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Modeling the Economic Impacts of Offshore Oil and Gas Activities in the Gulf of Mexico: Methods and Applications

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ABSTRACT

Recent changes in oil and gas activities on the Gulf of Mexico (GOM or Gulf) Outer Continental Shelf (OCS) have sparked interest in the economic impact that these activities have on coastal regions. Over the past several years, the MMS has initiated a number of different research projects of increasing degrees of sophistication, attempting to examine the relationship between OCS activity and the socioeconomic environment of coastal regions on the GOM. Recent MMS approaches have included the use of a common methodology known as Input-Output (I-O) modeling. I-O models examine relationships between industries and other economic agents within an economy. The mathematical formulae used to construct an I-O allow a researcher to simulate the effects that a change in one or several economic activities has on the entire economy.

A shortcoming with most I-O analysis is that the impact drivers (or multipliers) in the model are typically taken from sampled, nation-wide survey data. One primary driver in these models is the production function (or cost function) matrix that is an industry-specific calculation dividing commodity-specific input expenditures by total commodity input expenditures. These ratios are generally calculated from nationally, rather than regionally, relative production expenditure profiles. Such an approach assumes that industries in any given area will use inputs in the same proportion as the national average. For oil and gas firms operating on the Gulf OCS, this assumes that input expenditures are made in the same proportion as the national oil and gas industry average. Such an approach averages production costs shares from such varied regions as Alaska to the offshore GOM.

This report addresses a number of methodological shortcomings in the application of I-O analysis to the oil and gas industry. Our report presents examples of how the two approaches present differing empirical conclusions and why some modifications are in order. We offer a number of practical and applied alternatives to existing methods, as well as suggestions on improving production function and other standardized input data, to improve the understanding of how the oil and gas industry impacts coastal communities. We use coastal Louisiana as a case study for examining the implications of our work.

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1978 (OCSLAA), and the National Environmental Policy Act of 1969 (NEPA). Section 18 of the OCSLAA mandates that MMS management of the OCS shall consider the "economic, social, and environmental values of the renewable and nonrenewable resources contained in the Outer Continental Shelf, and the potential impact of oil and gas exploration on other resource values of the marine, coastal, and human environments" (43 USC 1344). "Human environment" includes "the physical, social, and economic components, conditions, and factors which interactively determine the state, condition, and quality of living conditions, employment, and health of those affected, directly or indirectly, by activities occurring on the Outer Continental Shelf…"(43 USC 1333).

NEPA requires federal agencies engaged in significant land actions to assess impacts, including those on the human environment, through the process of conducting Environmental Impact Statements (EIS) (MMS, 1996). The Council on Environmental Quality's (CEQ) Regulations for Implementing the Procedural Provisions of NEPA state that the human environment is to be "interpreted comprehensively" to include "the natural and physical environment and the relationship of people with that environment" (40 CFR 1508.14). An action's "aesthetic, historic, cultural, economic, social, or health" effects must be assessed, "whether direct, indirect, or cumulative" (40 CFR 1508.8). CEQ regulations state that when "economic or social and natural or physical environmental effects are interrelated, the EIS will discuss all of these effects on the human environment" (40 CFR 1508.14).

Over the past several years, the ESP has become increasingly engaged in the socioeconomic research of coastal communities in support of its EIS mission for the GOM Region (GOMR). In the past 10 years, the quantity of research funded under this program has tripled. While one cannot predict funding levels in years to come, a recent meeting of social scientists and researchers indicated that interest and commitment to these issues will continue to be strong.

Of the three major MMS regions (Alaska, Pacific, and Gulf of Mexico), the Gulf of Mexico appears to have a pressing need for continued socioeconomic impact analyses. The Gulf, in addition to providing a significant number of reserves and production, is also undergoing unique developments in both deepwater activity (900 meters and deeper) and the potential development of frontier areas in the eastern Gulf off the coast of Florida. In addition, drilling moratoria and uncertainties in the Pacific and Alaska make GOMR the only place where significant action is envisioned over the next several years.

1.2 Examination of Past Economic Impact Studies and Methods: As early as the mid-1980s, the GOMR began its efforts to model the implications that offshore development had on coastal communities. For close to 10 years, however, a good portion of these regional modeling initiatives focused more on past consequences of OCS oil and gas development than on predictive or forecasting methods. These initiatives could be broken into two general categories: (1) individual historic "consequences" analyses; and (2) the development of baseline analyses (Luton and Cluck, 2000). Information from both types of studies was regularly used as a basis for understanding economic impacts to local communities for EIS purposes.

This study employs an Input-Output (I-O) modeling framework. Such an approach attempts to shift the direction of analysis away from historical consequences and towards more forwardlooking impacts. Over the past several years, there has been a concerted effort by the MMS to develop increasingly more sophisticated modeling approaches that incorporate both quantitative rigor and applied realism. One of the first studies to examine offshore activities from a more rigorous and applied perspective was conducted by Foster Associates (FA Study) for the federal waters off the coast of Alabama (Kelley and Wade, 1999; Wade and Mott, 1998). The FA Study revealed a number of unique expenditure patterns that were required to support production of caustic (high H_2S) natural gas. The results of the FA Study help move MMS in the direction of: (1) employing I-O models as a basis for measuring the economic impact of all offshore activities and (2) incorporating real-world differences in the production characteristics of particular offshore areas.

The FA Study also highlighted one of the major advantages of moving forward with the use of I-O models – their ability to allow a researcher to simulate the effects that a change in one or several economic activities would have on the entire regional economy. It is predictive in the sense that the economic impacts associated with hypothetical events, like the opening of several new offshore blocks in the Gulf of Mexico, can be quantitatively modeled. The approach is also comprehensive since the I-O structure allows researchers to understand how exogenous shocks impact entire regional economic systems, and not just the limited impacts on particular sectors like only oil and gas activities.

In addition to breadth, these studies also provide depth of quantitative information. I-O techniques offer the advantage of measuring the direct, indirect, and induced impacts associated with offshore activities. The indirect and induced impacts are commonly referred to as "multiplier impacts" associated with a direct economic shock. These multiplier impacts quantify the idea that a dollar impact has ripple effects throughout a regional economy.

1.3 Purpose of This Study:

Section 2: How Are Economic Impacts of Offshore Activities Modeled?

2.1 Defining Offshore Expenditure Profiles: The exploration, development, operation and eventual decommissioning of offshore facilities is a considerable logistic challenge. These challenges are often revealed in the types of expenditures that are made by offshore operators. Thus, the first step in an analysis of this sort is to define a relevant set of expenditure categories taking into account many of the unique offshore oil and gas activities. Some of the expenditure categories that have unique implications for offshore oil and gas activity phases include:

Water and Air Transportation: Modes of transportation that are important in moving both personnel and equipment from onshore supply and staging bases to areas supporting offshore activities;

Food and Catering Services: Often food and catering services are contracted by offshore operators to feed crews supporting exploration, development, and production activities;

Water Supply: Potable water for drinking, as well as water for certain types of drilling muds, lubricants, and fluids, have to be transported to offshore areas;

Waste Disposal: While this activity is important to both onshore and offshore activities, transportation and onsite storage can create a number of unique logistical challenges to offshore activities;

Turbines and Fuel: Most offshore platforms have both primary and secondary power generation equipment as well as primary, and in some cases secondary, fuel to operate these generators; and

Communications, Instrumentation and SCADA (supervisory control and data acquisition) Systems: Digital and mobile technologies have had a growing importance for offshore activities.

During the course of this research, MMS was provided with a comprehensive listing of the unique expenditure categories, and their IMPLAN sector identifications. The categories used in modeling the economic impacts of offshore activities have been provided in Table 2.1.

Table 2.1: Offshore Expenditure Categories

IMPLAN Sectors	Sector Description	IMPLAN Sectors	Sector Description
38	Oil & Gas Operations	399	Transportation Equipment, NEC
50	New Gas Utility Facilities	401	Lab Equipment
53	Msc Nat Resource Facility Construct	403	Instrumentation
56	Maintenance and Repair, Other Facilities	435	Demurrage & /Motor Freight
57	Other Oil & Gas Field Services	436	Water Transport
160	Office Furniture and Equipment	437	Air Transport
178	Maps and Charts (Msc Publishing)	441	Communications
206	Explosives	443	Electric Services
209	Chemicals, NEC	[illegible]	[illegible]

$4 million per well, then the total direct economic shock would be $20 million. The next step in the process is to allocate this $20 million impact by the expenditure profile developed for exploratory drilling.

It is important for impact modeling to develop different expenditure profiles by activity phase given their tendency for variability and substantial compositional differences. In addition, there is a tendency for expenditure patterns, and their relative compositions, to shift as the development of a potential lease matures. This has implications for economic impacts since many expenditures can move from more capital intensive, construction-oriented activities in the exploration, development, pipeline, and gas processing construction phase, to more labor intensive, maintenance oriented activities in the production, workover, gas processing and transportation activities.

For instance, steel pipe expenditures can represent anywhere between 35 to 59 percent of total

2.4 Defining the Onshore Allocation of Offshore Activities: The allocation of expenditures to onshore areas is probably one of the more important factors for determining the region-specific economic impacts associated with offshore activities. These break-outs are important because they define the localities that are most affected by what happens offshore. There are historic tendencies for certain onshore support activities to be concentrated in particular geographic areas. This concentration has historically been primarily in Louisiana and Texas, and has continued despite the movement of offshore activities into deeper water and into the Central-Eastern portions of the Gulf of Mexico.

Part of this research included the development of allocations for offshore expenditures, by commodity categories outlined in Table 2.1, to the 10 major onshore regions defined by MMS that has been presented in Figure 2.1. Additional areas included in the analysis include the non-coastal Gulf of Mexico, and Rest of US/World (ROW).

