportunity costs so that the earnings of the resources employed in the new development may exceed the increase in resource earnings as a result of the development.

The study assumed that only five percent of the private profits of OCS development and five percent of the Federal taxes would accrue to New Englanders (p.148). It also included increased New England refinery capacity as the largest employment effect of the OCS development. It assumed that 60 percent of these jobs would be filled by low-skill New Englanders who would receive 33 percent higher annual earnings than without OCS activity. Consequently, .6 x .33 = .20 of the gross value of refinery payroll created by OCS would represent the increased refinery earnings due to OCS (p.165).

Although the study assumes that most income increases will be spent in New England it disregards second and successive round income increases since the regional input into these goods would be small, a large portion of expenditures would be on goods in which there is no excess production capacity, a large portion of expenditures will be on goods with price-inelastic supplies, and some portion of expenditures will be on goods for which marginal costs exceed marginal revenues (p.174).

The study attempted an estimate of the impact on regional income of five OCS disturbances of commercial fishing. Of the five possible effects--navigational hazard, platforms as reefs, interference of seabottom obstructions with trawling, interference of seismic activity with trawling, and interference of platforms with trawling--it concluded that only the latter would be significant. The study argued that interconnected platform structures could interfere with trawling if these structures were perpendicular to bottom contours since trawlers fish along contour lines. After calculating the ex-vessel value of fish by geographic location, it assumed a "worst possible" platform structure and calculated the production loss as proportional to the platform area covered. It then related this back to regional income (pp.206-210).

The principle concept used in this study, net real regional income, is the appropriate one for an impact study. However, the casual dismissal of indirect effects on regional income seems to be unfounded. These may be very important in a region with a low skilled labor force and high unemployment rates. Also, the treatment of "public profits" seem inadequate. There is no attempt to estimate additional public service costs.

2.3.2. Offshore Petroleum and New England, by Thomas A. Grigalunas (University of Rhode Island, 1975).

This study also attempts to measure the impact on New England of OCS development on the Georges Bank. It also assumes hypothetical development scenarios. It uses the Harris model, which is a long-run, multi-regional, multi-industry forecasting model.[4] This model allows autonomous changes in the components of final demand to generate estimates of employment, population, earnings, and personal income by year and by region. The model essentially is a dynamic input-output model which allocates a change in final demand to each region, depending on various economic relationships.

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[4] C.C. Harris, The Urban Economics, 1985: A Multi-Regional, Multi-Industry Forecasting Model, (Lexington Books, 1973).

The model requires estimates of:

(1) Direct OCS investment--this includes capital construction and equipment costs of platforms, pipelines, well drilling and exploration, onshore storage terminals, onshore gas processing plants, pumps and compressors, and other machinery--by industrial sector (p.73).

(2) Refinery investment by industrial sector.

(3) Offshore oil and gas refinery output.

(4) Public expenditures (or increased consumption as a result of tax savings) by industrial sector (p.61).

After assuming the regional share of investment costs (p.70), the above estimates are plugged into the Harris model, resulting in estimates of employment, payrolls, income, and population resulting from the various OCS scenarios (pp.74-79).

Several comments on this procedure are necessary. First, the inclusion of oil and gas production and refinery output as a final demand seems to be a misuse of the I-O model. It would be more accurate to first determine the sector-by-sector inputs on current account necessary to produce the given oil and gas, and refinery outputs, then let these inputs equal the final demands resulting from this output. Second, only property taxes are considered to directly accrue to New England (p.63). The assumption that property tax revenues equal the government expenditures necessary to provide public services to the OCS created economic activity assumes away a major issue which is the OCS impact on state and local governments. Third, it assumes the impact on New England of income taxes is neutral (p.62). This would be true if government and consumers had the same expenditure mix and if the marginal public service costs of servicing the new residents equalled the marginal tax revenues obtained from them. Both of these assumptions are questionable.

Recognizing that the resources used in OCS created economic activity have alternative uses, the study assumes that the real social cost of labor is no less than 75 percent of its market value and that idle capital has no alternative use. This results in a large difference between the estimate of regional earnings due to OCS ($19.6 million) and increases in regional earnings due to OCS ($49 million) (p.84).[5] Similarly, it is noted that tax revenue increases should be measured, but there was no attempt to measure the alternative tax revenue from private property in the absence of OCS activity. There are no environmental costs estimates.

2.3.3. Economic Study of the Possible Impacts of a Potential Baltimore Canyon Sale, by K.D. Reinfeld and Francis F. Callahan (U.S. Department of the Interior, Bureau of Land Mangement, December, 1975).

This study, done by private consultants for the BLM, also uses a Harris model with various development scenarios. One particular assumption is noteworthy. The study assumes that OCS oil production will simply displace imported oil and there will be no effect on total refinery capacity. It assumes that any expansion in refinery capacity will be demand stimulated rather than supply stimulated (p.56).[6] Gas processing capacity is assumed to be increased.[7] This is because pipeline economics suggests that gas processing plants will locate close to producing areas (p.61).

The study makes the following cost assumptions (pp.63-70):

(1) Average annual oil and gas operating costs are $2.65/bbl and $0.24/mcf, respectively.

(2) An exploratory well costs $3 million to drill.

(3) Platform and production equipment with installation costs $20 million.

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[5]The latter estimate includes the increased incomes of non-regional resources that are transferred into the region as a result of OCS activity.

[6]The study notes that BLM has planned to make a study of the economic relationship of OCS oil production and refinery investment (p.58).

[7]This processing includes only the stripping of valuable propanes and butanes from natural gas, not the process of separating oil, gas, and water at the wellhead.

(4) Large offshore and onshore pipelines cost $1. million per mile and $0.3 million per mile, respectively.

(5) An onland operations base supporting production of 200,000 barrels of oil per day costs $2.8 million.

(6) A pipeline land terminal with a 200,000 bbl/day oil capacity cost $4 million.

(7) Gas processing capacity of 500 mcf costs $40 million.

The direct employment requirements per unit of activity were assumed to be (p.71):

Exploration	113 men/rig
Development	65 men/rig
Production	
Offshore	16 men/rig
Onshore	136 men/rig
Transport	17 men/pipeline terminal
Gas Processing	49 men/processing plant
Service Support	absolute number used
Office	absolute number used

The study inserts these assumptions into the Harris model.

A unique contribution of the study is to incorporate the EPA Strategic Environmental Assessment System (SEAS) into the model. This system provides pollution technical coefficients which represent the amount of air and water pollution of various types per unit of economic activity. Air pollution emissions were calculated from data on (pp.216-220):

(1) Estimated personal and freight transportation vehicle miles.

(2) Natural gas, distilled oil, and coal used for residential, commercial and industrial fuel.

(3) Electric utility capacity.

(4) Dry cleaning emissions.

(5) Hydrocarbon pollution emissions from gasoline storage facilities.

The study concluded that the increase in water pollutants resulting from OCS activity was insignificant (p.247). There was no attempt to assign economic values to these pollutants.

2.3.4. Mid-Atlantic Regional Study--An Assessment of the Onshore Effects of Offshore Oil and Gas Development, by Woodward-Clyde Consultants (October, 1975).

This study assumes that the OCS employment multiplier (the number of indirect and induced jobs created by one direct OCS job) is 1.17 (p.14). This is much lower than the OCS employment multipliers estimated by Grubb, 3.5,[8] or by GSRI, 2.08.[9] Land and capital requirements per facility are estimated. The study uses the same assumptions as the Baltimore Canyon Study regarding men per exploratory rig, men per development rig, men per platform, and men per pipeline terminal. The study assumed 34 men per gas processing plant (p.389). These figures were obtained from the Offshore Operators Committee study reported above. The study noted that job vacancies would be filled by individuals who lived in the primary impact study areas,[10] individuals who must relocate to the primary impact areas, and individuals who would never reside in the Mid-Atlantic region. The percentages of workers in each of these categories by job function were obtained from the Offshore Operators Committee and are as follows:

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[8]Herbert W. Grubb, "Economic Aspects of the Petroleum Industries of the Texas Economy," (Office of Information Services, Austin, Texas, 1972).

[9]Jan Duggar, "Offshore Revenue Sharing," (Gulf South Research Institute) undated.

[10]Two primary impact study areas were defined. See their p.44 for the map delineation of these areas.

Job Function	Primary Impact Area Resident	Relocated Residents	Non Resident
Exploratory Rig	35%	40%	25%
Development Rig	35%	40%	25%
Services	60%	40%	0
Platforms	95%	5%	0
Pipeline Terminal	75%	25%	0
Gas Processing Plant	75%	25%	0
Office	40%	60%	0
Operations Base	80%	20%	0

Only the relocated residents will have an additional impact on public services of the primary impact area. In order to calculate the population change and the school age population change, the following assumptions were made using 1973 U.S. Bureau of the Census data (p.386):

Percent Married	78%
Average Family Size	3.5
Average Children Per Family	1.3
Percent of Children of School Age	75%

In order to calculate the gross income of the workers employed directly in OCS activities, the average annual salaries in Table 1 were used (p.392).

The study assumes that indirect employment resulting from OCS activity will be only 0.2 jobs in the primary impact area for every one direct OCS job. The argument is that most supplies will come from Gulf Coast enterprises or from enterprises in the Mid-Atlantic urban areas. Induced employment is assumed to be 0.8 jobs in the primary impact area for each direct or indirect job. Consequently, for every 1 direct job there will be 1.16 (1 x .8 + .2 x .8 + .2) more jobs created in the study area.

In order to calculate state tax revenues resulting from the OCS activities, the study first calculated expected retail sales. The following formula was used:

$$\text{Retail Sales} = (\text{Estimated Gross Income Resulting from OCS}) \times \frac{\text{U.S. Disposable Inc.}}{\text{U.S. Personal Inc.}} \times \frac{\text{Impact Area Retail Sales}}{\text{Impact Area Disposable Income}}$$

TABLE 2-1

ANNUAL AVERAGE SALARIES PER WORKER AT OCS FACILITIES*

Facility	Source	Average Annual Salary
Exploratory Rig	1	$13,300
Development Rig	1	14,200
Services	1	14,600
Platforms	1	13,700
Pipeline Terminal	1	14,300
Gas Processing Plant	1	14,100
Office	1	17,400
Operations Base	1	11,800
Construction	2	15,000
Platform Construction Facility	3	10,600

SOURCES:
1. Offshore Operators Committee. 1975. Unpublished data.
2. Woodward-Clyde Consultants calculations. 1975.
3. Urban Pathfinders, Inc. 1975. Brown and Root impact study.

*Taken from the Woodward-Clyde Study

Expenditures on selected services (hotels, personal, services, automobile services, repair services, and recreation services) were calculated as follows (p.146):

$$\textit{Selected Services} = (\textit{Estimated Retail Sales}) \times \frac{\textit{Impact Area Service Receipts}}{\textit{Impact Area Retail Sales}}$$

Sales Taxes resulting from the increased retail sales were calculated as follows (p.148):

$$\textit{Selected Services} = (\textit{Estimated Retail Sales}) \times \frac{\textit{Impact Area Service Receipts}}{\textit{Impact Area Retail Sales}}$$

Sales Taxes resulting from the increased retail sales were calculated as follows (p.148):

$$\textit{Retail Sales Tax Receipts} = (\textit{Estimated Retail Sales}) \times \left(\frac{\textit{Impact Area Taxable Sales}}{\textit{Impact Area Retail Sales}}\right) \times (\textit{Impact Area Tax Rate})$$

Taxes obtained from selected services were never calculated.

Income tax receipts were calculated by dividing employment into direct employment and indirect/induced employment using the following formula (p.191):

Income Tax Receipts = ((Average Salary of Direct Employees) x (Effective Tax Rate) x (Number of Direct Jobs)) + ((Average Salary of Indirect/ Induced Employees) x (Effective Tax Rate) x (Number of Indirect/Direct Jobs))

Corporate state income taxes were not estimated, although the study noted that they may be large (p.120).

Property taxes were calculated as follows (p.121):

Property Tax Receipts = ((Onshore Capital Construction) x (Property Tax Rate)) + ((Housing Units for Relocated Workers) x (Average Tax Per Dwelling Unit))

The study used U.S. Census of Governments data to calculate local government per capita expenditures (p.126). This per capita cost was multiplied by the increase in population resulting from relocated workers employed directly in OCS activities (pp.144-150). This assumes that all indirect workers come from within the impact area. This suggests a large underestimate of the additional local government expenditures required as a result of OCS activity. Also, major capital outlays were excluded, further biasing the expenditure requirements. This expenditure is excluded even though it was noted that additional classrooms may be required.[11] The study noted that a decline in OCS activity may result in excess capacity for public services unless a sufficient population growth eliminates excess capacity.

The study assumed that land use, by function, would be (pp.127-128):

140 acres per operation base
40 acres per pipeline terminal
75 acres per gas processing plant
120 acres for service companies at peak support service employment of 470 persons

The study also noted increased land use for transportation (highway, air, and rail) are recreation (.058 acres per person) (pp.129-132). Ecological effects were noted but nothing was done to measure their economic impacts (pp.133-142 and 195-208).

2.3.5. The Impact of Offshore Oil--New Hampshire and the North Sea Experience, by New Hampshire Department of Resources and Economic Development, 1975.

The usefulness of this study to the current study is limited. It is primarily a series of anecdotes regarding onshore impacts of offshore oil development in the North Sea (p.57-73). It notes several important impacts,

[11]The study calculated additional classrooms needed by using pupils per classroom data, (p.315).

such as rising housing prices, office rental rates, harbor entry fees, employment, etc., but is not helpful in quantifying precisely the onshore effects.

2.3.6. OCS Oil and Gas--An Environmental Assessment, by Council on Environmental Quality, April, 1974 (Vol.I-V).

This report was an extensive analysis of various aspects of OCS development. One of the volumes in the report attempted to predict onshore effects of OCS development on the Atlantic and Alaska OCS.[12] The study concentrates on the employment, output, social infrastructure, air pollution, water pollution, and land use impacts of OCS activities. The study does not attempt to arrive at an estimate of net income increases, as did the New England and Baltimore Canyon studies. No estimate of resource costs is made. However, the study did use some comparable worker per unit of activity figures for calculating the direct employment effects of OCS. These ratios were:

Exploration	*175 workers/rig (equals 87.5 man years per platform due to 7 days on-7 days off work schedule and includes on site plus onshore transportation support) (p.I-10).*
Development	*175 workers/platform (equals 87.5 man years per platform due to 7-7 policy) (p.I-13).*
Production	*90 workers/platform (equals 45 man years per platform due to 7-7 policy) (p.I-17).*
Platform Construction	*40 man years/$1 million (p.I-20).*
Transport	*No permanent regional impact (p.I-21).*
Gas Processing	*55 workers/500mcf capacity plant (p.III-7).*

[12] Resource Planning Associates and David M. Dornbusch and Company, Potential Onshore Effects of Oil and Gas Production on the Atlantic and Gulf of Alaska Outer Continental Shelf, Vol.IV of OCS Oil and Gas--An Environmental Assessment.

Except for gas processing, these ratios are considerably different from those used in the Baltimore Canyon and Mid-Atlantic studies, shown on p.40 above. It is not clear whether the latter studies considered the seven-days-on seven-days-off work policy for on site OCS employment. There were no assumptions of employment for pipeline terminals in this study. The study assumed that one 500mcf gas processing plant would require the following inputs (p.III-10):

20 acres
1800 Kwh per day
15,000 Gallons of water per day

There would be little water pollution and air pollution (Table III-7). The particular assumptions for estimating the impact on public service requirements are too lengthy to discuss here (pp.VII-1 to 7).

The study assumed no platforms would be constructed in either the Atlantic or Alaskan OCS. The percent of goods and services purchased within the respective regions, in conjunction with the 1970 average annual earnings by function, are given below:

	Percent Purchased in Region	Average Earnings (1970)
Exploration	20%	$13,000
Development	20%	13,000
Production	30%	12,000
Platform Construction	0	12,500
Gas Processing	???	10,000

The study assumed that the most complex, expensive equipment for exploration would come from the Gulf of Mexico region.

2.3.7. A Methodology for the Sitting of Onshore Facilities Associated With OCS Development, by New England River Basins Commission, January, 1976.

The primary purpose of this uncompleted project is to estimate the intensity and location of onshore impacts of OCS activities. The first report is a summary of OCS impacts on the size and location of platform fabrication plants and service bases for offshore operators. These will be the major onshore impacts of the OCS exploration and development stages. The study is useful in outlining the types of onshore impacts of these stages and in estimating their land and labor requirements. The project will estimate the impact intensity and locations of the production and distribution stages in future reports. Also, future reports will study the effects of OCS activities on support industries.

The study notes that onshore effects of geophysical exploration are nearly nonexistent (p.III-3). Firms may lease land and dock space from public authorities during initial stages, and early exploration requires 3-5 acres of service base per rig (pp.III-10 to 13). Exploratory drilling rig crews generally reside at the "home base" of the rigs, regardless of the location of exploratory drilling, while support companies tend to locate near the service bases (pp.III-14 to 16). Onshore demands for exploratory rig services vary directly with the number of rigs services.[13] Platform placement and fabrication will not necessarily be located near one another (p.III-21). Rigs vary in the onshore support needed-tender type rigs requiring more support facilities than self-contained rigs (p.III-19). Partial processing of well output (separating oil, gas, water, and impurities) may occur onshore or offshore, depending on relative costs (p.III-22). Gas processing plants will be located on line between OCS areas and onshore pipeline systems. The study uses the Council on Environmental Quality

[13]See Tables IV-E and IV-1 in the study for estimates of onshore service base requirements of land, fresh water, supply boats, and labor.

and Woodward-Clyde estimates of land, water, and employment impacts (p.III-34). The study notes that a pipe coating yard will employ 150-200 persons, emit dust, and require disposal of cement and asphalt-based wastes (p.III-37).

2.3.8. Florida Coastal Policy Study--Impact of Offshore Oil Development, by Florida Energy Office, October 28, 1975.

The purpose of this study was to predict the effects of Florida OCS activity on Manatee County, Florida. The unique feature of this study was the manner in which it estimated net fiscal impacts. The fiscal impact technique was very detailed, in contrast to other studies which simply assume average per capita revenue and costs. The study measures the estimated impact on the school system, the major municipality, and the county. The fiscal impact on the state, as a whole, is not estimated.

The study uses the following procedure to estimate these impacts:

(1) Estimates the industrial activity, commercial activity, and employment resulting from the OCS activity (Chapter IV).

