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ANALYSIS OF THE CUMULATIVE IMPACTS WESTERN GULF OF ALASKA IMPACT ANALYSIS

PREPARED FOR

BUREAU OF LAND MANAGEMENT
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ALASKA OCS SOCIOECONOMIC STUDIES PROGRAM
ANALYSIS OF THE CUMULATIVE IMPACTS
WESTERN GULF OF ALASKA
IMPACT ANALYSIS

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I. INTRODUCTION

Background

Historically, Alaska has provided a small part of the U.S. petroleum supply. By 1974, Alaska had produced only one percent of the total U.S. domestic crude oil (U.S. Geological Survey, 1975). Alaska will play a much more important part in meeting future U.S. petroleum needs. By 1985, as much as 25 percent of total U.S. oil production has been projected to be from Alaska (Federal Energy Administration, 1976).

Alaska's future importance as an energy supplier will result from two factors. First, production at Prudhoe Bay has increased the importance of existing Alaskan energy supplies. Secondly, future exploration and development of petroleum reserves in the United States will center on Alaska. Alaska accounts for over one-fourth of the identified oil and gas reserves and an estimated one-third of all undiscovered recoverable domestic oil reserves in the United States.

Because of their potential as a source of oil and gas, the U.S. Outer Continental Shelf (OCS) will play an important role in the future energy program of the United States. An estimated 60 percent of all undiscovered OCS reserves in the United States are in Alaska, so Alaska will be particularly important to the OCS program (U.S. Geological Survey, 1975).

The development of Alaska's petroleum reserves will affect the future Alaskan economy. Past changes produced by petroleum development have been

major. The rapid growth associated with petroleum development at Prudhoe Bay and the Upper Cook Inlet have strained both Alaskan society and the environment. At the same time, these developments generated the most prosperous period in the state's economic history. Future development of Alaska's OCS petroleum reserves will also affect the population and economy of the state.

The Purpose of the Study

The changes produced by Alaskan OCS development will not necessarily resemble those changes which were caused by past petroleum development. One objective of the participation by the Institute of Social and Economic Research (ISER) in the Bureau of Land Management's Alaska OCS Socioeconomic Studies Program is to provide the information needed to anticipate the major dimensions of the economic and social impacts of proposed oil and gas developments in the Alaska OCS. The Institute has participated in a series of studies describing the impacts of lease sales in the Beaufort Sea, Northern Gulf of Alaska, and Western Gulf of Alaska. The major objective of these studies has been to examine only a portion of the total OCS impact, the statewide and regional economic and demographic impacts.

One aspect of impact which has been neglected by these studies is the cumulative impact of the OCS program on Alaska. The previous studies have examined the impacts of the individual lease sales. The total effect on the Alaskan economy and population of the OCS program is also a concern. The lease sales through the Western Gulf are scheduled to occur within five years of each other, so development activity may be occurring simultaneously

in all lease sale areas. Because of the simultaneous nature of OCS development, the total cumulative impact could be important even if the impact of each individual lease sale is insignificant. The objective of this study is to examine the cumulative impact of the Alaskan OCS program through sale 46 in the Western Gulf of Alaska. To achieve this objective, ISER will provide a series of economic and population projections through 2000 under two alternative scenarios. The first scenario will assume that no OCS activity takes place, while the second will assume that the Lower Cook (1977), Beaufort Sea, Northern Gulf of Alaska, and Western Gulf of Alaska lease sale areas are developed at their mean probable resource levels. Of these sales, only the 1977 Lower Cook lease sale has actually been held. By contrasting these projections, it is possible to assess the major dimensions of the impacts of the Alaska OCS program on population, employment, income, and the state's fiscal position.

Study Design

This study consists of two parts: a base case projection describing the future economy without OCS development and an examination of the program impact of OCS development. This section describes the relationship of each of these parts to the impact assessment and the methodology chosen to make the necessary projections.

THE BASE CASE

Petroleum development in the OCS lease sale areas of Alaska may affect both the structure and size of the Alaska economy. Changes in the economy which result from the development of the OCS resources can be

defined as the impact of this development. This impact can only be described as changes from a certain pattern of economic growth which would have occurred without OCS development. The non-OCS base case is developed to provide a reference point for the analysis of the impacts of OCS development. Comparing a projection of economic activity with OCS development to a base case without OCS development will isolate the impacts of development.

THE ROLE OF SOCIOECONOMIC PROJECTIONS

The uncertainty of the future, though it may increase the problems associated with making projections, increases the importance of these projections. Decision makers in both the public and private sectors need information about the future in order to plan their actions. The more uncertain the future events, the more important is some projection of them. Projections serve two important purposes--they serve as a means of determining future demands and needs for services, and they allow policy makers to test the alternative effects of various policies.

Models can be used to test the relative efficiency of alternative policy choices. When models explicitly include policy variables, such as tax rates, or variables directly affected by policy, such as the level of petroleum employment, they can be used to test the effects of policies described by these variables. By making separate projections under various assumptions about policy choices, the effects on important variables such as population or employment can be compared. Alternative policy choices can be compared in terms of their relative costs and benefits.

Projections increase the information available to decision makers for making policy choices. Many present policy choices have important future implications which must be considered by policy makers. For example, current policy decisions regarding OCS petroleum development will have their major effect in the middle of the next decade. By providing descriptions of the most probable future levels of important variables, socioeconomic projections serve as a framework for making policy choices.

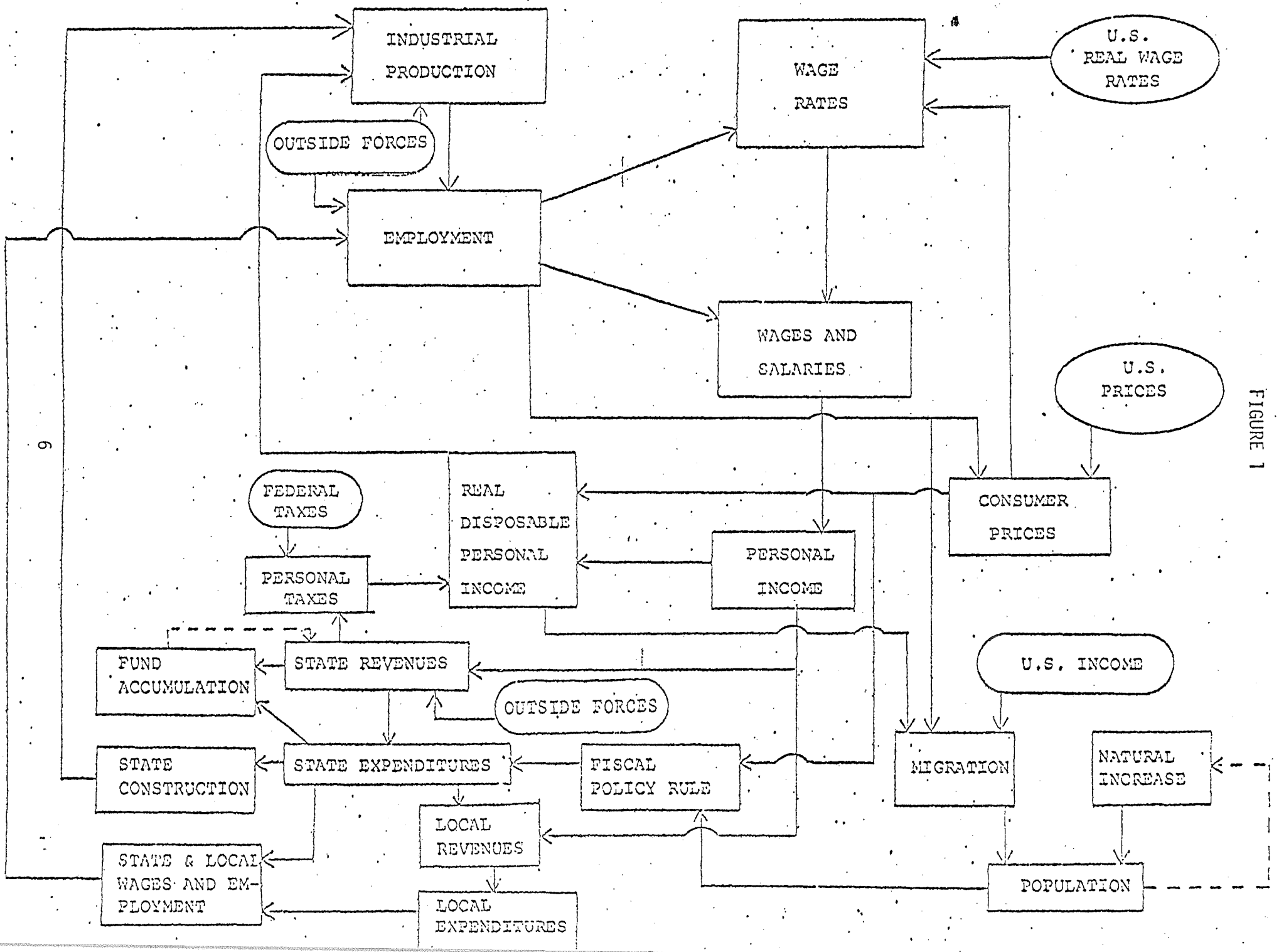
METHODOLOGY

This section describes the methodology used to make the projections of Alaskan economic growth in both the base case and OCS development case. An econometric model of the Alaska economy was used to make the projections. This section will describe the model and its strengths and weaknesses.

The Statewide Econometric Model

The basic model to be utilized in the analysis of the OCS development scenario is the statewide econometric model of the Alaskan economy developed in the Man-in-the-Arctic Program (MAP) presently being conducted by the Institute of Social and Economic Research of the University of Alaska. There are three components of this model: an economic model, a fiscal model, and a demographic model. The basic structure of the model is shown in Figure 1.

The economic model is divided into exogenous or basic sectors and endogenous or nonbasic sectors. The level of output in the exogenous sectors is determined outside the state's economy. The primary purpose of the


INDUSTRIAL PRODUCTION
WAGE RATES
U.S. REAL WAGE RATES
OUTSIDE FORCES
EMPLOYMENT
WAGES AND SALARIES
U.S. PRICES
FEDERAL TAXES
REAL DISPOSABLE PERSONAL INCOME
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OUTSIDE FORCES
STATE CONSTRUCTION
STATE EXPENDITURES
FISCAL POLICY RULE
MIGRATION
NATURAL INCREASE
LOCAL REVENUES
STATE & LOCAL WAGES AND EMPLOYMENT
POPULATION
LOCAL EXPENDITURES

FIGURE 1

nonbasic sector is to serve local Alaskan markets, so the level of output is determined within the Alaskan economy. The basic industries in the model are mining, agriculture-forestry-fisheries, manufacturing, federal government, and the exogenous components of construction and transportation. The nonbasic industries are transportation-communication-utilities, wholesale and retail trade, finance-insurance-real estate, services, and the remainder of construction.

In the model, industrial production determines the demand for labor and the level of employment; employment is that level needed to produce the required output. Employment and the wage rate determine wages and salaries, the most important component of personal income. The most important determinant of Alaskan wage rates are U.S. wage rates; wages are also affected by rapid growth of employment in Alaska. The level of disposable personal income is projected by adding an estimate of nonwage income to wages and salaries and adjusting this for income taxes. The level of real disposable income is found by deflating disposable personal income by a relative price index; the major determinants of Alaskan prices are U.S. prices, the size of the economy, and the growth rate of the economy. Incomes determine the demand for local production; incomes and output are simultaneously determined.

Each component of population change--births, deaths, and migration--is projected separately. The model uses age-sex-race specific survival rates and age-race specific fertility rates to project births and deaths for the civilian population. Total civilian population is found by adding civilian

net migration to the natural increase. Net migration is determined by the relative economic opportunities in Alaska. In the model, these are described by employment changes and the Alaskan real per capita income relative to the real per capita income of the United States. An exogenous estimate of military population is added to determine total population.

The fiscal model, which provides important pieces of information for the economic model, also provides a framework for analyzing the effects of alternate fiscal policies. The fiscal model calculates personal tax payments in order to derive disposable personal income. The fiscal model, based on an assumed state spending rule, also calculates personnel expenditures, state government employment, and the amount spent on capital improvements which determines a portion of employment in the construction industry. All three submodels are linked through their requirement for information produced by the other submodels.

STRENGTHS AND LIMITATIONS

The model used in this analysis has several strengths and weaknesses which must be considered when examining the reported results. The principal strength of this model is that it captures the essence of the Alaska growth process. Export base industries and government create growth directly through hiring and indirectly through the demand generated by their employees for locally produced goods and services. Incomes earned by these export base workers and the workers who supply the goods and services provide the base of the economy.

Compared to two alternative forms, economic base and input-output models, an econometric specification of this type is preferred, since it captures some of the dynamics of industry growth. An economic base model is useful for projecting marginal changes but assumes that changes in the support sector are proportional to changes in basic sector employment. This misses both the feedback effect of the growth of the support sector incomes and the change in the responsiveness of the support industries over time. While input-output models more precisely define the inter-industry flows of purchases of goods and services, it represents the economy only at a particular point in time. An econometric approach can capture some of the changing relationships over time, as they are described by historic changes or incorporated by the modeler.

The limits on the econometric method define the limits on the acceptance of the resulting projections. No model is able to capture revolutionary changes which violate the assumptions upon which the model is built, unless structural change has been foreseen and incorporated by the modeler. The limitations of the model increase the more the model is extended into the future and the more locationally precise the model is expected to be. In other words, more confidence should be placed in the 1985 results than those for 1995, and statewide projections are more likely to be "correct" than regional results.

Another important limitation of the model to projections is that they should be considered contingent. The accuracy of the projections depends on the continued relevance of the model's historical structure and the accuracy

of the assumptions about the level, timing, and distribution of the exogenous variables. One result of this contingency is that the projections may not necessarily agree with the actual levels of the projected variables for any given year. Projections are based on the average historical relationships between the projected variables and important exogenous variables. This leads to two reasons why projections in any year may differ from the actual levels of projected variables. First, estimates of the level of important exogenous variables may differ from the actual levels. Secondly, cyclical effects may cause yearly divergence from the general trend of economic growth. The relationships described by the model, while they may not predict actual levels in any particular year, describe the general trend of future Alaskan economic growth.

GENERAL METHODOLOGY FOR ANALYSIS

The general approach to be pursued in the analysis of the impacts of OCS development will be as follows: A scenario will be developed which contains no OCS development. This scenario will be run using the MAP model and will serve as a point of comparison for the OCS development scenario. The OCS scenario run will then be compared to the base run to examine the impact of this hypothetical development on the major dimensions of the Alaskan economy.

Overview

The remainder of this report will analyze the projected future growth of the Alaskan economy, both with and without OCS activity. Part II presents the projection of economic activity in a base case which contains no OCS

petroleum development in Alaska. Part III then describes the impacts of the OCS development. Finally, Part IV summarizes our major findings.

II. THE ALASKAN ECONOMY IN THE BASE CASE

This chapter will describe the projected growth of the Alaskan economy without the development of the Alaska Outer Continental Shelf petroleum resources. The following chapter will compare the effect of potential development of OCS petroleum resources in the Lower Cook Inlet, Beaufort Sea, Northern Gulf, and Western Gulf of Alaska to this non-OCS base case.

The Purpose of the Base Case

OCS petroleum development may affect both the structure and the size of the Alaska economy. Changes in the economy which result from the development of OCS resources can be defined as the impact of this development. The impact can only be described as changes from a certain pattern of economic growth which would have occurred without OCS development. The base case describes the projected growth of the economy without the development for which the impact is to be measured. Comparing two projections of the economy, the base case and the OCS case will define the impact of OCS development.

The base case scenarios described below are consistent, plausible patterns of development; however, they should not be mistaken for best-guess patterns of development in any sense. The actual pattern likely to occur is subject to an enormous amount of uncertainty determined by technology, market prices, federal policies, and other uncertain events. To project any one economic future would be little more than idle speculation, since at this point many major events and decisions affecting Alaska are uncertain.

The MAP model is designed to permit the formulation of ranges of scenarios which reflect these uncertainties in order to trace out the range of possible outcomes. This approach could be used to determine the range of alternative non-OCS assumptions. To estimate the impacts of OCS development, a single base case is needed. This must be selected on the basis of the consistency and plausibility of the assumptions, consistency with historical growth, and consistency with assumed future patterns of economic relations. The effect of this base case choice can be measured by testing the sensitivity of the results to certain of the more important assumptions.

The purpose of establishing a base case must be kept in mind when examining the results. The base case is run in order to isolate the changes resulting from OCS development. Rapid growth associated with OCS development will affect most economic variables. Although many variables will be affected, a much smaller number is important, and information on these dimensions of impact will describe the effect of rapid growth on state and regional economies. The base case will be analyzed to provide a point of reference for these dimensions of impact.

Base Case Assumptions

The base case is defined by assumptions about the future levels of certain exogenous variables. The set of assumptions necessary for a base case scenario includes three important components. The first involves assumptions about the level of employment in the exogenous industries. Those industries include manufacturing, agriculture-forestry-fisheries, federal government, mining, and a portion of the construction industry. The

second set of assumptions involves the level of certain exogenously determined revenues which result from the production of the petroleum industry. These include royalties, production taxes, property taxes, and corporate income tax. The final assumption concerns the rule which defines an assumed spending pattern for the state.

The uncertainty surrounding the future petroleum and world energy markets, as well as state economic decisions which influence economic growth, means that any assumption about the appropriate base case scenarios is subject to criticism. An extensive development of a base case scenario, which required considerable time and research would, because of the uncertainty, be subject to the same type of criticism. The uncertainty involves such major factors as the construction and timing of the ALCAN gasline and future state spending policy. Because of this, an extensive development of the base case scenario was not undertaken in this study; instead, a reasonable set of assumptions was developed which placed emphasis on consistency of assumptions and reasonableness of approach. This section describes the set of assumptions used in the base case.