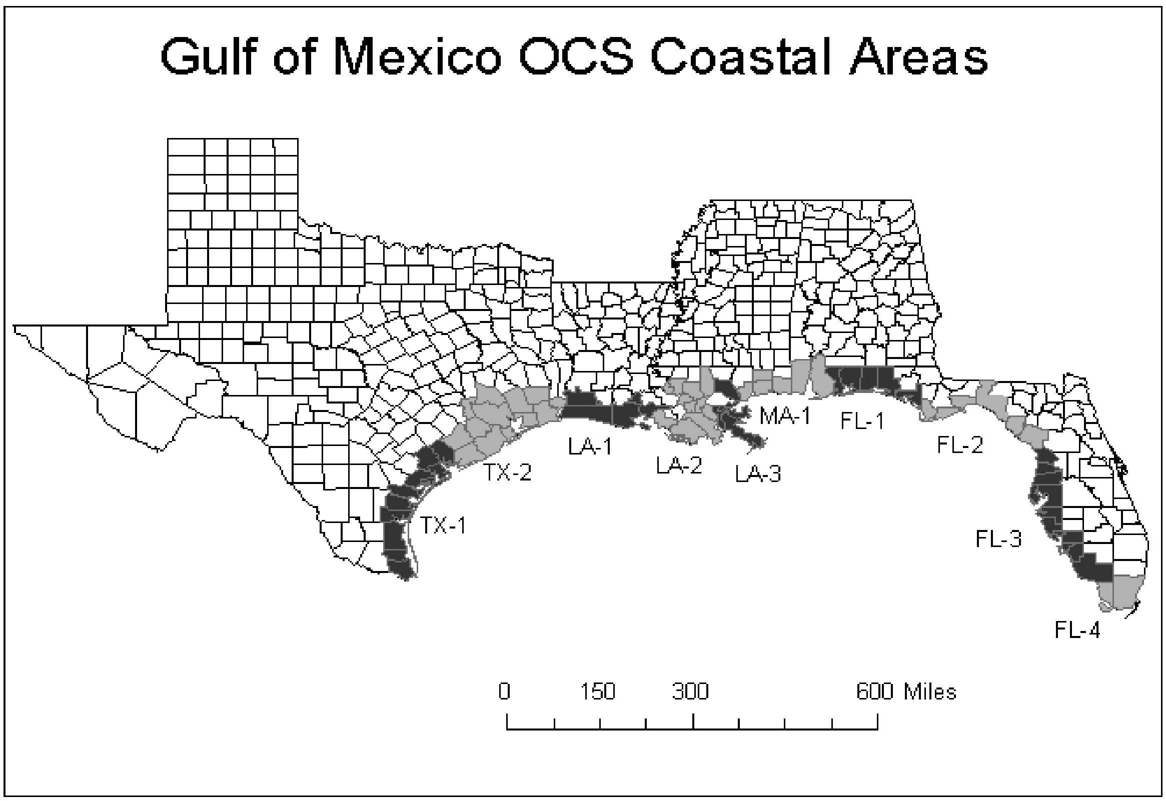

Figure 2.1: MMS Gulf of Mexico Coastal Areas.

2.5 Data Collection Issues and Challenges: During the course of this analysis, two data collection issues became particularly important:

(1) How to identify, locate, and secure reliable sources of information that did not require the use of survey instruments; and

(2) How to reconcile reported accounting information to economic factors examined in traditional input-output modeling.

The first issue was the more problematic of the two and one that can confound time-sensitive MMS social science research. This research needed to find a way to collect information that did not use survey or survey-type instruments. Therefore, mailing survey questionnaires to numerous companies operating offshore was not allowed. This restriction on data collection is placed on MMS, and other federal agencies by the Paper Work Reduction Act of 1980, which was reauthorized in 1995.

This purpose of the Act is to minimize the paperwork burden the federal government places on the public and to improve the quality and use of federal information (Lauterbach, 2000). The Act also requires each federal agency to seek and obtain approval from the Office of Management and Budget (OMB) before requesting information from ten or more persons. Furthermore, any reporting, record-keeping, or disclosure requirement contained in a rule is deemed to involve ten or more persons. OMB approval is also needed to continue a collection for which OMB's approval and the validity of the OMB Control Number are about to expire. OMB usually approves a collection for a maximum of three years.

In order to use a survey-based approach for this research project, a survey instrument review process would have been initiated that, under the best of situations, would have taken six to eiv 5this research pr

Section 3: Alternative Methods and Approaches to Modeling Economic Impacts

The previous section of this report outlined the main methodological issues associated with developing unique offshore production function, total cost, and allocation information. This section, divided into two parts, will discuss the actual mechanics of compiling information in each area. First, the production function and total cost information analysis, per activity phase, is discussed. Second, the collection and results from the onshore allocation analysis is described.

3.1 Exploratory Drilling: The first task undertaken was a comprehensive search for information that decomposed costs into specific cost categories for exploratory drilling activities. Such information would facilitate the development of an expenditure profile. This research canvassed a number of areas that included trade journals and magazines, technical reports, government research and analysis, and the academic literature. The research revealed little to no publicly available information. The only source identified was a drilling cost survey conducted by the Independent Petroleum Association of America (IPAA) in the early 1990s. The purpose of this IPAA survey was twofold: it examined cost allocations (expenditure profiles) for typical drilling activities, and it attempted to track cost inflation, by component, across time. This survey, unfortunately, suffered from two shortcomings. First, it examined only onshore drilling and equipping wells. Second, the survey was discontinued for cost reasons in 1994, and even here was aggregate continental United States data.

Given the lack of available information, the research turned to alternative information sources. The first alternative source of information that was relied upon came from industry. A number of industry sources offered accounting information on booked annual expenditures for exploratory wells. These accounting reports are referred to as either Allowances for Expenditures (AFE) or "Post Well Critiques." The information is provided in an accounting format, and more specifically, in the accounting format of any given company providing the information. The challenge in using this data was to take identified expenditure categories and reconcile them to standard Implan codes.

The second source of information relied upon was a type of engineering project cost estimation software known as Fieldplan Pro. This software, developed by Brown and Root, is regularly used by the MMS GOMR Office of Resource Evaluation for a variety of purposes. This software is developed in a manner that allows users to "price-out" a particular oil and gas project under different drilling and/or production configurations in the Gulf of Mexico. In this portion of the analysis, a number of hypothetical projects in the Gulf were developed and run through the perspective in understanding the difference in cost and expenditure allocations. Third, Fieldplan breaks costs into categories without any assumption on who performs those functions. This helps avoid the problem associated with contracting services. All costs are "internalized."

Appendix Table A.1 presents a breakout of the estimated exploratory drilling expenditure profiles. Expenditure profiles for each water depth have been presented in a column. The far right column presents a simple average across all water depths. The overwhelming proportion of expenditures for exploratory drilling falls into Implan Sector 38: Oil & Gas Operations. This sector classification is essentially a "catch-all" category for a number of different activities that includes technical engineering work, drilling work, mobilization, site preparation, rig moving expenses, among others. After consultation with industry sources, it was concluded that a large portion of shallow water drilling costs were allocated to contractor services. As operations moved into deeper waters, more of these activities tended to be performed by more in-house personnel, hence the relative decrease in Implan Sector 38 activities. The remaining expenditure categories include: oil and gas field services; instrumentation; and transportation (air and water).

Deviations across water depth were relatively minimal since the output from Fieldplan Pro was relied upon quite heavily. This is particularly true for Implan Sector 38 expenditures, which is the main cost driclaer depth c -13.8 TD -0.017rAd gas fiel13.8 or 38txs5r The far 484 ( )f( )dustry bsitl

Table 3.2: Comparison of Water Depth and Development Drilling Depth

Water Depth (Meters)	

there are some differences worthy of note. First, Sector 38: Oil & Gas Field Operations, which consists primarily of engineering functions, is stable in absolute value across water depths. On a relative basis, however, these activities decrease in the deep-water categories since a number of other activities are strongly influenced by water depth. This is most notable in both air (water decreases as a percentage) transportation and insurance costs, which increase dramatically as operating water depth is increased.

Clearly, transportation costs increasing as water depth, and hence, distance, increases probably comes as no surprise. What is interesting, however, is the increase in insurance costs. Theory suggests that insurance premiums should increase as the net expected value of a loss increases. This can change by either higher probabilities of a loss, or increased value of lost equipment, production, property, and life associated with deeper water activities, ceteris paribus.

Total costs were developed using the EIA price-out approach. These total (annual) costs have been presented in Appendix Table A.13. These costs appear to be reasonable and follow relatively stable trends. Costs are increasing over water depth, but in a fashion that seems to account for strictly depth-specific costs such a transportation (deeper water translates roughly to further distances) and insurance (deeper water translates into higher expected value of a loss associated with an offshore accident).

3.4 Platform Fabrication: Publicly available information on platform fabrication is sparse. Some recent media reports, for instance, have been known to cite total cost estimates for constructing platforms, yet these reports are usually sporadic, isolated, and focus on the more recent (deepwater) projects. In addition, these reported figures can often clutter total project cost information with total platform-specific costs.

Early in the project, some generalized, but highly subjective information, from the University of New Orleans School of Naval Architecture was secured. The opinion oriented nature of the information, along with the lack of breadth in its scope led to searches for supplementary and corroborating information. Given the lack of published alternative information, this research turned to the Fieldplan simulation tool as a source for verification and to supplement the information provided by UNO.[2]

Fieldplan runs examined three different construction options within each different water depth. Each option, however, was limited to a "typical" type of platform/offshore structure. In the 0-60 meter water depth, for instance, three different fixed platform structure configurations were examined. The 60-200 meter category also examined fixed structures of a much larger scope than those employed in shallow water. In the 200-900 meter category, the fabrication/installation of three different types of tension leg platforms (TLP) were examined. In the 900 meter and deeper category, three different configurations of a Spar were used as the typical platform technology.

The next step in the analysis was to classify each of the engineering cost components to Implan codes. Subsequently, a set of blended estimates was developed based upon the three simulations.

[2] UNO was sent a table of likely platform fabrication cost components and asked to "populate" the table based upon subject matter expertise across various water depths.

modeling in mind. Second, FERC information could have certain biases since major transportation companies, that have both onshore and offshore operations, will dominate the sample.

In terms of using the FERC information, the initial challenge was to separate the important from unimportant information. The first report examined was the balance sheet, or capital asset composition, for each offshore pipeline company. In examining this information, the analysis concentrated on only those companies with offshore assets that file a FERC Form 6. The second report we examined was the income statement, that highlights major annual expenditures associated with output, or in this case, through-put.

The first task was to remove companies from both reports (balance sheet and income statement) that did not have offshore assets. The second step was to segregate companies by the primary water depths in which they operate. This was a required step since data is filed with the FERC on a "per-company," as opposed to a "per-pipeline," basis. Companies were assigned to water depths based upon the miles of pipeline segments they owned/operated within certain water depths. Pipeline segment ownership statistics were compiled from the Foster Associates survey on offshore pipelines, that is actually generated from data collected by the MMS.