(2) Predicts specific locations for these activity and the housing generated by increases in the number of family (p.122).

(3) Outlines public service sectors and estimates the remaining capital value in each sector (p.114).

(4) Allocates a portion of the remaining value of capital to new developments on the proportion of capacity it uses (p.114).

(5) Stimulates added capital necessary and allocates these costs to the new developments (p.116).

(6) Allocates operations and maintenance costs in proportion to the new development's service sector demands (p.116).

(7) Some public service sector costs are allocated in a simple per capita basis (p.116).

(8) Specific revenue estimates are made for each type of development and service sector (p.116).

(9) One-time revenues are allocated annually over time (p.116).

This fiscal impact model is the most rigorous one to date. It also requires the most thorough data collection.

2.3.9. Decisions for Delaware: Sea Grant Looks at OCS Development, by Joel Goodman, (University of Delaware Sea Grant Program), February, 1975.

This study primarily takes excerpts from other OCS studies in order to predict the effects of OCS activity on Delaware.

2.3.10. See section 5.2 (Chapter 5) for a review of OCS fiscal impact literature and Chapter 7 for a review of the environmental impact literature.

CHAPTER 3

IMPACT METHODOLOGY--AN EXPLANATION OF THE NET BENEFIT APPROACH

3.1. Introduction

An economic activity generates benefits and imposes costs on society. The benefits consist of consumer savings and increases in factor earnings to factor owners. The costs, commonly called "opportunity costs," are the value of the best alternative uses of the factors which society foregoes by undertaking an activity. The net benefit of an activity is the difference between the benefits and costs.

Under the assumption that the market price of a factor of production accurately measures its opportunity cost, the cost of an activity is measurable by the total earnings of factors which must be transferred to the activity. The difference between factor earnings when employed by the activity and the earnings of these factors prior to their new employment represents the increase in factor earnings attributable to the activity. In addition to increases in factor earnings, an activity may result in price reductions or reductions in public service costs to consumers. The total consumer savings are included in the net benefit calculations. The existence of taxes merely allows the redistribution of net benefits among factor owners and consumers when the nation as a whole is considered but they can provide net benefits to citizens of a particular region. Calculations can be made of the net benefit to the whole society, or nation, of a particular activity. Similarly, one can also calculate the net benefit to a particular subset of society, a region, of this same activity.

The basic methodology proposed for measuring Louisiana's net benefits of OCS activity is an input-output (I-O) technique. This chapter outlines the general input-output technique, explains the problems encountered in applying the I-O technique to a small geographic area, such as a state.

3.2. Input-Output Technique

The Leontief input-output technique is well known. It has been used as a forecasting tool,[1] an impact tool,[2] and as a means of measuring the social cost of activities.[3] In this study, it is these last two uses which are important.

The activities under investigation generate two types of demands: on-site labor demand and materials, equipment, and supplies demands. The materials, equipment, and supplies come from the various sectors, or industries in the economy. The total value of these latter inputs, by industry, is referred to as the final demand created by the activity. If a particular activity, such as petroleum mining, engenders another activity, such as petroleum refining, the final demand will consist of the value of all the inputs required by both activities. This final demand is referred to as the direct demand. These are payments which must be made by the activities in question to the respective industries from which goods and services are purchased. These payments, in turn, end up in the hands of owners of land, labor, or capital, and in the hands of government through taxes. More specifically, these payments end up either as:[4]

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[1]William H. Miernyk, et. al., Simulating Regional Economic Development--An Interindustry Analysis of the West Virginia Economy, (West Virginia University, 1969).

[2]Walter Isard and Robert E. Kuenne, "The Impact of Steel Upon the Greater New York-Philadelphia Industrial Region," Review of Economics and Statistics (November, 1953), pp.289-301. Frederick T. Moore and James W. Petersen, "Regional Analysis: An Interindustry Model of Utah," Review of Economics and Statistics, (November, 1955), pp.368-383. Werrner Z. Hirsch, "Interindustry Relations of a Metropolitan Area," Review of Economics and Statistics, (November, 1959), pp.360-369. William H. Mierryk, et. al., Impact of the Space Program on a Local Economy, (West Virginia University, 1967).

[3]Haveman and Krutilla, Unemployment, Idle Capacity and the Evaluation of Public Expenditures, (Johns Hopkins Press, 1968).

[4]Haveman and Krutilla, op. cit., p.17.

(1) Employee compensation, by occupation (w).

(2) Net interest, by industry (i).

(3) Capital consumption (depreciation), by industry (d).

(4) Corporate profits, by industry (p).

(5) Proprietor and rental income, by industry (r).

(6) Indirect business taxes, by industry (t).[5]

These ultimate payments plus the payments for on-site labor represent value-added as a direct result of the activity. If factor payments represent opportunity cost and government taxes measure the cost of public goods and services required by the final demand, this value-added measures the opportunity cost of the activities in question.

The industries which produce the final demand must obtain inputs from other industries. The usefulness of the input-output technique is that is allows a quantification of these interindustry relations.[6] Assuming a_{ij} represents the value of inputs from industry i required per dollar of output of industry j, matrix A represents the structure of the interindustry relations:

$$(1) \qquad A = \begin{matrix} a_{11} & a_{12} & \cdots & a_{nn} \\ a_{21} & & & \vdots \\ \vdots & & & \vdots \\ a_{n1} & \cdots & \cdots & a_{nn} \end{matrix}$$

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[5]Direct taxes on factor earnings, such as income, property or profits taxes are not deducted from the above factor earnings.

[6]There are many good references on the I-O technique. These include Wassily Leontief, The Structure of the American Economy, 1914-1939, (Oxford University Press, 1951); H.B. Chenery and P.G. Clark, Interindustry Economics (John Wiley and Sons, Inc., 1959); William H. Miernyk, The Elements of Input-Output Analysis, (Random House, 1965).

Let the value of gross output of industry j be x_j , represented by matrix X =

(2) $$X = \begin{matrix} x_1 \\ \cdot \\ \cdot \\ \cdot \\ x_n \end{matrix}$$

The value of net output in industry i , y_k , would then be:

(3) $$X - AX = \begin{matrix} y_1 \\ \cdot \\ \cdot \\ \cdot \\ y_n \end{matrix} = Y ,$$

or, in condensed matrix form:

(4) $$(I - A)X = Y.$$

If the activities in question require a final demand represented by $\overline{Y}$, the gross output requirements from each industry are given by:

(5) $$\overline{X} = (I - A)^{-1} \; \overline{Y} .$$

$\overline{X}$ represents the sum of the inputs required directly and indirectly in order to produce the final demand, $\overline{Y}$.

Several useful pieces of information can be obtained using $\overline{X}$. First, suppose industry j requires 0_{kj} man-years of occupation k per dollar of output. Then:

(6) $$\begin{matrix} 0_{11} & 0_{12} & \cdots & 0_{1n} \\ \vdots & & & \vdots \\ 0_{m1} & \cdots & \cdots & 0_{mn} \end{matrix} \quad iX = 0X$$

gives the total man-years for each occupation required to produce the final demand, $\overline{Y}$. Under the linear assumptions of the I-O model, this represents the net increase in the man-years required as a result of the activity under investigation.

This net increase may come from unemployed workers or in-migrants from outside the system. If there are not a sufficient number of these workers available, prices may rise and outputs of some sectors fall as workers shift between sectors. Because of this, the man-years required as a result of the activity will be greater than or equal to the actual increase in jobs created as a result of the activity.

Second, suppose a dollar of gross output of industry j generates a value-added of type h (wages, interest, etc.) of v_{hj}. Then:

$$\begin{matrix} v_1 & \cdots & v_{1n} \\ \vdots & & \vdots \\ v_6 & \cdots & v_{6n} \end{matrix} \; iX = VX \tag{7}$$

represents the total value-added by type, excluding on-site labor costs, generated by the activities.

If factors are paid their marginal values to society and factor markets are perfectly competitive, the sum of on-site labor costs and the value-added calculated above would equal the social cost of the activities in question. However, if there is unemployment of some factors and the opportunity cost of these unemployed factors is less than their market price, the on-site labor costs and value-added will over represent the social cost of the activities when some of the unemployed factors are used in production. When the opportunity cost of the unemployed factors is zero and u percent of the factors are obtained from the unemployed pool of factors, the cost of these factors to society would be $(1-u)$ percent of the value-added created by these factors.[7]

It is not unreasonable to assume that the opportunity cost of unemployed labor is zero. Since capital can be stored for use by future generations, the opportunity cost of unemployed capital is the value of that capital to future generations if used now instead of being allowed to remain idle. This is approximately equal to the real depreciation rate in use.[8] The opportunity cost of nondepletable land which is lying idle is not identically zero since it may provide some non-marketable benefits such as beauty or wildlife habitat. Using the symbols above, page 53, to represent the rates of value added, per unit of the factor for labor (H), land (1), and capital (C), the following are the opportunity costs for these factors:

Labor: $w \cdot H\ (1-u_H)$

Capital: $i \cdot C\ (1-u_C) + d \cdot C$

Land: $\bar{r} \cdot L \cdot u_L$

where the u's represent the percent of factors obtained from the respective unemployment pools and $\bar{r}$ is the average value of idle land. The actual earnings of the factors of production above their opportunity costs would be one component of the net benefits of the activities in question.[9] These earnings increases plus the consumer cost-savings would equal the total net benefits to the whole society.

The above model provides a means of estimating the net benefits of an activity, or activities, to society. The following pieces of data are required:

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[7] Studies which simply measure earnings generated by an activity are not net benefit studies, unless they assume the opportunity costs of the factors used are zero.

[8] This assumes that depreciation results only from wear and tear.

[9] The above measures of opportunity cost do not deal with the cases where earnings of a factor may be above or below the opportunity cost to society due to monopoly or monopsony powers.

(1) the direct final demands placed by the activity on the system.

(2) society's indirect requirements matrix.

(3) labor requirements per dollar of output, by industry.

(4) labor requirements by occupation for each industry.

(5) the wage rate by occupation.

(6) value added, by component, per dollar of output by industry.

(7) the probability that a factor will be drawn from the unemployed pool. For labor, this is needed by occupation; for capital, by industry; and for land, by location.

With the exception of the value of idle land, most of these data are available at the national level.

There are several important data and conceptual problems in applying the above model to a subregion of the nation such as a state, and it is even more difficult to apply it to a parish or county. The input-output model assumes that some inputs will be imported from outside the region under study. The extent to which inputs are imported increases as the economic "size", or self-sufficiency, of the region is reduced. Since different regions have different industry mixes, the direct and indirect demands an activity places on a region will vary across regions and will probably not be the same as at the national level. For this reason, separate direct and indirect requirements matrixes must be drawn up for each region. The techniques for doing this are either direct sample techniques or location quotient techniques.[10]

The net benefits of an activity to a region consist only of those net benefits to residents of the region prior to the activity. The net benefits they receive would consist of increases in the earnings of factors they own

[10] For an explanation of the direct sample technique, see W.H. Miernyk Impact of the Space Program, op. cit. For an explanation of the location quotient technique, see Moore and Petersen, op. cit.

as well as cost-savings to them as a result of the activity. In addition, the new activity may generate a net increase in the benefits of public goods and services. This would occur if the new activity generated more additional tax revenue than costs. The total value-added created by an activity will end up in the hands of factor owners, some of whom reside in the region of the activity. Similarly, some of the cost-savings generated by the activity are obtained by regional residents. A regional net benefit study of an activity must measure four things:

(1) the value-added which goes to factor owners residing in the region prior to the activity.

(2) the opportunity cost to regional residents of shifting their owned factors into the activity-related employment.

(3) the cost savings to pre-activity regional residents of the activity.

(4) the net public goods and services benefits to pre-activity regional residents due to the activity.

Chapter 5 explains techniques for estimating the first three categories. Chapter 6 outlines techniques for measuring the fourth category.

CHAPTER 4
THE INSTITUTIONS AND PROCEDURES OF THE OCS INDUSTRY

4.1. Introduction

The activity whose net benefits to the State of Louisiana are to be measured is OCS activity off the coast of Louisiana. This will not be the same as the effect of OCS activity in the U.S., as a whole, on Louisiana. This is an important distinction and its implications will be noted below. OCS operations require "on-site" labor as well as support services which require on-shore labor. The annual man-years required for on-site OCS activities and support services can be referred to as the direct labor demand of the OCS activity in any given year. The value of OCS purchases of inputs and support services required for a year of OCS activities can be referred to as the direct final demand created by the activity. The direct final demand necessary to support a year of OCS activity will be divided between demands placed on establishments operating in Louisiana and establishments operating elsewhere. Estimates must be made of the value of purchases of equipment, materials, supplies, and services made by firms operating in the Louisiana OCS from firms operating in Louisiana. Since these data will be "plugged" into the input-output model to obtain the indirect effects, they must be fairly accurate.

A firm's operations in the Louisiana OCS are generally divided between geologic exploration, exploratory drilling, development drilling, production, and product transportation. Some firms may specialize in any one or several of these activities and contract their services to other firms. Or some highly integrated firms, primarily producers, may have subsidiaries which perform these functions. These operations must be quantified for each year.

The purpose of this chapter is to provide the reader with an overview of the important industry characteristics which must be grasped before a cost-benefit study can be initiated.

4.2. Discussion of the Stages in OCS Activity

Development on the Outer Continental Shelf involves a number of steps: (1) geophysical exploration, (2) exploratory drilling, (3) field development, (4) production, and (5) transportation and storage.[1]

4.2.1. Geophysical Exploration

Geophysical exploration describes all the techniques, except drilling, used to locate geological formations which may contain oil and gas accumulations. It includes passive reconnaissance techniques such as air and shipborne measurements of the earth's magnetic and gravity fields and of hydrocarbon seeps into the atmosphere.

Geophysical exploration also includes active surveying techniques such as seismic analysis, bottom sampling, and bottom coring. Seismic data are obtained by bouncing sound waves off the bottom to obtain a profile of subsurface formations. Propane-oxygen guns and high-powered oscillators rather than explosives generate the sound waves.

Bottom sampling and coring are used to obtain samples of the ocean floor and subsurface for geological examination. Coring, taking a core sample by drilling a shallow hole, is useful in identifying the type of unconsolidated sediments on the ocean bottom.

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[1]The explanation of these steps is taken from OCS Oil and Gas: An Environmental Assessment, Council on Environmental Quality, Vol.1, pp. 56-69.

4.2.2. Exploratory Drilling

Exploratory drilling is required to determine whether commercial quantities of oil and gas are present. In order to drill into offshore formations, the drilling equipment is mounted on a platform--a barge, a drill ship, a semi-submersible, or a jackup. The two most widely used are jackups and semi-submersibles.

Because many semi-submersibles drilling units operate while afloat or anchored, they are used extensively for deepsea drilling. Barges are frequently used for shallow water drilling. Drill ships, on the other hand, are often used to drill in waters deeper than 500 feet but probably are limited to less than 3,000 feet. Exploratory drilling is one of the most hazardous steps in the development of offshore oil and gas. The potential hazard stems from the possibility of a blowout--the sudden surge of oil or gas pressure up the drill hole causing loss of control over the well. Although most blowouts involve only gas, large quantities of oil may be released to pollute the marine environment. If ignited, oil and gas may burn out of control, threatening personnel and equipment. Drilling companies employ safeguards to minimize the likelihood of blowouts. These include circulating a heavy fluid called "drilling mud" in the drill hole to counteract the possible sudden flow of oil or gas, encasing the upper part of the drill hole with steel pipe set in cement to minimize the possibility of a blowout around the outside of the drill, and installing blowout preventers--control valves capable of closing off the drill hole in case a blowout does begin.

In addition to the potential threat of a blowout, there are other possible environmental damages associated with offshore drilling operations. Drill cuttings and drilling mud are usually disposed of in the ocean. Improper disposal of oil-contaminated and toxic materials (in violation of

OCS orders) may damage biological life near the drilling platforms. Other liquids and solid materials may also be dumped overboard.

4.2.3. Development

Discovery of commercial quantities of oil or gas calls for development plans which consider additional exploratory wells to determine the extent and capacity of the field; selection, construction, and assembly of the production facility; number of production wells; and transportation of the oil or gas to a processing plant. These development plans for OCS and state leases are submitted to the responsible Federal and state authorities, respectively, for approval before development begins.

An important choice is the facility for development drilling and production. In contrast to exploratory drilling; most offshore development drilling and production facilities are fixed platforms.

> Most offshore (production) platforms are comprised of a multi-level deck section supported by a framework of "jacket" of tubular steel members. Normally, the jacket is constructed onshore, barged to the installation site and launched. Steel piles are driven or drilled through the structure legs to hold the platform inpposition. Finally, the deck section is installed to complete installation.[2]

Such a platform may be used to drill 20 to 30 wells. After all wells are drilled, the drilling rig is disassembled and production equipment is installed on the platform.

An emerging alternative to fixed production platforms is the subsea production system, which involves placing the wellheads on the ocean floor rather than on platforms. There are three types of subsea systems under

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[2]"Status of Completion/Production Technology for the Gulf of Alaska and the Atlantic Coast Petroleum Operations," C.C. Taylor, (presented at the Resources for the Future, Washington, D. C., 1973), p.3.

development: single subsea wells, incapsulated systems, and nonencapsulated multi-well systems.

The single subsea well is drilled from a mobile rig and is then completed on the ocean floor. Oil and gas are piped to a nearby fixed platform or to a shore facility. For the second type, dry chambers enclose essentially dry land wellheads on the ocean floor. Workmen enter the I-atmosphere (nominally 14.7-pound-per-square-inch) pressure-chamber from a diving bell or submarine. If I-atmosphere encapsulated systems can be economically extended to 3000-feet depths, the cost of subsea completions will be relatively insensitive to water depth. The third type involves a wet system of several clustered subsea wells drilled from a vessel positioned over the system. The production equipment is located within the system and is serviced by a diving bell, which does not require a professional diver. This system is under development by Exxon.

After the fixed platform or subsea system is assembled, development drilling, similar to exploratory drilling, commences. Generally, a number of wells are drilled from a single platform. Directional drilling--a standard practice which directs the drill off a verticle line to reach lateral sections of the oil or gas reservoir--makes the most economical use of the expensive platforms. If commercial quantities of oil or gas are found, the well is completed, a term describing various steps in preparing a well for production:

> Completion can include setting and cementing, casing, perforating (cutting holes in the casing which will permit oil or gas to flow from the formation into the well hole), fracturing (applying pressure or using explosives to increase formation) permeability, acidizing (using acid to enlarge openings in the formation), consolidating sand (to keep sand from entering the well bore), setting tubing (conduit for routing the oil or gas to the surface), and installing downhole safety devices (valves

installed to prevent blowouts during production.[3]

Development drilling is generally less hazardous than exploratory drilling because the characteristics of the geological formations are better known. The potential threat of a blowout, however, remains. The severity of a development well blowout increases significantly if oil or gas is being produced simultaneously from wells already completed.