NON-OCS ASSUMPTIONS

Industry Assumptions

There are two special groups of industry assumptions which are required. First, assumptions about employment connected with special projects, mainly resource development projects, are needed. Secondly, assumptions about the growth of the major exogenous industries--manufacturing, agriculture-forestry-fisheries, and federal government--are required.

Special projects include petroleum projects, major construction projects, and the operations of these projects. Petroleum activity is assumed to continue at Prudhoe Bay with further exploration and development of the Kuparak and Lisburne formations. Mining employment peaks in this area at 1,783 in 1980. The Upper Cook Inlet fields are the other major area of petroleum activity. Employment is assumed to increase from its present level between 1985 and 1990 as the oil fields are shut down. Gas production continues after 1990 but with a reduced work force. There is little other new mining activity in the state with other mining maintaining current levels throughout the projection period.

Major construction projects in the state during the projection period include the Trans-Alaska Pipeline Service (TAPS) and the ALCAN gasline. TAPS is completed in 1977, after which the line's capacity is assumed to be increased by the addition of four pump stations between 1979 and 1982. The ALCAN gasline is assumed to be built between 1981 and 1984 with peak employment of 4,800 in 1982. The only other special construction project in the state during the projection period is the construction of the Pacific LNG plant between 1980 and 1983; project employment peaks in 1982 with 1,300 employees.

TAPS is assumed to require 850 workers per year for its long-term operations. ALCAN operations employment is assumed to be 96 beginning in 1985. TAPS' higher operations employment can be accounted for since TAPS has more pipeline in Alaska, Valdez port employment is part of TAPS employment, and TAPS has substantial Alaska headquarters employment. Operations employment for the Pacific LNG plant is 60 beginning in 1984.

The level of employment in federal government and agriculture-forestry-fisheries and output in manufacturing is set exogenously. Federal government employment is assumed to follow its general historical trend and remain constant at the 1976 level throughout the forecast period. The trend in the historical period reflected increases in civilian employment offsetting decreasing military employment. Employment in agriculture-forestry-fisheries is assumed to be dominated by increases in fisheries. In this study, we assume an average rate of employment growth of 3 percent per year. This assumption is consistent with moderate replacement of the foreign fishery by Alaskans (Scott, 1979). Output in manufacturing is assumed to increase at an average annual rate of 4 percent, which is consistent with both the historical trend and the assumed growth in the fisheries industry.

National Variables

Alaska is part of the larger U.S. economy, and it is affected by changes in the national economy. Three assumptions about the future growth of the U.S. economy are needed. These assumptions are based upon the long-term projections of the consumer price index by Data Resources, Inc. Assumed U.S. rates were those from DRI's TRENDLONG0678 forecast (DRI, 1978). This assumption assumes the continuation of long-term trends in important exogenous variables. The average annual rate over the period of the forecast was used as our assumption. The consumer price index was assumed to grow at 5.5 percent per year. The U.S. real per capita disposable income, adjusted to reflect consistent tax assumptions, was assumed to grow at 2.2 percent per year. Finally, DRI does not provide

a projection of U.S. weekly compensation. U.S. weekly compensation was assumed to increase at a rate of 6.8 percent per year.

Petroleum Revenues

The petroleum revenues received by the state consist of royalties, production taxes, property taxes, and the corporate income tax. The major source of these revenues in the projection period is the Prudhoe fields. The revenues are determined by the assumed rate of production of oil and gas and its wellhead value. Prudhoe oil production is assumed to peak in 1985 at 641.5 million barrels per year, while gas production is assumed to maintain its peak production of 912 billion cubic feet per year once this is reached in 1987. The wellhead value of Prudhoe oil is determined by the following assumptions: constant real West Coast market price of $12 per barrel, constant real vessel and processing costs of $1.75 per barrel, and a TAPS tariff of $5.25 in 1978. The nominal TAPS tariff is assumed to remain constant until 1990 when increasing operating costs are assumed to dominate decreasing capital costs; after 1990 the real tariff is assumed to remain constant. The wellhead value of gas was assumed to equal $1.00 per MCF in 1978; this assumes the producers pay a $.45 per MCF processing cost. These wellhead values are only part of an array of many possible wellhead values. The range of wellhead values is a function of the uncertainty about the future levels of those factors influencing these values. Revenues are determined by existing state laws describing royalties, production taxes, property taxes, and corporate income taxes.

THE STATE EXPENDITURE RULE

Because of the central role of state and local government in the Alaska economy and because the behavior of these governmental units depends largely on policy choices to be made over the next several years within a framework far different from the past, the treatment of expenditures by state and local governments is a central feature of any development scenario. Over the projection period, the state government is assumed to receive revenues from oil development which far exceed current levels of expenditures. The rate at which state government chooses to spend these revenues and the composition of these expenditures will serve to determine not only direct employment in the government sector but will also impact all endogenous sectors.

Two factors determine the current framework in which state expenditure policy will be determined. First, petroleum revenues to the state increased tremendously with the completion of the trans-Alaska oil pipeline. Future revenues will follow closely the pattern of production from Prudhoe Bay. Secondly, the establishment of the Permanent Fund places new constraints on the use of certain petroleum revenues. The Permanent Fund was adopted in 1976 as a constitutional amendment. It established that a minimum of 25 percent of all mineral lease rentals, royalties, royalty sale proceeds, federal mineral revenue sharing payments, and bonuses received by the state would be placed in the fund. This forced savings is only a portion of the revenues available to the state. Revenues accumulating in the General Fund will be greater than in the Permanent Fund for most of the period.

The rate of state expenditures, because it is a matter of policy choice to be made within a framework far different from past experience, cannot be modeled simply from past experience. However, past experience can provide a guide for developing the hypothetical spending rule used in the simulation. Scott, in his paper "Behavioral Aspects of the State of Alaska's Operating Budget FY 1970 - FY 1977," found two major factors responsible for the growth of state expenditures. First, real per capita state expenditures increased in response to real per capita income growth, a demand effect. Secondly, expenditures increased in relation to the funds available for state expenditures. Scott also found that the pattern of capital and operating expenditure growth differed. Capital expenditures increased strongly in response to available fund growth but the higher levels were not maintained. Operating expenditures did not respond as strongly to available funds; however, the higher levels of operating expenditures were maintained.

Based on this analysis, real per capita state expenditures were assumed to grow in response to increased personal income and fund availability. Real per capita expenditures were assumed to increase in response to increases in personal income. The income elasticity of both capital and operating expenditures was less than one to reflect assumed increases in scale economies associated with the production of state services.

The response to fund availability was composed of two parts. Expenditures responded to changes in the general fund balance. The response was weighted; the weight equalled the previous year fund balance divided by general fund expenditures. In other words, the response to a change in

the general fund was weighted by the number of years of existing expenditures which could be taken out of the general fund. The response to fund balance changes of capital expenditures was greater than the operating expenditure response. Another difference between operating and capital expenditures is that the real level of operating expenditures is assumed to be maintained, while the level of capital expenditures can fall.

Most relationships in the model are derived from historical relations. The elasticities in the operating and capital expenditure equations cannot be derived in this manner since the structure will be uniquely different in the future. Assumptions about these elasticities must be made. The elasticities in both sets of equations are chosen so that the elasticity of real per capita income equals .5. Real per capita expenditures increase at half the rate that real per capita incomes increase. This rate was chosen both to reflect economies of scale in production of government services and to reflect a decreased importance of state government in the Alaskan economy. Alaska has a much higher ratio of state expenditures to personal income than other states, and it was assumed that this ratio should fall toward the other states. The elasticities for the supply-affected portion of growth were determined by examining the changes in the period 1970 to 1971 which was the last period of rising general fund balance. Based on examining changes in this period, elasticities on the weighted increase in the general fund of 2 percent for the operating budget and 10 percent for the capital budget were chosen.

Admittedly, these expenditure rules are highly speculative, but they seem to reflect the wide range of policy choices open to state government as a consequence of new oil revenues. It is impossible to predict the specific expenditure path. Because of this, we assume a hypothetical rule which is reasonable.

The Causes of Economic Growth

Changes in three separate but interrelated factors: the level of employment in the exogenous sectors of the economy, the level of personal income, and state expenditures determine the growth of the state economy. The effect of each of these on the expansion of employment in the state can be easily seen.

Growth of the exogenous sector directly affects economic growth by the employment it creates. The growth of this sector is determined by external demand for Alaskan products. The most obvious example of this type of growth is the employment associated with the construction of the trans-Alaska pipeline.

State expenditures are also a source of growth because they translate revenues raised outside of the Alaskan economy, such as petroleum-related revenues, into demand for Alaskan products. State expenditures influence employment growth in two ways. First, state capital expenditures on projects such as ports and highways increase the output of the construction industry. This increases the demand for construction employment.

Secondly, state operating expenditures are partially spent on personnel expenditures. This determines the level of state government employment.

Increased incomes are the primary cause of economic growth. Expansion of the exogenous sectors and state government employment are not the only way in which income increases. Income increases with increases in the average income per worker and with increases in the number of workers in the economy. The average income is substantially determined by wages and salaries, so it reflects changes in the wage rate. The real wage rate is determined by bottlenecks in the economy associated with rapid growth and changes in U.S. wages. The U.S. labor market affects the Alaskan real wage rate because of the small size of the Alaskan labor market and the mobility of Alaskan workers. Because of these factors, migration becomes an equilibrating factor maintaining the relation between Alaska and U.S. wages. Changes in the sectoral composition of employment will also affect the average wage. As high wage sectors such as construction and mining increase in importance, wages and salaries will increase more than proportionally to employment growth.

Expansion of state government and the exogenous sector influences the growth of the remainder of the economy because of an increased demand for locally produced goods and services. Expansion of employment in these sectors increases income in the economy; a portion of this increased income will be spent in Alaska. The increased demand for local goods and services will increase employment in the endogenous sectors, since employment is determined by the demand for labor needed to produce a desired

level of output. This increased employment generates its own demand and creates more endogenous employment; the process stops when leakages outside the economy dominate the flow of income.

The response of the economy to increases in income will be determined by the structure of the economy. Larger economies provide more of their own goods and services; there are fewer leakages; and the multiplier is larger. This results because economies of scale allow lowered production costs and import substitution. Growth by affecting the structure of the economy will influence the response of the economy to increases in income.

The effect of an increase in personal income on growth will depend on the increase in prices. Real income determines the demand for goods and services. The price level of the Alaskan economy is determined by U.S. prices since Alaska imports most of its goods. The size of the economy also affects the price level; larger economies provide economies of scale which reduce the cost of production and reduce prices. A third determinant of the price level is the rate of growth. Rapidly growing regions are more subject to bottlenecks and supply constraints which lead to price increases.

Employment and income growth influence the growth of population in the state. Population grows as a result of natural increase and migration. Natural increase (the excess of births over deaths) is a function of the age distribution of the population. Migration is determined by the relative economic opportunities available in Alaska. Changes in employment

opportunities and the relative per capita income between Alaska and the rest of the United States will determine migration. Migration has a considerable effect on the age-sex distribution of the population. Migration which is determined by economic opportunities primarily affects the age group under forty. Migration after forty years of age is a response to other factors such as retirement and the high cost of living (Seiver, 1975).

Base Case Growth of the Alaskan Economy

The base case describes the general pattern of Alaska economic growth without OCS development. The impact of the OCS leasing program in Alaska will be measured as changes from this base case pattern of growth. This section will discuss the projected growth of the Alaskan economy; both the change in the magnitude of important economic variables and the change in the economic structure will be examined.

One reference for describing the projected economic growth is the historical growth of the Alaskan economy. The Alaskan economy experienced extremely rapid growth between 1965 and 1976. Employment grew at an average annual rate of over 8 percent throughout the period. The economic growth during this period was responsible for important structural changes. The most important of these were the increased importance of the support sector and the increased participation of the population in the labor force. Population grew at an annual average rate of 4.1 percent during this period. Migration was responsible for a large proportion of this growth. Growth improved the real per capita incomes of Alaskans but had little

effect on unemployment. As the scale of the economy increased, the price level fell relative to the United States, although the rapid growth connected with TAPS construction reversed this trend. The growth during this period was influenced by two major events: the discovery and production of petroleum at Prudhoe Bay and the construction of the trans-Alaska pipeline. These events were responsible for the magnitude and the character of the growth which occurred during the period.

THE GENERAL PATTERN OF DEVELOPMENT

Economic growth is a multidimensional process which no single indicator can describe. While population, employment, and personal income do not describe the full range of growth, they do describe the general pattern of growth. Employment growth measures the ability of the economy to create jobs, personal income measures the effect of the economy on residents' command over goods and services, and population growth describes the response of people to these changing economic opportunities. This section describes the projected base case growth of these aggregate indicators of economic growth.

Employment

The growth of employment is projected to be considerably less rapid than in the historical period. The adjustment to the completion of TAPS continues until 1979, after which employment begins to grow. Employment grows at an average annual rate of 2.23 percent between 1979 and 2000, reaching 306,906 by the end of the period. Employment experiences its greatest growth between 1979 and 1983 with the construction of the ALCAN

gasline. During this period, employment grows at an average annual rate of 3.7 percent. Employment falls by less than one percent after completion of the ALCAN.

The major reason employment growth is not projected to be as rapid as in the historical period is an assumed slower growth in the basic sector. This sector includes mining, federal government, agriculture-forestry-fisheries, manufacturing, and special projects construction and transportation employment. Basic sector employment is assumed to increase by 12,685 between 1979 and 2000. This is an average rate of only .9 percent per year. The basic sector grew at a rate of almost 3 percent per year between 1965 and 1976. Employment in the basic sector increases to a peak of 68,991 in 1982 because of construction of the ALCAN gasline and the Pacific LNG plant. Mining employment is assumed to peak in 1979 at 4,440 when Prudhoe Bay employment is assumed to peak. Mining employment increases between 1985 and 1990, then falls as the Upper Cook Inlet oil fields are assumed to be shut down. After 1994, mining employment is constant at 3,268, and growth in the basic sector is the result of growth in manufacturing and agriculture-forestry-fisheries. Table 1 illustrates the relation between basic and total employment during the projection period. The ratio of total to basic employment rises from 3.3 to 4.1 between the final year of ALCAN construction and the end of the period.

The changing relationship between total and basic sector employment shown in Table 1 is partially a result of increasing real incomes. The other reason for a change in this ratio is the changing structure of the economy.

TABLE 1. ALASKA EMPLOYMENT GROWTH
BASE CASE
1978-2000

	Total Employment	Basic Employment[2]	Total Employment/ Basic Employment
1978	197,081	61,109	3.23
1979	192,852	61,727	3.12
1980[1]	194,710	62,596	3.11
1981	201,721	64,938	3.11
1982	214,587	68,991	3.11
1983	223,652	68,234	3.28
1984	222,413	63,978	3.48
1985	223,110	64,414	3.46
1990	246,536	67,539	3.65
1995	270,386	70,356	3.84
2000	306,906	74,412	4.12

[1]ALCAN construction occurs between 1981 and 1984.

[2]Basic employment includes: federal government, manufacturing, agriculture-forestry-fisheries, mining and special project construction, and transportation.

SOURCE: MAP Model.

As the scale of the economy increases, more goods and services are produced locally and the ratio of total to basic employment will increase. The changing economic structure can be seen in Table 2. The support sector increases from 36.1 percent to 47 percent of employment over the forecast period. Government employment's share of total employment falls from 41.7 percent to 28.8 percent. The primary reason for this is the assumption that federal government employment will remain constant. The commodity producing industries increase their share of employment slightly from 22.2 percent to 24.2 percent primarily because of the expansion of manufacturing.

Population

Population increases through natural increase and net in-migration. Population is projected to increase by 186,351 between 1978 and 2000 to 588,820. Population grows at an average annual rate of 1.8 percent between 1979 and 2000; this is less than half the rate of growth between 1965 and 1976. The most rapid growth in population occurs between 1979 and 1983 with the construction of the ALCAN gasline, when population grows at an annual average rate of 2.9 percent. Table 3 shows the projected population growth.

Because of the relatively slow growth in employment, migration plays a smaller role in population growth than natural increase for most of the period. Migration is important during the buildup for ALCAN. Migration accounts for 67.3 percent of the population increase between 1981 and 1982. After the ALCAN peak construction years, out-migration occurs in 1984, 1985, and 1986. The importance of migration increases throughout the

TABLE 2. THE STRUCTURE OF EMPLOYMENT
BASE CASE

	Percent of Total Employment		
	Support Sector	Government	Commodity Producing Industries
1978	36.1	41.7	22.2
1980	34.5	41.5	24.0
1985	38.1	38.1	23.8
1990	40.6	35.2	24.2
1995	43.8	32.2	24.0
2000	47.0	28.8	24.2

Support Sector includes transportation-communication-public utilities, trade, finance, and service employment.

Government includes state, local, and federal government employment.

Commodity Producing Industries include manufacturing, mining, construction, and agriculture-forestry-fisheries employment.

SOURCE: MAP Model.

TABLE 3. ALASKA POPULATION GROWTH
BASE CASE
1978-2000

	Population	Migration[1]
1978	404,436	- 5,000
1979	402,469	- 14,077
1980	405,156	- 3,740
1981	415,106	3,772
1982	434,151	12,812
1983	450,886	10,093
1984	453,976	- 3,848
1985	456,806	- 3,856
1990	492,853	2,381
1995	530,883	2,531
2000	588,820	5,774

[1]Migration from previous year

SOURCE: MAP Model.

remainder of the period until it accounts for 45 percent of the population increase between 1999 and 2000.

Population increases slower than employment throughout the projection period. This repeats a trend observed in the historical period. The dependency ratio, defined as the ratio of population to employment, falls from 2.09 in 1978 to 1.92 by 2000. This fall is the result of an increased participation of the population in the labor force.