The next step in the analysis was to map the cost and asset categories into Implan sectors. Fortunately, costs for all offshore pipeline companies are required to be filed under a FERC-defined Uniform System of Accounts (USOA). Our job was to map these USOAs into Implan Codes. After the relevant sectors were identified, two sets of allocations/profiles were developed: one associated with capital expenditures, and the other associated with operational expenditures.

The capital and operation expenditure profiles can be found on Appendix Table A.5 and Appendix Table A.6, respectively. Both of these profiles tend to be more erratic than most all of the other expenditure profiles developed during the course of this project. For the pipeline capital expenditures, a good portion of the allocation was concentrated in Sector 50 (New Natural Gas Facilities). The next most significant category was in Sector 313 (Oil and Gas Machinery).

The operational expenditures were concentrated heavily in Implan Sector 444 (Natural Gas Utility Operations). The next closest expenditure percentage was concentrated in Sector 56 that represents maintenance and repair of generally unclassified infrastructure investments. In general, both Sector 444 and Sector 56 are generalized "catch-all" categories for utility activities. This seemed to be the appropriate delegation of costs since these assets are primarily utility-oriented in nature.

Total costs for pipeline construction and operation were developed from two different sources. Construction costs were taken from the annual survey of pipeline construction costs reported in the *Oil and Gas Journal*. These construction costs are summaries of reported costs provided to the FERC in the *Certificate of Need and Convenience* filings that are required to certify pipeline construction operations. Operational costs, however, were developed from the FERC Form 6. The same method of allocating offshore pipeline companies to water depth, and then calculating costs, was facilitated.

3.6 Gas Processing and Storage Construction and Operation: The process of estimating gas estimates of typical spill costs and expenditure profiles based upon past spill information that has been collected for the Gulf of Mexico.

Three main sources of information were consulted in the development of total oil spill costs and cost expenditure profiles. These included: the *Oil Spills Intelligence Report* (1998); the *Oil* water transportation. Transportation is needed not only for moving crews in and out of the Gulf to remove structures, but also for removing the structure themselves.

Total costs were taken directly from sources provided in the CES-LSU report. These costs come from surveys of actual industry experience, and expectations for the types of costs that will be increased in the future. We extrapolated some of the past experiences, for instance, to develop very deep-water costs. This extrapolation was developed using a statistical estimation of the relationship between costs and water depth for past industry abandonment experiences. Given the lack of experience in deepwater abandonment, this was our only objective means for estimation.

3.10 Onshore Allocations of Cost:

Section 4: An Application: Modeling the Impacts of Offshore Activities on Coastal Louisiana

<u>4.1 Introduction:</u> The primary purpose of our work has been to develop estimates for the cost characteristics of offshore oil and gas operations. Our secondary objective has been to develop estimates of the economic impacts of offshore activities on coastal Louisiana. This analysis will serve as a case study, and test for reasonableness, for our estimates of offshore expenditure profiles, activity costs, and onshore allocations.

The impacts that have been simulated in this study are based on the MMS proposed lease program for oil and gas well developments in the Gulf of Mexico regions for the period 1997-2031. Our analysis was limited to an investigation of the economic impacts associated with exploration, development, and production activities. Exploration wells are wells drilled in search of new oil and/or gas resources usually to find and produce oil or gas in an unproved area; find a new reservoir in a previously productive field in another reservoir; or expand the limit of an existing reservoir. Development wells are drilled within the proved area of an oil or gas reservoir to the depth of a productive stratigraphic horizon, and they are used for potential production or to increase the production of a hydrocarbon accumulation discovered and delineated by previous drilling. Production wells are successful and completed wells that currently produce oil and/or gas. Important indicators of levels of economic and social aspect development in the designated coastal communities are presented below.

Table 4.1 Demographic, Social, and Economic Indicators of Louisiana Coastal Areas (1996)

Region	Area (sq miles)	Population	Employment	Number of Households	Total Personal Income ($000)	Income per Household ($)
LA1	4,403	492,449	284,040	177,916	9,833,829	55,272

284,040 177,916 [illegible]

4.2 Review of Impact Analysis Methodologies: Impact analysis in a region focuses on the interaction between economic policy changes and the implications that these changes have on the local economy. This type of analysis can estimate the effect that a change in economic policy, or shift in major industry decision, can have on a variety of agents within the local economy, such

Models that can be used to examine direct, indirect and feedback effects of exogenous policy shocks are more useful for forecasting change and making policy decisions than are models that can only show direct impacts. This is because, in reality, the workings of a local economy shows inter-sectoral linkages, implying that the effects of a particular policy will not only be felt by the sectors directly impacted but also by other sectors directly or indirectly linked to that sector (Shaffer, 1989). Examples of such encompassing models constitute the class of inter-industry models. It is this type of model that is employed here. Hence, the choice in this model is to use inter-industry analysis models because of their general equilibrium holistic treatment of the economy.

4.3 Inter-Industry Economy Wide Models:

market income and transfers, and SAM explicitly accounts for all monetary flows in the economy. Therefore, SAM provides a consistent picture of the flow

Regional impact models based upon survey methods are sparse given the significant costs associated with their creation. In contrast to the survey-based models, there are non-survey-based models, or the so-called "ready-made" approaches. Strictly non-survey techniques attempt to depict regional transactions without recourse to detailed primary data, using procedures that have been described as essentially mechanical. In non-survey models, national coefficients, a region's share of national production of goods and services, are modified based on aggregate regional data to produce estimates of regional coefficients using a variety of approaches including RAS, location quotients, supply-demand pool, or some other statistical methods (West, 1990).

These types of non-survey based models are very common, particularly in the U.S. Some of the popular ones include ADOTMATR, RIMS, RSRI, GRIT (for Australia), and Professional (IMPLAN). The IMPLAN modeling system, originally developed by the U.S. Forest Service, is by far the most popular of the ready-made approaches. These models are very tractable in cost and time to utilize, especially with rapid advances in computer technology. Evaluation of the impact studies' results using these models seems to suggest no significant differences in aggregate estimates obtained for output and income, but large differences were observed with respect to employment (Brucker, et al., 1987).

Between the extremes of survey and non-survey models lie those models that combine survey and non-survey data to depict regional economic structures. These are called the regional hybrid models, and they combine information from a field survey with a ready-made format such as the IMPLAN. Econometrics, linear programming, published data, or budget approaches may be used to generate the required coefficient from data collected from surveys. These coefficients are incorporated into the standard models in existence to simulate policy impacts in the region(s) concerned. In current practice, especially in the U.S, ready-made models are the preferred approach by regional analysts, because they seem to combine the advantage of cost-effectiveness with timeliness desired by decision makers (West and Jensen, 1993).

This study relies on IMPLAN for our basic model construction. However, our study can be described as a hybrid approach to economic impact modeling since we have incorporated industry-specific information on offshore oil and gas activities, by water depth, into the IMPLAN framework. Such an approach allows us to specifically model those sectors of the coastal Louisiana economy for which we are most interested. For other sectors, we will facilitate the more generalized default information provided within the IMPLAN model.

4.5 Regional Multipliers and Impact Analysis: The concept of multipliers is central in the understanding of regional economic models, because it defines and forms the basis of impact analysis. Multipliers are based on the fundamental notion that one person's expenditure is another's income, and since consumption usually increases when income increases, any extra expenditure feeds through into further expenditure. These effects become smaller and smaller through each spending round due to leakages.

The idea of multipliers hinges upon the difference between the initial effect of an exogenous (final demand) change and the total effects of the change. The total effects can either be captured in terms of direct, indirect, and induced effects. Direct effects are the changes in the industries to which a final demand change was affected; indirect effects measure the changes in inter-industry purchases resulting from the new demands of the directly affected industries. Induced effects are those changes in spending from households as income or population increases or decreases due to changes in production (Miller and Blair, 1985).

Multipliers can be constructed in terms of output, income, employment, or value-added with different policy implications. There are four different multipliers commonly used in predictive modeling: Type I, Type II, Type III, and Type IV. Type I multipliers measure the direct and indirect effects of a change in economic activity. Type II captures both direct and indirect effects while taking into account the income and expenditures of households in addition to the inter-industry effects. Type III uses the Type I results to generate further economic activity by focusing the effect of the change on employment. Type IV (Madden and Batey, 1983) is based on patterns of spending between local residents and currently unemployed local residents.

4.6 The Coastal Louisiana Economic Impact Model: A typical non-survey or ready-made regional model such as IMPLAN is, in effect, a stepped-down national model. As explained previously, in such models available regional data can be used to improve model accuracy and validity. The basic foundation of the SAM models of the Louisiana economy is the IMPLAN database. In keeping with general practice, modifications have been made to this IMPLAN data to ensure a more realistic picture of the region's economy. These include modifications of regional purchase coefficients (RPC), regional supply-demand pool (SDP), transportation and marketing margins, and production functions based on primary or secondary data. Also, the production sectors in the basic IMPLAN-based models were aggregated into major industry groups. Aggregation may be justified on the grounds of resource limitation such as computational time. This consideration is important when the loss of additional information due to aggregation is not critical to the problem under consideration.

4.7 Regional Purchasing Coefficient: A regional purchase coefficient (RPC) represents the proportion of a region's total supply of a given commodity used to meet regional intermediate (industry) and final demand for that commodity. For example, an RPC of 0.25 for the natural gas sector means that local producers meet 25 percent of all demand for natural gas. Hence, 75 percent of regional natural gas demand is satisfied by regional imports.

RPCs are important in regional models since they represent the direction and magnitude of regional trade flows. Another potential measure for regional trade flows can be calculated through the use of SDPs, or supply-demand percentages. An SDP is the maximum amount of a regional supply that is available to meet regional demand. It is the ratio of regionally produced net commodity supply to gross regional demand. An SDP of less than one implies that the commodity will have to be imported even if none of the regional supply is exported domestically (Hughes and Litz, 1996).