If a dry well is drilled, it is plugged with cement and abandoned. If a well is to be abandoned, either because it is a dry well or all the economically recoverable resource has been extracted, then all casing and piling are severed to at least 15 feet below the ocean floor and are removed. In the past, stubs of casing and piling extending above the bottom have interferred with fishing and navigation. Current procedures for OCS well abandonment are covered in OCS Order No.3.[4]

4.2.4. Production

Once a well is completed and connected to production facilities, production may begin. If oil, gas, and other materials are produced, they must be separated. The oil is separated, metered, and pumped to shore by pipeline, to offshore storage tanks for eventual transfer to a tanker, or directly to a tanker. The gas is separated; if it contains water, it is dehydrated by contacting it with glycol; and then it is pressurized, metered, and pumped to shore by pipeline. Where there is no gas pipeline or OCS gas production is not economical under prevailing market conditions, the gas is pressurized and injected into the reservoir.

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[3] Energy Under the Oceans, University of Oklahoma Technology Assessment Group, (Normal, University of Oklahoma Press, 1973), pp.59-60.

[4] Notice to Leasees and Operators of Oil, Gas, and Sulpher Leases in the Outer Continental Shelf Gulf of Mexico, U. S. Geological Survey (Washington: Department of the Interior, undated), at 3-2,

When water is produced with the oil, separation is required. Consistent with OCS Order No.8, separated water may be discharged into the ocean.[5] The maximum allowable oil content is 100 parts per million; the average allowable oil content is 50 parts per million or less.

Because of possible explosions and fire, storms, and earthquakes, many devices are installed to warn off impending or existing dangers and to control or stop the flow of gas and oil if trouble is sensed. Some of the safety devices with which fixed platform production facilities are equipped are pressure, level, and combustable gas sensors; manual, automatic, and pressure relief valves; and fire protection and fighting equipment. In addition, each well is equipped with a subsurface safety valve which can shut the well down in case of surface equipment failure. Required safety and pollution control equipment and procedures are described in OCS Order No.8.[6]

Although production is a continuous activity, it is sometimes necessary to shut down and reenter a well to improve or restore production. A variety of operations may be involved in workover and servicing, including further drilling to deepen the well. Because the well may be active and/or open, well control is the primary safety consideration, requiring the use of blowout prevention equipment.

4.2.5. Oil and Gas Transportation and Storage

Crude oil and natural gas liquids may be transported to onshore processing facilities by pipeline or by tanker or barge. All the natural gas now produced in the Gulf of Mexico is transported to shore by pipeline.

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[5] Ibid., at 8-7 to 8-8.

[6] Ibid., at 8-3 to 8-11.

Because most of the OCS geological formations with oil and gas potential lie within 200 miles of shore, pipelines will probably continue as the preferred OCS transportation mode. Tankers may well be used for transporting oil during the early phases of field development in areas remote from established producing fields. Production can begin earlier, particularly far offshore, if tankers are loaded from offshore moorings in or near the field.

Pipelines transport large volumes of oil and natural gas. Once the pipeline route is selected and the volume to be pumped is determined, pipe size and strength are selected and line pressure calculated. Considered during route selection are bottom and subsurface foundations; current, wave, and tide conditions; and other uses--shipping, commercial, fishing, naval operations, etc.--of the area to be crossed.

In the past, pipelines were generally laid directly on the ocean bottom. Burial of pipelines which lie in less than 200 feet of water is now required. Doing so minimizes the potential for damage from natural forces and from marine equipment such as anchors.

Primary techniques for laying pipe in coastal waters are section-by-section or "stove pipe," reel barge, and pipe pulling. In the stove pipe method, short sections of pipe are welded together on a pipelaying barge. While the barge moves slowly forward the completed pipeline is released into the water and laid on the ocean floor. There are several types of barges and several ways to lower the pipe. The vessel may have a barge or ship hull or it may be semi-submersible. The barge hull is the most common, although it limits operations to relatively calm seas--6- to 14-foot waves. Semi-submersible hulls are the most stable. Behind the barge, the welded pipe section is supported by a pontoon or "stinger" that reduces stress caused by the pipe's own weight.

In the reel-barge method, pipe is welded together onshore and is wound onto a large reel on the pipelaying barge. The pipe is laid as it unwinds. For pipe diameters in the 4- to 10-inch range, reel barges are often more economical than other types of barges. The technique is limited to pipe diameters of 12 inches or less.

Pipe pulling uses barges and tugs to pull sections of welded pipe from an onshore launchway over the pipeline route. This method is limited to pipeline of relatively small diameter and short length. Generally, it is used only for laying pipelines nearshore.

Pipelines in nearshore areas are usually laid in dredged canals. Generally, two methods are used in marshes and wetlands: the "push" technique and the floatation method. In the push technique, a relatively small canal (up to 6 feet deep and 10 feet wide) is dredged. Sections of pipe are joined at the beginning of the canal, and the pipe is simply shoved along in the canal. Then the ditch is usually backfilled. This method requires relatively firm ground for the dredging equipment (usually a dragline) but is generally less costly than floatation.

The floatation method requires a wider canal to provide access for the pipelaying equipment. The canal is 40 to 50 feet wide and 6 to 8 feet deep; it may have an additional trench in the bottom to provide a 10- to 12-foot clearance over the pipeline. Lay barges are often used in marshes because of the soft and unstable ground. Dredged material placed along the sides of the canal forms a low, flat levee. In most cases, the floatation canal is not backfilled because the dredge spoil is usually very fluid and tends to disperse. Loss of spoil through dispersion reduces the material available for complete backfilling.

In the Gulf of Mexico, levees have generally been continuous, with few or no openings. Openings are now required to minimize distrubance to drainage patterns. Plugging the canal ends, known as bulkheading, is required to minimize erosion, intrusion of saline water, and damage from navigation when the canal intersects a waterway.

Pipelaying in wetlands can cause serious adverse physical and biological impacts. Natural drainage and water current patterns can be disrupted. Erosion of soft and unconsolidated sediments in marshlands can be markedly accelerated. Biologically productive land can be lost. Disturbance of marshlands can change turbidity, salinity, acidity, hydrogen sulfide toxicity, and biological oxygen demand.

As development proceeds farther from shore, it may become economical to store the oil offshore temporarily while awaiting tankers. This is especially important when severe weather conditions prohibit the mooring of tankers for extended periods of time. Three types of offshore oil storage systems are now being used in various parts of the world--elevated, floating, and bottom standing. The size of an elevated storage facility is severely limited because it must be mounted on a platform far enough above the water surface to avoid wave action during the most severe storms. The structural capability of the platform, then, is the limiting factor. In the Gulf of Mexico, maximum storage capacity on an individual platform is 10,000 barrels.[7]

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[7]Environmental Conservation, National Petroleum Council (Washington, D. C.: National Petroleum Council, 1972), p.203.

CHAPTER 5

MEASURING NET BENEFITS OF OCS ACTIVITY TO LOUISIANA

5.1. Introduction

OCS activities have been divided into exploration, development, production, and transportation of crude oil or natural gas. A list of producing firms operating in the Louisiana OCS and their representatives on the Offshore Operators Committee, is given in Appendix A. In order to generate the impacts of these activities on income, employment, and government, some simple measures of the levels of the respective activities must be established. Because these overall measurements will be utilized in many parts of the methodology, the measurements selected must be meaningful, in the sense of accurately indexing the levels of activity; accessible, in that data are easily obtainable; and useful, in that they fit into the impact model. We will use different measures of activity in the cost benefit analyses which follow. These are:

(1) OCS wells drilled as a measure of exploration and development (excluding transportation) activity combined.[1]

(2) The number of OCS platforms operating as a measure of production activity.[2]

(3) The number of inch-miles of pipe laid either offshore or from offshore to onshore connecting terminals as a measure of transportation development activity.[3]

The advantages and disadvantages of each of these measures are discussed below.

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[1]SOURCE: USGS, Outer Continental Shelf Statistics, U. S. Department of Interior; Minerals Yearbook, and American Petroleum Institute.

[2]Platforms operating = Number of OCS wells producing ÷ average number of wells per platform. SOURCE: USGS, Outer Continental Shelf Statistics.

[3]SOURCE: USGS, New Orleans District Office.

There is a choice in measuring production activity. One can use either actual output or actual inputs as measures. Actual output consists of barrels of crude oil and cubic feet of natural gas. A barrel per cubic foot equivalence measure could reduce both outputs to a common dimension, but there are two difficulties with such a combined measure. First, a barrel of crude oil will not necessarily be as costly to extract as the barrel-equivalent quantity of gas. A change in the mix of oil and gas produced which left total barrel-equivalents constant would not accurately reflect actual cost differences. Second, and more important, some wells produce a joint product of oil and gas with common costs.[4] For this reason, it seems more appropriate to measure production activity by the number of actual wells or platforms producing at some point in the test year or an average over the year. A difficulty with this measure is that inputs per well may vary with the output rate of the well but since a number of wells can be operated from a single platform, costs may vary more directly with platforms operating than with wells operating. The number of platforms operating is indirectly obtainable, since data on wells producing exist and one can use an average number of wells per platform.

Pipelines may be laid to connect new wells with existing pipelines on the OCS, or may be laid to connect these wells with on-shore facilities. Both types of pipelines must be considered as transport activity. Since pipeline costs vary with the length and diameter on the installed pipe, inch-miles installed in the test year is a reasonable measure of this activity.

Firms directly engaged in the above OCS operations require labor, materials, equipment, supplies, and services produced on-shore in Louisiana.

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[4]In 1972, 24% of all U.S. natural gas was obtained from oil wells. However, only 17% of Louisiana offshore natural gas was similarly obtained. (1972 Census of Mineral Industries, Oil and Gas Field Operations, p.17).

The expenditures for these inputs are referred to as the direct demand-induced expenditures. For any given year of OCS activity, expenditures on these Louisiana produced inputs constitute a portion of the final demand. The production of these OCS inputs will, in turn, require Louisiana produced inputs. The expenditures on these latter inputs are referred to as indirect demand-induced expenditures.

In addition to placing direct demands upon on-shore Louisiana industry, OCS production of crude oil and natural gas may initiate an expansion in the output of Louisiana petroleum refineries, chemical plants, and gas processing plants. The location of these activities depends on the location of inputs and product markets. Since petrochemical plants use refinery and gas processing outputs as inputs it is likely they will be located near each other. Refineries and gas processing plants locate near their raw materials sources or where these raw materials can be obtained with low transport costs. The locational advantages to refineries of ports and crude oil supply areas are clear from a casual scanning of U.S. refinery locations.[5] The expenditure on Louisiana produced inputs which are required to satisfy these expanded downstream fabrication activities are referred to as direct supply-induced expenditures since they are a result of the increased supply of OCS oil and gas.

The direct and indirect, demand- supply-induced expenditures in Louisiana result in increased earnings of factors of production used to produce the required output. The increases in factor earnings are one component of the net benefit of OCS activity. These increases depend on the magnitude of OCS direct and indirect expenditures as well as on the earnings of factors prior to their use in activities resulting from OCS activity. For example, even though a Louisiana person may earn $100 in

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[5]See the 1971 Crude Oil Pipeline Atlas, Oil and Gas Journal, October 11, 1971.

an OCS related activity, if that person would earn $60 in Louisiana without the OCS activity, the increase in earnings, $40, is the net benefit of the OCS activity.

This chapter is organized as follows. First, the measurement of direct OCS demand-induced expenditures in Louisiana are discussed. These expenditures are divided between labor and non-labor expenditures. Second, the direct OCS supply-induced expenditure impacts on Louisiana are discussed. Third, the indirect expenditure impacts are explained in the context of using a Louisiana input-output model. Finally, the measurement of net increases in factor earnings resulting from OCS activity is discussed. It cannot be overemphasized that this net increase is the relevant measure of the benefit of OCS activity to Louisiana.

5.2. Direct Demand-Induced Effects

The direct expenditures resulting from OCS activity refer to those expenditures immediately resulting for exploration, development, production, and transportation in OCS territory. These expenditures can be divided into three mutually exclusive categories: labor expenditure, capital expenditure, and supply expenditure.[6] Labor expenditure consists of payroll plus supplementary costs of both on-site labor as well as the share of administrative personnel costs attributable to OCS activities. Capital expenditures consist of new structures and additions to structure, machinery, and equipment needed to perform the OCS activities. Supply expenditures consist of all non-capital and non-labor costs for purchased materials. A firm's "capitalized expense" is not necessarily a capital expenditure by this definition.[7]

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[6] This breakdown of expenditures by inputs is necessary to estimate the expenditure impact in Louisiana, as will be evident in the next two sections.

[7] This is particularly important in the oil industry where exploration and development expenses may be capitalized.

It would be ideal to have the expenditures of all firms engaged in OCS activities off the Louisiana coast classified by exploration and development, production, and transport expenditures. This could be obtained by a sample survey of major firms engaged in Louisiana OCS activities. However, due to proprietary resistance, it may be necessary to revert to published data. Minimal data on direct OCS expenditures are available and will be discussed next.

In the two most recent Census of Mineral Industries (1967 and 1972) establishments were asked to report their offshore costs by state of establishment. Unfortunately, because of the way questions were asked, a firm located in Texas whose offshore activities are adjacent to Louisiana would not be considered to be operating in the Louisiana offshore area. Also, OCS offshore operations are not distinguished from non-OCS offshore operations. All costs are broken down by labor, capital, and supply costs and by Standard Industrial Classification (SIC) codes.

Firms directly engaged in OCS activities fall primarily into five SIC codes: Oil and Gas Operators (1311), Oil and Gas Drillers (1381), Oil and Gas Exploration Services (1382), Crude Oil Pipelines (4612, and Natural Gas Transmission (4922). A firm whose primary activity places it in one of these classifications can be engaged in the secondary activities of another industry. Also, a firm can contract out some of its activities, perhaps to a firm in another SIC industry. Costs of contract work were considered supply costs in the Census report.

In order to obtain an approximate breakdown of expenditures by type of activity and type of input, several simplifying assumptions must be made. First, it is assumed that exploration and development are undertaken only by firms classified as Oil and Gas Operators, Oil and Gas Drillers, and Oil and Gas Exploration Services. Second, it is assumed that production is undertaken only be firms classified as Oil and Gas Operators. Third, it is assumed that the Census data accurately reflect OCS expenses.

The Census has total OCS man-hours divided between exploration and development, on the one hand, and operations and maintenance on the other. It will be assumed that the only direct labor required for production is operations and maintenance labor. The Census also provides data on total payroll to OCS workers and total wages to non-salaried OCS workers. The difference between these two earnings totals represents the administrative overhead and salaried costs allocable to OCS production. The form of the OCS labor cost estimation model and the actual 1972 estimate are shown in Table 5-1. The subscripts represent the years in which the variables are to be measured. The ratios with 1972 subscripts should be held constant in future years when this methodology is applied. Total wages per man-hour and administrative labor cost per producing well will be increased above their respective 1972 ratios by an earnings index. The measures of wells drilled and producing should be taken annually.

An <u>alternative</u> technique for estimating the direct OCS labor expenditures is provided by data collected from the Bureau of Land Management. Table 5-2 shows employees required per unit of respective activity along with average monthly wages per employee for 1974. Labor usage rates for development and exploratory wells are in a per rig basis, rather than a per well basis. If the drilling time is known, total wells drilled can be converted to exploratory and development rig-years. Knowing the number of wells producing per platform allows the transformation of producing wells to production platforms for calculating production manpower requirements. Natural gas output can be converted to barrels of oil equivalents in order to calculate onshore operating base, office, and pipeline terminal manpower needs. The ratios for onshore base, office, terminal, and gas plants may not

TABLE 5-1

OCS LABOR EXPENDITURE MODEL AND 1972 ESTIMATE

A. Model

1. Exploration and Development (E & D)

$$\left(\frac{\text{Exploration and Development Man-Hours}}{\text{Wells Drilled}}\right)_{1972} \times \left(\frac{\text{Total Wages}}{\text{Total Man-Hours}}\right)_t \times (\text{Wells Drilled})_t$$

2. Production

$$\left(\frac{\text{Operations and Maintenance Man-Hours}}{\text{Wells Producing}}\right)_{1972} \times \left(\frac{\text{Total Wages}}{\text{Total Man-Hours}}\right)_t \times (\text{Wells Producing})_t$$

3. Administrative

$$\left(\frac{\text{Total Payroll-Total Wages}}{\text{Wells Producing}}\right)_t \times (\text{Wells Producing})_t$$

B. 1972 Estimate

1. (9.7mil.[a]/697[b]) X ($38.4mil.[c]/6.4mil.[d]) X (578[e]) = $48.2mil.
2. (5.8mil.[f]/4533[g]) X ($38.4mil./6.4mil.) X (3851[h]) = $30.0mil.
3. (21.2mil.[i]/4533) X 3851 = $18.1mil.

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[a] 1972 Census of Mineral Industries, Oil and Gas Field Services, pp.13C-5, 13C-6; Oil and Gas Field Operations, p.13A-9.

[b] 1972 Census of Mineral Industries, Oil and Gas Field Operations, p.13A-27 (excludes service wells).

[c] 1972 Census of Mineral Industries, Oil and Gas Field Operations, p.13A-9.

[d] 1972 Census of Mineral Industries, Oil and Gas Field Operations, p.13A-9.

[e] USGS, Outer Continental Shelf Statistics. Assumes one-half of new wells started and one-half of wells completed, p.40.

[f] 1972 Census of Mineral Industries, Oil and Gas Field Operations, p.13A-9.

[g] 1972 Census of Mineral Industries, Oil and Gas Field Operations, p.13A-23.

[h] USGS, Outer Continental Shelf Statistics. Equals wells, producing and active, p.34.

