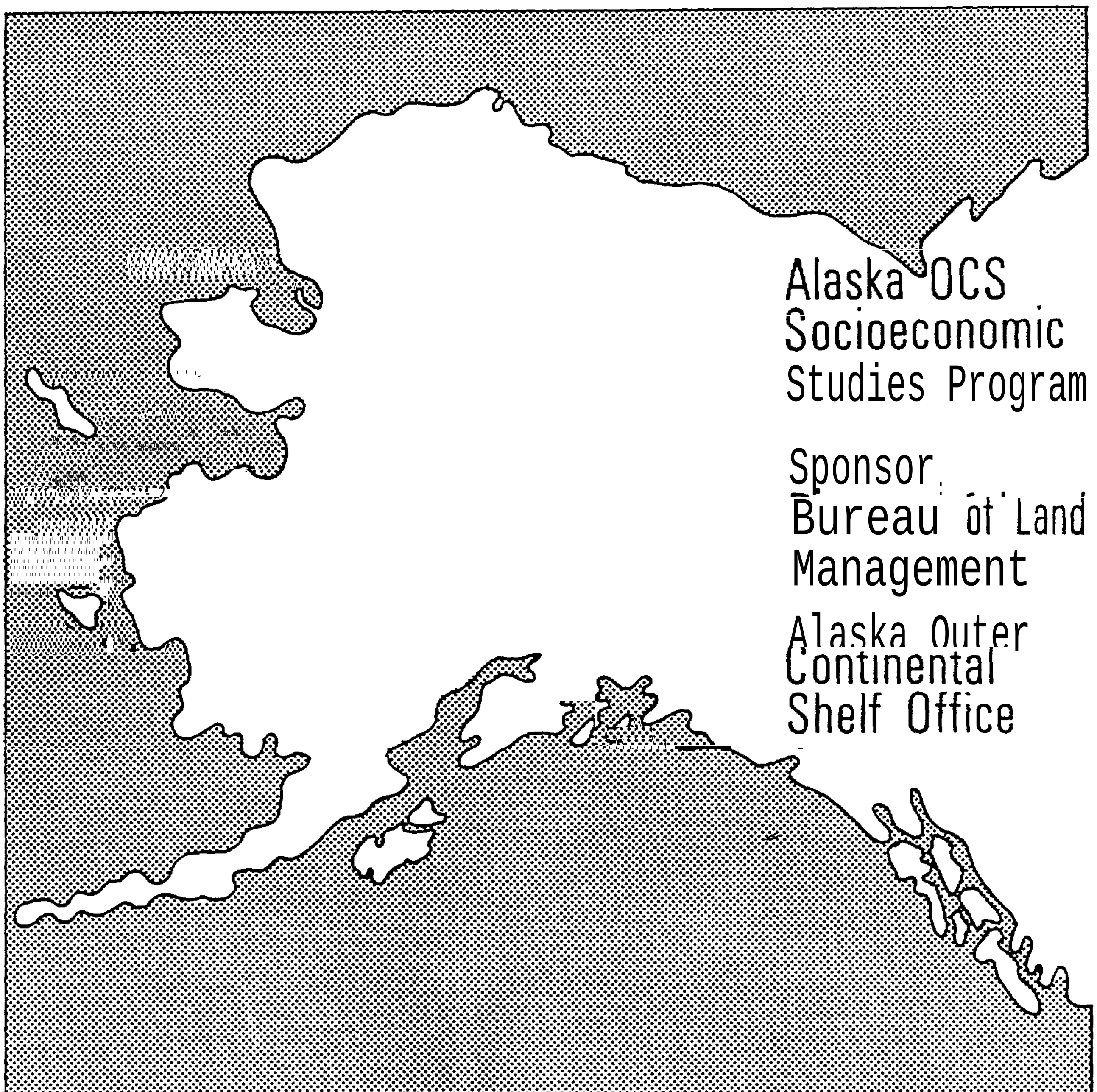
TECHNICAL REPORT NUMBER 73



ECONOMIC AND DEMOGRAPHIC STRUCTURAL CHANGE IN ALASKA

The United States Department of the Interior was designated by the Outer Continental Shelf (OCS) Lands Act of 1953 to carry out the majority of the Act's provisions for administering the mineral leasing and development of offshore areas of the United States under federal jurisdiction. Within the Department, the Bureau of Land Management (BLM) has the responsibility to meet requirements of the National Environmental Policy Act of 1969 (NEPA) as well as other legislation and regulations dealing with the effects of offshore development. In Alaska, unique cultural differences and climatic conditions create a need for developing additional socioeconomic and environmental information to improve OCS decision making at all governmental levels. In fulfillment of its federal responsibilities and with an awareness of these additional information needs, the BLM has initiated several investigative programs, one of which is the Alaska OCS Socioeconomic Studies Program (SESP).