RPCs, however, are more productive than SDP because they allow for cross-hauling (the simultaneous important export of the same commodity), which may result from such factors as brand differentiation. Ignoring cross-hauling in an I-O/SAM model may result in a bias of regional impacts resulting from an exogenous change in final demand. The use of RPC represents one way to reduce the possible bias in using ready-made national models in a regional

Table 4.2: Louisiana Model Aggregation Industry and IMPLAN Included Sectors

Table 4.3: Aggregated RPCs and SDPs

		LA1	LA2	LA3

4.9 Empirical Results for the Base Model Scenario: In Table 4.10, column 1, we present the general results of IMPLAN's run for the empirical structure of the coastal communities' economies based on IMPLAN data for 1996.[4] The results indicate that the total size of the LA1's economy is about $92.6 billion. Of these, industry output accounts for 29.6 percent or $27.4 billion, factor incomes represent 15 percent, or $13.5 billion, and household income is 12 percent, or $11.3 billion. The size of the federal government is estimated at 3 percent or $2.9 billion, and state and local governments are 3 percent or $2.8 billion. Businesses and enterprises also account for 2 percent or $1.7 billion, while capital investment and trade account for 5 percent or $4.9 billion and 13 percent and $11.7 billion, respectively.

For LA2, the results indicate the total size of the economy is approximately $180.6 billion. This total is comprised of industry output of 29 percent or $52.2 billion, factor incomes of 14 percent, or $25.6 billion, and household income of 13 percent or $23.3 billion. In addition, the federal government accounts for 3 percent or $6.2 billion, and state and local governments account for 4 percent, or $6.4 billion of economic activity. Businesses and enterprises contribute 2 percent or $2.9 billion, capital investment accounts for 6 percent, or $10.1 billion, and trade accounts for 11 percent, or $20.6 billion of regional economic activity.

Similarly for LA3, the results estimate a 1996 economy of $213.6 billion. The economy is composed of industry output of $54.2 billion (25 percent), factor incomes, $32.2 billion (15 percent), and household income of $29.6 billion (14 percent). The size of federal government economic activity is estimated to be $13.3 billion (6 percent), and the state and local governments are $8.2 billion (4 percent). Businesses and enterprises also account for $3.5 billion (2 percent), while capital investment and or $13.3 billion (11 percent) and trade amounts to $23.4 billion (6 percent).

Having established the base year structure of the respective LA economies, a vector of the potential exogenous changes or shocks must be determined. However, available data for subsequent simulation purposes as provided by the MMS are usually aggregated for larger planning areas indicated in Figure 2.1. Hence, onshore allocation of these offshore activities is necessary. The allocation of activities or expenditures to onshore areas is probably one of the more important factors for determining the region-specific economic impacts associated with offshore activities. These breakouts are important, because there are tendencies for certain onshore support activities to be concentrated in particular geographic areas. This concentration has tended to occur in Louisiana and Texas and has continued despite the movement of offshore activities into deeper water and into the Central-Eastern portions of the Gulf of Mexico. The allocated ratios used for the relevant sectors and regions are as given in Appendix Table B.5.

In addition to determining onshore allocations, we needed to identify specific expenditure allocations for the direct shocks we were going to examine in our economic impact analysis. The expenditure profiles for exploratory and development drilling, as well as production, that were developed in the first phase of our investigation, are facilitated. Direct costs that were developed for these activities were also used to estimate a direct shock associated with new offshore oil and gas activities.

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[4] Minnesota IMPLAN group, the owners of IMPLAN, update their database annually. 1996 data was the most recent at the beginning of this study.

4.10 Empirical Results for New Offshore Oil and Gas Activities: In Table 4.4 we present the results of the impact simulation for LA1. Detailed impacts by water depth, sectors, and activity phase have been presented in Appendix Table B.7. Subtables have been created to examine each subregional impact by water depth. In general, the results show that whether we consider direct, indirect, induced, or even total impact for output, labor income, value-added and taxes, the effect

Table 4.4: Economic Impact Results of Oil and Gas Development in the Gulf of Mexico 1997-2031: LA1 Annual per Well Impacts

Table 4.5: Economic Impact Results of Oil and Gas Development in the Gulf of Mexico 1997-2031: LA2 Annual per Well Impacts

	Exploratory				Development				Production			
Impact Item	**Direct**	**Indirect**	**Induced**	**Total**	**Direct**	**Indirect**	**Induced**	**Total**	**Direct**	**Indirect**	**Induced**	**Total**
Output ($)	716,297	73,474	37,625	827,395	623,569	67,773	Tc (73,474) Tj	25.08 0 TD 0 Tc 0.03 Tw ( ) Tj 10.8 0 TD 0.055 Tw (.				

Table 4.7: Income Distribution Impacts: LA1 Area

Household Income Category	Annual Impact Per Well ($)		
	Exploratory	Development	Production
< $5,000	199	188	17
$5,000---$10,000	1,024	964	90
$10,000---$15,000	2,767	2,605	243
$15,000---$20,000	4,024	3,788	354
$20,000---$30,000	13,416	12,628	1,182
$30,000---$40,000	16,986	15,988	1,496
$40,000---$50,000	17,006	16,007	1,498
$50,000---$70,000	26,126	24,592	2,302
> $70,000	26,306	24,762	2,318

Table 4.8: Income Distribution: LA2 Area

Household Income Category	Annual Impact Per Well ($)	
	Exploratory	Development

The results show that oil and gas development has more impact in the LA1 economy than the other two economies, which share similar relative impacts. Exploratory, development, and producing wells contribute about twice as much (on a per well basis) more than the contribution to the economies in LA2 and LA3. In addition, exploratory and development drilling create the biggest impact in all three regional economies.

4.11 Summary and Conclusion of Impact Analysis: The purpose of this section of our report has been to examine the economic impacts of offshore activities by incorporating two new methodological approaches. The first is the use of a Social Accounting Matrix, or SAM, to look at the full range of economic impacts across all regional economic agents and institutions. The second was to incorporate our considerable work in developing offshore industry cost drivers for economic impact modeling purpose. These cost drivers included offshore industry activity expenditure profiles, total unit costs, and onshore cost allocation factors.

Although there are varieties of economic activities undertaken by oil and gas industries in the Gulf of Mexico OCS region, our simulation was based on the basic industry activities of exploration, development, and production wells spanning the period 1997-2031 as forecast by the MMS. Our results show that in terms of aggregate output, labor income, value added, employment, and tax base in all three economies, production activities add the most value to these onshore regional economies. Exploration and development, or overall drilling activities, tend to have a less substantial impact. Exploration and development activities add about 3 jobs per drilled well annually. Production activities, however, increase total local employment by 200 jobs for every production well in operation.

Although these regional economies are of varying sizes, our analysis reveals that the impacts of offshore activities are not directly correlated with size. For example, while LA1 economy is clearly smaller than LA2, the relative impact of offshore activities in LA1 is considerably higher than in LA2. Likewise, our analysis shows that the relative impact on the LA2 and LA3 economies are very similar despite the fact that the LA3 economy is much larger. Thus, it is important to recognize the importance of the structure of the economy in terms of inter-industry linkages and potential levels of leakages out of the economy when examining the economic impacts of large construction and infrastructure projects or any type of major public policy initiative.

Income distribution effects are an additionally important consideration in the policy analysis of how industries impact local communities. Our analysis shows that while all income groups benefit from an increase in offshore activities, the benefits are skewed more toward the upper income households. In all three coastal Louisiana economies, we found that as much as 50 percent of the income gains that are created by increased offshore activities accrues to households with annual incomes greater than $50,000, while another 50 percent goes to those under $50,000. Such a result would tend to support the fact that the distribution of benefits associated with offshore activities is relatively balanced.

Section 5: Conclusions and Suggestions for Future Research

The research encompassed in this report has expanded the opportunities for a more detailed and industry-specific approach to modeling the economic impacts of offshore activities. However, it would be a display of hubris to suggest that we have come even close to developing a comprehensive approach of understanding the complete economic impact of these oil and gas industry activities. At best, this work can claim to have at least successfully developed a framework upon which future research can move forward.

There are at least five generalized areas where these approaches could be expanded and improved:

(1) Customizing onshore allocations

(2) Developing cost functions for specific technologies

(3) Developing labor and value added implications

(4) Understanding the implications of activities on public finance

(5) Developing a model that incorporates interregional linkages

5.1 Onshore Allocations: The onshore allocations used in our report were generalized across all offshore activities and water depths. This aggregation however, can generalize economic impacts. Further disaggregation could result in a more refined understanding of how those impacts accrue across specific (county/parish) coastal regions. There are a number of ways these onshore allocations could be improved, however, the two most readily available opportunities for disaggregation includes: (a) developing specific onshore allocations for each activity type and (b) developing on-shore allocations for each water depth.

As noted earlier in this report, each offshore activity phase is unique. Not only are the expenditure patterns of these activities unique, but in many instances, particular areas supporting these activities can be concentrated in a certain locale. For instance, as the industry has become more consolidated, certain activities can also become more consolidated in particular regions as the number of firms becomes more concentrated. For instance, there has been a notable tendency for platform fabrication and shipbuilding to become concentrated in particular areas. While our current allocations reflect some of this concentration – the current framework does not provide a dynamic approach of how these concentrations are changing.

Another area of improvement within the allocation process is related to water depth. In particular, attempting to understand if there are unique onshore allocations associated with offshore production in varying water depths. Do deepwater activities tend to have different onshore allocations than shallow water activities? There is at least some anecdotal evidence that would suggest there is a greater out-of-area impact associated with deepwater activity than shallow water. In particular, deepwater activity has often been characterized as more “global” in nature, and as such, deepwater activities in the Gulf more than likely pull resources from deepwater producing basins around the world.

5.2 Cost Functions By Technology: One of the other limitations of the current approach is that there has been an aggregation of cost functions across technologies used in each activity phase. This analysis assumed that within each activity phase, and within each water depth, there was a "typical" technology that was being facilitated. Thus, in the pipeline construction phase, a "typical" pipeline diameter is assumed, over a typical area, facilitating a particular pipeline laying process. However, one of the first points many offshore professionals would make today is that there is no such thing as a "typical" offshore approach – this is particularly true with deepwater activities.

Thus, this lane of research could be improved by disaggregating offshore activities by a range of feasible technologies. The advantage of conducting such methods in a straightforward, disaggregated manner will hopefully provide more accurate understanding of the impacts of changing technology on local communities. For instance, conventional wisdom would tend to support the notion that technological innovation, with its greater reliance on computer-driven automation and remote applications, can only be bad for labor – it results in less labor demand, higher unemployment, and a lower quality of living for households directly associated with offshore activities.