[i] 1972 Census of Mineral Industries, equals wells, producing and active, p.13A-9; Oil and Gas Field Operations,

TABLE 5-2

MID-ATLANTIC OFFSHORE DEVELOPMENT
NUMBER OF EMPLOYEES AND MONTHLY WAGES
ONSHORE AND OFFSHORE OPERATIONS

Type of Operation	No. of Employees	Average Wages $/Month	Employees Hired Locally	Employees Maintaining Local Residence	Surface Acreage	On-Shore Capital Investment 1974 - $
Per Rig						
Exploratory Well	113	1,107	42	87	--	---
Development Well	65	1,181	28	65	--	---
Per Platform						
Production Operations	22	1,180	20	22	--	---
Per 200,000 BOPD Production						
Onshore Operating Base	136	979	111	136	50	2,800,000
Onshore Office	42	1,448	16	42	10,000 sq. ft.	Rental
Pipeline Terminal	17	1,188	13	17	40	2,400,000
Per 300,000 MCFD Production						
Gas Processing Plant	21	1,179	13	21	75	24,000,000
Per 10-20 Rigs						
Service Support	174	1,219	108	176	38	5,195,000
Single Facility if Required						
Pipeline Tanker and Barge Terminal	25	1,324	17	25	60	9,800,000

* **Data obtained from BLM, New Orleans Office.**

remain constant for all levels of operation due to economics of scale. In fact, for a 1,000,000 mcfd gas plant, 34 employees are required, with 75 acres, and an onshore capital investment of $68.2 million.[8]

The capital expenditures of OCS activities consist of new structures, additions to existing capacity, new machinery and equipment.[9] As noted above, it will be assumed that all capital expenditures, with the exception of pipeline expenditures, are allocable to exploration and development activities. Table 5-3 shows the OCS capital expenditure model and an actual 1972 estimate. While the construction cost per well drilled and the machinery cost per well drilled are estimated from the 1972 Census, the ratios in future time t between publication dates of the mineral census can be found by applying a construction cost index and capital equipment cost index to the respective ratios. The same is true for pipeline costs. Since OCS capital expenditures can be made by operators, drillers, and exploration firms, the construction and equipment costs of all three SIC industry codes must be included (SIC 1311, 1381, and 1382).

It is not possible to estimate supply expenditures from the Census data. However, a study by firms directly engaged in OCS activities has found that OCS allocated non-labor operating and maintenance costs of pro-

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[8]Letter from Offshore Operators Committee to J. M. Meier, BLM, New Orleans.

[9]While depreciation is an actual cost of using capital, it is difficult to measure and it is assumed, in this study, that maintenance costs include the depreciation costs due to wear and tear on machinery and plant. The cost of purchased used machinery and equipment is not a capital cost to society, as a whole. Even though it may be a cost to a region if purchased from another region, it is not included in the above estimates.

TABLE 5-3
OCS CAPITAL COST MODEL AND 1972 ESTIMATE

A. Model

1. EXPLORATION AND DEVELOPMENT (E & D)

$$\left(\frac{\text{New Structures and Addidtions}}{\text{Wells Drilled}} + \frac{\text{New Machinery and Equipment}}{\text{Wells Drilled}}\right)_t \times (\text{Wells Drilled})_t$$

2. TRANSPORTATION

$$(\text{Pipeline Cost Per Inch-Mile})_t \times (\text{Inch-Miles Installed})_t$$

B. 1972 Estimate

1. (133.2[a]/697[b]) + (215.1[c]/697) x 578 = $288.8 million.
2. (To be estimated)

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[a]U.S. Census of Mineral Industries, Oil and Gas Field Operations, p.13A-9 and Oil and Gas Field Services, p.13C-9, 1972.

[b]U.S. Census of Mineral Industries, Oil and Gas Field Operations, p.13A-27 (Excludes service wells).

[c]U.S. Census of Mineral Industries, Oil and Gas Field Operations, p.13A-9 and Oil and Gas Services, p.13C-9, 1972.

ducing and pipeline companies in 1971 were $362.3 million.[10] Assuming all operating and maintenance expenses are allocable to production operations, and since there were 3429 Louisiana OCS wells producing in 1971, operating and maintenance costs would be $0.106 million per producing well.

Firms engaged in OCS activities purchase the above non-labor inputs from both Louisiana and non-Louisiana firms. The share of these non-labor expenditures which represent purchases from Louisiana firms can be obtained in two ways. First, major OCS firms can be surveyed, in more or less detail, and asked what share of their annual non-labor expenditures represent Louisiana purchases. In order to be compatable with the input-output technique, which will be used later, these expenditures should be broken down by the 85 industries of the U.S. Input-Output Model.[11] However, it is doubtful that data of sufficient detail would be available from firms.

The alternative approach is to simply take industry's casual estimates. In a study by Mid-Continent Oil and Gas, it was estimated that 60% of all capital costs and 80% of all supply costs were incurred in Louisiana.[12] Using this approach, Table 5-4 shows the estimating model and actual 1972 estimates of the non-labor direct OCS purchases in Louisiana.

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[10] Operating and maintenance costs in 1971 for each process were calculated to be:

Producing companies	$356.0 million
Oil and Gas Pipeline Companies Offshore Louisiana	6.3
Oil and Gas Pipeline Companies Onshore to Export OCS Gas and Oil from Louisiana	5.8
Natural Gas Processing Plants	8.0

Only the first two cost categories are included in the above figure. "Study: The Economic Impact of the Louisiana Offshore Oil Industry on the State of Louisiana," by Committee of the Mid-Continent Oil and Gas Association, unpublished and undated.

[11] The Louisiana I-O model, although not completed, follows almost identically the national I-O format.

[12] It is not certain whether the capital costs referred to here were purchases of capital in Louisiana or capital investment situated in Louisiana.

TABLE 5-4

OCS NON-LABOR DIRECT PURCHASES IN LOUISIANA

A. Model

$$(\text{OCS Capital Cost})_t \times \left(\frac{\text{Percent of Capital Purchased in Louisiana}}{100}\right)_T$$

$$(\text{OCS Supply Cost})_t \times \left(\frac{\text{Percent of Supplies Purchased in Louisiana}}{100}\right)_T$$

B. 1972 Estimate

($288.8 mil.)[a] x (.60) = $173.3 million.

($362.3 mil.)[b] x (.80) = $289.8 million.

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[a] See Table 5-3.

[b] See p. 79.

Once the value of Louisiana purchases has been determined, it must be broken down by industry source for use in the input-output model. In the absence of survey information, the only technique for doing this is to assume that the input structure of OCS activities is the same as that of the "Crude Petroleum and Natural Gas" sector of the Louisiana input-output model.[13] Capital expenditures have been divided between construction and equipment expenditures. Since there is no construction row in the input-output model, construction expenditures must be allocated across the construction sector column. The only construction expenditures which are relevant to the input-output model are the costs of intermediate inputs. In 1967, on the national level, these represented 60% of new construction value.[14] Therefore, 60% of new construction costs incurred in Louisiana can be allocated across the 83 sectors of the Louisiana input-output model. New machinery and equipment expenditures incurred in Louisiana can be allocated across sectors 43-64 of the Interindustry Transaction Table for the crude petroleum and natural gas column, as shown in Table 5-5.

Without explicit survey information, supply expenditures are more difficult to allocate across industries. As a rough approximation, supply expenditures can be allocated across the remaining oil and gas input sectors, excluding sectors 37-64, as dictated by the Louisiana input-output model. This technique is shown in Table 5-5.

5.3. Direct Supply-Induced Effects

OCS production has two types of direct effects on Louisiana: (1) it requires inputs from Louisiana residents and firms, and (2) it may generate

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[13]If the input structures of oil and gas are known separately in the Louisiana model, a more detailed breakdown by industry source is possible. The U.S. input structure is not used since it would misrepresent the inputs by industry source purchased in Louisiana.

[14]"The Input-Output Structure of the U.S. Economy," *Survey of Current Business*, February, 1974, p. 38.

TABLE 5-5

MODEL OF OCS NON-LABOR DIRECT PURCHASES IN LOUISIANA FROM INDUSTRY j

1. **Capital Cost**

   a. **Construction Payments to Sector j**

$$\text{(New Structures and Additions)}_t \times \left(\frac{\text{\% of Capital Purchased in Louisiana}}{100}\right) \times \left(\frac{\text{\% of Construction Cost Non-Labor}}{100}\right)$$

$$\times \left(\frac{\text{1967 Sales of Louisiana Industry } j \text{ to New Construction Sector}}{\Sigma \text{ 1967 New Construction Sales of Louisiana Sectors 37-42}}\right)_{1967}$$

   b. **Equipment Payments to Sector j**

$$\text{(New Machinery and Equipment)} \times \left(\frac{\text{\% of Capital Purchased in La.}}{100}\right)_T \times$$

$$\left(\frac{\text{1967 Sales of Louisiana Industry } j \text{ to Oil and Gas Sector}}{\Sigma \text{ 1967 Sales of Louisiana Sectors 43-64}}\right)$$

2. **Supply Payments to Industry j**

$$\text{(Supply Cost)}_t \times \left(\frac{\text{\% of Supplies Purchased in Louisiana}}{100}\right) \times$$

$$\left(\frac{\text{1967 Sales of Louisiana Industry } j \text{ to Sectors Other Than 43-64, 65, and 71 to Oil and Gas Sector}}{\Sigma \text{ 1967 Sales of Louisiana Sectors Other Than 37-64}}\right)_{1967}$$

the expansion of downstream fabrication capacity and output which, in turn, requires Louisiana based inputs. Techniques for measuring the first effects have been described above in 5.2. This section describes techniques for measuring the second, or direct supply-induced effects.

If OCS activities in Louisiana were to cease, domestically produced oil could be replaced by foreign oil. Louisiana refineries, being input-oriented, would probably maintain operating capacity in Louisiana since Louisiana also offers traditional port facilities and is anticipating the construction of a deep draft terminal off its coast. However, there may be a tendency for the chemical industry to reduce its capacity in Louisiana and expand capacity closer to major market areas as natural gas availability diminishes. Also, natural gas processing capacity would be diminished.

It is reasonable to assume that some chemical and natural gas processing capacity exists in Louisiana solely as a result of OCS production. Of course, the problem is to determine how much capacity is due to OCS production. It is reasonable to assume that refinery capacity would not change when the level of OCS production changes since OCS crude oil will simply be displaced by foreign crude imported through Louisiana ports and the porposed deep-draft terminal.

One technique for estimating the chemical and gas processing capacity attributable to OCS production is to apply the Harris model.[16] However, this may be very expensive and other techniques may have to be used.

In order to measure the direct-supply induced effects, one must calculate the effects which OCS oil and gas production has on the location of petro-chemical companies in Louisiana. One cannot estimate these effects by simply referring to the historical relation between OCS production and refinery, chemical, and gas processing capacity in the State of Louisiana.

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[16] C. C. Harris, op. cit.

Since non-OCS sources of oil and gas exist in Louisiana, it is difficult to estimate how much of this output is due to OCS production. More importantly, if OCS production did not exist off the coast of Louisiana, firms could still obtain oil and gas inputs from foreign sources through Louisiana ports, and from Texas on-shore and off-shore production.

Location theory suggests that the location of an economic activity depends primarily on the interaction of three factors:

(1) the location of inputs,

(2) the location of output markets,

(3) the cost of transporting inputs to the fabrication facility relative to the cost of transporting outputs to the market.

Industries can be characterized as input-oriented or output-oriented depending on their tendencies to locate near input sources or markets.

The three downstream processes which interest us are natural gas processing, crude petroleum refining, and hydrocarbon-based chemical production. Each of these can be more or less characterized as input- or output-oriented industries. Both natural gas processing and petroleum refining would probably be more input-oriented than chemical production. This is because the cost of transporting outputs relative to inputs is probably less for processing and refining than for chemical production. This can be shown statistically.

Industrial chemical production requires primarily inputs of processed natural gas and refined crude petroleum and, of course, petroleum refining requires inputs of crude petroleum. Using data by state for 1972, the simple correlation coefficient between value-added by industrial chemicals and value-added by petroleum refining was .77. The correlation between value-added by industrial chemicals and natural gas production was .66. However, the correlation between value-added in petroleum refining and crude oil production was .87. This is evidence of less locational input-dependence by chemicals plants than refineries. Furthermore, while the correlation between value-added by industrial chemicals and total value-added in manufacturing (a measure of general economic activity) was .45, the correlation between value-added by petroleum refining and total value-added in manufacturing activity was only .34. This shows relatively greater output orientation for chemical plants than for refineries, which suggests that chemical plants would be more likely to reduce capacity in Louisiana as the supply of oil and gas from the OCS diminishes if foreign inputs were unobtainable. Another technique would be to ask industry how much gas processing capacity and chemical capacity is solely attributable to OCS gas production but only very crude approximations will be obtained. We discussed this problem with a few industry officials but didn't receive, nor did we expect, any definitive answer. We feel reasonably confident that refinery capacity located in Louisiana is largely unaffected by OCS production, but further study of the chemical and especially the gas processing industries is necessary.

The Louisiana input-output table yields the required inputs per dollar of output for both refineries and chemical plants, but not for gas plants.[15] These coefficients, when multiplied by the expected increments in output, yield estimates of the net increases in output from the various industries necessary to supply the increased gas processing and chemical activity. These estimated amounts must be added to the Louisiana input requirements necessary to satisfy OCS activities in order to obtain the final demand vector which must be produced by Louisiana firms.

5.4. Indirect Effects

The mechanics of the input model were explained in Chapter 3. The

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[15]Gas plants are included in the "Crude Petroleum and Natural Gas" sector of the input-output table.

direct effects of OCS activity were described in the previous sections. This section describes how the direct non-labor effects are introduced into the input-output model in order to generate the indirect effects of OCS activities.

The direct effects of OCS activity on Louisiana consisted of the purchases of inputs from Louisiana firms for OCS activities and for the increased outputs of gas processing plants, crude petroleum refineries, and chemical plants resulting from OCS production. Section 5.2. showed how the value of these purchases could be distributed across Louisiana sectors of the input-output model. These values represent the value of net output which must be produced in Louisiana by each sector as a result of OCS activities. In Chapter 3, they are the components of the $\overline{Y}$ vector in equation 5. The value of the gross outputs which must be produced in Louisiana by each sector in order to end up with these net values are given by the components of the $\overline{X}$ vector in equation 5 in Chapter 3. Given the number of man-years per dollar of output by sector and occupation o_{ij} in equation 6, one can calculate total man-years necessary in each sector to produce this gross output.

It is necessary to point out that the Louisiana input-output model, as it currently exists, will not show all of the indirect effects of the OCS activities. It will be recalled that new construction directly for OCS activities or for downstream fabrication plants resulting from OCS production was included in the net output vector, $\overline{Y}$. However, in the current Louisiana input-output model, there is no coefficient representing new construction inputs required per dollar of output of a sector.[16] This is simply the implication of static input-output models that existing struc-

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[17]In input-output parlance, the new construction row of the direct requirements matrix is zero.

tures are sufficient to handle additional activity. Furthermore, the interindustry transactions that are allowable for inclusion in the input-output model are only purchases on current account. The purchases necessary for plant expansion are not included in the input-output model. In other words, the Louisiana input-output model assumes the existence of excess capacity. This assumption will bias downward the estimation of the indirect effects of the OCS activity. This bias can only be corrected only by making independent estimates of secondary construction effects and annualizing these estimates over a period of time, say 30 years.

5.5. Estimating Personal Income Increases Resulting From OCS Activity

The net benefit model introduced in Chapter 3 stated that the net benefits of OCS activity to Louisiana residents had three sources:

(1) Increased earnings of factors of production owned by Louisiana residents.

(2) Cost savings to Louisiana residents.

(3) Net increases in the benefits of public goods and services.

It was noted that the net benefits to individuals who became residents to Louisiana because of the job vacancies created directly and indirectly by OCS activity should not be counted as net benefits to Louisiana residents. This section discusses the techniques for estimating the increased incomes obtained by Louisiana residents as a result of OCS activity.

OCS activities will cause resources to be transferred from previous uses. Some of the factors transferred as a result of OCS activity may not be factors owned by residents of Louisiana prior to the activity. In order to estimate earnings increases of factors owned by Louisiana residents, it is necessary to do two things:

(1) Determine how many of the factors owned by Louisiana residents were transferred, both directly and indirectly, as a result of OCS activity.

(2) Determine the earnings of these factors with and without the OCS activity.

The earnings of the factors without the activity will depend on their employment status without OCS activity.

The increased incomes of Louisiana residents are due to these residents' ownership of factors of production whose earnings increase as a result of OCS activity. In a world where factor markets are perfectly competitive, there would be no unemployment of factors and the earnings increases obtained from shifting factors between uses would be very small.[17] However, such a world is a theoretical abstraction, as evidenced by unemployment and underemployment of factors. In actuality, factors of production which are transferred as a result of OCS activity will have been unemployed, underemployed, or fully employed in Louisiana or elsewhere.

Since OCS activity already exists in Louisiana, the earnings of a factor in its absence is a hypothetical question; yet it must be asked in order to determine the net benefits of OCS activity. Of course, what a factor is capable of earning depends on its detailed characteristics. Techniques for estimating the alternative earnings of labor, capital, and land in the absence of OCS activity are discussed below.

5.5.1. Estimating Increases in Louisiana Labor Income

The total direct and indirect employment impact on Louisiana will come from the following sources:

(1) Off-shore employment in OCS activity (exploration, development, production, and transportation).

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[17]However, since wage differentials would be exactly compensating in such a world, earnings increases (or decreases) could be obtained by labor when shifting jobs but total "psychic" benefits would be changed very little.

(2) On-shore employment for OCS purposes in firms which are engaged directly in the OCS activities.

(3) On-shore employment in expanded gas processing, and chemical production and construction employment for capacity expansion.

(4) On-shore employment which is <u>indirectly</u> required to provide the equipment supplies, and services for the OCS and downstream fabrication activities.

The OCS activities directly and indirectly generate job vacancies which will be filled either by Louisiana or non-Louisiana residents. Some non-Louisiana residents may take up residence in Louisiana, placing an added burden on public services. Some Louisiana residents may have been previously employed, so movement to the new OCS job creates a job vacancy which may be filled by a Louisiana or non-Louisiana resident. The increase in personal income to Louisiana residents as a result of OCS activities depends on how many of these vacancies are filled by Louisiana residents and whether these residents were previously unemployed. The added burden which OCS activities place on public services also depends, in part, on how many vacancies are filled by non-Louisiana residents. For these two reasons, it is crucial to accurately estimate the employment impacts on Louisiana. This section discusses the procedure for estimating the direct and indirect employment impacts of OCS activities.