The Alaska OCS Socioeconomic Studies Program is a multi-year research effort which attempts to predict and evaluate the effects of Alaska OCS Petroleum Development upon the physical, social, and economic environments within the state. The overall methodology is divided into three broad research components. The first component identifies an alternative set of assumptions regarding the location, the nature, and the timing of future petroleum events and related activities. In this component, the program takes into account the particular needs of the petroleum industry and projects the human, technological, economic, and environmental offshore and onshore development requirements of the regional petroleum industry.

The second component focuses on data gathering that identifies those quantifiable and qualifiable facts by which OCS-induced changes can be assessed. The critical community and regional components are identified and evaluated. Current endogenous and exogenous sources of change and functional organization among different sectors of community and regional life are analyzed. Susceptible community relationships, values, activities, and processes also are included.

The third research component focuses on an evaluation of the changes that could occur due to the potential oil and gas development. Impact evaluation concentrates on an analysis of the impacts at the statewide, regional, and local level.

In general, program products are sequentially arranged in accordance with BLM's proposed OCS lease sale schedule, so that information is timely to decisionmaking. Reports are available through the National Technical Information Service, and the BLM has a limited number of copies available through the Alaska OCS Office. Inquiries for information should be directed to: Program Coordinator (COAR), Socioeconomic Studies Program, Alaska OCS Office, P. Ct. Box 1159, Anchorage, Alaska 99510.

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NOTICE

Alaska OCS Socioeconomic Studies Program
Economic and Demographic Structural Change in Alaska

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ABSTRACT

This collection of five papers analyzes a number of aspects of structural change associated with economic growth and OCS development in Alaska. The first two papers, by Lee Huskey, examine two related factors which determine rural local economic impacts. The first paper addresses local economic response in the form of support sector expansion as additional basic employment is "multiplied." The strength of the multiplier appears to be related to both community income and population. , The second paper addresses local labor force response to additional employment opportunities. A model of rural labor markets is developed, which suggests that local labor force response to OCS employment opportunities will increase as subsistence costs increase, tastes change in favor of market goods, and opportunities for spending money increase.

The third paper, by Will Nebesky, examines residency patterns of OCS workers in Alaska. The proportion of workers who are local residents increases as the size of the local community increases. The final two papers, by Lee Huskey and Bradford Tuck, address statewide patterns of structural change which occur with economic growth in general, and with oil development in particular. Economic growth is accompanied both by export expansion and by import substitution, which occurs in response to economies of scale. Bradford Tuck's paper on structural change with petroleum industry expansion uses input-output

models which have been developed of other regions. He concludes that relatively little structural change will occur in the Alaska economy due to petroleum development, although forward linkages will be stronger than backward linkages.

I. INTRODUCTION

This study consists of five papers which examine the process of economic growth and structural change in the Alaskan economy, and in particular the response of the economy to oil development. The first three papers address these issues for rural economies, while the last two papers focus on the statewide economy.

The Process of Growth in Rural Alaska

Traditional approaches to describing regional economic growth are not always appropriate for describing regional growth in rural Alaska. The traditional approach is some form of economic base model. This approach assumes that the economy can be separated into two sectors, the basic and the support sector. The basic sector includes those industries which sell their goods primarily to markets outside of the region, while the support sector includes industries which sell their products primarily in local markets. The support sector is assumed to grow in response to growth of the basic sector. In many analyses, this growth is assumed to follow a constant relation defined by the multiplier. A second assumption important to the traditional description of regional economic growth is that population growth is determined solely by economic growth. Population is assumed to change in proportion to employment growth.

Economic growth in rural Alaska differs from the traditional description of regional economic growth in two subtle ways. First, the linkages between basic and support sector growth and employment and population growth are not as direct as usually assumed. Secondly, the relations between sectors are not fixed and may change through the projection period as a result of the factors which initiate growth. The major reasons for this difference are the importance of the subsistence economy; the frontier nature of the economy, and the small size of the economy.

The transition from isolated subsistence economy to full participation in the market passes through four stages: (1) pure isolated subsistence, (2) subsistence with supplementary cash activity, (3) cash orientation with supplementary subsistence, and (4) complete market specialization (Fisk, 1975). The local economies in rural Alaska are in the transitional stages with mixed cash and subsistence economies.