Furthermore, consider the offsetting impacts that these technologies can also have. Recent emphasis on computer applications and SCADA systems are changing a number of production processes. These are streamlining communications and creating greater emphasis on communications related expenditures, fiber optic cable installation, switching equipment, contractor expenditures as a lump sum, or as one contractor, when many could have been used, in different places on the Gulf; and (2) these contractors hire labor and purchase equipment, tools, services and other things that have unique expenditure profiles of their own. One important limitation with the curre

5.5 Interregional Analysis: Another limitation of the current research, and in the more recent approaches of modeling the economic impacts of offshore activities, is the lack of linkages between offshore areas. The economic impact framework used in this study examines onshore communities in aggregate blocks across an expansive area in the Gulf. There may be, however, substantial linkages between the areas in terms of their potential mutual support for differing activities. Future analysis should examine the degree of linkages between these defined areas. One might anticipate, for instance, that expenditures in localized areas may spill over into neighboring regions to help support offshore activities. Conventional wisdom might lead one to expect that these linkages may become stronger during boom periods when some local economics could become saturated. In addition, there is some evidence that particular activities, particularly those associated with deepwater activities, have highly specialized functions that are "pulled-together" from throughout the Gulf region. Future research should explore the magnitude and extent of such potential spill-over effects.

5.6 Project Summary and Conclusions: This study is the first of its kind to comprehensively examine the cost structures of offshore activities in the Gulf of Mexico. No other research has examined total costs, activity-specific costs, and the allocation of costs to onshore areas in the manner presented here. As noted earlier, there are a number of areas where this research can be improved. We are confident that this report has made a significant contribution to the literature. Nevertheless, we believe that, in conjunction with the work of our colleagues at the MMS, we have started the process of developing analytic tools that quantify the links between the offshore industry and onshore communities.

We believe that the results of our research have yielded benefits that go beyond intellectual curiosity. The process of creating real world models for offshore oil and gas activities in the Gulf of Mexico can yield meaningful differences when compared to standardized, secondary I-O models. We believe the MMS motivation for moving forward with creating these customized approaches appears to be justified.

In conclusion, we would like to present estimates that compare the standardized results from the IMPLAN modeling approach to the customized results for exploratory drilling in the 0-60 meter water depth for the LA-2 region. Table 5.1 presents two sets of analyses that result from shocking both the generalized IMPLAN model and the IMPLAN model using our specialized expenditure profiles and onshore allocations. The first analysis is the generalized, standard IMPLAN results, while the second analysis comes from our Gulf-specific analysis. The table shows considerable percent differences between the two types of analyses.

Table 5.1: Estimated Economic Impacts for Exploratory Drilling, LA-2 Region

Estimated Annual Impact --

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Table A.1: Production Functions for Exploratory Drilling in the Gulf of Mexico by Major Water Depth

EXPLORATORY DRILLING						
IMPLAN Sectors	Sector Description	Average Production Function 0-60 Meters	Average Production Function 60-200 Meters	Average Production Function 200-900 Meters	Average Production Function 900 + Meters	Total Average Production Function (All Depths)

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Table A.2: Production Functions for Development Drilling in the Gulf of Mexico

DEVELOPMENT DRILLING						
IMPLAN Sectors	**Sector Description**	**Average Production Function 0-60 Meters**	**Average Production Function 60-200 Meters**	**Average Production Function 200-900 Meters**	**Average Production Function 900 + Meters**	**Total Average Production Function (All Depths)**
38	Oil & Gas Operations	0.65341	0.52344	0.64192	0.69198	0.62769
50	New Gas Utility Facilities					
53	Misc Natural Resource Facility Construction					
56	Maintenance and Repair, Other Facilities					
57	Other Oil & Gas Field Services	0.03447	0.02107	0.04069	0.03348	0.03243
160	Office Furniture and Equipment					
178	Maps and Charts (Msc Publishing)					
206	Explosives					
209	Chemicals, NEC					
210	Petroleum Fuels	0.02746	0.03349	0.03049	0.02664	0.02952
232	Hydraulic Cement	0.06566	0.11871	0.07490	0.06410	0.08084
258	Steel Pipe and Tubes	0.07104	0.15527	0.06077	0.05149	0.08464
284	Fabricated Plate Work					
290	Iron and Steel Forgings					
307	Turbines					
311	Construction Machinery & Equipment					
313	O&G Field Machinery	0.01545	0.01524	0.01039	0.00947	0.01264
331	Special Industrial Machinery					
332	Pumps & Compressors					
354	Industrial Machines, NEC					
356	Switchgear					
374	Communication Equipment, NEC					
392	Shipbuilding and Ship Repair					
399	Transportation Equipment, NEC					
401	Lab Equipment					
403	Instrumentation	0.04110	0.04222	0.04375	0.03817	0.04131
435	Demurrage/Warehousing/Motor Freight					
436	Water Transport	0.08355	0.08276	0.08873	0.07739	0.08311
437	Air Transport	0.00787	0.00780	0.00836	0.00729	0.00783
441	Communications					
443	Electric Services					
444	Gas Production/Distribution					
445	Water Supply					
446	Disposal					
454	Eating/Drinking					
455	Msc Retail					
459	Insurance					
462	Real Estate					
469	Advertisement					
470	Other Business Services					
473	Msc. Equipment Rental and Leasing					
490	Doctors & Veterinarian Services					
494	Legal Services					
506	Environmental/Engineering Services					
507	Acct/Msc Business Services					
508	Management/Consulting Services					
509	Testing/Research Facilities					
Total		1.00000	1.00000	1.00000	1.00000	1.00000

IMPLAN Sectors	Sector Description	Average Production Function 0-60 Meters	Average Production Function 60-200 Meters	Average Production Function 200-900 Meters	Average Production Function 900 + Meters	Total Average Production Function (All Depths)
	PRODUCTION , OPERATIONS					
38	Oil & Gas Operations	0.29058	0.27271	0.26142	0.25126	0.26899
50	New Gas Utility Facilities					
53	Misc Natural Resource Facility Construction					
56	Maintenance and Repair, Other Facilities					
57	Other Oil & Gas Field Services	0.07158	0.07020	0.07018	0.07018	0.07054
160	Office Furniture and Equipment					
178	Maps and Charts (Msc Publishing)					
206	Explosives					
209	Chemicals, NEC					
210	Petroleum Fuels					
232	Hydraulic Cement					
258	Steel Pipe and Tubes	0.03560	0.03324	0.03171	0.03033	0.03272
284	Fabricated Plate Work					
290	Iron and Steel Forgings					
307	Turbines					
311	Construction Machinery & Equipment					
313	O&G Field Machinery	0.04846	0.04526	0.04317	0.04129	0.04455
331	Special Industrial Machinery					
332	Pumps & Compressors					
354	Industrial Machines, NEC					
356	Switchgear					
374	Communication Equipment, NEC					
392	Shipbuilding and Ship Repair					
399	Transportation Equipment, NEC					
401	Lab Equipment					
403	Instrumentation	0.02755	0.02573	0.02454	0.02347	0.02532
435	Demurrage/Warehousing/Motor Freight					
436	Water Transport	0.35196	0.32868	0.31353	0.29987	0.32351
437	Air Transport	0.05306	0.07260	0.07581	0.07832	0.06995
441	Communications	0.00843	0.01023	0.01043	0.01057	0.00991
443	Electric Services					

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Table A.4: Production Functions for Platform Fabrication in the Gulf of Mexico

PLATFORM FABRICATION						
IMPLAN Sectors	Sector Description	Average Production Function 0-60 Meters	Average Production Function 60-200 Meters	Average Production Function 200-900 Meters	Average Production Function 900 + Meters	Total Average Production Function (All Depths)
38	Oil & Gas Operations					
50	New Gas Utility Facilities					
53	Misc Natural Resource Facility Construction					
56	Maintenance and Repair, Other Facilities					
57	Other Oil & Gas Field Services	0.02500	0.02500	0.02650	0.02750	0.02600
160	Office Furniture and Equipment					
178	Maps and Charts (Msc Publishing)					
206	Explosives					
209	Chemicals, NEC					
210	Petroleum Fuels					
232	Hydraulic Cement					
258	Steel Pipe and Tubes	0.36377	0.42526	0.48000	0.56312	0.45804
284	Fabricated Plate Work					
290	Iron and Steel Forgings					
307	Turbines	0.01312	0.01250	0.01250	0.01250	0.01266
311	Construction Machinery & Equipment					
313	O&G Field Machinery	0.00125	0.00125	0.00125	0.00125	0.00125
331	Special Industrial Machinery	0.05380	0.05750	0.05750	0.05750	0.05658
332	Pumps & Compressors	0.03205	0.03625	0.03625	0.03625	0.03520
354	Industrial Machines, NEC					
356	Switchgear					
374	Communication Equipment, NEC					
392	Shipbuilding and Ship Repair	0.43063	0.35395	0.27625	0.21337	0.31855
399	Transportation Equipment, NEC					
401	Lab Equipment					
403	Instrumentation					
435	Demurrage/Warehousing/Motor Freight					
436	Water Transport	0.01266	0.01714	0.02275	0.01972	0.01807
437	Air Transport	0.01250	0.01250	0.01250	0.01250	0.01250
441	Communications					
443	Electric Services					
444	Gas Production/Distribution					
445	Water Supply					
446	Waste Disposal					
454	Eating/Drinking	0.00377	0.00364	0.00425	0.00375	0.00385
455	Msc Retail					
459	Insurance					
462	Real Estate					
469	Advertisement					
470	Other Business Services					
473	Msc. Equipment Rental and Leasing					
490	Doctors & Veterinarian Services					
494	Legal Services					
506	Environmental/Engineering Services	0.05145	0.05501	0.07025	0.05254	0.05731
507	Acct/Msc Business Services					
508	Management/Consulting Services					
509	Testing/Research Facilities					
Total		1.00000	1.00000	1.00000	1.00000	1.00000