The total test year direct OCS employment can be approximated from information presented in Tables 5-2 and 5-6. The total employment in the test year can be divided into four subgroups:

(1) Those who were Louisiana residents prior to OCS activities in the test year and remained Louisiana residents.

(2) Those who were Louisiana residents prior to the test year but migrated elsewhere during the test year.

(3) Those who were non-Louisiana residents prior to the test year but who migrated to Louisiana in the test year.

(4) Those who remained non-Louisiana residents.

TABLE 5-6

OCS EMPLOYMENT

A. Model

1. On-Site Employment

   a. Exploration and Development (E & D)

$$\left(\frac{\text{Exploration and Development Man-Hours}}{\text{Wells Drilled}}\right)_{1972} \times (\text{Wells Drilled})_t \div (\text{Annual Hours Worked/Man})_t$$

   b. Production

$$\left(\frac{\text{Operating and Maintenance Man-Hours}}{\text{Wells Producing}}\right)_{1972} \times (\text{Wells Producing})_t \div (\text{Annual Hours Worked/Man})_t$$

2. Administrative Employment

$$\left(\frac{\text{Payroll-Wages}}{\text{Average Salary Per Man}}\right) \div (\text{Wells Producing})_{1972} \times (\text{Wells Producing})_t$$

B. 1972 Estimate

1. a. $(13{,}900)^a \times (578)^b \div (2133)^c = 3767$ man years
   b. $(1{,}280)^d \times (3851)^e \div (2133)^e = 2311$ man years
2. $\{(\$21.2 \text{ mil.})^f \div (\$14{,}000)^g \div (4533)\} \times 3851 = 1286$ man years

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[a] Table 5-1.

[b] Table 5-1.

[c] U. S. Census of Mineral Industries, Oil and Gas Field Operations, p.13A-9.

[d] Table 5-1.

[e] Table 5-1.

[f] Table 5-1.

[g] An assumption.

It is the personal income increase of the first group which is of interest in this study. The second group will undoubtedly be small. The third group imposes an additional public service burden on Louisiana government.[18] The fourth group is irrelevant to this study.

Unless a survey is taken of actual OCS employees, it is impossible to separate the first, second, and third subgroups from easily accessible data. For example, a survey is currently being administered by the Mid-Continent Oil and Gas Association wherein member firms are asked what percent of their manpower engaged in OCS activities has Louisiana resident status. This gives no information on the composition of these three subgroups. It will be an overestimate of the first subgroup since some of the workers will have established Louisiana residency after filling the OCS vacancy. It obviously provides no information on the second subgroup.

An indirect way of separating these three subgroups is to take the industry estimate of the percent of its OCS labor force which has Louisiana resident status and assume that the percent of Louisiana residents employed in the activities who were non-residents prior to the test year activities is equal to the gross in-migration rate for the state.[19] This will probably

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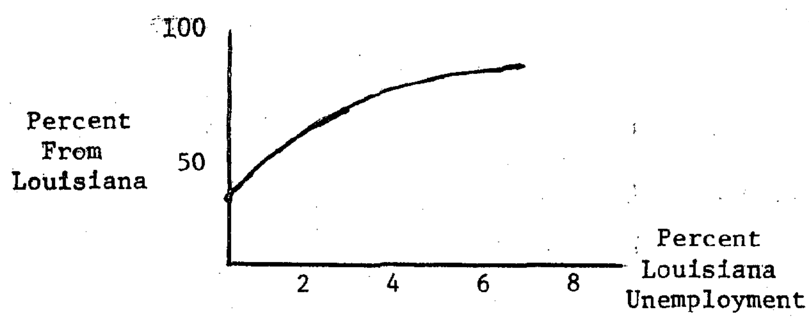
[18]Another group, not described in the above taxonomy, will impose additional public service burdens on government. These are Louisiana residents who change communities as a result of OCS activity.

[19]In theory, the higher the Louisiana employment rate for a particular occupation, the greater the percentage of vacancies which will be filled by Louisiana residents. This relationship may resemble the following graph:



This suggests that the gross in-migration rate which should be used depends on the Louisiana unemployment rate.

lead to an underestimate of the number of non-Louisiana residents employed in OCS activities since OCS jobs are notably high paying and may attract highly mobile labor force. Considering this bias and the fact that labor may not immediately respond to job vacancies, it is not too unreasonable to use the 1965-70 U. S. Census of Population migration rates. Table 5-7 illustrates this estimation technique.

An alternative is to use the BLM data in Table 5-2. These data show the number of employees hired locally and the number of employees maintaining local residence. These data were developed for future Mid-Atlantic OCS developments but they can be applied to Louisiana OCS activity. These locally hired employees can be presumed to place no additional demands on public services. The difference between employees maintaining local residence and employees hired locally consist of both non-Louisiana and Louisiana residents. In order to estimate the share of these workers who are simply mobile within Louisiana, the Census migration rate can be applied to this difference. Both groups place additional demands on local public services.

The net increase in employment created indirectly by OCS activity can be estimated using the Louisiana input-output model and the appropriate man-hours per dollar output coefficients.

The employed Louisiana residents who shift jobs as a result of OCS activities may leave vacancies in their wake.[20] These vacancies are, in turn, filled by the Louisiana unemployed and employed, or by non-Louisiana residents. This process repeats itself and also works in reverse. Those workers who obtain jobs when OCS activities cease may displace an employed individual. The displaced worker may leave Louisiana or become unemployed or employed in Louisiana.

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[20] OCS activities may shift demands for labor so that workers leaving one job do not leave vacancies. For example, OCS activity may interfere with commercial fishing so that fishermen become offshore workers.

TABLE 5-7

DIRECT OCS EMPLOYMENT IMPACT ON LOUISIANA

A. Model

1. Non-Louisiana Residents--NLR_t

$$(\text{Direct OCS Employment})_t \times \left(\frac{\text{\% OCS Workers Who Are Louisiana Residents}}{100}\right)_t \times \left(\frac{\text{In-Migrants}}{\text{Louisiana Population}}\right)_t$$

2. Louisiana Residents

$$(\text{Direct OCS Employment})_t \times \left(\frac{\text{\% Louisiana Residents}}{100}\right)_t - NLR_t$$

B. 1972 Estimate

1. (7364)[a] x (.867)[b] x (.067)[c] = 428 persons
2. (7364) x (.867) — (428) = 5957 persons

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[a]See Table IV-

[b]$.867 = \frac{\text{Number of Louisiana Residents Employed in Mining}}{\text{Louisiana Employment in Mining}}$ (U. S. Bureau of the Census)

This is admittedly an overestimate of the percent of OCS workers who are Louisiana residents. First, some of the Louisiana residents may not be employed in Louisiana mining activities. Second, OCS activities probably have a higher percent of non-residents employed than non-OCS mining activities.

[c]1970 Census of Population, Characteristics of the Population, p.20-161. This is the gross in-migration rate between 1965 and 1970. It excludes the in-migration of college students and Armed Forces personnel.

If ℓ percent of all vacancies in Louisiana are filled by Louisiana residents, of whom u percent were previously unemployed, and E is the net direct plus indirect increase in jobs as a result of OCS activity, it can be shown that $E \times \frac{\ell u}{1-\ell+\ell u}$ previously unemployed Louisiana residents would then have jobs.[21] When all vacancies are filled by Louisiana residents, $\ell=1$, and this value is E. When all vacancies are filled by the unemployed (u=1), this value is ℓE. This derivation is essential to estimating the earnings increases of Louisiana workers due to the OCS activity. Table 5-8 shows how these created vacancies are filled.

The initial job vacancies which create the displacement effects are in OCS activities (E_1), downstream petroleum and gas processing (E_2), and in industries which supply these activities with inputs (E_3). Therefore:

$$E = E_1 + E_2 + E_3 \ .$$

Let the average annual earnings for each of these types of jobs be W_1, W_2, and W_3; let the average Louisiana annual earnings be $\overline{W}$; and let average unemployment benefits in Louisiana be $\overline{V}$. A minimum estimate of the income increases of Louisiana residents as a result of OCS activities would be the sum of:

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[21]The proof is as follows. Suppose a net increase of E jobs is created directly and indirectly by OCS activity. Assume ℓ percent of these jobs are filled by Louisiana residents, of whom u percent were previously unemployed. Therefore, ℓuE individuals would have been Louisiana unemployed workers and $\ell(1-u)E$ would have been Louisiana employed workers. These Louisiana employed workers would have left Louisiana jobs, thus, leaving $\ell(1-u)E$ vacancies, of which $\ell u(\ell(1-u)E$ would be filled by Louisiana unemployed workers and $\ell(1-u)\ \ell(1-u)E$ by Louisiana employed workers. Similarly in the second round, $\ell(1-u)\ \ell(1-u)E = \ell uE\ \ell(1-u)^2$ of the vacated jobs would be filled by Louisiana unemployed. The net increase in E jobs allows $\ell uE + \ell uE\ \ell(1-u) + \sum_{n=0}^{\infty} \ell uE\ \ell(1-u)^2 + \ldots \ell uE\ \ell(1-u)^n = E \frac{lu}{1-\ell(1-u)}$ previously unemployed workers to be employed. Therefore, out of the E total jobs created by OCS activities, $\frac{\ell u}{1-\ell(1-u)}$ percent are filled by previously unemployed Louisiana residents.

TABLE 5-8

SOURCE OF LABOR FOR FILLING JOB VACANCIES CREATED BY NET ADDITION OF E JOBS TO LOUISIANA ECONOMY[a]

	From Louisiana Unemployed	From Louisiana Employed	Non-Louisiana Residents
Direct + Indirect	$u\ell E$	$(1-u)\ell E$	$(1-\ell)E$
Displacement 1	$u\ell\{(1-u)\ell E\}$	$(1-u)\ell\{(1-u)\ell E\}$	$(1-\ell)\{1-u)\ell E\}$
Displacement 2	$u\ell E\{(1-u)\ell\}^2$	$(1-u)\ell E\{(1-u)\ell\}^2$	$(1-\ell)\{1-u)\ell\}^2E$
.			
.			
.			
n	$u\ell E\{(1-u)\ell\}^n$	$(1-u)\ell E\{1-u)\ell\}^n$	$(1-\ell)\{(1-u)\ell\}^nE$

E = Net increase in jobs directly and indirectly created by OCS activity.

ℓ = percent of vacancies filled by Louisiana residents.

u = percent of vacancies filled by unemployed workers.

(1) Income increases of laborers employed directly or indirectly as a result of OCS activities who were Louisiana unemployed residents prior to the activity. Table 5-8 shows that there are $u\ell E$ in this category; hence, their income increase is:

$$u\ell \sum_{i=1}^{3} E_i(W_i - \overline{V})$$

(2) Increases in income of laborers employed directly or indirectly who were Louisiana employed residents prior to the activity. Table 5-8 shows there were $(1-u)\ell E$ in this category; hence, their income increase is:

$$(1-u)\ell \sum_{i=1}^{3} E_i(W_i - \overline{W}) \ .$$

(3) Income increases of laborers who became employed due to the transfer of Louisiana employed residents to the new direct and indirect jobs resulting from OCS activities. Table 5-8 shows there are $u\ell\{(1-u)\ell\}^2E$ in this category; hence, their income increase is:

$$u\ell\{(1-u)\ell\}^2 \quad E(\overline{W} - \overline{V}) \ .$$

The sum of these values is clearly an underestimate of earnings increases because it excludes the earnings of unemployed labor beyond the first displacement.[22] Since workers who were previously unemployed no longer receive unemployment benefits, state and local taxes can be reduced. These reductions result in increases in after tax incomes by the value of the unemployment benefits. Assuming $\overline{V} = 0$ in the above calculations yields an estimate of earnings increases plus tax savings resulting from OCS activity.

5.5.2.. Estimating Increases in Louisiana Capital Income

The existence of OCS activities provides Louisiana residents with increases in capital earnings. The capital whose earnings are affected consists of capital in enterprises of multiple ownership and in proprietorships run by single owners. In the latter case, OCS activities may result in increases in capital earnings as well as proprietors' salaries. In any given

[22]The latter earnings could be included. For the second round of displacements, they would equal $u\ell\{(1-u)\ell\}^2 \ E(\overline{W} - \overline{V})$. However, if $u=.1$ and $\ell=.7$, this would only be $.024 \ W \times E$.

time period, some capital would find alternative uses while some would be unemployed in the absence of OCS activities. In the long run, all capital would find an alternative use. Let r be the rate of return on capital in the presence of OCS activity, $\bar{r}$ the rate obtainable in the absence of OCS activity when capital is transferable to other uses, and $\bar{u}$ the depreciation rate on capital due to wear and tear in use. The increased earnings per unit of capital for transferable capital would be equal to $(r-\bar{r})$ while that of nontransferable capital would be $(r-\bar{u})$ since leaving this capital idle saves on capital costs by $\bar{u}$.

The task of estimating the increased earnings of capital owned by Louisiana residents is complicated by the lack of good published data on:

(1) Capital owned by Louisiana residents.

(2) Rates of return on capital invested in OCS related activities.

(3) Rates of capital depreciation due to wear and tear in use.

(4) Transferability of the various forms of capital.

However, several strong assumptions will allow an estimation of increased capital earnings.

First, if proprietorships can be distinguished from multi-owner companies, it may not be too unreasonable to assume that Louisiana residents own such a small share of multi-owned companies that increased capital earnings of such companies going to Louisiana residents are insignificant.[23] Second, the value-added created by an industry ends up as factor payments and indirect business taxes. Suppose we assume the value-added per dollar of output going to capital is the same for each Louisiana industry as it is for the respective industries at the national level. Third, suppose excess capacity rates in each Louisiana industry are the same as the respective

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[23] According to company records, Louisiana residents owned only 0.1% of the common stock of a major oil company and only 1.0% of a major gas company.

industries as a whole. Excess capacity represents idle capital and some of this capital will become employed as a result of OCS activities.[24] Fourth, downstream processing of oil and gas occurs in large plants where ownership is highly dispersed geographically.[25] It can be assumed that an insignificant portion of increased earnings of capital employed in these activities goes to Louisiana residents. Establishments which operate offshore tend to be larger than onshore operators. Table 5-9 shows the percent of establishments by location and activity which employ 20 or more employees. OCS drillers tend to be the largest firms. Many OCS establishemnts may be members of multi-establishment firms since only 5.4% of the value-added originating in the U.S. crude oil and natural gas industry comes from non-incorporated firms.[26]

Firms which engage in Louisiana OCS activities contract out some of their OCS work. It may not be too unreasonable to assume that this contract work is done primarily by small firms for larger firms. Furthermore, unless actual data are collected, one can assume this contract work is done by establishments located in Louisiana. The value of OCS activities done on contract can be used as an estimate of the value of output of Louisiana unincorporated firms. The capital earnings resulting from this contract work can be taken as an estimate of the direct Louisiana capital earnings due to OCS. This is an heroic assumption, but it is the best one can do without designing an expensive survey.

The capital earnings obtained from this contract work can be estimated using national value-added ratios. The U.S. Bureau of Economic Analysis (BEA)

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[24]As in the case of labor, the higher the excess capacity, the greater the probability that capital will come from the unemployed pool rather than be transferred from other uses.

[25]For example, out of all chemical and allied products establishments in Louisiana in 1972, 85% had 100 or more employees. A similar statistic for petroleum and coal products establishments was also 85%. (Statistical Abstract of Louisiana, 1974, (University of New Orleans), p.313.

[26]1972 Census of Mineral Industries, "Type of Organization," p.6-61

TABLE 5-9

PERCENT OF ESTABLISHMENTS WITH AT LEAST 20 EMPLOYEES, BY LOCATION AND TYPE OF ACTIVITY

	Total U.S.	Offshore U.S.	Louisiana Offshore
Oil and Gas Operations[a]	10.7	36.6	48.7
Drilling Oil and Gas Wells[b]	30.0	89.2	93.1
Oil & Gas Exploration Services[b]	12.7	30.8	*
Oil & Gas Field Services, Not Elsewhere Classified[b]	20.0	55.7	63.8

[a] 1972 Census of Mineral Industries, "Oil and Gas Field Operations," p.13A-S.

[b] 1972 Census of Mineral Industries, "Oil and Gas Field Services," p.13C-S.

*Not available for proprietary reasons.

breaks down value-added per dollar of output into employee compensation, indirect business taxes, and property-type income. Property-type income is comprised of:[27]

(1) Proprietors' income
(2) Rental income of persons
(3) Corporate profits and inventory valuation adjustment
(4) Net interest
(5) Business transfer payments
(6) Surplus of government enterprises less subsidies
(7) Capital consumption allowances

A breakdown of value-added by each of these sources can be obtained through several data sources.[28] Multiplying the value of contract output by the sum of proprietors' income and corporate profits per dollar of output in crude oil and natural gas mining gives an estimate of Louisiana capital earnings directly obtained from OCS activity.[29]

The above estimate of capital earnings overestimates the increase in capital earnings to the extent that the capital employed directly in OCS activities has alternative uses. If this capital were to remain idle in the absence of OCS activities, capital costs would be reduced by the value of capital depreciation due to wear and tear. Therefore, the increase in earnings per dollar of output for capital which is drawn from excess capacity would equal the difference between capital earnings per dollar of output and

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[27] Albert J. Walderhaug, "The Composition of Value Added in the 1963 Input-Output Study," Survey of Current Business, April, 1973, p.35.

[28] See Haveman and Krutilla, op. cit., p.26.

[29] Actually, proprietors' income includes a labor earnings component which should not be attributed to capital, but which is not included in the calculations of increased labor earnings above. Corporate profits per dollar of output are assumed equal to returns on proprietary capital per dollar of output.

capital consumption allowances per dollar of proprietary output.[30] It is clear that an estimate of the share of capital drawn from excess capacity by OCS activities must be made.

As in the case of labor, there is expected to be a relation between the rate of excess capacity and the probability that capital employed in OCS activities would be drawn from this unemployed capital. The relation would look similar to the figure in footnote 19 above, with excess capacity measured on the horizontal axis. Since we are considering the capital earnings increases of small firms, it is not too unreasonable to assume that capital receives a normal rate of return in both OCS use and when it is used elsewhere. Therefore, the increased earnings of OCS capital which does not come from excess capacity can be assumed to be zero. Table 5-10 summarizes the capital earnings estimating procedure.