Personal Income

Since wages and salaries are the major component of personal income, growth in personal income is related to growth in employment. The rate of growth of personal income will be affected by changes in the composition of employment, changes in the productivity of labor, and the growth of U.S. wages. Between 1979 and 2000, real personal income grows at an average annual rate of 4.4 percent. Real personal income grows faster prior to the 1983 ALCAN peak construction. Between 1979 and 1983, personal income grows at an average rate of 10.4 percent per year. The high wages earned by construction workers on the ALCAN project influences this growth. After 1983, personal income drops by nine percent.

Increases in personal income measure the increased command of residents over goods and services. The full effect of increases in personal income is diminished by price increases; as the price of goods and services increases, a dollar of income can buy less. In order to increase the command of the average resident over goods and services, real personal

income must increase faster than population. Increases in real per capita income are a better measure of the benefits to the average resident. Table 4 shows the projected change in real personal income and real per capita income.

Personal income increases faster than population and prices so that real per capita income increases. Real per capita income increases by 69 percent between 1979 and 2000. The average growth rate is 2.5 percent per year. This is slightly faster than the assumed 2.2 percent growth rate for U.S. real per capita income. This is less than the 5.4 percent growth rate between 1965 and 1976.

The State Fiscal Position

Over the projection period, state government will receive revenues from petroleum development which exceed current levels of expenditure. State government's decision on the expenditure of these revenues will influence the growth of the Alaska economy. In the historical period, we observed state government's role in the growth process. State government contributes to growth by the expenditure of revenues directly through state government employment and indirectly through capital expenditures, which influences the level of activity in the construction sector. When revenues from outside the economy such as exogenous petroleum revenues are spent, this extra demand causes growth. This section describes the projected revenues to the state, the state's projected expenditures, and the overall fiscal position of the state in the projection period.

TABLE 4. ALASKA GROWTH OF PERSONAL INCOME
BASE CASE
1978-2000

(Millions of Constant 1978 $)

	Real Personal Income	Real Per Capita Income[1]
1978	3,973	9,822
1979	3,872	9,612
1980	4,038	9,968
1981	4,391	10,606
1982	5,099	11,780
1983	5,675	12,085
1984	5,170	11,346
1985	5,138	11,262
1990	6,328	12,813
1995	7,608	14,356
2000	9,542	16,209

[1]All real amounts are adjusted to constant 1978 levels. The real per capita projections produced by the model are adjusted to a 1957 base. For the tables, these real per capita amounts are also adjusted to a 1978 base.

SOURCE: MAP Model.

State Revenues. The State of Alaska has two major sources of revenues, exogenous petroleum revenues which are determined by the flow of oil and gas on state lands and endogenous revenues which are determined by the state's economic activity. Endogenous revenues include income tax, business taxes, and other revenues determined by the growth of the economy. Table 5 shows the growth of state government revenues in real terms between 1978 and 2000. Total revenues are almost $777 million larger in 2000 than in 1978. Overall, these revenues increase at a rate of 2.5 percent per year. Prudhoe oil revenues peak in 1985. Prior to 1985, the rate of increase in revenues averages 11.9 percent per year. The real level of state revenues falls by 22 percent between 1985 and 2000. The pattern of revenues follows the pattern of petroleum revenues received by the state.

The most important source of revenues to the state during the period between 1978 and 2000 are petroleum revenues. Petroleum revenues include royalties, production taxes, property taxes, and petroleum corporate income taxes from petroleum production. Petroleum revenues are earned from production on state lands in Upper Cook Inlet and Prudhoe Bay. Because of their importance, Prudhoe Bay production dominates these revenue flows. Real petroleum revenues increase until 1985, after which they decline. The decrease in revenues reflects declining production at Prudhoe Bay. Between 1978 and 1985, yearly petroleum revenues increase at an average rate of over 20.1 percent per year. After 1985, real petroleum revenues fall, falling 56 percent by 2000. Other endogenous real revenues, which include personal and business taxes, fall with the slowdown of the economy after TAPS completion. The increase in these revenues results

TABLE 5. STATE REVENUES
BASE CASE, ALASKA
1978-2000

(Millions of Constant 1978 $)

	General Fund Revenues	Petroleum Revenues	Endogenous Revenues
1978	1,092	471	334
1979	1,302	764	265
1980	1,402	889	238
1981	1,597	1,083	236
1982	1,754	1,190	270
1983	1,912	1,273	321
1984	2,251	1,571	345
1985	2,393	1,693	335
1990	2,247	1,301	439
1995	2,003	952	586
2000	1,869	753	815

SOURCE: MAP Model

from the growth of the economy. These revenues grow at an average rate of 5.5 percent between 1979 and 2000. The increase in these revenues after 1985 counteracts the decline in petroleum revenues.

State Expenditures. State government expenditures increase during the projection period; the level of state expenditures in 1978 prices is shown in Table 6. The increase in state expenditures is a result of two forces. First, expenditures grow as a response to the general growth of the economy. Increased population and prices result in increasing expenditures to provide the same level of services as measured by real per capita expenditures. The growth of income is assumed to increase the demand for the level of services provided. The second force operating on state expenditures is the accumulation of unspent revenues. These revenues will place pressure on the government to increase expenditures.

Real state expenditures more than double between 1978 and 2000. The average annual growth rate during this period is 3.7 percent per year. After 1985 when petroleum revenues peak, the growth of expenditures is at a rate of only 2.6 percent per year. The projected growth in state expenditure repeats over a much longer period the experience of the state after the Prudhoe lease sale. The Prudhoe Bay experience may provide an indication of how the state will expand services in the future. Despite the rapid growth of expenditures during the historical period, the functional distribution of expenditures remained fairly stable. From this, we may be able to infer that the state will continue to distribute expenditures between the nine functional categories (education, social services, health,

TABLE 6. STATE EXPENDITURES
BASE CASE, ALASKA
1978-2000

(Millions of Constant 1978 $)

	Total Expenditures	Real Per Capita Expenditures
1978	1,270	3,139
1979	1,294	3,214
1980	1,446	3,570
1981	1,479	3,573
1982	1,582	3,654
1983	1,762	3,903
1984	1,859	4,080
1985	1,903	4,172
1990	2,291	4,640
1995	2,445	4,614
2000	2,817	4,785

SOURCE: MAP Model

natural resources, public protection, justice development, transportation, and general government) as in the past (Goldsmith, 1977).

Real per capita expenditures can be considered a measure of the level of state services received by an individual. Increases in state expenditures are of two types--providing additional services and providing the same level of services to an increased population. Increases in services occur throughout the period. Real per capita expenditures increase by 52.4 percent between 1978 and 2000. This is a modest expansion when it is compared to the rise in real per capita expenditures of 118 percent between 1969 and 1973 (Goldsmith, 1977). The growth in real per capita expenditures is not even throughout the period; 87 percent of the increase occurs between 1978 and 1985 when real oil revenues peak. The reduction in the rate of growth in the accumulated fund balance after 1985 causes a drop in real per capita expenditures between 1990 and 1996.

State Fiscal Position. The state's fiscal position is determined by the interaction of the revenues received by the state and the state's expenditures. The state's fiscal position at any point in time can be measured by the state's fund balance. The revenues earned by the state from oil and gas production place the state in a unique position; these excess revenues allow the state to build up a fund balance. Fund balance revenues are not only a source of future revenues; they also generate yearly interest earnings which are an additional source of revenues. The fund balance consists of balances in the permanent and general funds.

Two factors influence the state's fiscal position. First, petroleum revenues from Prudhoe Bay are a major portion of state revenues; they account for the rapid buildup in the fund balances. These revenues are a fixed flow through time, and they will not be affected by the growth of the economy. Secondly, economic growth increases expenditures without a proportional response in revenues. These factors lead to the projected decline of the fund balances.

Table 7 illustrates the state's fiscal position in the base case. The state's fund balance (adjusted for price increases) increases rapidly as revenues flow from petroleum production.

By 1985, when real petroleum revenues peak, the state has accumulated $3.4 billion in its fund balances; until this time, fund balances grow at an average rate of 25.3 percent per year. The real fund balances peak in 1991 with $5.4 billion; between 1985 and 1991, the fund balance grows at an average annual rate of 7.9 percent. The real fund balance is drawn down by 59 percent between 1994 and 2000; so that by the end of the projection period, there is $2.2 billion in the fund.

The fund is drawn down to meet expenditures which cannot be met out of revenues. When state expenditure policy is tied in any way to revenues, the cyclical pattern of petroleum revenues and their importance to the state will lead to expenditures eventually exceeding revenues. A measure of this pattern is the difference between general fund revenues and expenditures. The excess of revenues over expenditures increases throughout

TABLE 7. STATE FISCAL POSITION
BASE CASE, ALASKA
1978-2000

(Millions of Constant 1978 $)

	General Fund Revenue Minus Expenditures	Total Fund Balance
1978	39	705
1979	232	897
1980	191	1,042
1981	356	1,349
1982	437	1,722
1983	452	2,100
1984	713	2,713
1985	843	3,418
1990	378	5,383
1994[1]	44	
1995	- 58	4,715
2000	- 499	2,186

[1] Fund balance peaks.

SOURCE: MAP Model.

the projection period until 1985 when Prudhoe Bay oil production peaks. After 1985, excess revenues are reduced. By 1995, expenditures are in excess of revenues, and the fund must be drawn down to meet expenditures.

III. THE IMPACT OF OCS DEVELOPMENT ON THE ALASKAN ECONOMY

Previous studies have concluded that lease sales in the Beaufort Sea, Northern Gulf of Alaska, and Western Gulf of Alaska will have relatively small impacts on the Alaskan economy (Huskey and Porter, 1978, and Huskey and Nebesky, 1979). These conclusions may be misleading. While the separate lease sales may have only a limited impact on the Alaskan economy, the simultaneous nature of the OCS leasing program may make the combined impact of these sales quite important. The Bureau of Land Management has proposed as many as ten lease sales between 1979 and 1984 in its five-year leasing schedule. Because of the number of areas which could be simultaneously developed, the cumulative program impact of these sales becomes an important planning concern. This chapter will analyze the impact of the first part of BLM's leasing program, the lease sales through the proposed Western Gulf sale in 1980.

This section will analyze the impact of the OCS leasing program on the Alaskan economy by examining the combined effect of development in four lease sale areas: the Lower Cook Inlet, the Beaufort Sea, the Northern Gulf of Alaska, and the Western Gulf of Alaska. The scenario described in this section assumes that the level of petroleum activity associated with the mean probability resource find takes place. This scenario is only one of many possible scenarios which could be analyzed. The actual probability of this scenario's occurring is quite low, much less than the probability

that each separate development will take place.[1] Even though the chance that this actual scenario will take place is quite low, it does provide a useful exercise in examining the total program effects of such an occurrence.

The OCS Scenarios

When the Western Gulf lease sale is held in 1980, there will have been five sales held in the Alaska OCS. The first sale was held in the Northern Gulf of Alaska in 1976. Eleven unsuccessful exploratory wells were drilled on these leases; there are no current plans for further drilling on these leases (Dames and Moore, 1978). Because of this, no activity was assumed to occur after 1977. The second sale was held in the Lower Cook Inlet in 1977; this was the first of two sales scheduled in the Lower Cook. A moderate level of development is assumed to occur in this lease sale area consistent with recoverable resource levels of 1.0 billion barrels of oil and 2.0 trillion cubic feet of gas (Porter, 1977). Three future sales are scheduled. A joint federal-state sale is scheduled for the Beaufort Sea in 1979. The lease sale area is off Prudhoe Bay. It is assumed a moderate level of development activity also occurs in the Beaufort lease sale area. The activity is consistent with the mean probability recoverable resource funds of .75 billion barrels of oil and 1.6 trillion cubic feet of gas (BLM, 1979). A second sale is scheduled for the Northern Gulf of Alaska in 1980. The mean probable resource find of .45 billion barrels of oil and 1.25 trillion cubic feet of gas is assumed to be found. Moderate

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[1] If the probability is .50 that development in each separate lease sale area will take place, the probability that it will occur in all four areas is .063 (= .50 x .50 x .50 x .50).

development activity consistent with these resource levels was assumed to occur (BLM, 1979A). The final sale considered in this report is the Western Gulf sale to be held in 1980. The mean recoverable reserves of .16 billion barrels of oil and no gas are assumed to be found. Although 200 million barrels of oil and 700 billion cubic feet of gas are assumed to be found in two basins, only 160 million barrels of oil are assumed economic (Dames and Moore, 1978).

Tables 8 and 9 describe the direct effect of OCS development. OCS development affects the Alaska economy through increased employment and increased revenue to the state. The effect of direct OCS employment on the Alaska economy will depend on the extent to which the incomes earned in OCS development are spent in Alaska. The impact of these earnings will be limited by two factors. First, the probable enclave nature of the development will limit the extent of the interaction with the economy when the workers are on the job. Secondly, the international character of OCS crews may mean that when they are not working, they will be outside of Alaska. Because of these factors, the first step in estimating the impact of OCS development is to estimate the share of direct employment which interacts with the Alaskan economy. Table 8 contains estimates of the Alaskan resident employment in the OCS program. Alaskan resident means any employee residing in Alaska and interacting with the economy during the duration of employment.

Since the phases of development overlap in each field, it is impossible to separate the total program employment into exploration, development, and

TABLE 8. OCS ALASKAN RESIDENT
TOTAL EMPLOYMENT

	Construction	Mining and Transportation	Total
1978	0	70	70
1979	88	321	409
1980	162	664	826
1981	157	1,066	1,223
1982	236	1,029	1,265
1983	247	909	1,156
1984	545	973	1,518
1985	160	801	961
1986	422	804	1,226
1987	551	954	1,505
1988	647	1,253	1,900
1989	466	1,536	2,002
1990	155	1,513	1,668
1991	155	1,452	1,607
1992	77	1,340	1,417
1993	155	1,282	1,437
1994	155	1,387	1,542
1995	77	1,293	1,370
1996	22	1,295	1,317
1997	0	1,272	1,272
1998	0	1,248	1,248
1999	0	1,236	1,236
2000	0	1,163	1,163

SOURCES: 1) Lower Cook and Beaufort: L. Huskey and W. Nebesky, 1978. "The Growth of the Alaska Economy: Future Conditions Without the Proposal" and "Beaufort Sea Statewide and Regional Population and Economic Systems Impact Analysis." Report for BLM-Alaska OCS Office.

2) Northern Gulf: Communication from BLM-Alaska OCS Office, 1979.

3) Western Gulf: Dames and Moore, 1978. Western Gulf of Alaska Petroleum Development Scenarios. Prepared for BLM-Alaska OCS Office.

production phases. OCS activity begins in 1978 with exploration in the Lower Cook Inlet. Until 1981, all OCS activity occurs in the Lower Cook Inlet. Employment begins in the other three lease sale areas in 1981. OCS employment reaches an early peak in 1984 when direct Alaskan resident employment equals 1,518; this is coincident with an early construction employment peak. Total resident employment peaks in 1989 with 2,002 employees. At this time, only 23 percent of employment is in construction. Peak employment is distributed between the lease areas with Lower Cook having 21 percent of employment, Beaufort having 54 percent, Northern Gulf having 22 percent, and Western Gulf having 3 percent. By the end of the projection period in 2000, total employment has fallen by 42 percent to 1,163. All employment is in mining and transportation. Employment is evenly divided between three of the fields with Lower Cook having 36 percent of direct resident employment, Beaufort having 34 percent, and the Northern Gulf having 30 percent. There is no production in the Western Gulf in 2000; 1999 is assumed to be the final year of production.

Table 9 shows the direct revenue effects of Beaufort; because it is a joint federal-state sale, it is the most important lease sale for state revenue. (Revenue projections are in 1978 dollars.) A portion of the production from the Beaufort lease sale is assumed to be from state lands. The production on state lands produces bonus, royalty, production tax, and corporate income tax revenues. The only source of state revenues earned from the totally federal lease sales are property taxes. Petroleum revenues from OCS activity reach a peak of $74.2 million by 1994, after which they decline. By 2000, they are $52.8 million.

TABLE 9. OCS DEVELOPMENT
DIRECT REVENUE EFFECTS

(Millions of Constant 1978 $)[1]

	Bonus[2]	Royalties[3]	Production[4] Tax	Property[5] Tax	Corporate[6] Income Tax
1979	47	0	0	0	0
1980	0	0	0	0	0
1981	0	0	0	.36	0
1982	0	0	0	.45	0
1983	0	0	0	.64	0
1984	0	0	0	.81	0
1985	0	0	0	.86	0
1986	0	0	0	2.29	0
1987	0	0	0	4.20	0
1988	0	0	0	6.95	0
1989	0	7.23	6.06	16.36	.25
1990	0	18.20	16.54	16.96	3.91
1991	0	26.70	22.50	17.50	5.45
1992	0	27.20	22.90	17.40	5.54
1993	0	27.40	23.00	17.70	5.67
1994	0	27.50	23.10	17.90	5.74
1995	0	27.10	22.70	17.70	4.85
1996	0	26.80	22.50	17.20	5.10
1997	0	26.40	22.20	16.40	5.00
1998	0	24.50	20.60	15.70	4.40
1999	0	22.10	18.50	14.90	3.50
2000	0	19.60	16.50	14.10	2.58

[1]Deflated by base case RPI.

[2]BLM-Alaska OCS Office.

[3]Royalties estimates at 12.5 percent of total wellhead value.

[4]Production tax equals 12 percent of the nonroyalty portion of total wellhead value.

[5]Tax at 20 mills of petroleum property value.

[6]Corporate income tax at 9.4 percent of taxable petroleum income.

Definition and Measures of Impact

OCS development will lead to changes in those factors which have been isolated as important causes of economic growth: exogenous employment, personal income, and state expenditures. Changes in these factors will result in changes in population, the structure of employment, the state's fiscal position, and the regional distribution of growth. These changes are the economic impact of OCS development.

We will examine the impact of the OCS petroleum development scenario. The impacts will be compared to economic growth in the moderate case. The impact will be affected by the scenario in terms of its primary employment impact, timing, level of production, and revenues which accrue to the state. The impacts will be measured as changes from the base case. In making this comparison, it must be assumed that the economy responds the same to employment and revenues generated by OCS development as it did to similar changes in the past.