Table A.5: Production Functions for Pipeline Construction in the Gulf of Mexico

PIPELINES: CONSTRUCTION						
IMPLAN Sectors	Sector Description	Average Production Function 0-60 Meters	Average Production Function 60-200 Meters	Average Production Function 200-900 Meters	Average Production Function 900 + Meters	Total Average Production Function (All Depths)
38	Oil & Gas Operations	0.00209	0.01330	0.01560	0.00000	0.00775
50	New Gas Utility Facilities	0.78299	0.81386	0.78306	0.96255	0.83562
53	Misc Natural Resource Facility Construction					
56	Maintenance and Repair, Other Facilities					
57	Other Oil & Gas Field Services					
160	Office Furniture and Equipment	0.00508	0.00358	0.00587	0.00000	0.00363
178	Maps and Charts (Msc Publishing)					
206	Explosives					
209	Chemicals, NEC					
210	Petroleum Fuels					
232	Hydraulic Cement					
258	Steel Pipe and Tubes					
284	Fabricated Plate Work					
290	Iron and Steel Forgings					
307	Turbines					
311	Construction Machinery & Equipment					
313	O&G Field Machinery	0.19694	0.14566	0.18518	0.03629	0.14102
331	Special Industrial Machinery					
332	Pumps & Compressors					
354	Industrial Machines, NEC	0.00228	0.00226	0.00435	0.00000	0.00222
356	Switchgear					
374	Communication Equipment, NEC	0.00456	0.01054	0.00397	0.00116	0.00506
392	Shipbuilding and Ship Repair					
399	Transportation Equipment, NEC	0.00433	0.00614	0.00115	0.00000	0.00290
401	Lab Equipment	0.00088	0.00008	0.00001	0.00000	0.00024
403	Instrumentation					
435	Demurrage/Warehousing/Motor Freight					
436	Water Transport					
437	Air Transport					
441	Communications					
443	Electric Services					
444	Gas Production/Distribution					
445	Water Supply					
446	Waste Disposal					
454	Eating/Drinking					
455	Msc Retail					
459	Insurance					
462	Real Estate	0.00085	0.00457	0.00080	0.00000	0.00156
469	Advertisement					
470	Other Business Services					
473	Msc. Equipment Rental and Leasing					
490	Doctors & Veterinarian Services					
494	Legal Services					
506	Environmental/Engineering Services					
507	Acct/Msc Business Services					
508	Management/Consulting Services					
509	Testing/Research Facilities					
Total		1.00000	1.00000	1.00000	1.00000	1.00000

PIPELINES: OPERATIONS & MAINTENANCE

IMPLAN	Average Production	Average Production	Average Production	Average Production	Total Average Production

GAS PROCESSING & STORAGE: CONSTRUCTION

IMPLAN Sectors	Sector Description	Average Production Function 0-60 Meters	Average Production Function 60-200 Meters	Average Production Function 200-900 Meters	Average Production Function 900 + Meters	Total Average Production Function (All Depths)
38	Oil & Gas Operations	0.58415	0.58415	0.58415	0.58415	0.58415
50	New Gas Utility Facilities					
53	Misc Natural Resource Facility Construction	0.04208	0.04208	0.04208	0.04208	0.04208
56	Maintenance and Repair, Other Facilities					
57	Other Oil & Gas Field Services					
160	Office Furniture and Equipment					
178	Maps and Charts (Msc Publishing)					
206	Explosives					
209	Chemicals, NEC					
210	Petroleum Fuels					
232	Hydraulic Cement					
258	Steel Pipe and Tubes					
284	Fabricated Plate Work					
290	Iron and Steel Forgings					
307	Turbines					
311	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

GAS PROCESSING & STORAGE: OPERATIONS & MAINTENANCE

IMPLAN Sectors	Sector Description	Average Production Function 0-60 Meters	Average Production Function 60-200 Meters	Average Production Function 200-900 Meters	Average Production Function 900 + Meters	Total Average Production Function (All Depths)
38	Oil & Gas Operations	0.05635	0.05635	0.05635	0.05635	0.05635
50	New Gas Utility Facilities	0.00000	0.00000	0.00000	0.00000	0.00000
53	Misc Natural Resource Facility Construction					
56	Maintenance and Repair, Other Facilities	0.06933	0.06933	0.06933	0.06933	0.06933
57	Other Oil & Gas Field Services					
160	Office Furniture and Equipment					
178	Maps and Charts (Msc Publishing)	0.00007	0.00007	0.00007	0.00007	0.00007
206	Explosives					
209	Fteel Pip884ations6.00000					

Table A.9: Production Functions for Workovers in the Gulf of Mexico

WORKOVERS						
IMPLAN Sectors	Sector Description	Average Production Function 0-60 Meters	Average Production Function 60-200 Meters	Average Production Function 200-900 Meters	Average Production Function 900 + Meters	Total Average Production Function (All Depths)
38	Oil & Gas Operations	0.06899	0.06543	0.06455	0.06375	0.06568
50	New Gas Utility Facilities					
53	Misc Natural Resource Facility Construction					
56	Maintenance and Repair, Other Facilities					
57	Other Oil & Gas Field Services	0.37196	0.35280	0.34804	0.34373	0.35413
160	Office Furniture and Equipment					
178	Maps and Charts (Msc Publishing)					
206	Explosives					
209	Chemicals, NEC					
210	Petroleum Fuels					
232	Hydraulic Cement					
258	Steel Pipe and Tubes					
284	Fabricated Plate Work					
290	Iron and Steel Forgings					
307	Turbines					
311	Construction Machinery & Equipment					
313	O&G Field Machinery	0.04905	0.04652	0.04589	0.04532	0.04669
331	Special Industrial Machinery					
332	Pumps & Compressors					
354	Industrial Machines, NEC					
356	Switchgear					
374	Communication Equipment, NEC					
392	Shipbuilding and Ship Repair					
399	Transportation Equipment, NEC					
401	Lab Equipment					
403	Instrumentation					
435	Demurrage/Warehousing/Motor Freight					
436	Water Transport	0.47569	0.49167	0.49529	0.49857	0.49030
437	Air Transport	0.02361	0.03282	0.03544	0.03781	0.03242
441	Communications	0.00214	0.00264	0.00278	0.00291	0.00261
443	Electric Services					
444	Gas Production/Distribution					
445	Water Supply					
446	Waste Disposal					
454	Eating/Drinking	0.00857	0.00812	0.00801	0.00792	0.00816
455	Msc Retail					
459	Insurance					
462	Real Estate					
469	Advertisement					
470	Other Business Services					
473	Msc. Equipment Rental and Leasing					
490	Doctors & Veterinarian Services					
494	Legal Services					
506	Environmental/Engineering Services					
507	Acct/Msc Business Services					
508	Management/Consulting Services					
509	Testing/Research Facilities					
Total		1.00000	1.00000	1.00000	1.00000	1.00000

Table A.10: Production Functions for Oil Spills in the Gulf of Mexico

IMPLAN Sectors	Sector Description	OIL SPILLS Average Production Function 0-60 Meters	Average Production Function 60-200 Meters	Average Production Function 200-900 Meters	Average Production Function 900 + Meters	Total Average Production Function (All Depths)
38	Oil & Gas Operations	0.00230	0.00119	0.00352	0.00352	0.00263
50	New Gas Utility Facilities					
53	Misc Natural Resource Facility Construction					
56	Maintenance and Repair, Other Facilities					
57	Other Oil & Gas Field Services	0.00210	0.00147	0.00178	0.00178	0.00178
160	Office Furniture and Equipment					
178	Maps and Charts (Msc Publishing)					
206	Explosives					
209	Chemicals, NEC	0.00399	0.00454	0.00444	0.00444	0.00435
210	Petroleum Fuels					
232	Hydraulic Cement					
258	Steel Pipe and Tubes					
284	Fabricated Plate Work					
290	Iron and Steel Forgings					
307	Turbines					
311	Construction Machinery & Equipment					
313	O&G Field Machinery					
331	Special Industrial Machinery					
332	Pumps & Compressors					
354	Industrial Machines, NEC					
356	Switchgear					
374	Communication Equipment, NEC					
392	Shipbuilding and Ship Repair	0.00536	0.00832	0.01409	0.01409	0.01047
399	Transportation Equipment, NEC					
401	Lab Equipment					
403	Instrumentation					
435	Demurrage/Warehousing/Motor Freight	0.00132	0.00088	0.00099	0.00099	0.00104
436	Water Transport					
437	Air Transport					
441	Communications	0.00012	0.00005	0.00000	0.00000	0.00004
443	Electric Services					
444	Gas Production/Distribution					
445	Water Supply					
446	Waste Disposal	0.00178	0.00018	0.00020	0.00020	0.00059
454	Eating/Drinking	0.00247	0.00148	0.00167	0.00167	0.00182
455	Msc Retail	0.00273	0.00104	0.00117	0.00117	0.00153
459	Insurance					
462	Real Estate					
469	Advertisement	0.00189	0.00109	0.00000	0.00000	0.00075
470	Other Business Services					
473	Msc. Equipment Rental and Leasing	0.01409	0.00903	0.01079	0.01079	0.01118
490	Doctors & Veterinarian Services	0.04327	0.04437	0.04387	0.04387	0.04384
494	Legal Services	0.67255	0.70237	0.77443	0.77443	0.73094
506	Environmental/Engineering Services	0.15935	0.14437	0.14287	0.14287	0.14736
507	Acct/Msc Business Services					
508	Management/Consulting Services					
509	Testing/Research Facilities	0.08669	0.07963	0.00019	0.00019	0.04167
Total		1.00000	1.00000	1.00000	1.00000	1.00000

Table A.11: Production Functions for Platform Abandonment in the Gulf of Mexico

		PLATFORM ABANDONMENT					
IMPLAN Sectors	Sector Description	FA Platform Abandonment	Average Production Function 0-60 Meters	Average Production Function 60-200 Meters	Average Production Function 200-900 Meters	Average Production Function 900 + Meters	Total Average Production Function (All Depths)
38	Oil & Gas Operations	NA	0.14855	0.16929	0.17309	0.20139	0.17308
50	New Gas Utility Facilities	NA	0.03732	0.04683	0.05043	0.05972	0.04858
53	Misc Natural Resource Facility Construction	NA	0.05050	0.03210	0.01563	0.01667	0.02872
56	Maintenance and Repair, Other Facilities						
57	Other Oil & Gas Field Services	NA	0.17102	0.11066	0.10253	0.01389	0.09952
160	Office Furniture and Equipment						
178	Maps and Charts (Msc Publishing)						
206	Explosives						
209	Chemicals, NEC						
210	Petroleum Fuels						
232	Hydraulic Cement						
258	Steel Pipe and Tubes						
284	Fabricated Plate Work						
290	Iron and Steel Forgings						
307	Turbines						
311	Construction Machinery & Equipment						
313	O&G Field Machinery						
331	Special Industrial Machinery						
332	Pumps & Compressors						
354	Industrial Machines, NEC						
356	Switchgear						
374	Communication Equipment, NEC						
392	Shipbuilding and Ship Repair						
399	Transportation Equipment, NEC						
401	Lab Equipment						
403	Instrumentation						
435	Demurrage/Warehousing/Motor Freight						
436	Water Transport	NA	0.58534	0.62886	0.64319	0.69028	0.63692
437	Air Transport						
441	Communications						
443	Electric Services						
444	Gas Production/Distribution						
445	Water Supply						
446	Waste Disposal						
454	Eating/Drinking						
455	Msc Retail						
459	Insurance						
462	Real Estate						
469	Advertisement						
470	Other Business Services						
473	Msc. Equipment Rental and Leasing						
490	Doctors & Veterinarian Services						
494	Legal Services						
506	Environmental/Engineering Services	NA	0.00728	0.01226	0.01513	0.01806	0.01318
507	Acct/Msc Business Services						
508	Management/Consulting Services						
509	Testing/Research Facilities						
Total		NA	1.00000	1.00000	1.00000	1.00000	1.00000