In addition to the capital earnings increases obtained from employing capital directly in OCS activities, there will be increased capital earnings due to indirect demands for capital. We have already summarized how to estimate the gross value ofoutput by sector which results from the OCS and corresponding downstream activities. The probability that capital in each sector will have been unemployed in the absence of OCS activity is obtainable, in theory, once the excess capacity is known by sector. The increased earnings of this capital per dollar of output will be the difference between the sum of proprietors' income and corporate profits, and capital consumption allowances per dollar of output. The value of estimated gross output by sector times the probability the capital comes from excess capacity in that sector times the difference between returns on capital and capital consumption allowances per dollar yields the increased indirect capital earnings by sector.

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[30]For an explanation of this estimation see

TABLE 5-10

ESTIMATING INCREASED CAPITAL EARNINGS RECEIVED BY LOUISIANA RESIDENTS AS A RESULT OF OCS ACTIVITY

A. Model

1. Exploration and Development (E & D)

$$\left(\frac{\text{Louisiana Offshore Exploration and Development Contract Work}}{\text{Wells Drilled}}\right) \text{ X } (\text{Wells Drilled})_t \text{ X}$$

$$(\text{Proprietors' Income--Capital Consumption Allowance per Million Dollars of Output})_T \text{ X}$$

$$(\text{Percent of Capital From Excess Capacity})_t$$

2. Production

$$\left(\frac{\text{Louisiana Offshore Production Contract Work}}{\text{Wells Producing}}\right) \text{ X } (\text{Wells Producing})_t \text{ X}$$

$$(\text{Propritetors' Income--Capital Consumption Allowance Per Million Dollars of Output})_T \text{ X}$$

$$(\text{Percent of Capital From Excess Capacity})_t$$

B. Estimate

1. $(10.6^{a}/697^{b}) \times (578) \times (\,?\,^{c}) \times (\,?\,^{d}) = \,??$ Million
2. $(478.1^{e}/4533^{b}) \times (4533) \times (\,?\,) \times (\,?\,) = \,??$ Million

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[a] 1972 Census of Mineral Industries, Oil and Gas Field Services, pp.13C-9 to 13C-12.

[b] See Table 5-1.

[c] See Havemann and Krutilla, op. cit., p.26.

[d] Estimated.

[e] 1972 Census of Mineral Industries, Oil and Gas Field Operations, p.13A-9.

[f]

The sum of these estimates across sectors is, of course, the estimate of total increased capital earnings of Louisiana received indirectly as a result of OCS activity.

Although the above technique is recommended as a rough approximation, it contains biases whose directions are impossible to state. On the other hand, if the value added breakdown is not obtained, the value-added per dollar output ratio will include non-capital earnings and will not exclude depreciation. On the other hand, the estimate of the value of output by Louisiana proprietorships, the value of contract work, is somewhat arbitrary and its bias is unknown.

5.5.3. Estimating Increases in Louisiana Land Income

The problems of estimating earnings' increases from land ownership are almost as difficult as those encountered in estimating capital earnings increases. These increased land earnings occur in the form of increased rents. Increases in the market value of land reflect increased rental values since land values are capitalized rents, according to the formula:

$$\Delta V = \frac{\Delta R}{i} \quad ,$$

where ΔV is the change in land value, ΔR is the change in annual rental rates ad infinitum and i is the rate of return on land. A proper estimate of the effect of OCS activities on land values would require collection of information on the increase in land values as a result of OCS activity.

The increased demand for land directly or indirectly used for OCS activities results in increased values in land so used, as well as other land. For society as a whole, increased land rents represent transfers of income, not net income increases. Within a subset of society, such as a region, increased land rental incomes to landowners may not be exactly offset by increased rental payments of non-landowners.

Assume that land may be divided between land used directly for OCS activity, for the supplies of inputs to OCS activity, for indirect suppliers of OCS supplies; and all other land. Furthermore, assume that increased land rents for Louisiana land used in the last three categories are exactly offset by increased rental payments of Louisiana non-landowners. Finally, assume that the increased rents on land used for OCS activities are paid mostly by non-Louisiana residents through payments for oil and gas related products. Under these assumptions, the problem of estimating increased land earnings as a result of OCS activity is narrowed down.

The only technique for estimating these increased rental incomes is to survey a sample of OCS firms and estimate the increased land values resulting from their location. Local assessors may be consulted to arrive at estimated values of OCS used land and comparable land. Land sales to OCS firms may be compared to other land sales.[31] Using the data on land requirements per unit of activity in Table 5-2 will allow the researcher to expand the sample data to the total production. There is no reasonable method, short of actual surveys, to ascertain whether the land is owned by Louisiana or non-Louisiana residents.

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[31]Much of the direct OCS used land may be along canals.

CHAPTER 6
PROCEDURES FOR ESTIMATING LOUISIANA NET FISCAL IMPACTS FROM OCS ACTIVITY

6.1. Introduction

The State of Louisiana and its political subdivisions tax businesses and individuals to finance public services provided for their citizens. The development of the Outer Continental Shelf raises serious questions about the fiscal impact on state and local governments because the tax base is located beyond the taxing jurisdiction of state and local governments, whereas: (1) some employees and their dependents reside onshore, (2) the OCS activity may require special public roads, ports, and sewage facilities, and (3) OCS activity may also impose environment-related costs. On the other hand, OCS activity does stimulate onshore economic development which increases state and local tax revenues.

While the public sector impact is an important component of regional impact analysis, it is one of the most underdeveloped. Most public service impact studies are simplistic ratios of expenditures and tax revenues per capita. The limited development of public sector impact analysis is due primarily to the lack of data availability and to the lack of a widely accepted theoretical framework which, in large part, is caused by researchers using only the simplistic data available. The problem is not a lack of general data, as it is a lack of particularized data related to the specific project impact being investigated.

The need for particularized data is exemplified in a study of OCS impacts on the public sector. One cannot provide an accurate estimate of OCS public sector impacts unless he is aware of the economic characteristics of the industry, including the location of its suppliers and employees, the distribution of output, taxes paid, unique services required, etc.

The chapter suggests various methodologies for estimating the "net fiscal impact" of OCS activities. Net fiscal impact refers to the difference between state and local revenues received and public service costs incurred as a result of OCS activities. The suggested methods vary in accuracy as well as cost.

6.2. Previous Methodologies Used in Estimating Public Sector Impacts

Any approach to estimating state and local net fiscal impact must assume a given level of OCS activity and calculate the associated employee and business onshore tax revenues and costs resulting therefrom. The individual taxes to be estimated include the state individual income tax, the residential property tax, local and state general sales taxes, excise taxes, and user charges. Taxes paid by firms include state corporate income taxes, sales taxes, excise taxes, and personal and real property taxes. It would not be too unrealistic to assume that the state plus local tax revenues generated by the indirect activities resulting from OCS exactly equal the public service costs resulting from those activities. One is then left with the problem of comparing tax revenues directly created by OCS with public service costs directly attributable to OCS.

In order to test whether OCS activities create revenues which cover their costs, suppose that OCS imposes per capita public service costs equal to the average statewide per capita costs. Assuming governments balance their budget, OCS per capita costs financed from within the state would equal the average statewide per capita revenues from state and local taxes. Dividing tax revenues (individual plus business) generated directly from OCS activities by the population increase resulting directly from OCS activities yields a measure of per capita OCS revenue. These estimated per capita OCS tax payments are then compared with state-wide per capita revenues. If the per capita tax revenue generated by the OCS employees and OCS business is greater than the per capita revenues for the state as a whole, OCS developments might be considered to be paying more than their proportional share of public expenditures.

One study has used this technique in conjunction with forecasting for the 23 coastal states.[1] The FY1974 per capita state and local revenue for Louisiana was $687. This amount was then compared with OCS generated tax revenues for 18 years of OCS development. During the first two years of development, OCS generated per capita tax revenue is less than the average per capita tax revenue in the State. However, for each year thereafter, with one exception, OCS generated revenues exceed average state revenues. This pattern is typical for other states. The author concludes that after 2 to 4 years, OCS development pays its own way.

There are three serious problems with this methodology and numerous difficulties with their empirical assumptions.

The first methodological problem is associated with the assumption that all OCS employees will initially be from out-of-state and that they will then reside in the state adjacent to OCS area. For example, all workers on Louisiana's OCS are assumed to reside in Louisiana. It compares the associated revenues and public service demands for these employees. However, if the OCS related employees are relocated within the state the methodology is less clear. For example, if there is a movement of employees from Parish A to Parish C, because of OCS development, the employees leaving Parish A may create excess public service capacity in their wake. This may burden Parish A with additional per capita debt servicing costs.

The second methodological problem is that this approach assumes that OCS public service impacts on a per capita basis are equal to those imposed by

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[1] Robert L. Bish, "Fiscal Effects on State and Local Government From Offshore Oil and Gas and Port Development," Institute for Urban Studies, University of Maryland. Review draft, March 15, 1976.

the average economic sector, However, data shown below on pages suggest that public sector costs per capita are higher for OCS activity than the average of other economic activities in the state. This may be because OCS activities require expensive public facilities, such as ports. In other words, the production caused public service costs may exceed the population caused costs. This assumption is the key to the issues to be dealt with in an OCS net fiscal impact study.

The third problem associated with the Bish methodology is the difficulty encountered in separating OCS from non-OCS generated revenues when a firm engages in both types of activities. However, this problem will be encountered in any accurate net fiscal impact methodology.

The study notes that some onshore activity directly resulting from OCS activity is taxable. For example, tank farms, pipelines, and gas processing plants are subject to state and local property, use, and sales taxes because these activities require land purchases and may require construction.[2] These items may consist of new construction or simply a transfer in use from handling onshore to handling offshore production.[3]

The study also helps to determine at what point in the chain of effects induced by OCS activity the researcher should stop in measuring net fiscal impact. These effects are commonly divided into direct, indirect, and induced effects. As noted above, in Chapter 5, the direct effects consist of the OCS activity itself plus the immediate supply induced and demand induced activities. The supply induced activities include activities resulting from the increase in oil and gas production. They may include expansion of gas processing, refinery, or petro-chemical plants. Immediate

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[2]*Ibid.*, p.11.

[3]Depending on current tax laws, this property may fall out of the states taxing jurisdiction when transferred from onshore to offshore use. See Bish, footnote 7, p.30, for an idea of the importance and variability of tax laws relevant to this study.

demand induced activities are those which supply the inputs to the OCS activities. They include platform fabrication, pipeline construction and coating, food service for offshore rigs, etc. Because of the unique tax laws which allow state and local tax exemptions for these direct activities, it is essential to carry the net fiscal impact study at least to this point in the chain of effects.

The next set of effects are indirect effects, consisting of demand induced increases in supply to provide inputs into the firms directly supplying OCS activities with inputs. Finally, the induced effects are supply increases resulting from the increased consumption demands of households. Unless there is reason to expect that marginal public service costs do not equal marginal tax revenues for these indirect and induced activities, there is no reason to carry the net fiscal impact study to the indirect and induced levels.

The first alternative integrated the public service costs and benefits by examining the comparative per capita revenues generated by OCS and non-OCS employees. More traditional public sector impact studies separately estimate the costs and revenues generated by the industry in question. Actually, the costs imposed by OCS activity are easier to measure than the public sector revenues derived from the activity. Although we much prefer and recommend a detailed estimation of costs one can always use per capita expenditures multiplied by the estimated OCS related population. A crude estimate of OCS cost impact can be made as follows:

1. *OCS Related Population = Number of directly related OCS employees times the number of individuals per employed worker.*

2. *Relevant Expenditures made by state and local governments equal total state and local expenditures minus:*
   a. *Receipts from Federal government*
   b. *Intergovernmental transfers from state to local governments*
   c. *Charges and miscellaneous revenues*

3. *Public Sector Cost of OCS Activities = OCS related population times relevant expenditures of state and local governments.*

4. *Example*
OCS Related Population: 38,000[4] *x* 2.1[5] = 79,800

Per Capita State and Local Expenditures:
$2.3 mil.[6]*/3.6 mil.*[5] = *$640 x 84,630* = $51 million

Per capita cost ratios are often used to estimate OCS related costs, and then other methods are employed to estimate revenues paid as a result of OCS activity. This technique was employed in a short Texas Study.[7] The Texas study used the Texas input-output model to estimate revenues. This estimate was obtained by increasing Texas oil and gas production in the model by the amount of OCS production. If tax revenues per dollar of activity are known by industrial sector, an estimate can be made of taxes collected directly and indirectly as a result of OCS activity.

There are several important errors in the Texas study. Although the study is vague on this point, it appears that the study gives only industrial tax revenues and not individual tax revenues. The Texas study made no apparent attempt at estimating individual tax revenues. Also, there did not appear to be any attempt to measure taxes received directly as a result of OCS production, such as property taxes, use taxes, etc. The study also fell into the trap of assuming that OCS activities create public service costs similar to any other economic activity in the state. A simple test of this hypothesis is provided in the next section.

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[4] See page 33 of this report.

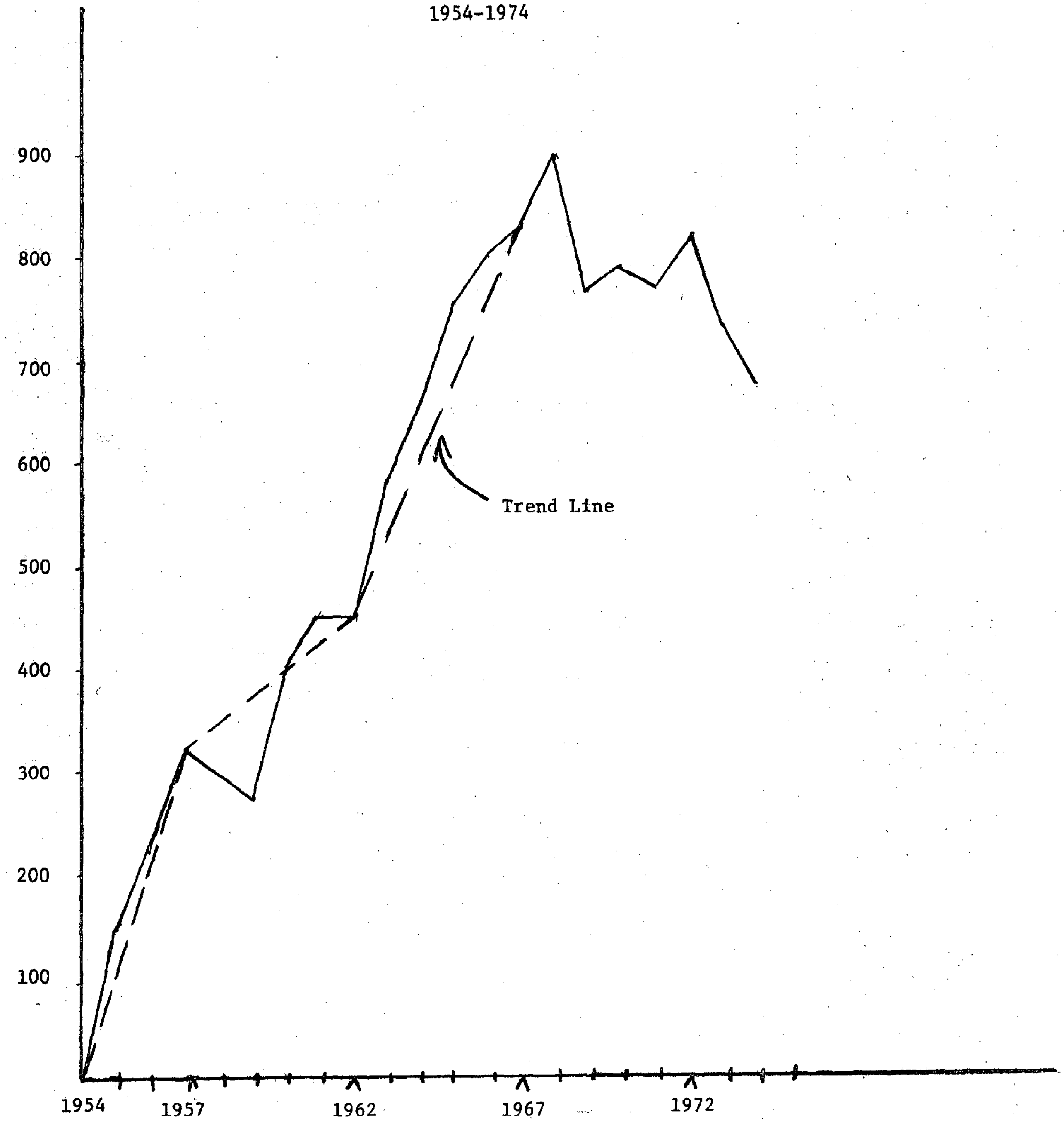
[5] U. S. Bureau of the Census, Census of Population.

[6] U.S. Bureau of the Census, Census of Governments, 1972, Vol.4, Government Finances, p.94.

[7] "Benefits and Costs to State and Local Governments in Taxes Resulting From Offshore Petroleum Leases on Federal Lands," Office of Information Services (Austin, Texas; November, 1974).

FIGURE 6-2

NEW WELLS STARTED
LOUISIANA OCS
1954-1974



6.3. Local OCS Public Service Impact

The above public sector impact methodologies all assumed that OCS public service costs equalled statewide per capita costs. It is necessary to determine if particular local or parish governments are experiencing extraordinarily high per capita government costs because of the demands placed on these parishes by OCS activities. We decided to test the hypothesis that the coastal parishes are impacted more heavily than other parishes. Our test is very limited and the results must be interpreted as only tentative and illustrative.

We have assumed that the primary impact area for OCS created population increases consists of the parishes lying within a two parish deep area along the Gulf Coast. These 17 parishes are those shown in Figure 6-1 which are located below the heavy dark line. The average per capita parish public service direct operating costs for this area and for Louisiana as a whole are shown by five year intervals from 1957 to 1962 in Table 5-1, columns 1 and 2. Since OCS activities will not impose a net cost of self-financing government activities, the costs of these activities are excluded.[8] It is interesting to note that these undeflated per capita operating costs are higher in the primary impact parishes than all parishes combined. This difference is greater in 1957 and 1967 than in the other two years. This is consistent with the pattern of OCS activity between 1954 and 1972.