Rapid economic growth associated with OCS development will affect most economic variables. Although many variables will be affected, a much smaller number is important; and information on these dimensions of impact will describe the effect of rapid growth on the state economy. Petroleum development in the Alaska OCS can have two major types of impact. First, OCS development will affect the magnitude of the economic indicators. OCS development will expand the economy. Secondly, OCS development may change the process of growth. OCS development may

change certain structural trends observed in the base case. Both of these dimensions will be considered when the impact of OCS development is examined.

The impact of any specific scenario can be discussed by referring to the following set of questions:

1. How has the magnitude of economic indicators been changed by OCS development?
   a. How has the growth of the aggregate indicators of economic activity--employment, population, personal income--been affected by OCS development?
   b. How has OCS development affected the state's fiscal position? Have state revenues and expenditures changed? What is the effect on the fund balance?
   c. What is the effect of OCS development on the earning power of individuals, as measured by real per capita income?
   d. What is the effect of OCS development on the average level of services, as measured by real per capita state expenditures, provided by the state?

2. Has OCS development changed the process of growth?
   a. Are the components of population growth changed in relative importance?

b. Are past trends in the dependency ratio changed by OCS development?

c. Are past trends in the composition of employment changed by OCS development?

The Impacts of OCS Dvelopment On the Alaskan Economy

This section will describe the economic impact of the OCS development scenario. OCS development will affect the Alaskan economy through increased direct employment and revenues. In this section, we will describe the impact of OCS development on the population, employment, and the state's fiscal position.

The OCS development scenario includes the development of a number of lease areas. Each phase of activity--exploration, development, and production--occurs at different times in each area, so the phases of activity are not distinct. Exploration begins in the Lower Cook in 1978, and production begins in the Beaufort Sea and Northern Gulf in 1989. After 1989, only production occurs. This schedule of activity provides two significant time periods to examine: 1978-1989, when development and exploration occur, and after 1989, when only production activity occurs.

EMPLOYMENT

This section will examine the impact of OCS development on employment. Employment is one of the aggregate indicators of economic growth. OCS

development increases the growth of employment in the projection period. OCS development not only affects the magnitude of employment growth but may also change the structure of employment observed in the base case. If OCS development affects the growth of industries differently than in the base case, the structure will change.

By 2000 employment is projected to be approximately 6,125, or 2.0 percent greater than in the moderate base case. (See Table 10.) The average growth rate between 1979 and 2000 has increased slightly from 2.2 percent per year in the base case to 2.3 percent per year with OCS development. The peak impact occurs in 1990 when employment is 7,108, or 2.9 percent greater than in the base case. This occurs in the year following peak direct employment; in 1989, when direct employment peaks, the employment impact is 7,102, or 3 percent higher than in the base case.

The general pattern of employment impact follows the pattern of direct Alaska resident employment. Direct employment is between 20 and 30 percent of the total impact throughout the period. The decreased importance of direct OCS employment in the impact results is a result of increasing real incomes. As the real incomes of direct employees increase, their impact on the Alaskan economy also increases. This parallels the relation between basic and total employment found in the base case. OCS development does not prevent the fall in employment after the peak ALCAN construction years in 1983; however, it does reduce the fall in employment from 1,200 in the base case to 550 with OCS development. The growth of employment from 1979 to 1989 averages 2.5 percent per year. This is 9 percent

TABLE 10. EMPLOYMENT IMPACT
OCS DEVELOPMENT SCENARIO,
ALASKA

	Base Case Employment	OCS Scenario Employment	Impact
1980	194,710	196,419	1,709
1985	223,110	227,557	4,447
1989[1]	240,900	248,002	7,102
1990	246,536	253,644	7,108
1995	270,386	276,995	6,609
2000	306,906	313,030	6,125

[1]Peak direct Alaska resident employment. The end of the "exploration development" phase.

SOURCE: MAP Model.

greater than in the base case. The growth rate after 1989 is less than in the base case. The reduced rate of growth in the production period is a result of the decrease in employment impact after its peak in 1990.

The growth caused by OCS development does not significantly change the structure of employment from that observed in the base case. Table 11 compares the structure of the economy, as described by the employment distribution in the base and impact cases. The major change in the structure of the economy observed in the base case is supported by the introduction of the OCS development scenario. This change is a gradual process which results from the growth of the economy. OCS development has a relatively small impact on the economy which does not disrupt this trend. The support sector increases in importance throughout the projection period, increasing to approximately 47 percent in both cases.

POPULATION

Population is an aggregate indicator of economic activity which measures the response of people to increased employment opportunities. OCS development will increase the magnitude of population growth. OCS development may also change the characteristics of the population or the importance of the components of change. This section will examine the impact on population of OCS development.

Population is 15,701 greater by 2000 because of OCS development; this is a 2.7 percent increase over the base case. Population impact peaks in 1996 at about 16,200, which is 3.0 percent greater than the base case. The peak

TABLE 11. THE STRUCTURE OF THE ECONOMY
OCS SCENARIO, ALASKA

	Proportion of Total Employment				
	1980	1985	1990	1995	2000
Support Sector					
Moderate Base	34.5	38.1	40.6	43.8	47.0
OCS Scenario	34.5	38.4	40.9	44.0	47.2
Government					
Moderate Base	41.5	38.1	35.2	32.2	28.8
OCS Scenario	41.2	37.6	34.6	31.8	28.5
Basic Sector					
Moderate Base	24.0	23.8	24.2	24.0	24.2
OCS Scenario	24.3	24.0	24.5	24.2	24.4

Support Sector includes transportation-communication-public utilities, trade, finance, and service employment.

Government includes state, local, and federal employment.

Basic Sector includes mining, manufacturing, agriculture-forestry-fisheries, and construction employment.

population impact is delayed since it is the combined effect of increased in-migration and natural increase. OCS development has an initial impact on population through its effect on migration. Increased employment opportunities lead to in-migration. The migration effect leads to the major impact at the time of peak employment. There are no larger decreases in employment after its peak, so there is little out-migration. OCS development also affects natural increase. Because there is a larger population with OCS development, natural increase will be larger. This effect is cumulative and increases through time without major out-migration. Peak population occurs seven years after the level of direct Alaska resident employment in the OCS program reaches its peak. Table 12 describes the population impact.

The pattern of growth is affected by OCS development. The reduction in population after 1978 is reduced slightly by OCS development. Population grows faster in the period prior to 1989 because of OCS activity; after 1989, when all areas are in production, population grows slower than in the base case. Between 1978 and 1989, the average annual rate of population growth equals 2.10 percent with OCS development and 1.86 percent in the base case. After 1989, growth in the base case is slightly faster, with an annual average of 1.80, compared to 1.77 in the base case.

OCS development affects the components of population change. Table 13 compares the role of migration in population change between 1983 and 1993. This covers the years of most important direct OCS employment growth. After 1993, population impact is relatively constant, fluctuating only

TABLE 12. POPULATION IMPACT
OCS DEVELOPMENT SCENARIO
ALASKA

	Population	OCS Scenario Population	Impact
1980	405,156	407,511	2,355
1985	456,806	465,280	8,474
1989[1]	484,146	498,194	14,047
1990	492,853	507,570	14,717
1995	530,883	546,636	15,753
1996[2]	540,954	557,134	16,180
2000	588,820	604,521	15,701

[1]Peak direct Alaska resident employment. The end of the exploration-development phase.

[2]Peak population impact.

SOURCE: MAP Model.

TABLE 13. THE MIGRATION COMPONENT OF POPULATION CHANGE
OCS DEVELOPMENT SCENARIO
1983-1993

	Migration as a Percent of Total Population Change	
	Base Case	OCS Scenario
1983	60.3	61.1
1984	*	*
1985	*	*
1986	*	*
1987	5.7	14.5
1988	23.9	37.5
1989	27.1	38.0
1990	27.4	28.4
1991	6.3	6.9
1992	7.0	0.7
1993	14.7	12.2

*Net out-migration occurs

SOURCE: MAP Model.

slightly around 15,800. The importance of migration as a component of population change is increased relative to the base case during most of this period. Migration accounts for a greater proportion of the population change from 1987 to 1991 with OCS development. After 1991, migration is less important to population change than in the base case. The decrease in level of employment in the OCS case and the higher number of births resulting from higher population are responsible for this effect. By the time the population impact stabilizes in 1993, the importance of migration as a component of population change is similar in both cases. By 2000, migration is responsible for about 44 percent of population change in both cases.

The reduction in the dependency ratio is also projected to occur in the OCS development case. By 2000, the dependency ratio in both the base and OCS development cases has fallen to 1.9. The major reasons for this are an increase in the labor force participation of the working-age population and an increase in the proportion of working-age population in the population.

PERSONAL INCOME

The final aggregate indicator of economic growth is personal income. The impact of OCS development is to increase personal income relative to the base case. (Table 14 shows personal income adjusted to account for price increases.) By 2000, OCS development will have increased the level of real personal income by $221 million, or 2.3 percent. Personal income is projected to increase at an average annual rate of 4.44 percent

TABLE 14. PERSONAL INCOME IMPACT
OCS DEVELOPMENT SCENARIO, ALASKA

(Millions of Constant 1978 $)

	Base Case Personal Income	OCS Scenario Personal Income	Impact
1980	4,038	4,092	54
1985	5,138	5,267	129
1989[1]	6,047	6,328	281
1990	6,328	6,549	221
1995	7,608	7,859	251
2000	9,542	9,763	221

[1]Peak direct Alaska resident employment. The end of the exploration-development phase.

SOURCE: MAP Model.

between 1978 and 2000. This is slightly greater than the growth rate in the base case of 4.39 percent per year.

The impact of OCS development on real personal income rises to a peak in 1989, then falls until 1993. This coincides with the decrease in the level of OCS employment. After 1993, direct resident employment fluctuates, peaking again in 1994. The impact on real personal income follows the fluctuations of the direct employment impact. OCS development is not enough to prevent the fall in personal income after the peak ALCAN year in 1983. The magnitude of the fall is reduced in the impact case. Growth in real personal income averages a rate of 4.3 percent per year between 1978 and 1989. After all fields are in production in 1989, the average rate of growth is 4.0 percent per year. As with employment and population, the rate of growth of personal income is faster during the exploration-development phase than during the same time period in the base case and slower than in the base case after this period.

Since income is the sum of wages, interests, and rents, the growth in personal income reflects the ability of the economy to generate increased returns to factors. One measure of welfare is real per capita income. This measures the command of the average individual over goods and services. Real per capita income accounts for the effect of prices and population on the growth in personal income. Table 15 shows the impact of OCS development on real per capita income. The development of the Alaska OCS has two differential periods of impact. OCS activity has a positive effect on real per capita incomes until 1996; after this, the

TABLE 15. REAL PER CAPITA INCOME IMPACT
OCS DEVELOPMENT SCENARIO, ALASKA

	Real Per Capita Income		
	Base Case	OCS Scenario	Impact
1980	9,968	10,055	87
1985	11,262	11,360	98
1989[1]	12,499	12,673	174
1990	12,813	12,916	103
1995	14,356	14,372	16
2000	16,209	16,176	- 33

[1]Peak real per capita income impact. Peak direct Alaska resident employment. The end of the exploration-development phase.

SOURCE: MAP Model.

impact on real per capita income is negative. The impact on real per capita income is greatest in 1988, the year of the peak direct Alaska resident construction employment; real per capita income is $182, or 1.5 percent greater than in the base case. By 2000, real per capita income is not significantly different from the base case. The greatest difference occurs when the peak in high wage construction employment occurs, not when the peak in total employment occurs. Real per capita income as a measure of welfare does not consider the distribution of income.

THE STATE FISCAL POSITION

The development of the Alaska OCS will affect the state fiscal position in two ways. First, OCS development will affect the revenues received by the state. Secondly, OCS development will affect the state's fiscal position through its impact on state expenditures. The increase in population and economic activity which will result from OCS development may change the determinants of state expenditures. Both of these changes will affect the fund balance and the level of services provided by the state. This section will describe the impact of OCS development on the state's fiscal position.

Revenues

Table 16 illustrates the impact of OCS development on state revenues. (Revenues are adjusted for price increases.) Total general fund revenues increase to approximately $2.0 billion by 2000 with OCS development.

TABLE 16. STATE REVENUE IMPACT
OCS DEVELOPMENT SCENARIO, ALASKA

(Millions of Constant 1978 $)

	General Fund Revenues			Endogenous Revenues		
	Base Case	OCS Scenario	Impact	Base Case	OCS Scenario	Impact
1980	1,402	1,408	6	238	240	2
1985	2,393	2,410	17	335	348	13
1989[1]	2,365	2,418	53	413	432	19
1990	2,247	2,331	84	439	459	20
1995	2,003	2,129	126	586	611	25
2000	1,869	1,986	117	815	839	24

[1]Peak direct Alaska resident employment. The end of the exploration-development phase.

SOURCE: MAP Model.

This is 6.3 percent greater than in the base case. Total revenues increase at an average annual rate equal to 2.8 percent, which is only slightly faster than the base case rate of 2.5 percent per year.

The development of the petroleum resources of the Alaska OCS provides the state with a new source of revenue. The Beaufort Sea, because it is a joint state-federal sale, generates the greatest revenue impact. Production in state waters provides revenues in the form of bonuses, royalties, production taxes, and corporate income tax. All lease sale areas provide property tax revenues from petroleum facilities. Major OCS petroleum revenues begin in 1989 with production in the Beaufort Sea. OCS petroleum revenues peak in 1994 at $74.2 million. By 2000, revenues have declined by 29 percent to $52.8 million. This decline coincides with the decline in Beaufort production. OCS petroleum revenues account for over fifty percent of the total revenue impact from the beginning of Beaufort production in 1989 until 1998.

OCS petroleum revenues make up a relatively small portion of total petroleum revenues. In 1994, OCS revenues account for only 7 percent of total petroleum revenues. These revenues do slow the decline of petroleum revenues after 1985. Petroleum revenues decrease at a rate of 4.1 percent per year in the base case; with OCS development, the rate is slowed to 2.1 percent per year.

Those revenues which are affected by the growth of the economy are the other important source of revenues. Endogenous revenues include business

and income taxes. They are 3 percent larger in 2000 because of OCS development. The growth of these revenues helps to counteract the fall in petroleum revenues.

State Expenditures

Table 17 shows the expenditure impact of OCS development (adjusted for price increases). Total real expenditures increase because of OCS development. By 2000, real state expenditures are projected to be $2.9 billion with OCS development; this is $53 million, or 1.9 percent greater than in the base case. The expenditure impact peaks in 1994, after which it decreases. In 1989, state expenditures are $39 million, or 1.7 percent greater than in the base case. Real expenditures increase at a rate of 4.3 percent per year between 1978 and 1994 and 2.5 percent after 1994. This is greater than the base case rate of 4.1 percent in the earlier period but less than the 2.7 percent in the later period.

Expenditures increase for two reasons. First, expenditures increase because of increases in population and prices. As population and prices increase, expenditures must, in the absence of significant economies of scale, increase to maintain the same level of service. Secondly, expenditures will increase if the level of service provided by state government increases. Real per capita expenditures are a measure of the level of services provided by the state. Table 17 shows the impact of OCS development on the real per capita expenditures. Real per capita expenditures are less than in the base case for most of the period. The

TABLE 17. STATE GOVERNMENT EXPENDITURE IMPACTS
OCS DEVELOPMENT SCENARIO, ALASKA

	Total State Expenditures (Millions of Constant 1978 $)			Real Per Capita State Expenditures		
	Base Case	OCS Scenario	Impact	Base Case	OCS Scenario	Impact
1980	1,446	1,452	6	3,570	3,567	- 3
1985	1,903	1,930	27	4,172	4,164	- 8
1989[1]	2,236	2,275	39	4,595	4,556	- 39
1990	2,291	2,342	51	4,640	4,620	- 20
1995	2,445	2,511	66	4,614	4,592	- 22
2000	2,817	2,870	53	4,785	4,754	- 31

[1]Peak direct Alaska resident employment. The end of the exploration-development phase.

SOURCE: MAP Model.

difference is less than one percent throughout the period. The maximum difference in real per capita expenditures occurs in 1988, when they are $42 less than in the base case. By 2000, real per capita expenditures are $4,754 with OCS development.

State Fiscal Position

We can assess the impact of OCS development on the state's fiscal position by examining the impact on the fund balance. OCS development will affect both the permanent and general funds. A portion of the bonus and royalty revenues from the Beaufort Sea are subject to inclusion in the permanent fund. Table 18 shows the impact of development on the fund balance (adjusted for price increases). In both the base and OCS cases, the fund balance follows the same pattern, rising to a peak and then falling as the fund balance is drawn down to meet expenditures. With OCS development, a peak of $5.4 billion is reached in 1991. By the end of the projection period, the fund balance is $2.2 billion, which is 28.4 percent greater than in the base case. This increase is a result of the extra revenues produced by Beaufort development's exceeding the increased cost.

Even though the fund is much higher because of OCS development, this development has not eliminated the pattern illustrated by general fund revenues net of expenditures. With OCS development, expenditures are greater than revenues by 2000. This means that even with OCS development, the state is forced to draw down its fund balance to meet expenditures.

TABLE 18. IMPACT ON STATE FISCAL POSITION
OCS DEVELOPMENT SCENARIO, ALASKA

(Millions of Constant 1978 $)

	Fund Balance			General Fund Revenues Minus General Fund Expenditures		
	Base Case	OCS Scenario	Impact	Base Case	OCS Scenario	Impact
1980	1,042	1,090	48	192	196	4
1985	3,418	3,436	18	842	838	- 4
1989[1]	5,251	5,320	69	552	573	21
1990	5,383	5,479	96	378	422	44
1995	4,715	5,052	337	- 579	13	71
2000	2,186	2,807	621	- 499	- 409	90

[1]Peak direct Alaska resident employment. The end of the exploration-development phase.