IMPLAN Sectors	Definition	TX-1	TX-2	LA-1	LA-2	LA-3	MA-1	FL-1	FL-2	FL-3	FL-4	Gulf-Other	US-Other
38	Oil & Gas Operations	0.00	0.34	0.09	0.06	0.15	0.00	0.00	0.00	0.00	0.00	0.25	0.12
50	New Gas Utility Facilities	0.07	0.38	0.05	0.10	0.10	0.10	0.00	0.00	0.00	0.00	0.13	0.07
53	Misc Natural Resource Facility Construction	0.03	0.21	0.23	0.15	0.30	0.02	0.00	0.00	0.00	0.00	0.06	0.03
56	Maintenance and Repair, Other Facilities	0.06	0.31	0.04	0.08	0.09	0.08	0.00	0.00	0.00	0.00	0.22	0.11
57	Other Oil & Gas Field Services	0.00	0.30	0.26	0.12	0.16	0.00	0.00	0.00	0.00	0.00	0.11	0.05
160	Office Furniture and Equipment	0.15	0.54	0.00	0.00	0.08	0.23	0.00	0.00	0.00	0.00	0.00	0.00
178	Maps and Charts (Msc Publishing)	0.12	0.59	0.02	0.06	0.11	0.10	0.00	0.00	0.00	0.00	0.00	0.00
206	Explosives	0.50	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
209	Chemicals, NEC	0.03	0.64	0.04	0.10	0.04	0.04	0.00	0.00	0.00	0.00	0.08	0.04
210	Petroleum Fuels	0.11	0.50	0.09	0.16	0.09	0.05	0.00	0.00	0.00	0.00	0.00	0.00
232	Hydraulic Cement	0.00	0.10	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.50	0.30
258	Steel Pipe and Tubes	0.00	0.50	0.31	0.05	0.07	0.00	0.00	0.00	0.00	0.00	0.08	0.04
284	Fabricated Plate Work	0.04	0.63	0.06	0.09	0.05	0.14	0.00	0.00	0.00	0.00	0.00	0.00
290	Iron and Steel Forgings	0.00	0.81	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.14	0.00
307	Turbines	0.05	0.65	0.00	0.10	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00
311	Construction Machinery & Equipment	0.06	0.42	0.00	0.06	0.19	0.11	0.00	0.00	0.00	0.00	0.11	0.06
313	O&G Field Machinery & Equipment	0.03	0.18	0.27	0.18	0.22	0.00	0.00	0.00	0.00	0.00	0.08	0.04
331	Special Industrial Machinery	0.00	0.00	0.00	0.38	0.54	0.00	0.00	0.00	0.00	0.00	0.05	0.03
332	Pumps & Compressors	0.04	0.30	0.17	0.22	0.09	0.00	0.00	0.00	0.00	0.00	0.12	0.06
354	Industrial Machines, NEC	0.05	0.66	0.06	0.10	0.06	0.06	0.00	0.00	0.00	0.00	0.00	0.00
356	Switchgear	0.00	0.63	0.00	0.07	0.11	0.07	0.00	0.00	0.00	0.00	0.11	0.00
374	Communication Equipment, NEC	0.13	0.50	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.13	0.00
392	Shipbuilding and Ship Repair	0.09	0.24	0.05	0.24	0.18	0.19	0.00	0.00	0.00	0.00	0.00	0.00
399	Transportation Equipment, NEC	0.00	0.78	0.06	0.11	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00
401	Lab Equipment	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
403	Instrumentation	0.01	0.13	0.39	0.27	0.08	0.00	0.00	0.00	0.00	0.00	0.08	0.04
435	435												

4350.000.056 0 TD (0.00) Tj 19.I6 0 TD (0.00) Tj 41.52 0 TD (0.08) Tj 36.96 0 TD (0.043.0.06) rreigh TD (031.2 Tj 19.56 0 TD (0.00) Tj 19.56 0 TD (0.00) Tj 41396 0 TD

0.00

403 Instrumentation 0.01 0.13 0.39 0.27 0.00 0.04

[redacted].13: Total Cost Analysis: Summary of Total Costs by Offshore Activity and Water Depth

[redacted]

Appendix B:
Coastal Impact Tables

Appendix Table B.1:
Socioeconomic and Demographic Indicators

Project Area		Mean

[redacted]

Project Area		Mean
LA1	Population (number of persons), 1997	99,280.80
LA2	Population (number of persons), 1997	[redacted]
LA3	Population (number of persons), 1997	

Appendix Table B.2:
Selected Socioeconomic and Demographic Indicators, All Louisiana

Indicator Description	Estimate
Average earnings per job (1996 dollars)	26,798.00
Civilian labor force (BLS), number, 1996	19,997,300.00
Civilian labor force (BLS),unemployment rate, 1996	6.7
Educational attainment, percent of persons 25 years and over college graduates, 1990	16.1
Educational attainment, percent of persons 25 years and over high school graduates, 1990	68.3
Farm employment, 1996	37,476.00
Farm income, 1996	497,478.00
Mining Employment, 1996	58,023.00
Nonfarm employment, 1996	2,258,496.00
Nonfarm personal income ($1000) , 1996	88,569,068.00
Oil and gas extraction earnings ($1000) , 1996	3,049,679.00
Per capita personal income (dollars) , 1996	20,458.00
Per capita transfer payments, 1996	4,326.00
Population (number of persons) , 1996	4,351,769.00
Population, 65 years and over, 1996	496,606.00
Population, percent white, 1996	66.3
Population, percent American Indian, Eskimo, or Aleut, 1996	0.4
Population, percent Asian or Pacific Islander, 1996	1.2
Population, percent Hispanic (maybe of any race), 1996	2.5
Population, percent Black, 1996	32
Poverty, percent below poverty, 1993	23.9
Private nonfarm establishments, percent retail trade, 1995	24.3
Private nonfarm establishments, percent service, 1995	36.5
Total full- and part-time employment, 1996	2,295,972.00

Source: REIS, U.S. BEA, and Government Information Sharing Project (http://govinfo.kerr.orst.edu)

[redacted]

[redacted]

(Continued)

IMPLAN Code	Commodity	Net Commodity Supply	Total Gross Commodity Demand	Domestic SDP	Average RPC
369	Lighting Fixtures and Equipment	209.83	264.61	0.7900	0.0000
392	Ship Building and Repairing	1114.65	482.23	1.0000	0.0800
393	Boat Building and Repairing	154.05	110.61	1.0000	0.0200
441	Communications- Except Radio and TV	2638.85	3697.48	0.7100	0.5500
442	Radio and TV Broadcasting	49.96	50.90	0.9800	0.4200
456	Banking	3503.09	4880.19	0.7200	0.5600
457	Credit Agencies	453.91	571.53	0.7900	0.5600
460	Insurance Agents and Brokers	1094.68	615.82	1.0000	0.5200
461	Owner-occupied Dwellings	5193.65	7647.46	0.6800	0.6800
462	Real Estate	4020.84	8567.45	0.4700	0.4700
467	Funeral Service and Crematories	189.45	169.26	1.0000	0.9000
482	Miscellaneous Repair Shops	541.96	461.39	1.0000	0.6900
488	Amusement and Recreation Services- N.E.C.	1940.41	768.92	1.0000	0.8500
495	Elementary and Secondary Schools	383.69			

Appendix Table B.4:
Adjusted RPC and State Domestic Product Ratio for Selected Commodities

(Continued)

IMPLAN Code	Commodity	SDP Ratio	Modified RPC
393	Boat Building and Repairing	1.0000	0.5000
441	Communications- Except Radio and TV	0.7137	0.6500
442	Radio and TV Broadcasting	0.9816	0.7500
456	Banking	0.7178	0.6000
457	Credit Agencies	0.7942	0.7500
460	Insurance Agents and Brokers	1.0000	0.9000
461	Owner-occupied Dwellings	0.6791	1.0000
467	Funeral Service and Crematories	1.0000	1.0000
482	Miscellaneous Repair Shops	1.0000	0.9000
488	Amusement and Recreation Services- N.E.C.	1.0000	0.9500
495	Elementary and Secondary Schools	0.9396	0.9000
496	Colleges- Universities- Schools	0.9550	0.9000
497	Other Educational Services	1.0000	0.9500
503	Business Associations	1.0000	0.7500
504	Labor and Civic Organizations	0.8816	0.7500
513	U.S. Postal Service	0.9885	0.9000
515	Other Federal Government Enterprises	1.0000	1.0000

Source: IMPLAN, Minnesota Implan Group, Inc.