Figure 6-2 shows new wells started in the Louisiana OCS between 1954 and 1974. The period prior to 1957 and the period from 1962 to 1968 are clearly periods of consistently rapid growth in new wells. Because platform fabrication probably creates the greatest secondary impact in the coastal area, one would expect per capita public service operating costs to rise

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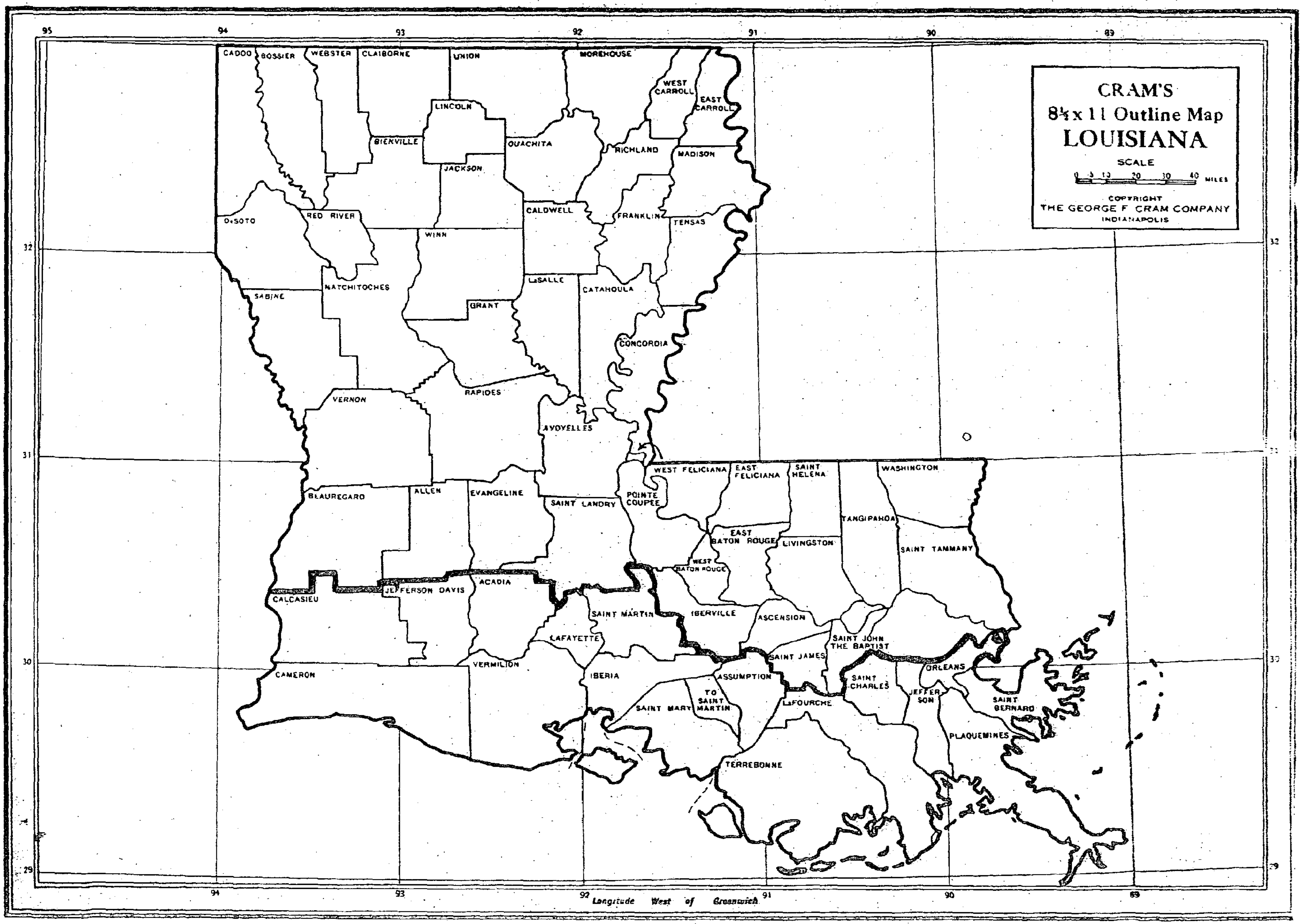
[8]Direct costs exclude intergovernmental transfers. The sum of direct local and state operating costs would equal total operating costs in the state.

FIGURE 6-1



CRAM'S
8½ x 11 Outline Map
LOUISIANA
SCALE
0 5 10 20 30 40 MILES
COPYRIGHT
THE GEORGE F. CRAM COMPANY
INDIANAPOLIS
CADDO
BOSSIER
WEBSTER
CLAIBORNE
UNION
MOREHOUSE
WEST CARROLL
EAST CARROLL
LINCOLN
BIENVILLE
OUACHITA
RICHLAND
MADISON
JACKSON
CALDWELL
FRANKLIN
TENSAS
DeSOTO
RED RIVER
WINN
SABINE
NATCHITOCHES
LaSALLE
CATAHOULA
GRANT
CONCORDIA
VERNON
RAPIDES
AVOYELLES
WEST FELICIANA
EAST FELICIANA
SAINT HELENA
WASHINGTON
BLAUREGARD
ALLEN
EVANGELINE
SAINT LANDRY
POINTE COUPEE
EAST BATON ROUGE
TANGIPAHOA
LIVINGSTON
SAINT TAMMANY
WEST BATON ROUGE
CALCASIEU
JEFFERSON DAVIS
ACADIA
SAINT MARTIN
IBERVILLE
ASCENSION
LAFAYETTE
SAINT JOHN THE BAPTIST
SAINT JAMES
ORLEANS
CAMERON
VERMILION
IBERIA
ASSUMPTION
SAINT CHARLES
JEFFERSON
SAINT BERNARD
TO SAINT MARTIN
SAINT MARY
LAFOURCHE
PLAQUEMINES
TERREBONNE
Longitude West of Greenwich

TABLE 6-1

PER CAPITA PUBLIC SERVICE DIRECT CURRENT OPERATING COSTS FOR LOUISIANA AND THE PRIMARY OCS IMPACT AREA, BY CENSUS YEAR[a]

Year	Primary Impact Parishes	All Parishes Combined	State Expenditures Excluding Intergovernmental Transfers
1957	96.54[b]	52.39[c]	95.45[c]
1962	134.24[d]	128.51[e]	80.18[e]
1967	192.07[f]	178.81[g]	114.41[g]
1972	324.72[h]	315.59[i]	199.05[i]

Population of the 17 parish OCS impact area in 1972 was 1,798,038.

[a]U.S. Bureau of the Census, Census of Governments, 1957, 1962, 1967, 1972.

Operating costs exclude the costs of these self-financing government operations: utilities, insurance trusts.

[b]1957, pp.18-22, using 1960 population.

[c]1957, p.12, using 1960 population.

[d]1962, pp.410-415, using estimated 1962 population.

[e]1962, p.94 and p.75, using estimated 1962 population.

[f]1967, pp.45-50, using 1966 population.

[g]1967, p.28 and p.8, using 1966 population.

[h]1972, pp.410-415, using 1970 population.

[i]1972, p.94, using 1970 population.

more rapidly than usual during these periods due to increased OCS related demand for public services. This is precisely what happened.

The preceeding analysis suggests two important points:

(1) The primary impact parishes have historically had higher public service operating costs per capita than other parishes.[9]

(2) The level of public service operating costs per capita are dependent upon the level of OCS operations.

If the per capita costs in Table 5-1 were deflated for rising prices, the difference in per capita costs between primary impact and other parishes would be narrowing over the period observed.[10]

6.4. Operating Cost Estimation

The above results suggest that it may be important to distinguish between the primary impact areas and other areas when determining the OCS created operating costs to Louisiana.[11] In particular, if one is limited to using per capita cost data the following breakdown should be used in calculating total local plus state operating costs:

(1) For the direct population effects of OCS activity, use as per capita public service operating costs, the sum of per capita direct operating costs in the primary impact parishes, and per capita direct operating costs for state government.

(2) For the first round interaction of the input-output model, use the same per capita sum as in (1) above. This assumes that the immediate suppliers to OCS are located in the primary impact parishes.

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[9] Since our data starts in 1957, the "historically" high public service costs may already be due to OCS activities prior to that date. Alternatively, the extensive wetlands area and relatively low population density may cause these higher costs.

[10] This may be due to operating costs rising in the impacted areas prior to the increase in population. This suggests it may be useful to distinguish between "production created" and "population created" public services. If such a distinction is important, using statewide average costs per capita may underestimate public service costs if production precedes.

[11] It should be noted that in one parish which is strongly impacted by OCS activities, St. Mary's parish, the per capital direct public service operating costs were $456, $206, and $148 for 1972, 1967, and 1962 respectively. These figures are much higher than the averages for the remainder of the primary

(3) For successive iterations of the input-output model, use the sum of per capita direct operating costs in <u>all</u> parishes combined and per capita direct operating costs for state government.

Perhaps only the first step will be required because successive iterations will "pick-up" more widely dispersed suppliers who will not be placing an extraordinarily heavy burden on local areas, and who could be expected to be paying sufficient tax revenues to pay their way. The widely dispersed suppliers would also be able to phase into the state's economy more easily without producing "ghost-town" effects when OCS activity tapers off significantly.

OCS activities are peculiar in that the location of the population impact may not be the same as the location of production. In particular, on-site offshore workers may not reside in the coastal parishes or in Louisiana. In order to measure the <u>population created</u> public service operating costs directly resulting from OCS activity, this suggests that it is necessary to at least identify whether or not a worker resides in Louisiana. It can then be assumed that the public service costs generated by these Louisiana population increases equal the sum of average statewide parish--including municipality and district--per capita operating costs plus state per capita costs times the population increase. This assumption would hold regardless of the specific parishes impacted by the population increase.

The production created operating costs of OCS activities have traditionally been assumed to equal the production created costs of the state's existing mix of activities. In other words, it is assumed that OCS activities require the normal road maintenance per unit of output, the normal sewage maintenance per unit of output, etc. A major purpose of an OCS public service impact study is to test whether or not this assumption is valid. A measure of the abnormal OCS related operating costs can be obtained in several ways.

(1) Cost Differences

Assume that normal parish per capita operating costs are equal to the statewide average but that the abnormal costs attributable to OCS activities equal the difference between primary impact parish per capita costs and the statewide average times the primary impact parish population increase. From Table 6-1 this would have been ($324.72 - $315.59) x (1,798,038) = $16.4 million in 1972. Of course, this makes the possibly untenable assumption that the only reason for per capita cost differences is OCS activity.

(or)

(2) Enumeration of Abnormal Demands

Identify by parish-wide surveys the abnormal demands placed in public services by OCS activities and their immediate suppliers.

The second technique would be more costly, yield a more accurate estimate, and require more discretion by the researcher than the first procedure. However, the first procedure may provide control totals to which the results of this technique can be compared. The second technique is discussed more thoroughly below.

The enumeration of abnormal demands technique requires a five step procedure:

(1) Categorize the types of onshore activities necessary for OCS activity.

(2) Identify a sample of firms in sample impact parishes which are engaged in the above activities.

(3) Obtain information from these firms regarding abnormal public service usage and levels of OCS related output produced. For example, a firm may use a public pier, employ x persons and have y percent of its sales going directly to OCS activities.

(4) Obtain from public agencies the total usage of respective public facilities and their operating costs. For example, identify total dockings and total operating costs at a port, and use information from (3) to allocate operating costs to OCS activity.

(5) The operating costs identified in steps one through five should be excluded from the population created operating costs.

Some abnormal demands, such as highways which service primarily OCS activities, can be identified through public agencies, such as the Department of Highways. The researcher would have to use subjective judgments in many cases, but should be conservative in making estimates. Many abnormal demands would be clear, such as highways and airports which primarily service OCS activities, port facilities and dredging attributable to OCS activities. Each parish would be taken on a case-by-case basis. There is probably no better technique than this for estimating production created abnormal public service demands.

6.5. Capital Cost Estimation

The previous section dealt with the estimation of population and production induced costs of operating public facilities. This section deals with the costs of providing the sotck of public facilities, the public capital. There are basically two techniques for estimating the requisite capital costs resulting from a change in the level of demand for public facilities. The first is to derive an estimate of the physical increase in the various types of facilities required and establishing the costs of providing those facilities. The second is to use historical per capital expenditures, adjusted for changes in cost indices, as the basis for estimation. Each technique has its advantages and disadvantages.

6.5.1. The Capital Enumeration Technique

This technique requires the following information:

(1) The physical quantity of facilities per unit of "population" demanding the facility; for exapple, police cars per person, square feet per shool child, gallons of sewage capacity per person, pier footage per vessel, etc.

(2) The cost of each unit of capacity.

(3) The increase in "population" demanding the facility.

The ratios used in step one assume a given level of public service quality and these must be defined by the study. They might be set equal to historic ratios in various regions of the country.[12] The data in the second step can be obtained from published and non-published construction cost data. The data in the third step consist of increases in population, firms, and activity levels of firms since demands for public facilities are population and production induced.

The primary advantage of the capital enumeration technique is that it better enables one to estimate the incremental costs of providing public capital for OCS related population and firms. The use of per capita ratios in the second technique is rather meaningless when excess capital capacity exists because additional population can be accomodated without additional capital costs. The only way to determine whether excess capacity exists is to survey actual capital facilities and compare them to some estimated given quality of requisite capital. The latter could be obtained by multiplying statewide or nationwide physical capital per unit of affected population by the particular geographic area's actual population.

There are several empirical difficulties with the capital enumeration technique. <u>First</u>, the human population-induced facilities are probably easier to estimate than the production-induced facilities, since the latter will be specific to the type of production. It may be best to estimate the production-induced facility requirements on a case-by-case basis from parish surveys. <u>Second</u>, per unit facility cost figures may be difficult to find. <u>Third</u>, related to the excess capacity problem, there is the problem of

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[12] It whould be noted that historically low ratios in primary impact parishes may be due to the inability to tax OCS related activities in those parishes. On the other hand, high ratios would result if parishes anticipated the increased demands and built facilities early.

estimating additional costs when there is a shift from on-shore to off-shore activity. For example, a particular firm in Parish A may switch from providing on-shore well services to providing off-shore well services. There may be no net increase in public facilities required, yet the above technique would result in both population and production induced facility demands attributable to OCS activity. It should only be the increase in total activity which results in the increase in public facilities. Increased OCS activity may not lead to a net increase in population if it displaces some other activity such as fishing or on-shore services or production.

One way out of the third dilemma mentioned above is to measure two things:

(1) Total net increase in the demanding population (or firm sales).

(2) The net increase in OCS related population (or sales).

Increased capital costs resulting from net increase in demand can be divided between OCS and non-OCS by the ratio of the net OCS increase to the net total increase. This would attribute capital costs to OCS activities in the same proportion as net increases in OCS demands to net increases in total demand but it would require obtaining data on individual firms.

Finally, the capital enumeration technique may error on the low side by not counting all capital costs. There is probably not much difficulty in this respect in estimating population-induced costs. However, a large portion of the more specific production-induced costs must be thoroughly estimated on a case-by-case method.

This technique should yield fairly accurate estimates of the incremental capital costs attributable to increases in the level of OCS activities. However, these incremental costs may not be the costs for which a government body should be subsidized. This is because the above technique penalizes government body for planning ahead, since the existence of excess capacity reduces incremental capital costs. Perhaps, for subsidy purposes, excess capacity should be disregarded as affecting subsidizable costs.

6.5.2. The Ratio Technique

The second major capital cost estimation technique is to use per capita capital expenditures in a manner similar to one of the techniques for estimating operating expenses. There are two variants to this approach:

(1) The incremental cost per capita approach.

(2) The average cost per capita approach.

These will be discussed in turn.

6.5.2.1. Incremental Cost Per Capita Approach

Assume that a governmental body supplies public facilities instantly to response to demand and there is no depreciation of public facilities. In any given year, the public capital expenditures divided by the increase in the additional population serviced provides an estimate of the incremental capital costs per unit of the population. For example, dividing annual state and local capital expenditures by the increase in statewide population would give an estimate, under the above assumptions, of the capital cost per capita. Population- and production-induced capital costs would be included in this ratio. Unfortunately, public bodies are not so perfectly responsive to public service demand and there is depreciation on public facilities so that a portion of the state and local capital expenditures each year are for the replacement of the detiorated capital stock. The imperfect response means that the capital expenditures in the numerator are not caused by the population change in the denominator, yielding a meaningless per capita ratio. For example, capital expenditures in 1976 may be in response to population increases in 1974 or 1973-1974. Some public bodies may lag in providing services while some may lead. It may be that these biases may "wash-out" across a number of public bodies, so that calculating the ratio for a state and all of its local bodies may be a meaningful estimate. There is still the problem of depreciation, however. If there is depreciation, the incremental per capital technique will yield a higher than actual incremental capital cost estimate. However, depreciation of public facilities may be low and not great enough to worry about.

Using an incremental actual capital expenditure ratio may result in a downward biased estimate of actual capital costs attributable to OCS activity. First, to the extent that OCS activity creates an increased demand for public facilities, but these activities cannot be taxed to pay for the facilities, there may be a decline in the quality of public services, as evidenced by a lower incremental per capita expenditure ratio than the historic average capital costs per capita. This may be more of a problem for primary impact parishes and may be insignificant for the state as a whole. This suggests that using primary impact parish actual incremental ratios may be inappropriate. Second, statewide ratios embody overall population- and production-induced capital requirements. OCS activities may require "abnormal" production-induced public facilities which would not be captured in statewide ratios. Because of this, such "abnormal" public capital costs should be identified on a case-by-case basis in each primary impact parish, or in a sample of these parishes. Because of the first bias, it would not be appropriate to use the incremental ratios for the primary impact parishes to eliminate the second bias.

6.5.2.2. The Average Cost Per Capita Approach

The second variant of the actual capital expenditures per capita is to use to ratio of annual capital expenditures to total population. This technique would accurately measure the incremental capital costs attributable to OCS activity if all public capital completely depreciates and is replaced in each year the average ratios are computed. This assumption, in effect, puts all state residents on the same basis as the new OCS related population. If the total capital stock has to be replaced, then the average capital cost ratio is a meaningful ratio. Obviously, this assumption is not realistic. This means that the lower the depreciation rate of capital--hence the lower the amount of replacement capital--the greater the relative amount of OCS related capital facilities and the less the relative quantity of capital facilities to service the non-OCS population. This, in turn, means that if one uses the average capital cost ratio to estimate OCS capital impact, he will drastically underestimate the true OCS capital cost. This explains our reluctance--despite thier ready availability--to recommend the use of these average ratios.

The ratio technique is implicit in those studies which use total expenditures (operating plus capital) per capita in estimating public service costs of a particular activity. This is an inferior technique and its use can be justified only if budgetary constraints prohibit the use of the incremental technique discussed in 6.5.2.1.