SOURCE: MAP Model.

The overall impact of the state's fiscal position with OCS development is ambiguous. The fiscal position is a combination of the impact on state services as measured by real per capita expenditures and the fund balance. OCS development is projected to have opposite effects on each of these. The fund balance increases because of OCS development; however, the increase in the fund balance is partially a result of a reduction in the level of state services.

IV. SUMMARY AND CONCLUSIONS

Previous work on the effect of OCS development on the Alaskan economy has been sale specific. This approach has not examined the simultaneous nature of the OCS program in Alaska. Because a series of lease sales are scheduled to occur in Alaska, the total OCS program impact may be large even though the impacts of individual sales are not large. In this report, we have assessed the major impacts that offshore oil and gas development connected with lease sales in the Lower Cook Inlet, Beaufort Sea, and Northern and Western Gulf of Alaska will have on Alaska's economic growth. The projected impacts were assessed in terms of an assumed base case growth without the project.

The qualitative nature of the influence of OCS development on the growth process is similar to most exogenously induced growth. Development generates direct employment activity in the construction, mining, manufacturing, and transportation industries. Since a number of fields are developed, the various phases of development occur simultaneously. This development activity generates both new private incomes and public revenues which induce impacts. Expenditure of wages and salaries earned in OCS activity generates further income and employment in the endogenous sector of the economy through the increased demand for the output of these sectors. The increased economic activity also increases public expenditures which affect economic activity by increasing government employment and construction expenditures.

The qualitative nature of the OCS program impacts supports trends found in both the base case and the historical period. Three major structural changes were observed in the base case. First, as the scale of the economy increased, more goods and services were produced locally and the importance of the support sector increased. Secondly, the population aged and labor force participation increased over time; this led to an increase in the proportion of the population which is employed. Finally, state expenditures and revenues were projected to follow a pattern in which expenditures would increase faster than revenues after the major petroleum revenues peaked. This pattern of expenditure and revenue increase would necessitate drawing down the general fund balance. This results from the declining importance of the petroleum revenues throughout the period. OCS development supports these trends.

OCS development causes a significant change in the magnitude of growth. By 2000, OCS development has increased employment by 6,124, or 2 percent. Population is 15,700 larger than in the non-OCS base case; this is an increase of 2.7 percent. Personal income is also increased because of OCS development; personal income is $221 million, or 2.3 percent greater than in the base case by 2000. Although these impacts are significant, when compared with recent Alaskan experience, they are relatively small. Although OCS development accounts for 16,000 extra people at its peak, there is no one year of extremely rapid growth. The largest increase resulting from OCS development is 2,000 people. The impact is moderated by the long period over which it occurs.

OCS development has relatively little impact on the indicators of individual welfare. By 2000, the real per capita income of Alaskan residents is reduced by less than one percent because of OCS development. At the maximum difference, OCS development increased real per capita income by slightly more than one percent. Real per capita expenditures are a measure of state services provided the average resident. OCS development reduces real per capita expenditures for most of the projection period. By 2000, real per capita expenditures differ by less than one percent between the cases. A final measure of individual welfare is the per capita real fund balance. This measures the claim on the fund balance which each resident would hold if the fund were turned over to the public. It also measures the ability of the fund to provide future revenues. Real per capita fund balance is increased by OCS development. By 2000, this measure is 25 percent greater because of OCS development.

Table 19 examines the major dimensions of OCS impact.

TABLE 19. SUMMARY OF LONG-RUN OCS DEVELOPMENT IMPACTS

	1980	1990	2000
Growth			
Employment			
Base	194,710	246,536	306,906
OCS	196,419	253,644	313,030
Population			
Base	405,156	492,853	588,820
OCS	407,511	507,570	604,521
Personal Income (Millions of Constant 1978 $)			
Base	$ 4,038	$ 6,328	$ 9,542
OCS	$ 4,584	$ 6,549	$ 9,763
Structure			
% of Employment in Support Sector			
Base	34.5	40.6	47.0
OCS	34.5	40.9	47.2
Dependency Ratio			
Base	2.08	2.00	1.92
OCS	2.07	2.00	1.93
General Fund Revenue Minus Expenditures (Millions of Constant 1978 $)			
Base	192	378	- 499
OCS	196	422	- 409
Individual Welfare			
Real Per Capita Income			
Base	$ 9,968	$12,813	$16,209
OCS	$10,055	$12,916	$16,176
Peak Per Capita State Expenditure			
Base	$ 3,570	$ 4,640	$ 4,785
OCS	$ 3,567	$ 4,620	$ 4,754
Real Per Capita Fund Balance			
Base	$ 7,160	$30,582	$10,394
OCS	$ 7,498	$30,260	$13,023

SOURCE: MAP Model.

APPENDIX A

Direct Employment Estimates

TABLE A.1. OCS ALASKA RESIDENT CONSTRUCTION EMPLOYMENT BY LEASE SALE AREA

	Lower Cook[1]	Beaufort[2]	Northern Gulf[3]	Western Gulf[3]	Total
1978	0	0	0	0	0
1979	88	0	0	0	88
1980	162	0	0	0	162
1981	108	49	0	0	157
1982	38	198	0	0	236
1983	0	247	0	0	247
1984	0	247	38	260	545
1985	0	99	12	49	160
1986	0	304	86	32	422
1987	0	333	218	0	551
1988	0	466	181	0	647
1989	0	466	0	0	466
1990	0	155	0	0	155
1991	0	155	0	0	155
1992	0	77	0	0	77
1993	0	155	0	0	155
1994	0	155	0	0	155
1995	0	77	0	0	77
1996	0	22	0	0	22
1997	0	0	0	0	0
1998	0	0	0	0	0
1999	0	0	0	0	0
2000	0	0	0	0	0

[1]Assumes that offshore exploration and construction workers will be nonresident and have no interaction with Alaskan economy (Huskey and Nebesky, 1978).

[2]Assumes that development uses existing Prudhoe manpower and all interact with Alaskan economy.

[3]SEAR adjusted. SEAR ratio describes proportion of Alaskan resident employment by task. (See Appendix C, Huskey and Nebesky, 1979.)

TABLE A.2. OCS ALASKA RESIDENT MINING AND TRANSPORTATION EMPLOYMENT BY LEASE SALE AREA

	Lower Cook[1]	Beaufort[2]	Northern Gulf[3]	Western Gulf[3]	Total
1978	70	0	0	0	70
1979	321	0	0	0	321
1980	664	0	0	0	664
1981	804	67	62	133	1,066
1982	572	198	125	134	1,029
1983	523	198	125	63	909
1984	622	232	109	10	973
1985	604	67	47	83	801
1986	545	112	0	147	804
1987	411	276	176	91	954
1988	417	479	255	102	1,253
1989	417	616	440	63	1,536
1990	417	595	440	61	1,513
1991	417	524	450	61	1,452
1992	417	503	334	86	1,340
1993	417	432	347	86	1,282
1994	417	535	349	86	1,387
1995	417	438	352	86	1,293
1996	417	440	352	86	1,295
1997	417	417	352	86	1,272
1998	417	393	352	86	1,248
1999	417	393	352	74	1,236
2000	417	394	352	0	1,163

[1]Assumes that offshore exploration and construction workers will be nonresident and have no interaction with Alaskan economy (Huskey and Nebesky, 1978).

[2]Assumes that development uses existing Prudhoe manpower and all interact with Alaskan economy.

[3]SEAR adjusted. SEAR ratio describes proportion of Alaskan resident employment by task. (See Appendix C, Huskey and Nebesky, 1979.)

APPENDIX B

MAP Model Assumptions

A set of assumptions about the level of exogenous variables determines a development scenario; this section describes the assumptions in the non-OCS base case scenario. There are four major types of assumptions required for a scenario. First, there are assumptions about the growth of exogenously determined employment in both the petroleum and nonpetroleum sectors. Secondly, assumptions about exogenously determined petroleum revenues received by the state are needed. Thirdly, there are assumptions about national variables. Finally, an assumption about the way the state spends its money is needed. Once these assumptions are set, the set of projections is determined by the model.

EMPLOYMENT ASSUMPTIONS

Employment assumptions include those associated with special projects and those associated with industry growth in manufacturing, agriculture-forestry-fisheries, and federal government.

Special Projects

Special projects include three basic types--petroleum projects, major construction projects, and operations of the major projects. Tables B.1 and B.2 show the project employment assumptions. The methods used to determine these levels are described below.

TABLE B.1. MINING EMPLOYMENT

Year	Prudhoe,[1] Lisburne and Kuparak	N. Gulf[2] and Lower Cook OCS	Upper[3] Cook	Other[4] Mining
1977	1,586	271	575	2,082
1978	1,624	0	575	2,082
1979	1,585	0	575	2,082
1980	1,783	0	575	2,082
1981	1,402	0	575	2,082
1982	1,149	0	575	2,082
1983	897	0	575	2,082
1984	904	0	575	2,082
1985	987	0	575	2,082
1986	963	0	610	2,082
1987	985	0	645	2,082
1988	985	0	680	2,082
1989	1,009	0	715	2,082
1990	1,009	0	750	2,082
1991	1,020	0	300	2,082
1992	1,020	0	300	2,082
1993	940	0	300	2,082
1994	886	0	300	2,082
1995	886	0	300	2,082
1996	886	0	300	2,082
1997	886	0	300	2,082
1998	886	0	300	2,082
1999	886	0	300	2,082
2000	886	0	300	2,082

[1]Based on employment scenarios from Alternatives for the Future: Petroleum Development Study, North Slope of Alaska (Department of Natural Resources, 1977). Scenarios for 1 and 5 billion barrel reserves were adjusted to reflect reserves and production schedules of these fields.

[2]Exploration activity drilled 9.6 wells; assumed employment per well equaled 90 man-years from OCS Technical Report No. 17 (Dames and Moore, 1978).

[3]Estimate by the author assumed current employment held constant until 1985. Employment assumed to increase between 1986 and 1990 for shutdown of petroleum production. Only gas production assumed after 1990.

[4]Net employment in mining.

TABLE B.2. CONSTRUCTION EMPLOYMENT

	ECONX 1			ECONX 2
Year	TAPS	ALCAN[3]	Total	Pacific[4] LNG
1977	5,300[1]	0	5,300	0
1978	0	0	0	0
1979	90[2]	0	90	0
1980	90	0	90	146
1981	90	1,425	1,515	844
1982	90	4,763	4,853	1,323
1983	0	4,663	4,663	420
1984	0	265	265	0
1985	0	0	0	0

[1]Based on estimate of TAPS construction employment by the Alaska State Labor Department.

[2]Assumed construction of four pump stations to increase capacity by 1982. Pump Station construction employment estimate from The Beaufort OCS Petroleum Development Scenarios, Dames and Moore, 1978.

[3]Northwest Energy Company manpower estimate, July 17, 1978.

[4]Based on letter to the Department of Natural Resources from S. California Gas, March 17, 1978, estimating peak construction employment of 1,500. Four-year construction period from E.I.S. for Pacific Alaska LNG Project, November 1974.

- Prudhoe Bay, Lisburne, and Kuparak mining employment was estimated from two sources of information. Employment scenarios were based on the scenarios described in the Alaska Department of Natural Resources, Alternatives for the Future: Petroleum Development Study, North Slope of Alaska (1977). The employment schedules were adjusted based on the estimated reserves, productivity, and the production schedules in Beaufort Sea Region Petroleum Development Scenarios (Technical Report No. 6, Alaska OCS Socioeconomic Studies Program, 1978).

- Northern Gulf OCS employment is an estimate of 1977 exploration employment. This was based on information in Monitoring Petroleum Activities in the Gulf of Alaska (Technical Report No. 17, Alaska OCS Socioeconomic Studies Program, 1978). Total employment associated with exploration was divided by the total wells drilled to obtain a man-years-per-well figure of approximately 90. Approximately 9.6 wells were drilled in 1977. Total exploration employment was adjusted by the percentage of Alaskan resident employment assumed in the report. There is no activity assumed after 1977.

- Upper Cook employment was an estimate of current employment made by the author. Employment was assumed to increase slightly between 1985 and 1990 as the oil fields are shut down. Gas production is assumed to continue after 1990.

- Other mining was assumed to maintain its 1976 level, except in Anchorage and Fairbanks which were adjusted to an estimate of the 1977 mining employment.

Table 6 shows special project construction employment.

- ECONX1 are highly paid construction workers associated with major projects, long hours, and extreme working conditions. Two projects are assumed in this category, the trans-Alaska pipeline and the ALCAN gasline. TAPS is completed in 1977. The 1977 employment is based on an actual estimate made by the Alaska Labor Department. After 1977 the line's capacity is assumed to be increased by the addition of four pump stations. Pump station construction employment estimates made in Technical Report No. 6 (Alaska OCS, 1978) were used to estimate employment. With completion of the TAPS construction in 1977, the line's capacity is assumed to be 1.2 million barrels per day. The capacity must be expanded to deliver the assumed base case North Slope production, which is 1.73 million

barrels per day by 1983. Four additional pump stations were assumed to be needed to deliver this production. This was based on the ratio of capacity to pump stations (.15 million barrels per pump station) with eight pump stations. With this ratio, twelve pump stations would be needed to deliver 1.73 million barrels per day. These additions would also allow the line some additional capacity. The ALCAN gasline is assumed to be built between 1981 and 1984. The estimates are based on the most recent construction manpower estimates made by Northwest Energy Company in a letter to the state (July 1, 1978).

- ECONX2 employment is associated with special construction projects which are assumed to have regular employment schedules and be able to draw on local labor markets. One project of this type is assumed to be built, the Pacific LNG project. Pacific LNG is scheduled to begin construction in 1980 and operations in 1984 (Anchorage Daily News, September 23, 1978). The construction schedule is based on an estimated peak construction employment of 1,500 (letter from S. California Gas to Alaska Department of Natural Resources, May 17, 1978) and the four-year construction period from the 1974 E.I.S. for the Pacific LNG project.

Operations employment for these projects is transportation employment for the pipelines and manufacturing for the petrochemical projects. Alyeska estimated an operations employment of 300 for startup in 1977 and 850 per year for the long-term operations (Alaska Construction and Oil, October 1976). ALCAN operations employment is assumed to be 96 beginning in 1985. This estimate was based on ALCAN's 1976 application to the Federal Power Commission. The difference in operations employment is accounted for because TAPS has more pipeline in Alaska, the Valdez port employment is part of the TAPS employment, and TAPS has substantial Alaska headquarters employment. Operations employment for the Pacific LNG plant is 60 beginning in 1984.

Employment for these special projects is allocated to MAP Regions as follows:

1. Prudhoe, Lisburne, Kuparak employment to Region 1
2. Upper Cook N. Gulf OCS, Pacific LNG employment in Region 4
3. Other mining at its appropriate regional level
4. ALCAN and TAPS construction based on miles of pipe in region plus 300 TAPS headquarters in Anchorage in 1977
5. ALCAN operations is allocated by the miles of pipeline in each region
6. TAPS operations employment will be allocated as follows: 300 in Anchorage, 200 in Valdez, and the remainder based on the regional distribution of the pipeline

Industry Growth

The level of employment in federal government and agriculture-forestry-fisheries is set exogenously. Federal government employment is assumed to follow its general historical trend and remain constant at the 1976 level throughout the forecast period. The trend in the historical period reflects increases in civilian employment offsetting decreasing military employment. The regional allocation will also remain constant. Employment in agriculture-forestry-fisheries will be assumed to increase at a rate of 3 percent per year. This reflects an assumption of little growth in agriculture and a modest increase in fisheries. The South-central Water Study estimated approximately a 5 percent annual increase with maximum fisheries development. Employment will be assumed to increase at this rate in each region.

Output in manufacturing must be determined exogenously. It is assumed to increase at an average annual rate of 4 percent which is consistent with both the historical trend and the assumed growth in the fisheries industry. Regional growth will be determined by the mix of industries with food manufacturing growing at the same rate as fisheries, 3 percent; lumber growing at 4 percent; paper growing at 2.5 percent; and other manufacturing bringing the growth rate into line with the overall 4 percent per year.

PETROLEUM REVENUE ASSUMPTIONS

Petroleum revenues to the state consist of royalties, production taxes, property taxes, and the corporate income tax. This section will examine the revenue assumptions chosen for the base case. Where it was possible and did not conflict with other assumptions made in this study, we used revenue estimates made by the state; in other cases, revenues were estimated based on assumptions about the wellhead value and production.

COOK INLET REVENUES

Table B.3 details the royalty and severance revenues from oil and gas production in Upper Cook Inlet. The overall assumption is that oil production would be over in 1995, while gas production will continue throughout the projection period. The specific assumptions are:

- Oil royalties and production tax are from a Legislative Affairs Agency memo of July 14, 1977. Revenues were estimated through 1985; after that a 15 percent decline was assumed in the value of oil produced. The average production of the well was assumed

TABLE B.3. COOK INLET REVENUES[1]

Fiscal Year	Oil Royalties (Millions)	Oil Production Tax (Millions)	Gas Royalties (Millions)	Gas Production Tax (Millions)
1978	33.1	16.3	4.4	2.3
1979	31.3	14.4	5.4	2.8
1980	29.5	12.7	6.9	3.6
1981	27.9	10.9	8.3	4.4
1982	26.4	9.1	9.0	4.6
1983	24.6	7.3	9.1	4.7
1984	22.9	5.5	9.3	4.8
1985	21.2	3.7	9.4	4.9
1986	20.1	3.0	9.4	4.9
1987	19.1	2.0	9.4	4.9
1988	18.2	1.0	9.4	4.9
1989	17.3	0	8.5	4.4
1990	16.4	0	7.7	3.9
1991	0	0	6.9	3.5
1992	0	0	6.2	3.2
1993	0	0	5.6	2.9
1994	0	0	5.0	2.6
1995	0	0	4.5	2.3
1996	0	0	4.1	2.1
1997	0	0	3.7	1.9
1998	0	0	3.3	1.7
1999	0	0	3.0	1.5
2000	0	0	2.6	1.4

[1]Same as The Permanent Fund and the Alaskan Economy (Goldsmith, 1977) study except oil royalties which are the same until 1985, then decline at 15 percent to be eliminated in 1996.

to decline below the taxable rate in 1989, and production was assumed to stop in 1995.