Appendix Table B.5: Onshore Allocation Ratios/Profile for LA1, LA2, LA3 in Gulf of Mexico

IMPLAN Sector	Description	LA1	LA2	LA3
38	Oil & Gas Operations	0.0900	0.0600	0.1500
50	New Gas Utility Facilities	0.0500	0.1000	0.1000
53	Misc. Natural Resource Facility Construction	0.2300	0.1500	0.3000
56	Maintenance and Repair, Other Facilities	0.0400	0.0800	0.0900
57	Other Oil & Gas Field Services	0.2600	0.1200	0.1600
160	Office Furniture and EquipmentOffice Furniture 0			

Appendix Table B.6:
Expenditure Allocation

Appendix Table B.6.3:
LA Model Production Drilling Expenditure Distribution by Water Depth

IMPLAN Sector	Description	Water Depth

Appendix Table B.7:
Implan Exogenous Shock Vector by Water Depth and Activity, and LA Area Activity

Appendix Table B.7.1:
LA1: Exploratory Wells
($000)

IMPLAN Sector	Description	Water Depth			
		0-60 m	60-200 m	200-900 m	900 m+
38	Oil & Gas Operations	691,730	525,388	1,216,429	1,863,125
57	Other Oil & Gas Field				

Appendix Table B.7.3:
LA1: Production Wells
($000)

IMPLAN Sector	Description	Water Depth			
		0-60 m	60-200 m	200-900 m	900 m+
38	Oil & Gas Operations	20,441,559	20,207,687	20,088,158	19,887,889
57	Other Oil & Gas Field Services	5,035,185	5,202,146	5,392,425	5,555,373
258	Steel Pipe and Tubes	2,504,271	2,463,413	2,436,825	2,400,751
313	O&G Field Machinery & Equipment	3,409,248	3,353,624	3,317,429	3,268,318
403	Instrumentation	1,938,100	1,906,479	1,885,903	1,857,984
436	Water Transport	24,759,234	24,355,271	24,092,407	23,735,751
437	Air Transport	3,732,265	5,379,830	5,825,176	6,199,475
441	Communications	593,278	758,029	801,245	836,403
454	Eating/Drinking	2,558,454	2,516,711	2,489,549	2,452,694
459	Insurance	5,374,999	7,957,432	10,512,860	12,959,441
	Total:	70,346,593	74,100,623	76,841,976	79,154,080

Appendix Table B.7.4:
LA2: Exploratory Wells
($000)

IMPLAN Sector	Description	Water Depth			
		0-60 m	60-200 m	200-900 m	900 m+
38	Oil & Gas Operations	461,153	350,258	810,953	1,242,083
57	Other Oil & Gas Field Services	23,330	17,758	32,278	49,503
210	Petroleum Fuels	19,288	14,701	26,720	40,965
232	Hydraulic Cement	45,543	36,098	64,209	100,662
258	Steel Pipe and Tubes	42,120	32,605	48,822	74,272
403	Instrumentation	27,757	21,158	38,294	58,662
436	Water Transport	56,351	42,962	77,545	118,939
437	Air Transport	5,308	4,048	7,312	11,222
	Total:	680,850	519,589	1,106,132	1,696,310

Appendix Table B.7.5:
LA2: Development Wells
($000)

IMPLAN Sector	Description		Water Depth	

Appendix Table B.7.9 :
LA3: Production Wells
($000)

IMPLAN Sector	Description	Water Depth	
		0-60 m	60-200 m

Appendix C:
Discussion of Input-Output Structure

Appendix C.1: The Basic Structure of Theoretical Input-Output Models

Let z_{ij} be noted as the sales of industry i to j. Assume an economy with n sectors, and let X_i be the total output (production) of sector i and Y_i the total final demand for sector i's product, then

(1) $$X_i = z_{i1}$$

(5) $$a_{ij} = X_{ij}/X_j$$

The relationship between nominal intermediate flows to nominal output (expressed as ratios) is given by

(6) $$P_i a_{ij} / P_j = P_i X_i / P_j X_j$$

Given a base-year, normalized units can be used where flows are in real units and all prices equal one. In this case, equation (5) and equation (6) above are equivalent. Dividing by the price and using the I-O coefficients, (4) above can be written as

(7) $$X_i = a_{ij} X_j + Y_i$$

This is the material balance equation of the I-O model. In matrix notation, it is

(8) $$X = AX + Y$$

or, solving for X,

(9) $$X = (I-A)^{-1}Y$$

where, $(I-A)^{-1}$ is the well known Leontief inverse. The most basic element in input-output analysis is estimating changes in output levels for particular sector(s) of an economy that is required to achieve a final output (Hewings, 1985). Given exogenously specified final demand, (y_i) production requirements necessary to satisfy the demand can be estimated using the Leontief inverse. That is,

(10) $$X = (I-A)^{-1} Y$$

Given final demand targets, the Leontief inverse $(I-A)^{-1}$ allows for the estimation of the implied targets for sectoral production.

Appendix C.2: The Basic Structure of Theoretical SAM Models

Mathematically, an algebraic representation of SAM is essentially the same as an I-O. In this case, the matrices and vectors are of higher dimensions since more variables are considered and more issues may be analyzed. For example, the A-matrix may be expanded to include households as producers and other institutions may be included as rows and columns in highly disaggregated and explicit formulation (Holland and Wyeth, 1993; Waters and Holland, 1996).

Assume households, government revenue, and employments are treated as endogenous. Given this framework, various multipliers can be estimated. Hence, the total impact of a policy change on the entire economy can be estimated. As an illustration, the result of treating households endogenously is a partitioned SAM specified as follows:

$$S = \begin{bmatrix} A & O & C \\ V & O & O \\ O & Y & H \end{bmatrix} \quad \begin{matrix} \text{Activities} \\ \text{Value - Added} \\ \text{Endogenous Institution} \end{matrix}$$

where: S is the matrix of SAM direct coefficients
A is the matrix of technical coefficients (analogous to the input6Tw ( ) Tj098y 0038rp38.52 T2o6ut to098 T

TD (ê) T2.84D -0.048T (ê) Tj 0.12 11.52 TD (ê) T2.70.12 0 TD (ê) Tj 0.12 11.52 TD (ê) Tj9

Tj 0.12 11.52 TD (ú) Tj9

j 0.12 11.52 TD (ê) T2.84D -0.048T (ê) Tj 0.12 11.52 TD (ê) T2.70.12 0 TD (ê) Tj 0.12 11.52 TD (ê) Tj9

12 0 TD (ú) Tj 0.12 11.52 TD (ú) Tj9

From (12), an (I-S) matrix can be constructed that when inverted is a matrix equation showing the level of sectoral supply, value-added, and household income as a function of exogenous variables or

$$\begin{bmatrix} \\ \\ \end{bmatrix} = \quad - \quad {}^{-} \begin{bmatrix} ev \\ ey \end{bmatrix}$$

“brain-dead SAM” ordinarily constructed from social accounts of ready-made models such as the IMPLAN. These SAMs are said to be brain-dead because there is no explicit correspondence between detailed sectoral value-added receipts by factors from industry and the factor disbursement sub-matrix containing only aggregated allocations of factor receipts by institutions (Sullivan, McCollum, and Alward, 1997). The Louisiana models defined institutions to include labor, property, and enterprise institutions while also explicitly designating the usual institutional categories of households, government, and capital/savings accounts. Labor as an institution receives and disburses labor payments to households (“owners” of labor); property as an institution receives and disburses land income to landowners. The enterprise institution disburses capital income to owners of capital in addition to accounting enterprise savings.

year production while capital formation are expenditures made on durable goods or capital equipment. These two capital accounts categories are combined into a single capital account in the Louisiana I-O and SAM models for the nine industrial sectors.

C.3.9 Rest of the World (Trade) Expenditure Account: The rest of the world (ROW) account consists of exports out of the region and earned income received by regional economic agents from out-of-the sources, such as dividend payments to residents from outside of the state capital investments. In general, IMPLAN ROW expenditures consist of foreign exports, which are the demand by regional consumers for goods and services produced outside of the U.S., and domestic exports, which are the demands by regional consumers for goods and services produced elsewhere in the U.S. These two accounts are consolidated into a single export account in the Louisiana I-O and SAM models.

C.3.10 Receipts (Rows) Accounts: Revenue accounts (read across a row in the tables) are income received (earned or transfers) by the sector or institution represented in that row from the paying sector or institution in the respective column. In the fixed-price models these include income received for sales of intermediate goods and services to industries, income received by factors as value-added from industries, income received by institutions such as households, governments, or savings.

C.3.11 Production (Intermediate Sales) Accounts: Intermediate sales accounts are the mirror image of the intermediate purchase accounts. In both the I-O and SAM models all purchases made by each of the nine industrial sectors from other regional sectors are sales revenues earned by the same nine sectors. Thus, the inter-industry matrix is always square.

[illegible]

regional applications of I-O, households are endogenized, the result is a gross overestimation of multiplier effects. This is because value-added is often used as a proxy for household income in these studies and is a much larger figure than personal income in a SAM (Holland and Wyeth, 1993). On the other hand, the structure of the SAM as constructed in this study allows for explicit mapping of household income from three economic perspectives: value-added, non-household institutions, and households. Therefore, the multiplier effects of an exogenous change in the SAM when closed with respect to any or all of these perspectives, allows for both the open loop and close loop effects[5] often observed in the SAM. In the Louisiana SAM, payments received by each household category include institutional income distribution, payments between the three household income groups, government income transfers to households and enterprises, and remittances from out of the region to households and governments.

C.3.15 Federal Government Revenue Accounts: In most applications, a regional I-O does not include an explicit government income-receiving sector. A SAM includes a government sector and also disaggregates it into each level of government. For I-O models with a government sector (Wolff and Howell, 1989), it is usually a single consolidated account of all levels of government. In the Louisiana I-O, a single consolidated government sector is used. The federal government sector in the SAM receives income from businesses in the form of IBT, tax revenue from factor accounts, corporate tax revenue, personal income tax revenue from household accounts, and out of region remittances. For state/local government sector, a single consolidated government account receives all income due to all levels of government in the SAM; revenue sources are similar to those of the federal government except that state/local government also receives direct transfers from the federal government.

C.3.16 Capital (Savings) Account: Savings are usually treated as pure leakage in regional I-O models and thus accounted for in the ROW account. Because of this treatment of regional savings, a consolidated capital account is often constructed to accommodate savings and ROW receipts. When capital income is also considered a pure leakage, the leakage account combines capital income, savings and ROW accounts (Kraybill, 1994). The savings account is present in both the Louisiana I-O and the SAM models. In the Louisiana I-O, the savings account includes household savings, government savings, and net capital remittances from out of the region. In the Louisiana SAM, these sources of savings are also present, but depreciation and retained earnings by enterprises are now included.

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[5]Open loop multipliers describe the effects of an external shock that is transmitted to other blocks of the SAM matrix and end there, not been f

4s2, not be0 Tat8sin-39.aT4W108 -6.96 4s2, no72 loca8re, 52

C.3.17 Rest of the World (ROW) Account: The ROW account holds import of industrial sector for production of local goods, household and government imports of goods and services. It also includes income transfers out of the region by regional

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The Department of the Interior Mission

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