6.6. OCS Created Tax Revenues

The previous sections focused on estimating procedures for OCS impact costs. This section will briefly discuss the procedures for estimating OCS created tax revenues. We previously argued that the availability of OCS oil and gas has no real significant impact on refinery capacity location in Louisiana and we included in the cost impact methodology only those industries whose products and services were demanded by the OCS industry--i.e., the immediate suppliers of the OCS--the OCS industry itself and the gas processing industry. One can reasonably assume that further levels of activity generate revenues sufficient to offset whatever deficits or surpluses result from the first two levels of activity. It would defeat the purpose of the study to assume that the revenues resulting from OCS activity itself equal the product of statewide, or even parish-specific, per capita revenues times the population generated by the first two levels of activity.

There are two techniques which could be used to estimate revenues: (1) the I-O approach which is virually identical in its mechanics to the use of I-O to estimate cost impacts, and (2) the specific enumeration approach. The I-O approach requires estimates of tax revenues per unit of activity, measured either as sales, output, or income. For example, suppose the fabrication of each platform generated y dollars in state and local revenues. Total tax revenues would equal y times the number of platforms constructed. Or suppose state income taxes were, on average, x dollars per dollar of income. Increased income tax receipts could be estimated knowing average earnings of employment in the first two levels of OCS related activity associated with the <u>increase</u> in the number of employed workers and the increase in earnings of previously employed workers.[13] There is one major flaw in this approach--which is a problem in all I-O models--the assumption that tax revenues are proportional to the level of the activity. This is particularly not true for property tax revenues, at

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[13]Also, reduced welfare expenditures on the previously unemployed must either be deducted from costs or added to revenues. Increased costs and revenues related to production are more straightforward than increases costs and revenues related to population, since assumptions regarding population location and employment status must be made.

least in the short run. If the technique is used, there must be some way of separating revenues that vary directly with OCS activity levels from those that do not.

The I-O approach would require the following information from a sample of firms directly engaged in OCS activity or supplying inputs to OCS activity:

(1) Property and non-property state and local tax payments by firms of both types.

(2) Total sales for firms of both types and direct sales to OCS activities for OCS suppliers.

This technique requires primary data collection and may face opposition from firms. Another problem with this technique is that caution must be exercised to avoid the case whereby a supplier firm pays x dollars in tax, has y percent of its sales to OCS, yet pays no state taxes on the OCS activity, due to OCS input tax exemptions. The researcher must know the portion of a firm's taxes which are applicable to OCS.

The specific enumeration technique requires a higher level of abstraction, less data collection, and avoids the problem of attributing a firm's taxes to OCS-related production when, in fact, sales to OCS are exampted. This procedure requires the following:

(1) A catalog of the types of state and local taxes and rates to which the OCS firms, OCS suppliers, and population are subject.

(2) An estimate of the increase in the relevant tax bases resulting from the OCS activities.

The second set of information would be the most difficult to obtain. However, more or less accurate estimates could be made. Employment created increases in tax revenue would be estimated once the previous employment status and location of workers is known. Corporate profits taxes could be estimated assuming an average profit/sales ratio. Sales taxes could be estimated once OCS exemptions are known. Property taxes would consist mostly of taxes of on-shore structures. These taxes depend on local assessment procedures and exemptions to property taxes. Property taxes would be the most difficult to estimate and may be large, meriting intensive consultation with taxing agencies.

A related methodology which might be employed is the series of estimating ratios which were utilized in the Woodward-Clyde study summarized above. Their methodology was fully discussed in 2.3.4. and will not be repeated here.

CHAPTER 7
ENVIRONMENTAL COSTS AND BENEFITS

7.1. Introduction

There is a wide range of ecological effects resulting directly and indirectly from OCS activities.[1] Some of these effects may be desirable, such as the creation of aritificial reefs; while some may be undesirable, such as destruction of wetlands. In order to obtain a measure of the "net ecological impact" of OCS activities, it would be necessary to:

(1) Quantify the relationship between the level of OCS activity and the various types of ecological effects--the "dose-response" function.

(2) Assign a common unit of measure, such as dollar values, to the various effects.

At this time, there are no well established techniques for doing either of these. However, this section will describe the useful work that has been done in these areas.

Most of the work related to the ecological impact of OCS activity has focused on:

(1) Descriptions of effects rather than precise quantification of intensity relations.

(2) Quantification of ecological impacts of oil spills.

(3) Quantification of land loss.

(4) Quantification of water quality effects of drilling and laying pipelines onshore and offshore.

An example of the first type is the conclusion by Gulf Universities Research Consortium (1974) that drilling platforms may act as artificial reefs for fishes and invertebrates, to the benefit of sport and commercial fishing industries. However, it is not known how this would reduce fishing

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[1]For a brief outline of the types of effects, see BLM, Final Environmental Statement, OCS Sale #41, Vol.1, pp.372-466.

search costs or increase yields. Studies of the second type are represented by analyses of the effects of oil on fish, fowl, and shellfish.[2] Examples of the third type include calculations of surface area lost to fishing,[3] and land loss due to pipeline canal construction.[4] Examples of the fourth type include the studies of drilling and pipeline laying effects on plankton, benthos, and nekton.[5]

There have been several attempts to relate ecological effects to economic activity. The most thorough model was developed by Isard, in which rows and columns representing ecological processes were added to the traditional I-O model.[6] However, this model remains primarily at the conceptual stage. A second ecologic-economic model has been developed by the Environmental Protection Agency. It predicts air and water pollution levels as a function of the levels of economic activity and population.[7] This model has been used in at least one OCS impact study.[8] The Louisiana

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[2]See BLM, Final Environmental Statement, pp.412-445.

[3]Ibid., p.424.

[4]Private communication with Gener Turner, Center for Wetland Resources, Louisiana State University, Baton Rouge. To illustrate the complexity of the environmental issues, Kilegan and Ularris (1973) conclude that some closed-off canals can be used as fish and shellfish farms. ("Mariculture Potential in Estuarine Oil-Pipeline Canals," Proceedings: Gulf Caribbean Fisheries Institute, 23: 75-80).

[5]See BLM, op. cit., pp.372-399.

[6]Isard, W., Ecologic-Economic Analysis for Regional Development, (The Free Press, New York, 1972).

[7]Strategic Environmental Assessment System.

[8]Reinfeld, Kenneth D., et. al., "Economic Study of the Possible Impacts of a Potential Baltimore Canyon Sale, Technical Paper No.1, Bureau of Land Management, New York Outer Continental Shelf Office, (December, 1975).

State University Center for Wetland Resources has attempted to quantify the value of fish as a result of pipeline construction in wetland areas.[9]

Even when ecological effects have been quantified, the assignment of dollar values to those effects involves very stringent assumptions. Most of the economic studies of ecological effects have been limited to assigning dollar values to varying air and water pollution levels. There have been mainly two types of attempts to measure the dollar costs of pollution. The first type catalogs the effects of emissions, assigns a dollar value to each of the effects, and sums up the costs. For example, a given quantity of raw sewage at a particular time and place will kill a given number of fish and cause a given amount of disease in the human population. The value of the killed fish plus the cost of the disease would represent the cost of the emission.[10] The second type attempts to measure pollution costs by estimating how much people would pay to avoid a polluted area. This has been done by land value studies,[11] wage rate studies,[12] and surveys.[13]

The first technique is applicable as long as the "dose-response" function is quantified and economic values can be placed on the responses. However, it may understate the pollution costs if all responses are not

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[9] This study assumes that a loss of wetland area causes a proportionate loss of fish, a strong assumption. Personal communication with Gene Turner, Center for Wetland Resources, Louisiana State University.

[10] For example, Waddell T.E., The Economic Damage of Air Pollution, Socioeconomic Environmental Studies Series, May, 1974.

[11] For example, Ridker, R.G., and Henning, J.A., "The Determinants of Residential Property Values with Special Reference to Air Pollution," Review of Economics and Statistics, May, 1967, Vol.49, No.2, pp.246-257.

[12] For example, National Academy of Sciences, "The Costs and Benefits of Automobile Emission Control," Air Quality and Emission Control, Vol.4, prepared for the Committee on Public Works, U. S. Senate, Serial No.93-24.

[13] For example, Randoll A., Ives, B., and Eastman, C., "Bidding Games for Valuation of Aesthetic Environmental Improvements," Journal of Environmental Economics Management, August, 1974, pp.132-149.

specified. The second technique is useful for measuring the costs of pollution in general. However, its use requires the ability to control for all non-pollution variables affecting the variations. This technique is clearly inappropriate for measuring pollution effects on non-marketable wetlands and ocean areas.

The major ecological effects of OCS activity will arise due to:

(1) Spills, either at the wells or along pipelines.

(2) Channelization of wetlands for pipelines and offshore access.

(3) Resulting economic activity onshore.

The ecological costs of spills must be evaluated on a case-by-case basis, so will not be dealt with here. The second and third causes create annual costs and are discussed below.

7.2. Channelization of the Wetlands

Canals have been constructed through Louisiana estuaries for pipelines, navigation, and access to estuarine oil and gas production areas. The area of the marshland destroyed equals the sum of the canal surface area plus the area of spoil banks and dredge spoil disposal sites. One study has shown that the marshland area in Louisiana destroyed as a result of canals is from 4 to 9 percent of the total Louisiana marshland area. However, not all of this area is a result of canals created for OCS purposes. Canals providing access to estuarine oil and gas producing areas could not be considered OCS related; some pipelines do not serve OCS areas; and navigation canals are used for both OCS and non-OCS related activities. In order to measure the cost of OCS related channelization, one must:

(1) Measure the marshland area destroyed as a result of OCS activity.

(2) Estimate a cost related to the lost marshland.

A minimum estimate of the marshland lost as a result of OCS activity would be the canal area used by OCS pipelines, pipeline terminals, and gas plants. This would require an enumeration of all OCS pipelines, terminals, and gas plants located in wetland areas.

Estuarine dependency of commercial fish species ranges from complete estuarine dependency (Virginia oyster) to species using estuarines as nurseries (shrimp and menhaden).[14] In 1967, 85 percent of the ex-vessel values of estuarine-dependent Louisiana commercial fish landings consisted of shrimp and menhaden. The filling or diking of estuarine areas will have a direct relationship to the commercial shrimp and menhaden stock.[15] However, some estuarine channels may improve estuarine conditions by creating access to previously inaccessible marshes.[16] An estimate of the annual cost of OCS created pipeline canals, terminals, and gas producing plants would be to assume that the marshland area lost as a result of these OCS purposes results in an equal percentage loss in the value of estuarine-dependent commercial fish landings. This may be an over-estimate of the effect of these particular OCS marshland uses on commercial fishing since some channelization may be favorable to fishing.[17] This loss of fish value would be divided between loss of Louisiana and non-Louisiana consumer surplus and loss of Louisiana and non-Louisiana factor income.

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[14] Granville H. Sewell and Robert F. Hillman, The Future Economic Value of Estuarine-Dependent Commercial Fisheries, (EPA, April, 1971), pp.B10-B11.

[15] Ibid., p.B15 and B17.

[16] Ibid., p.B15.

[17] Also, the long term effects of channelization are unknown and may be smaller than the short term effects.

Although channelization may inhibit the growth of furbearing animals, the quantification of these effects is impossible given the lack of dose-response information.

7.3. General Economic Activity

The increased economic activity resulting from OCS activity will generate increased air, water, and aesthetic pollution. This pollution will result from both the production stimulated by OCS activity and the increased population concentrated in the areas of production activity. At present, techniques exist to quantify only the emission coefficients for point-source air and water pollution. These techniques are described below.

Air pollution emission coefficients have been used in several studies to relate population and production activity to the following pollutants: particulates, sulfur oxide, nitrogen oxide, hydrocarbons, and carbon monoxide. An Environmental Protection Agency (EPA) study has quantified the pollution outputs per unit of activity for the sources shown in Table 7-1.[18] One BLM study has used this model to predict onshore pollution effect of OCS activity.[19] A less sophisticated technique has been used in a study by a team at the University of New Orleans to derive similar dose-response coefficients.[20] We would recommend using the EPA model.

Water pollution emission coefficients were also used in the above mentioned studies to estimate the effects of economic activity on biological oxygen demand, suspended solids, heavy metals, nitrates, phosphates, and oil

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[18] This model is known as the Strategic Environmental Assessment System (SEAS) model.

[19] Kenneth D. Reinfeld, et. al., *op. cit.*

[20] Anthony J. Mumphrey and Thomas F. Whalen, "Economic Growth, Life-style Preferences, and Urban Size," (University of New Orleans, 1976), unpublished paper.

TABLE 7-1

Major Air Pollutants Associated by Source[a]

SOURCE	MAJOR POLLUTANTS[b]
TRANSPORTATION	
Personal (Automobile and Bus)	SP, SO_x, NO_x, HC, CO
Freight (Trucks)	SP, SO_x, NO_x, HC, CO
RESIDENTIAL FUEL USE	
Natural Gas	SP, SO_x, NO_x, HC, CO
Distillate Oil	SP, SO_x, NO_x, HC, CO
COMMERCIAL FUEL USE	
Distillate Oil	SP, SO_x, NO_x, HC, CO
INDUSTRIAL FUEL USE	
Coal, Gas, Oil	SP, SO_x, NO_x, HC, CO
ELECTRIC UTILITIES	
Oil	SP, SO_x, NO_x, HC, CO
INDUSTRIAL SOURCES	
Gas Processing	SO_x, NO_x, HC
Construction	SP
Petroleum Refining and Storage	HC
Others (Chemicals, Manufacturing)	SP, SO_x, HC
CONSUMER ACTIVITIES	
Dry Cleaning	HC
Painting	HC
Gasoline Service Stations	HC

[a]Kenneth D. Reinfeld, *op. cit.*, p.220.

[b]Suspended Particulates (SP), Sulfur Oxides (SO_x), Nitrogen Oxides (NO_x), Hydrocarbons (HC), and Carbon Monoxide (CO)

and gas emissions into water systems. Again, the EPA model is recommended for this study.

The increased levels of activity in the various industrial sectors and the increases in population due to OCS activity can be used along with the emission coefficients obtained from the above-mentioned studies in order to obtain the total physical quantities of harmful air and water emissions. The next task is to assign dollar costs to these physical quantities. This requires two steps:

(1) Quantification of dose-response functions.

(2) Assignment of dollar costs to the response.

Attempts have been made to quantify the economic costs of air pollution, so air pollution will be discussed first.

There have been attempts to quantify the effects of air pollution on human health, materials, vegetation, aesthetics, soiling, animals, and the natural environment in general. Several studies have estimated the effects of air pollution on real estate market values. Most investigators agree that costs associated with organoleptic effects as well as soiling-caused cleaning and maintenance expenditures are capitalized in this estimator.[21] These studies found that the marginal capitalized sulfation damages in the urban areas studied ranged from a \$100 to \$600 increase in mean property values for each 0.1 mg $SO_3/100\ cm^2$ day increase in sulfation. If the area of major economic activity resulting from OCS activity is defined and the sulfur output resulting from this activity is quantified, the annual sulfation costs of soiling and aesthetic effects can be calculated as follows:[22]

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[21] Thomas E. Waddell, "The Economic Damages of Air Pollution," (U.S. Environmental Protection Agency, May, 1974), p.27.

[22] The obvious pitfalls of this approach are:

1. Assuming linearity
2. Assuming rural = urban effects
3. Defining the affected land area

$$\textit{Capitalized Damage} = \left(\frac{\textit{Mg Sulfer Output/Day}}{\textit{Land Area in } cm^2}\right)\ 100 \times (\$100 \text{ to } \$600) \times$$
(Number of Households in Land Area)

Annualized Damage = (Discount Rate) x (Capitalized Damage)

The only other types of air pollution effects whose dose-response functions have been calculated are morbidity and mortality. The EPA has initiated the Community Health and Environmental Surveillance System (CHESS) program which relates selected respiratory diseases to pollution composite.[23] Lave and Seskin used multivariate regression techniques to explain variations in mortality rates across cities as a function of sulfate and suspended particles pollution. After making assumptions about the value of work days lost as a result of respiratory disease and the value of human life, the health costs of OCS created air pollution can be approximated.

Unfortunately, little work has been done on quantifying the economic effects of water pollution. The effects of water quality can be broken down into aesthetic, ecological, human health, and production effects. One study has suggested that recreation, a subcategory of aesthetics, is the single most important source of monetary costs of water degredation.[24] Whether or not this is true remains unknown, since few studies have established relationships between economic costs and water quality.[25] Any attempt at estimating the effects of OCS created water pollution on re-

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[23]C.M. Shy, et. al., "An Overview of CHESS," in Health Consequences of Sulfer Oxides: A Report from CHESS, National Environmental Research Center, Research Triangle Park, North Carolina.

[24]David L. Jordening, Estimating Water Quality Benefits, (EPA Office of Research and Monitoring, August, 1974), p.7.

[25]As an example, see Herbert M. Stoevener, et. al., "Multi-Disciplinary Study of Water Quality Relationships: A Case Study of Yaquina Bay, Oregon," Oregon State University, Special Report 348, February, 1972.

creational activities in Louisiana estuaries would be pioneering and expensive. However, the benefit/cost ratio of such a study may be high.

In summary, the ability to make estimates of environmental costs of particular activities is hindered by the lack of crucial data. The best quantified data are the pollution outputs per unit of economic activity. There is little quantification beyond this. Data on the environmental effects of this ecological output, the dose-response functions, are poorly quantified.

The economic value of these environmental effects are not well quantified. However, economists have been able to assign some economic values to some effects. Finally, the interdependencies of ecological and economic systems have been recognized in only an elementary form. Even if the first level effects of pollution are known, secondary effects cannot be quantified without some type of economic-ecologic input-output model, as suggested by Isard. For example, if pipelines destroy wetlands, and wetlands are inputs into ecologic processes, say shrimp production, a long chain of currently unquantifiable ecologic and economic effects are generated.

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University of New Orleans.

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APPENDIX A

MAJOR PRODUCERS OPERATING IN LOUISIANA'S OCS

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Offshore-Frontier Production Region
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Houston, Texas 77001

Mr. C. D. Hudson
Atlantic Richfield Company
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Houston, Texas 77001

Mr. Joe Stasney, Jr.
Bass Enterprises Production Co.
3100 Ft. Worth Nat'l Bank Bldg.
Ft. Worth, Texas 76102

Mr. Frank K. Little
Belco Petroleum Corporation
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Mr. W. P. Oliver
Burmah Oil and Gas Company
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Mr. Jim Reaux
Camco, Inc.
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Mr. D. Goodwill
Champlin Petroleum Company
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