- Gas royalties and production tax are based on estimates of production through 1985 made by the Revenue Department in Revenue Journal, Vol. 1, No. 2, October 1976. Decline after 1985 was assumed by the author to be at a rate of 10 percent per year. The 1977 ratio of royalties and production taxes to production was assumed to hold throughout the projection period.

PRUDHOE BAY REVENUES

Prudhoe Bay will produce the major petroleum revenues for the state in the projection period. To arrive at revenue estimates, estimates of production and the wellhead value are needed. These estimates are shown in Table B.4 and Table B.5.

- Production of oil was assumed to equal estimates made in Technical Report No. 6 (Alaska OCS Socioeconomic Studies Program, 1978).

- The wellhead value per barrel of oil was calculated based on discussion with BLM-OCS. These assumptions reflect those made with respect to N. Gulf oil.

    1. West Coast market price is $12/bbl. This reflects a $1.50 discount from a $13.50/bbl Gulf Coast price. The discount is for transport costs. The real market price stays constant.

    2. Vessel costs equal $1.00/bbl from Valdez to the West Coast and $.75/bbl processing costs. These costs remain constant in real terms.

    3. The TAPS tariff is $5.25 in 1978. The nominal tariff remains constant until 1990 when it is assumed the increased

TABLE B.4. PRUDHOE BAY OIL[1]

Fiscal Year	Production (Million Bbls)	Wellhead Price ($/Bbl)	Total Wellhead Value (Million$)	Royalties (Million$)	Production Tax (Million$)
1978	237.3	5.00	1186.5	148.3	124.6
1979	474.5	5.56	2638.2	329.8	277.0
1980	584.0	6.16	3597.4	449.7	377.7
1981	595.7	6.79	4044.8	505.6	424.7
1982	607.5	7.45	4525.9	565.7	475.2
1983	619.6	8.15	5049.7	631.2	530.2
1984	631.5	8.88	5607.7	701.0	588.8
1985	641.5	9.66	6196.9	774.6	650.7
1986	613.2	10.48	6426.3	803.3	674.8
1987	545.7	11.35	6193.7	774.2	650.3
1988	511.9	12.25	6270.8	783.9	658.4
1989	475.4	13.22	6284.8	785.6	659.9
1990	409.7	14.24	5834.1	729.3	561.5
1991	367.7	15.02	5522.9	690.4	531.6
1992	347.7	15.85	5511.0	688.9	530.4
1993	329.4	16.72	5507.6	688.5	530.1
1994	299.3	17.64	5279.7	660.0	508.2
1995	268.3	18.61	4993.1	624.1	480.6
1996	246.4	19.63	4836.8	604.6	465.5
1997	228.1	20.71	4724.0	590.5	454.7
1998	211.7	21.85	4625.6	578.2	445.2
1999	197.5	23.05	4552.4	569.1	438.2
2000	183.8	24.32	4470.0	558.8	430.2

[1]See text for explanation.

TABLE B.5. PRUDHOE BAY GAS[1]

Fiscal Year	Production (Billion C. Ft)	Wellhead Price ($/MCF)	Wellhead Value (Million$)	Royalties (Million$)	Production Tax (Million$)
1978	3.9	1.00	3.9	.5	.4
1979	5.1	1.06	5.4	.7	.6
1980	5.9	1.11	6.5	.8	.7
1981	28	1.17	32.8	4.1	3.4
1982	43	1.24	53.3	6.7	5.6
1983	50	1.31	65.5	8.2	6.9
1984	780	1.38	1076.4	134.6	113.0
1985	830	1.45	1203.5	150.4	126.4
1986	870	1.53	1331.1	166.4	139.8
1987	912	1.62	1477.4	184.7	155.1
1988	912	1.71	1559.5	194.9	163.7
1989	912	1.80	1641.6	205.2	172.4
1990	912	1.90	1732.8	216.6	181.9
1991	912	2.01	1833.1	229.1	192.5
1992	912	2.12	1933.4	241.7	203.0
1993	912	2.23	2033.8	254.2	213.5
1994	912	2.36	2152.3	269.0	226.0
1995	912	2.48	2261.8	282.7	237.5
1996	912	2.62	2389.4	298.7	250.9
1997	912	2.77	2526.2	315.8	265.3
1998	912	2.92	2663.0	332.9	279.6
1999	912	3.08	2809.0	351.1	294.9
2000	912	3.25	2964.0	370.5	311.2

[1]See text for explanation.

operating costs dominate the decreasing capital costs. After 1990, the tariff remains constant in real terms.

This assumption reflects only one of a number which could be made concerning oil wellhead values.

- Production of gas at Prudhoe is assumed to increase following the Department of Revenue assumed production until 1987 when the peak production assumed by Dames and Moore (Beaufort OCS Petroleum Scenarios, 1978) is reached. This production level is assumed to remain throughout the period.

- The wellhead value of gas was calculated assuming the compromise energy bill is adopted so that Prudhoe gas could sell at a wellhead value of $1.45 per MCF. This assumes the ability to roll this gas with other gas. It is assumed that producers pay $.45 processing costs for a net of $1.00 wellhead. A constant real price of gas is assumed.[1]

Revenues from these are determined based upon state laws. Royalties are 12.5 percent of the wellhead value of oil and gas. The production tax in each case is a fraction of the nonroyalty value. This fraction depends upon the productivity of the average well in the field. The production tax on oil was assumed to equal 12 percent through 1989 when production declines and the rate falls to 11 percent. The production tax on gas is assumed to equal 12 percent throughout the projection period.

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[1]Base case was selected prior to final adoption of Federal Energy Act of 1978 which set a ceiling for Alaskan gas wellhead price.

MISCELLANEOUS REVENUES

There are three important miscellaneous petroleum revenues: the property tax, the reserves taxes, and the corporate income tax. Table B.6 shows the assumed value of these taxes.

- The property tax taxes all petroleum-related property except oil refining and gas processing property and leases at a rate of twenty mills. We used the property tax revenue series estimated by the Department of Revenue in Alaska Oil and Gas Structure. This assumed construction of the TAPS and ALCAN lines.
- The reserves tax involves the repayment by the state of taxes paid by petroleum producers in 1976 and 1977. Credits of up to 50 percent of the production taxes are given until the $499 million collected is repaid. This tax affects only producers at Prudhoe.
- The Alaskan corporate income tax was changed in the last legislative session so that no state projection of this revenue stream is available. The corporate income tax on petroleum is 9.4 percent of taxable petroleum income. Taxable income is gross income minus capital and operating costs and Alaskan taxes. The figure is not net of federal taxes. The tax was based on estimates of net income determined by the following procedure.

    1. ALCAN and TAPS income was based on an assumption that these lines would be guaranteed a 20 percent after-tax return on their equity by the rate structure. It

TABLE B.6. OTHER REVENUES

Fiscal Year	Property Tax[1] (Million$)	Reserves Tax[2] (Million$)	ANCSA[3] (Million$)	Corporate Income Tax[4] (Million$)
1978	173.0	(83.3)	(23.8)	33.5
1979	185.0	(166.4)	(52.9)	127.8
1980	193.2	(204.8)	(72.1)	167.3
1981	226.7	(44.8)	(81.6)	188.5
1982	251.8	0	(91.6)	212.8
1983	257.0	0	(102.3)	265.1
1984	261.4	0	(68.8)	348.9
1985	295.9	0	0	384.8
1986	281.1	0	0	405.1
1987	267.0	0	0	407.2
1988	253.7	0	0	421.6
1989	241.0	0	0	428.7
1990	229.0	0	0	421.4
1991	217.5	0	0	409.7
1992	206.6	0	0	416.5
1993	196.3	0	0	425.7
1994	186.5	0	0	418.8
1995	177.2	0	0	410.1
1996	168.3	0	0	410.7
1997	159.9	0	0	409.9
1998	151.9	0	0	411.0
1999	144.3	0	0	416.6
2000	137.1	0	0	418.5

[1] Based on estimates in Alaska Oil and Gas Tax Structure, Department of Revenue.

[2] 50 percent of Prudhoe production taxes.

[3] 2.0 percent of wellhead value at Prudhoe until $500 million is paid to the fund.

[4] Actual fiscal year 78 value; afterwards estimated as explained in the text.

was assumed that 15 percent of the capital cost of both projects was equity. The TAPS project was assumed to cost $10.5 billion and the Alaskan portion of the ALCAN line was assumed to cost $4.3 billion. The equity portion was depreciated in a straightline return on the remaining equity adjusted for an assumed 48 percent Federal tax rate.

2. Corporate taxable income for Prudhoe Bay gas and oil production was derived by estimating the components of revenues and costs. Revenues are derived above. The cost assumptions were derived from Technical Report No. 6 (Alaska OCS Socioeconomic Studies Program, 1978). The assumptions are shown below:

	Prudhoe Oil	Prudhoe Gas
Total Costs	$9.45 billion	$2.6 billion
Debt Proportion	25 %	25 %
Interest on Debt	9.0%	9.0%
Project Life	25 years	26 years
Total Throughput	10.5 billion bbls	26 billion MCF

Capital costs per barrel were found with this information. Per barrel costs were used to account for the flow of investment over the life of the field. Capital costs equalled debt service plus depreciation costs. Operating costs were added for total costs. These costs were:

	Prudhoe Oil	Prudhoe Gas
Capital Costs	$1.24/bbl	$.14/MCF
Operating Costs	$1.00/bbl	$.08/MCF

In addition, $.12 per barrel and $.02 per MCF were allowed for overhead as per the legislation. Taxable income was found by subtracting these costs and allowable Alaska taxes from revenues.

3. The ratio of oil and gas taxable income to severance taxes at Prudhoe Bay was applied to Cook Inlet to estimate taxable income from this production.

4. Estimated corporate income tax was found by applying the .094 rate to this income.

5. A final portion of the tax includes a redistribution of multistate corporate profits. This portion allocates

worldwide corporate profits based on three factors: non-production property in Alaska as a percent of worldwide property, nonproduction payroll in Alaska as a percent of worldwide payroll, and Alaskan sales as a percent of worldwide sales. The average of these was taken as the proportion of worldwide profits which were taxed at 9.4 percent. Conversation with Alaska Department of Revenue led us to the conclusion that this component would be extremely small, so it was ignored in this study.

APPENDIX C

Assessment of Recent Changes in the MAP Econometric Model

The MAP econometric model of the Alaskan economy is subject to frequent evaluation and revision. This is particularly true in connection with recent lease sale impact analyses subcontracted under the OCS Studies Office. The following discussion outlines the reasons for and content of major structural adjustments that have been introduced since January 1, 1979. The primary objectives underlying these changes center on the model's capability to more adequately reflect the impact pattern of smaller exogenous changes, as well as of lagged effects of income and output. The model's sensitivity to the size of exogenous change depends largely on its responsiveness to scale economies (i.e., increased efficiency and savings in money outlays resulting from economic expansion) and to "boom" growth (i.e., rapid or sudden economic development which, in the context of the Alaska economy, is determined exogenously). These adjustments pertain to a subset of industry-specific wage rate (WR) and output (XX) equations and to the statewide Alaska Relative Price (RPI) equation.

Changes in the Wage Rate Equations

In the earlier (pre-1979) version of the MAP model, WR equations in those sectors where labor market conditions are considered to be sensitive to the level of petroleum development (i.e., services, transportation-communications-public utilities, construction, and mining) were appended with a "boom term."

These wage rate equations have the general form:

$$WR_i = e^a \cdot \left(\frac{WEUS}{CPI}\right)^b \cdot RPI^c \cdot \underbrace{(EMP9 + ECONX)^d}_{\text{"boom term"}} \qquad (1)$$

where WR_i = wage rate in industry i

WEUS/CPI = inflation-adjusted average weekly U.S. compensation

RPI = Alaska Relative Price Index

EMP9+ECONX = exogenous mining and construction employment, respectively

The final term in this equation is a proxy for the tightness in the labor market associated with rapid economic growth. Rapid growth results in binding supply constraints which are assumed to have positive effects on the wage rates.

Relatively high employment, normally maintained in the mining sector, exerted continual upward pressure on wage rates. As a result, personal income and employment grew continually, amplifying economic growth and impacting net migration and population. In cases where the mining sector did not grow, however, the boom effect remained constant, rather than gradually dissipating. To correct this problem, EMP9 was restricted to 1976 levels throughout the projection. This permitted ECONX to transmit the "boom" effect.

Changes in the RPI Equation

Specification adjustments in the pre-1979 RPI equation involved the coordination of boom and scale effects of growth. Given the general representation,

$$\frac{RPI}{CPI} = RPI\ (\text{constant}, EM991, EM991(\%\Delta)\ ) \qquad (2)$$

where CPI = U.S. consumer price index

EM991 = total nonenclave employment,

the dependent variable in the expression is equal to the ratio of RPI and CPI. The annual percentage change in employment, EM991(%Δ), is the boom component in (2). We assume that rapid employment growth would reflect tight local supply markets, putting upward pressure on prices. The scale term (EM991) is a four-year moving average of employment. Under conditions of stable economic growth, the percent difference between USCPI and RPI is assumed to decrease over time. The boom effect, therefore, increases the RPI-USCPI ratio in the short run (i.e., two-to-three years), while the effect of scale economies associated with growth tends to reduce this ratio over time.

A wide range of RPI specification alternatives were examined using regression analysis and additional simulation experiments. The specification selected for the Northern and Western Gulf lease sale impact analysis postulates a simple linear relationship between the rate of change in RPI and the rate of change in CPI and in employment. That is,

$$RPI(\%\Delta) = a + b \cdot CPI(\%\Delta) + c \cdot EM991(\%\Delta) \qquad (3)$$

Scale effects are captured in the historical relation between the growth in CPI and in RPI. EM991(%Δ) transmits the effects of boom and scale on RPI. To see this, note that EM991(%Δ) = EM991(i) - EM991(i-1)/EM991(i-1) (where i = a given period). The denominator controls for scale, while the numerator controls for boom. As the economy grows, EM991(i-1) in the denominator increases, so that the effect on RPI of a given change in employment (as a component of EM991) is reduced over time. Thus, the boom effect becomes less important as the economy grows.

Moderating the boom term in the RPI equation and restricting EMP9 in the WR equations reduced the impacts generated by the MAP model. These changes cover the scope of model editing that occurred between the Beaufort and the Northern and Western Gulf impact analyses. Further refinements have been introduced as a result of experimentation associated with documentation of the MAP model.

Changes in the Wage Rate Equations: Round 2

Nominal sector-specific wage rates have been replaced by real wage rates in the dependent variable. This is equivalent to imposing a unitary elasticity on the RPI coefficient in the original version of the WR equations. In the previous WR specification, the RPI coefficients fell within a range of 1 to 1.5. Thus, RPI's effect on WRs has been neutralized (and reduced). Removal of the RPI term from the right-hand side may also reduce the presence of significant correlation between the explanatory variables (i.e., multicollinearity) and, therefore, increase the precision of coefficient estimates.

EMP9, which was previously (and somewhat arbitrarily) held constant, has been removed from the boom term. Additionally, the boom component no longer depends solely on the level of construction employment (ECONX) and is, instead, a function of the size of ECONX relative to the remainder of Alaskan employment (EM991). Thus, the effect of an exogenous employment injection via ECONX is transmitted relative to the size of the non-enclave economy. The boom component is also a distributed lag having a two-period length. Sector-specific WRs are now capable of diminishing growth in periods of relative economic decline.

Changes in the RPI Equation: Round 2

The new version of the RPI equation is a composite of separable boom (or cyclical) and scale components.

$$RPI = f(SCALE) + f(CYCLE). \tag{4}$$

Explicit separation of these relationships in the construction of the equation follows from the assumption of structural change in the economy. The RPI format is as follows: First, isolate information which does not account for scale effects in a vector of residuals (RESID), obtained by regressing the ratio of RPI to CPI on an indicator of economic scale. (See equation (5).)

$$\frac{RPI}{CPI} = f(SCALE) + RESID \tag{5}$$

The scale term is assumed to be a simple two-period moving average of non-enclave employment (EM991). The time series for this regression ends in 1974, when pipeline construction begins.

Next, regress the residual vector[1] RESID on an indicator that is capable of transmitting the effects of rapid growth in the Alaskan economy. (See equation (6).

$$RESID = f(CYCLE) \tag{6}$$

We have selected the annual rate of EM991 growth, squared, as the boom indicator (CYCLE). The effect is symmetrical: a decline in EM991 growth will produce a decline in RESID, the boom component of RPI, and vice versa.

Finally, we merge the results of this "2-stage" procedure into a single expression for RPI. (See equation (4).)

Over the projection period, the new RPI equation appears to perform with less volatility than its predecessor. The scale effect will generally dominate the boom effect, with the exception of a large or an abrupt fluctuation in employment.

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[1]By definition, residuals equal the difference between actual and fitted values. Even though the "scale" regression (equation (4)) was performed on data limited to 1973, fitted values were calculated to 1977 using actual data for right-hand-side variables in (4). Thus, the residual vector (i.e., dependent variable in the "boom" regression, equation (5)) includes "projected" residuals, which contain information regarding the pipeline boom.

Changes in the Output Demand Equations

The original specification for industry output is

$$XX_i = a + b \cdot DPI3R + c \cdot DPIXR \qquad (7)$$

where XX_i = output in industry i

DPI3R = real disposable personal nonpipeline income (nonenclave)

DPIXR = real disposable personal pipeline income (enclave)

In this specification, there is no provision for factors which tend to sustain economic activity during a bust or a period of general decline. These factors include:

(1) personal income reserves which accumulate during a boom and contribute to higher post-boom spending;

(2) the capital stock effect, which resists short-run change and, instead, adds stability to cyclical variation in the economy; and

(3) the attempts of business organizations to continue operations under economic circumstances which encourage exit from the industry.

To capture these effects, nonenclave real disposable income (DPI3R(-1)) was appended to the output equations in all sectors. Lagging DPI3R is a proxy for those effects described above which tend to sustain the economy in the post-boom period.

Summary of Model Changes

Changes in the character of impacts associated with the original and new version of the MAP model are examined in connection with the Beaufort moderate scenario, using the Lower Cook moderate scenario as a base case.

The ratio of new version to original version Beaufort moderate impacts are listed for selected aggregate indicators in Table C.1.

TABLE C.1. IMPACT COMPARISON, THE RATIO OF NEW TO OLD VERSION IMPACTS IN THE BEAUFORT MODERATE SCENARIO

	Population	Employment	Personal Income
1980	1.06	1.06	1.31
1990	.87	.90	.60
2000	.42	.39	.43

The impact ratios in Table C.1. show that over the projection period, the new model version impacts taper off relative to those of the original model. New version impacts experience increasing moderation as the projection range advances.

With the exception of minor oscillations, personal income impacts in the new version stabilize at approximately $275 million between 1994 and 2000, when direct exogenous employment injections level off. On the other hand, impacts in the original version continue to grow and reach a level of about $663 million in 2000. Over this forecast interval, the average annual rates of personal income impact growth for the new and original models are 0.6 and 7.3 percent, respectively.

These impact level and growth rate differentials follow from the removal of the cumulative effect on aggregate demand in the WR equations. That is, moderation of average WR growth (particularly during periods of constant direct employment growth) reduces the level of WRs in any given period and, therefore, the start value for simulation in the next period. WRs are an important determinant of income and population growth in the MAP model. In the new version, average WR growth is comparable to the national average of about 2 percent per year.

The decline in aggregate demand as a result of WR moderation is felt most in the endogenous support sector of the economy. Support sector employment is reduced by about 92 percent between original and new model versions. The Anchorage region is most sensitive to the redistribution away from support sector activity.

Cyclical variation associated with large direct employment injections is also reduced. Table C.2. displays the new to original version, personal income impact ratios from 1983 (peak direct ALCAN employment) to 1986.

TABLE C.2. PERSONAL INCOME IMPACT RATIO DURING SELECTED ALCAN AND POST-ALCAN PROJECT YEARS

Year	Ratio of New to Original Version Personal Income Impacts
1983	.88
1984	.82
1985	1.08
1986	1.20

It is evident that boom period impacts are moderated and the bust is smoothed in the new model. This change follows from adjustments in the output equations.

APPENDIX D

Selected Model Output

Variable Definitions

POP	Population (10^3 persons)
MIGNET	Net migration (10^3 persons)
NINCTOT	Natural increase (10^3 persons)
EM99	Total employment (10^3 persons)
EMSPP	Proportion of employment in the support sector
EMG9P	Proportion of employment in the government sector
EMNSP	Proportion of employment in the basic sector
EMA9	Employment in agriculture-forestry-fisheries (10^3 persons)
EMGF	Employment in federal government (10^3 persons)
EMP9	Employment in mining (10^3 persons)
EMT9	Employment in transportation (10^3 persons)
EMS9	Employment in services (10^3 persons)
EMPU	Employment in utilities (10^3 persons)
EMM9	Employment in manufacturing (10^3 persons)
EMFI	Employment in finance-insurance-real estate (10^3 persons)
EMD9	Employment in trade (10^3 persons)
EMCN	Employment in construction (10^3 persons)
EMCN1	Employment in local construction (10^3 persons)
EMGA	Employment in state and local government (10^3 persons)
EMOT	Other employment (10^3 persons)
PI	Personal income (millions of nominal dollars)
PIRPC	Real per capita personal income
RPI	Relative price index ($1957 US = 100)
E99S	Total state expenditures (millions of nominal dollars)
EXOPS	Total state operating expenditures (millions of nominal dollars)
EXCAP	Total state capital expenditures (millions of nominal dollars)
E99SRPC	Real per capita state expenditures
REVGF	Total general fund revenue (millions of nominal dollars)
RP9S	Total petroleum revenues (millions of nominal dollars)
RT98	Total nonpetroleum tax revenues (millions of nominal dollars)
RENS	Total endogenous revenues (millions of nominal dollars)

Variable Definitions (continued)

GFBAL	General fund balance (millions of nominal dollars)
PFBAL	Permanent fund balance (millions of nominal dollars)
RINS	Fund balance interest (millions of nominal dollars)
FUND	Total fund balance (millions of nominal dollars)
FUND77	Real fund balance (millions of real 1977 dollars)
SIMP	General fund revenue minus general fund expenditure (millions of nominal dollars)
EXBITES	State total expenditure as a percentage of personal income
VIABL2	Nonpetroleum revenues as a percentage of general fund expenditures
RENSRAT	Endogenous revenues as a percentage of personal income

BASE CASE

SIMULATION OUTPUT BY DSET

NOCS

	POP	MIGNET	NINCTOT	EM99	EMSF.EM	EMG9.EM	EMNS.EM	EMA9
1978	404.436	-5.	7.394	197.081	0.361	0.417	0.222	1.2
1979	402.469	-14.077	7.088	192.852	0.345	0.426	0.229	1.2
1980	405.156	-3.74	6.399	194.71	0.345	0.415	0.24	1.2
1981	415.106	3.772	6.166	201.721	0.353	0.399	0.247	1.3
1982	434.151	12.812	6.232	214.587	0.367	0.373	0.26	1.3
1983	450.886	10.093	6.656	223.652	0.38	0.368	0.253	1.4
1984	453.976	-3.848	6.947	222.413	0.384	0.382	0.234	1.4
1985	456.806	-3.856	6.672	223.11	0.381	0.381	0.238	1.4
1986	460.696	-2.56	6.435	225.38	0.382	0.375	0.242	1.5
1987	467.351	0.375	6.267	229.763	0.388	0.37	0.243	1.5
1988	475.542	1.952	6.231	235.234	0.394	0.363	0.243	1.6
1989	484.146	2.333	6.265	240.9	0.4	0.358	0.242	1.6
1990	492.853	2.381	6.32	246.536	0.406	0.352	0.242	1.7
1991	499.673	0.431	6.383	250.694	0.414	0.348	0.239	1.7
1992	506.531	0.476	6.372	254.941	0.419	0.342	0.239	1.8
1993	513.931	1.018	6.373	259.593	0.426	0.335	0.239	1.8
1994	521.89	1.548	6.401	264.635	0.432	0.329	0.239	1.8
1995	530.883	2.531	6.453	270.386	0.438	0.322	0.24	1.9
1996	540.954	3.517	6.546	276.832	0.444	0.315	0.241	2.
1997	551.931	4.294	6.677	283.828	0.451	0.308	0.241	2.1
1998	563.477	4.704	6.836	291.101	0.457	0.301	0.241	2.1
1999	575.845	5.358	7.006	298.852	0.464	0.294	0.242	2.2
2000	588.82	5.774	7.196	306.906	0.47	0.288	0.242	2.2

	EMGF	EMP9	EMT9	EMS9	EMPU	EMM9	EMFI	EMD9
1978	42.921	4.281	11.132	23.805	1.304	11.73	6.372	25.103
1979	42.921	4.242	10.366	22.026	1.212	12.297	5.819	23.955
1980	42.921	4.44	10.206	22.117	1.193	12.822	5.824	24.599
1981	42.921	4.059	10.575	23.747	1.234	13.322	6.241	26.217
1982	42.921	3.806	11.188	26.716	1.3	13.811	6.987	29.093
1983	42.921	3.554	11.973	28.907	1.393	14.299	7.715	31.25
1984	42.921	3.561	12.287	28.769	1.439	14.854	7.85	31.233
1985	42.921	3.644	12.322	28.579	1.433	15.356	7.803	31.165
1986	42.921	3.655	12.324	28.956	1.433	15.872	7.9	31.85
1987	42.921	3.712	12.57	30.057	1.461	16.4	8.2	32.984
1988	42.921	3.747	12.885	31.412	1.498	16.945	8.569	34.308
1989	42.921	3.806	13.239	32.897	1.539	17.506	8.976	35.703
1990	42.921	3.841	13.598	34.414	1.58	18.084	9.392	37.099
1991	42.921	3.402	13.95	35.826	1.62	18.68	9.781	38.306
1992	42.921	3.402	14.235	37.118	1.653	19.296	10.135	39.527
1993	42.921	3.322	14.546	38.538	1.688	19.932	10.523	40.853
1994	42.921	3.268	14.879	40.066	1.726	20.59	10.941	42.258
1995	42.921	3.268	15.226	41.724	1.765	21.269	11.394	43.805
1996	42.921	3.268	15.61	43.562	1.808	21.971	11.897	45.49
1997	42.921	3.268	16.021	45.557	1.853	22.696	12.442	47.306
1998	42.921	3.268	16.458	47.684	1.902	23.445	13.024	49.199
1999	42.921	3.268	16.904	49.921	1.951	24.219	13.636	51.202
2000	42.921	3.268	17.375	52.294	2.003	25.019	14.286	53.288

	EMCN	EMCN1	EMT9X	EMGA	EMOT	PI	PIRPC	RPI
1978	11.558	11.431	0.85	39.242	15.004	3973.01	3507.97	280.036
1979	11.554	11.337	0.85	39.207	14.839	4104.47	3433.44	297.015
1980	13.343	12.98	0.85	37.966	14.912	4522.12	3559.6	313.556
1981	16.05	13.564	0.85	37.582	15.182	5181.29	3787.82	329.522
1982	21.238	14.935	0.85	37.054	15.665	6323.33	4206.74	346.232
1983	21.222	16.012	0.85	39.297	15.997	7037.21	4316.02	361.624
1984	16.335	15.943	0.85	42.055	15.952	6978.51	4052.33	379.34
1985	16.708	16.561	0.946	42.067	15.978	7347.04	4021.98	399.886
1986	17.526	17.399	0.946	41.649	16.06	7989.65	4121.36	420.795
1987	17.945	17.818	0.946	41.992	16.217	8745.29	4231.92	442.173
1988	18.473	18.346	0.946	42.572	16.411	9598.75	4349.63	464.061
1989	18.872	18.784	0.946	43.241	16.61	10521.4	4464.37	486.784
1990	19.194	19.147	0.946	43.818	16.805	11517.2	4576.44	510.625
1991	19.173	19.125	0.946	44.2	16.948	12499.1	4668.63	535.799
1992	19.348	19.299	0.946	44.148	17.092	13612.	4776.01	562.669
1993	19.731	19.681	0.946	44.139	17.249	14842.5	4887.79	590.865
1994	20.171	20.12	0.946	44.156	17.418	16199.7	5003.5	620.372
1995	20.788	20.736	0.946	44.184	17.608	17727.4	5127.42	651.248
1996	21.528	21.475	0.946	44.32	17.818	19433.7	5256.12	683.492
1997	22.339	22.285	0.946	44.53	18.044	21326.3	5387.59	717.2
1998	23.186	23.131	0.946	44.768	18.276	23404.1	5519.58	752.508
1999	24.098	24.042	0.946	45.024	18.519	25708.6	5654.16	789.596
2000	25.051	24.993	0.946	45.316	18.769	28243.6	5789.47	828.507

	E99S	EXOPS	EXCAP	E99SRPC	REVGF	RP9S	RT98	RENS
1978	1270.12	944.	280.	1121.45	1092.37	471.4	261.09	334.136
1979	1371.84	1019.	290.	1147.61	1380.32	810.7	205.751	280.951
1980	1619.58	1080.78	468.604	1274.86	1570.06	996.3	187.427	266.409
1981	1744.76	1169.28	497.816	1275.55	1884.06	1278.1	191.876	279.088
1982	1962.33	1299.62	572.128	1305.46	2175.1	1475.3	237.529	335.426
1983	2273.26	1504.53	666.015	1394.2	2465.55	1642.	300.534	414.033
1984	2508.93	1657.71	733.465	1456.89	3039.33	2121.	338.303	465.952
1985	2721.87	1738.92	848.985	1490.04	3422.26	2421.4	342.242	478.885
1986	3007.43	1869.67	981.094	1551.35	3552.76	2427.9	369.314	515.849
1987	3267.2	2040.23	1044.15	1581.03	3735.83	2473.9	408.654	569.395
1988	3565.91	2236.38	1117.62	1615.87	3920.25	2509.7	458.733	636.136
1989	3867.92	2451.87	1173.31	1641.21	4090.73	2523.5	518.691	715.033
1990	4169.07	2679.71	1215.03	1656.61	4090.36	2367.7	581.781	798.938
1991	4413.34	2912.15	1194.52	1648.46	4151.99	2281.2	655.032	895.027
1992	4673.11	3136.57	1200.23	1639.63	4301.06	2296.5	726.649	990.041
1993	4980.42	3379.57	1242.26	1640.11	4464.93	2316.8	811.719	1101.68
1994	5311.82	3639.76	1290.78	1640.64	4570.6	2276.1	904.026	1223.66
1995	5696.95	3920.96	1368.86	1647.77	4667.09	2219.	1012.99	1365.72
1996	6139.75	4232.22	1472.13	1660.57	4806.71	2204.9	1133.65	1523.87
1997	6623.33	4575.15	1585.48	1673.21	4969.13	2201.7	1277.28	1709.47
1998	7154.84	4950.84	1708.98	1687.38	5137.64	2203.8	1433.32	1913.[illegible]
1999	7719.85	5358.76	1842.16	1697.84	5333.82	2218.7	1617.93	2150.[illegible]
2000	8337.	5805.62	1987.27	1708.96	5551.18	2230.3	1819.57	2411.[illegible]

	GFBAL	PFBAL	RINS	FUND	FUND78	SIMP	RF9S.GF
1978	651.	54.475	47.07	705.475	705.457	38.813	0.432
1979	804.813	146.275	49.656	951.088	896.696	245.613	0.587
1980	898.389	268.	67.308	1166.39	1041.67	215.3	0.635
1981	1183.03	404.475	82.987	1587.5	1349.07	421.114	0.678
1982	1572.88	556.425	113.148	2129.31	1722.16	541.806	0.678
1983	1987.79	724.699	151.834	2712.49	2100.46	583.181	0.666
1984	2733.94	941.649	193.498	3675.59	2713.32	963.111	0.698
1985	3699.9	1180.55	262.	4880.45	3417.64	1204.86	0.708
1986	4588.77	1430.35	347.534	6019.12	4005.58	1138.67	0.683
1987	5448.89	1677.2	428.49	7126.09	4512.96	1106.97	0.662
1988	6243.02	1928.8	507.212	8171.82	4931.13	1045.74	0.64
1989	6944.64	2182.95	581.671	9127.59	5250.76	955.769	0.617
1990	7390.58	2425.45	649.845	9816.03	5383.15	688.448	0.579
1991	7658.32	2657.05	699.249	10315.4	5391.2	499.347	0.549
1992	7622.78	2891.25	735.361	10714.	5332.15	398.656	0.534
1993	7873.3	3128.32	764.438	11001.6	5214.	287.602	0.519
1994	7738.24	3361.82	785.755	11100.1	5010.45	98.438	0.498
1995	7375.47	3589.65	793.813	10965.1	4714.87	-134.945	0.475
1996	6782.21	3816.5	785.506	10598.7	4342.33	-366.406	0.459
1997	5945.95	4044.	760.992	9989.95	3900.55	-608.762	0.443
1998	4831.8	4272.6	719.517	9104.4	3388.	-885.551	0.429
1999	3440.64	4503.39	658.671	7944.04	2617.34	-1160.36	0.416
2000	1730.25	4736.37	578.599	6466.62	2185.67	-1477.42	0.403

OCS DEVELOPMENT

SIMULATION OUTPUT BY DSET

NWMLK2

	POP	MIGNET	NINCTOT	EM99	EMSP.EM	EMG9.EM	EMNS.EM	EMA9
1978	404.436	-5.	7.394	197.185	0.361	0.417	0.222	1.2
1979	403.256	-13.289	7.088	193.51	0.345	0.424	0.231	1.2
1980	407.511	-2.203	6.431	196.419	0.345	0.412	0.243	1.2
1981	419.562	5.783	6.258	204.746	0.354	0.394	0.251	1.3
1982	440.274	14.314	6.4	218.508	0.369	0.368	0.263	1.3
1983	457.932	10.797	6.877	227.878	0.382	0.363	0.255	1.4
1984	462.438	-2.669	7.186	227.33	0.386	0.376	0.238	1.4
1985	465.28	-4.118	6.948	227.557	0.384	0.376	0.24	1.4
1986	469.501	-2.462	6.688	229.76	0.385	0.37	0.245	1.5
1987	477.136	1.108	6.514	234.561	0.39	0.363	0.246	1.5
1988	487.542	3.9	6.498	241.309	0.396	0.356	0.248	1.6
1989	498.194	4.048	6.601	248.002	0.403	0.35	0.247	1.6
1990	507.57	2.663	6.711	253.644	0.409	0.346	0.245	1.7
1991	514.843	0.498	6.769	257.783	0.416	0.342	0.242	1.7
1992	521.645	0.044	6.748	261.698	0.422	0.336	0.242	1.8
1993	529.306	0.931	6.719	266.319	0.428	0.33	0.242	1.8
1994	537.641	1.592	6.734	271.437	0.434	0.324	0.242	1.8
1995	546.636	2.207	6.779	276.995	0.44	0.318	0.242	1.9
1996	557.134	3.637	6.852	283.627	0.446	0.311	0.243	2.
1997	567.907	3.785	6.982	290.334	0.453	0.305	0.243	2.1
1998	579.424	4.396	7.115	297.495	0.459	0.298	0.243	2.1
1999	591.673	4.974	7.269	305.107	0.465	0.291	0.243	2.2
2000	604.521	5.4	7.442	313.03	0.472	0.285	0.244	2.2

	EMGF	EMP9	EMT9	EMS9	EMPU	EMM9	EMFI	EMD9
1978	42.921	4.351	11.132	23.812	1.304	11.73	6.374	25.117
1979	42.921	4.563	10.372	22.09	1.213	12.297	5.836	24.061
1980	42.921	5.104	10.245	22.337	1.198	12.822	5.883	24.892
1981	42.921	5.067	10.734	24.198	1.246	13.322	6.362	26.719
1982	42.921	4.759	11.424	27.392	1.319	13.811	7.165	29.747
1983	42.921	4.407	12.217	29.699	1.415	14.299	7.924	31.968
1984	42.921	4.508	12.51	29.672	1.462	14.854	8.088	32.114
1985	42.921	4.403	12.609	29.52	1.461	15.356	8.059	31.983
1986	42.921	4.43	12.569	29.845	1.457	15.872	8.135	32.626
1987	42.921	4.57	12.874	31.007	1.485	16.4	8.449	33.876
1988	42.921	4.902	13.248	32.613	1.526	16.945	8.883	35.428
1989	42.921	5.22	13.672	34.32	1.574	17.506	9.351	36.981
1990	42.921	5.225	14.055	35.842	1.617	18.084	9.778	38.375
1991	42.921	4.75	14.401	37.239	1.657	18.68	10.163	39.554
1992	42.921	4.678	14.607	38.48	1.687	19.296	10.505	40.734
1993	42.921	4.54	14.91	39.905	1.722	19.932	10.892	42.054
1994	42.921	4.491	15.239	41.455	1.759	20.59	11.316	43.49
1995	42.921	4.497	15.591	43.117	1.798	21.269	11.773	45.024
1996	42.921	4.499	15.972	45.006	1.84	21.971	12.284	46.74
1997	42.921	4.476	16.378	46.963	1.886	22.696	12.827	48.543
1998	42.921	4.452	16.811	49.078	1.934	23.445	13.406	50.403
1999	42.921	4.44	17.244	51.291	1.982	24.219	14.011	52.391
2000	42.921	4.389	17.689	53.664	2.033	25.019	14.661	54.467

	EMCN	EMCN1	EMT9X	EMGA	EMOT	PI	PIRPC	RPI
1978	11.565	11.438	0.85	39.242	15.008	3976.23	3510.82	280.036
1979	11.685	11.38	0.85	39.193	14.865	4128.61	3447.68	296.964
1980	13.682	13.157	0.85	37.978	14.978	4583.8	3590.64	313.268
1981	16.45	13.807	0.908	37.81	15.297	5288.43	3829.77	329.119
1982	21.809	15.27	0.926	37.497	15.81	6472.98	4252.16	345.764
1983	21.831	16.374	0.906	39.869	16.15	7205.2	4358.4	361.016
1984	17.293	16.356	0.876	42.565	16.13	7201.34	4113.7	378.55
1985	17.236	16.949	0.988	42.666	16.138	7531.93	4057.24	398.992
1986	18.309	17.76	0.975	42.081	16.217	8198.2	4157.61	419.987
1987	18.907	18.229	1.042	42.317	16.388	9016.49	4281.78	441.337
1988	19.661	18.887	1.054	42.989	16.624	9967.37	4414.55	463.11
1989	19.981	19.427	1.068	43.939	16.856	10946.6	4525.67	485.51
1990	20.035	19.833	1.075	44.782	17.049	11919.9	4612.9	509.096
1991	20.075	19.872	1.075	45.179	17.188	12913.5	4694.7	534.273
1992	20.181	20.055	1.01	45.139	17.32	14029.1	4792.48	561.172
1993	20.642	20.437	1.01	45.095	17.474	15296.	4902.52	589.454
1994	21.093	20.887	1.01	45.119	17.642	16700.1	5018.32	618.966
1995	21.483	21.354	1.01	45.181	17.824	18233.2	5132.84	649.84
1996	22.397	22.124	1.01	45.235	18.037	20013.3	5265.89	682.157
1997	22.965	22.912	1.01	45.498	18.251	21895.5	5385.92	715.845
1998	23.803	23.748	1.01	45.716	18.477	23989.3	5510.9	751.277
1999	24.712	24.656	1.01	45.92	18.713	26328.9	5643.94	788.445
2000	25.662	25.604	0.988	46.18	18.956	28896.8	5776.95	827.451

	E99S	EXOPS	EXCAP	E99SRPC	REVGF	RP9S	RT98	RENS
1978	1270.12	944.	280.	1121.45	1092.41	471.4	261.121	334.168
1979	1371.84	1019.	290.	1145.56	1431.12	860.7	206.211	281.455
1980	1626.58	1080.6	475.789	1274.15	1576.85	996.3	189.325	268.669
1981	1756.73	1175.07	503.672	1272.2	1895.12	1278.42	196.071	284.238
1982	1986.13	1313.18	581.905	1304.68	2190.59	1475.75	244.558	344.101
1983	2304.7	1524.39	676.882	1394.08	2484.41	1642.71	310.021	425.695
1984	2543.04	1680.46	743.873	1452.7	3060.7	2121.72	349.944	480.033
1985	2759.6	1762.07	862.399	1486.51	3447.26	2422.26	356.959	496.936
1986	3036.35	1887.71	990.58	1539.85	3578.45	2430.97	383.16	532.704
1987	3301.34	2061.12	1055.92	1567.75	3767.27	2480.15	424.604	588.415
1988	3613.38	2265.73	1134.02	1600.36	3963.07	2520.75	479.216	660.672
1989	3936.02	2496.39	1194.85	1627.27	4183.46	2575.2	545.998	747.801
1990	4262.87	2735.36	1250.7	1649.71	4243.04	2471.56	613.01	836.659
1991	4524.18	2968.45	1245.54	1644.76	4344.86	2418.85	686.431	933.351
1992	4803.1	3199.62	1261.87	1640.78	4513.11	2443.29	759.909	1030.51
1993	5119.25	3447.35	1305.69	1640.78	4696.36	2472.49	846.548	1144.07
1994	5465.71	3717.83	1356.59	1642.43	4824.63	2440.84	942.457	1270.15
1995	5826.12	4006.42	1400.07	1640.11	4939.62	2387.32	1055.39	1417.12
1996	6271.57	4319.	1504.	1650.18	5101.05	2379.69	1179.15	1578.88
1997	6768.68	4672.69	1619.42	1664.97	5287.43	2381.19	1328.29	1771.21
1998	7301.4	5047.06	1744.72	1677.3	5467.21	2379.1	1485.11	1976.33
1999	7870.26	5457.78	1878.18	1687.08	5673.34	2385.18	1673.51	2217.97
2000	8493.8	5909.03	2024.7	1698.04	5880.49	2386.62	1879.31	2483.84

	GFBAL	FFBAL	RINS	FUND	FUND78	SIMP	RP9S.GF
1978	651.	54.475	47.07	705.475	705.457	38.844	0.432
1979	843.106	158.775	49.656	1001.88	944.745	296.406	0.601
1980	940.267	280.5	70.926	1220.77	1091.24	218.886	0.632
1981	1226.71	416.975	86.856	1643.69	1398.52	422.919	0.675
1982	1613.33	568.925	117.143	2182.26	1767.38	538.574	0.674
1983	2021.59	737.199	155.603	2758.79	2139.91	576.534	0.661
1984	2760.79	954.149	196.801	3714.94	2748.1	956.153	0.693
1985	3720.27	1193.05	264.816	4913.32	3448.36	1198.38	0.703
1986	4609.6	1442.85	349.897	6052.45	4035.51	1139.14	0.679
1987	5472.63	1689.7	430.886	7162.33	4544.51	1109.88	0.658
1988	6270.41	1941.3	509.812	8211.71	4965.38	1049.39	0.636
1989	7005.29	2198.57	584.526	9203.87	5308.54	992.159	0.616
1990	7522.04	2450.02	655.263	9972.07	5485.15	768.201	0.582
1991	7889.25	2694.37	710.294	10583.6	5547.2	611.562	0.557
1992	8159.79	2942.25	754.325	11102.	5540.	518.419	0.541
1993	8327.78	3193.77	791.854	11521.6	5473.49	419.508	0.526
1994	8319.53	3442.52	822.477	11762.1	5321.32	240.504	0.506
1995	8104.95	3686.02	840.556	11791.	5080.96	28.922	0.483
1996	7678.63	3929.22	843.798	11607.9	4765.09	-183.117	0.467
1997	7021.3	4173.64	832.196	11194.9	4379.32	-412.91	0.45
1998	6096.83	4418.72	804.514	10515.5	3919.54	-679.402	0.435
1999	4902.8	4665.07	758.182	9567.86	3398.18	-947.684	0.42
2000	3394.95	4912.57	693.075	8307.52	2811.46	-1260.34	0.406

OCS IMPACT

	POP	MIGNET	NINCTOT	EM99	EMA9	EMGF	EMP9	EMT9
1978	0.	0.	0.	0.104	0.	0.	0.07	0.
1979	0.787	0.788	0.	0.657	0.	0.	0.321	0.005
1980	2.355	1.537	0.032	1.709	0.	0.	0.664	0.039
1981	4.456	2.01	0.092	3.025	0.	0.	1.008	0.159
1982	6.124	1.503	0.168	3.921	0.	0.	0.953	0.236
1983	7.045	0.704	0.22	4.227	0.	0.	0.853	0.245
1984	8.462	1.179	0.238	4.917	0.	0.	0.947	0.223
1985	8.474	-0.262	0.276	4.447	0.	0.	0.759	0.288
1986	8.806	0.078	0.253	4.38	0.	0.	0.775	0.245
1987	9.785	0.732	0.247	4.797	0.	0.	0.858	0.304
1988	11.999	1.948	0.267	6.075	0.	0.	1.155	0.363
1989	14.047	1.715	0.336	7.102	0.	0.	1.414	0.434
1990	14.717	0.282	0.391	7.108	0.	0.	1.384	0.457
1991	15.169	0.067	0.386	7.089	0.	0.	1.348	0.451
1992	15.114	-0.431	0.376	6.757	0.	0.	1.276	0.371
1993	15.375	-0.087	0.346	6.726	0.	0.	1.218	0.364
1994	15.751	0.043	0.334	6.802	0.	0.	1.223	0.36
1995	15.753	-0.324	0.327	6.609	0.	0.	1.229	0.364
1996	16.18	0.119	0.306	6.795	0.	0.	1.231	0.361
1997	15.976	-0.509	0.305	6.506	0.	0.	1.208	0.357
1998	15.947	-0.308	0.279	6.394	0.	0.	1.184	0.353
1999	15.828	-0.384	0.264	6.255	0.	0.	1.172	0.34
2000	15.701	-0.374	0.246	6.125	0.	0.	1.121	0.314

	EMT9X	EMS9	EMPU	EMM9	EMFI	EMD9	EMCN	EMCN1
1978	0.	0.007	0.	0.	0.002	0.014	0.007	0.007
1979	0.	0.064	0.001	0.	0.017	0.105	0.131	0.043
1980	0.	0.22	0.005	0.	0.059	0.294	0.339	0.177
1981	0.058	0.451	0.012	0.	0.121	0.502	0.401	0.244
1982	0.076	0.676	0.019	0.	0.178	0.655	0.571	0.335
1983	0.056	0.792	0.022	0.	0.209	0.718	0.609	0.362
1984	0.026	0.903	0.022	0.	0.238	0.881	0.958	0.413
1985	0.042	0.941	0.028	0.	0.256	0.818	0.529	0.369
1986	0.029	0.889	0.025	0.	0.235	0.776	0.783	0.361
1987	0.096	0.951	0.024	0.	0.249	0.892	0.962	0.411
1988	0.108	1.201	0.028	0.	0.313	1.12	1.188	0.541
1989	0.122	1.422	0.035	0.	0.374	1.278	1.109	0.643
1990	0.129	1.428	0.037	0.	0.386	1.276	0.84	0.685
1991	0.129	1.414	0.036	0.	0.382	1.248	0.902	0.747
1992	0.064	1.361	0.035	0.	0.37	1.207	0.833	0.756
1993	0.064	1.366	0.034	0.	0.369	1.201	0.911	0.756
1994	0.064	1.389	0.033	0.	0.374	1.233	0.922	0.767
1995	0.064	1.394	0.034	0.	0.379	1.218	0.696	0.619
1996	0.064	1.444	0.033	0.	0.387	1.251	0.87	0.65
1997	0.064	1.407	0.033	0.	0.385	1.237	0.626	0.626
1998	0.064	1.395	0.032	0.	0.382	1.204	0.617	0.617
1999	0.064	1.37	0.03	0.	0.375	1.189	0.614	0.614
2000	0.042	1.371	0.03	0.	0.375	1.179	0.611	0.611

	EMGA	EMOT	PI	PIRPC	RPI	E99S	EXOPS	EXCAP
1978	0.	0.004	3.225	2.848	0.	0.	0.	0.
1979	-0.014	0.026	24.133	14.24	-0.051	0.	0.	0.
1980	0.012	0.066	61.676	31.048	-0.289	7.	-0.185	7.185
1981	0.228	0.115	107.137	41.951	-0.403	11.955	5.79	5.856
1982	0.443	0.144	149.645	45.418	-0.468	23.793	13.556	9.777
1983	0.572	0.152	167.984	42.375	-0.608	31.438	19.86	10.867
1984	0.51	0.178	222.828	61.371	-0.79	34.114	22.748	10.407
1985	0.599	0.16	184.887	35.256	-0.894	37.728	23.152	13.415
1986	0.432	0.157	208.547	36.25	-0.808	28.921	18.039	9.487
1987	0.325	0.17	271.199	49.859	-0.836	34.145	20.887	11.767
1988	0.417	0.213	368.617	64.926	-0.951	47.469	29.356	16.406
1989	0.698	0.246	425.227	61.305	-1.274	68.092	44.515	21.536
1990	0.964	0.243	402.699	36.461	-1.529	93.797	55.646	35.673
1991	0.979	0.24	414.422	26.066	-1.526	110.836	56.299	51.02
1992	0.992	0.227	417.094	16.477	-1.498	129.988	63.043	61.635
1993	0.956	0.224	453.422	14.723	-1.412	138.832	67.775	63.436
1994	0.962	0.225	500.352	14.824	-1.406	153.895	78.072	65.816
1995	0.997	0.216	505.715	5.422	-1.408	129.172	85.462	31.214
1996	0.915	0.219	579.57	9.77	-1.335	131.816	86.781	31.866
1997	0.968	0.207	569.156	-1.664	-1.356	145.352	97.539	33.942
1998	0.948	0.201	585.199	-8.676	-1.23	146.566	96.219	35.739
1999	0.896	0.194	620.27	-10.219	-1.152	150.41	99.016	36.01
2000	0.864	0.188	653.281	-12.52	-1.056	156.801	103.203	37.425

	E99SRPC	REVGF	RP9S	RT98	RENS	GFBAL	PFBAL	RINS
1978	0.	0.031	0.	0.031	0.031	0.	0.	0.
1979	-2.045	50.799	50.	0.46	0.504	38.292	12.5	0.
1980	-0.718	6.784	0.	1.898	2.26	41.878	12.5	3.618
1981	-3.343	11.06	0.322	4.195	5.15	43.683	12.5	3.869
1982	-0.785	15.485	0.452	7.029	8.676	40.451	12.5	3.995
1983	-0.122	18.86	0.712	9.488	11.662	33.806	12.5	3.769
1984	-4.186	21.375	0.723	11.641	14.081	26.851	12.5	3.304
1985	-3.538	24.996	0.862	14.718	18.051	20.363	12.5	2.817
1986	-11.501	25.687	3.073	13.846	16.855	20.836	12.5	2.363
1987	-13.274	31.444	6.254	15.951	19.02	23.746	12.5	2.396
1988	-15.507	42.821	11.055	20.483	24.536	27.391	12.5	2.6
1989	-13.94	92.739	51.7	27.308	32.768	60.656	15.625	2.855
1990	-6.904	152.675	103.86	31.229	37.72	131.457	24.575	5.418
1991	-3.706	192.871	137.65	31.398	38.324	230.926	37.325	11.045
1992	1.146	212.055	146.79	33.26	40.472	337.016	51.	18.964
1993	0.672	231.43	155.69	34.829	42.369	454.473	65.45	27.416
1994	1.797	254.031	164.74	38.431	46.491	581.289	80.7	36.722
1995	-7.658	272.539	168.32	42.402	51.406	729.48	96.375	46.742
1996	-10.385	294.332	174.79	45.505	55.005	896.418	112.725	58.292
1997	-8.236	318.301	179.49	51.014	61.443	1075.35	129.646	71.204
1998	-10.084	329.574	175.3	51.795	63.126	1265.02	146.121	84.998
1999	-10.763	339.512	166.48	55.588	67.415	1462.15	161.672	99.511
2000	-10.913	349.309	156.32	59.746	72.46	1664.7	176.199	114.476

	FUND	FUND78	SIMP
1978	0.	0.	0.031
1979	50.792	48.049	50.792
1980	54.378	49.568	3.586
1981	56.183	49.455	1.804
1982	52.951	45.215	-3.232
1983	46.306	39.454	-6.646
1984	39.351	34.772	-6.958
1985	32.863	30.719	-6.487
1986	33.336	29.934	0.473
1987	36.246	31.547	2.911
1988	39.891	34.25	3.648
1989	76.281	57.777	36.39
1990	156.035	101.996	79.753
1991	268.25	156.	112.215
1992	388.016	207.852	119.763
1993	519.922	259.484	131.906
1994	661.988	310.875	142.066
1995	825.855	366.09	163.867
1996	1009.14	422.758	183.289
1997	1205.	478.765	195.852
1998	1411.14	531.535	206.148
1999	1623.82	580.843	212.68
2000	1840.9	625.795	217.078

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