The existence of a subsistence component of these economies insures that the community response to exogenous change will differ from that found in complete market economies. The possibility of obtaining goods through subsistence will affect the demand for market goods and services since there is an alternative to the market. Subsistence is nonmarket work, which is an alternative to market work. The returns to and cost of subsistence will affect the allocation of residents' time to other uses, including participation in this labor force. Finally, subsistence provides a cultural context which provides an added social cost to any migration decision. This cultural context will affect the migration decisions of residents.

Rural Alaska economies are sparsely populated. Economies with low levels of population and with relatively high resource levels are considered frontier economies (see Watkins). In such regions, the character of growth will be affected by the character of the resource being developed. The low density of these areas requires that most inputs used to produce the resource must be imported. The technology of resource production will determine the extent that new residents must be imported. The technology will also determine the demands for inputs generated by resource production. The low density and under-developed character of these regions will weaken the links between resource development and support sector and population growth; resource developments may hire few workers from the region and buy few goods and services. In the extreme, resource developments may occur in enclaves which have no links to the local economy; resource enclaves have their major economic links and impacts outside the region in which they occur.

The small size of the local market is a result of the existence of nonmarket substitutes for some goods and the low levels of population. The small market size affects the community response in two related ways. First, small markets are able to provide few of the specialized goods and services required by resource firms. This results in the firms turning outside the local economy for purchase of these goods and services which reduces the links between resource production and the economy. Secondly, because of the small size of these markets, little is produced in the local economy. The value added locally is a small portion of any good, and the leakages from local expenditures are large. These factors contribute to the small size of the support sector response in these economies.

The small size of the economies and their underdevelopment suggests that structural change will occur in all components of community response. Structural change occurs with economic development and is one measure of economic development. Studies of countries and regions support this. The potential for structural change in response to changes in exogenous economic activity is primarily a result of the relative size of this activity. Resource development projects, such as OCS, are large relative to the size of local cash economies. This means they will be nonmarginal changes and suggests the possibility of structural change.

The response of rural Alaska economies to exogenously generated economic change differs from the response expected in a complete market economy. This knowledge is of little assistance when we attempt to assess the effects of potential OCS development on the local economies. Chapters II and III provide some empirical dressing to this knowledge. We address two major components of community response: the multiplier, which describes the response of the local support sector, and the labor force participation rates, which describe the willingness of local residents to participate in the market. For each of these, we examine empirical and theoretical evidence in order to estimate a level and pattern of change for each of these important components of community response.

In the discussions of multiplier and labor force participation, we rely importantly on developing a theoretical understanding of the pattern of growth. There are two reasons for this. First, there is only limited information concerning community response in the rural areas, and this must be supported and extended with theoretical analysis. Second, and most important, the potential for structural change means that historical information will be of little help in explaining the pattern of future change. For each of these reasons, we incorporate theoretical analysis into our discussions of community response parameters. Parameter and model structure are suggested based on information specific to rural Alaska, patterns found in similar regions, and theoretical analysis.

Resident Employment in Alaska's Outer Continental Shelf Industry

Chapter IV examines residency patterns of workers in Alaska's Outer Continental Shelf industry. Residency patterns are an important link in modeling both local and statewide economic response to OCS development. The chapter examines historical experience to provide specific recommendations for residency parameters for use in the MAP and SCIMP models used at the University of Alaska Institute of Social and Economic Research for modeling and projecting the impacts of OCS development.

Structural Change in the Alaskan Economy

The final two chapters address statewide patterns of structural change which occur with economic growth in general and with oil development in particular. A variety of structural changes occur as a small, resource-based economy matures into an economy providing a wide range of support services.

These structural changes affect the process of economic growth, generating new industries, and influencing costs, which in turn brings about additional structural change. Chapter V examines a number of kinds of structural change, such as changes in demand, changes in technology, export expansion, and import substitution. Chapter VI looks at the particular kinds of structural change which accompany oil development.

II.
STRUCTURAL CHANGE AND THE LOCAL ECONOMIC RESPONSE TO OCS DEVELOPMENT IN RURAL ALASKA

by

Lee Huskey

ABSTRACT

Structural Change and the Local Economic Response To OCS Development 'in Rural Alaska

To understand the possible effects of OCS development on rural Alaska communities, we must improve our understanding of the pattern of rural community response to major exogenous changes such as OCS development. The pattern of change is likely to be dominated by the size of the exogenous change relative to the community. When this change is large, as in most cases of OCS development in rural Alaska, the pattern of response may change as the structure of rural relationships change. The potential for structural change limits the usefulness of past responses for the explanation of the future.

This paper examines the local economic response to major exogenous change. It highlights the effect of structural change on this response and the causes of structural change. The local economic response is one part of the total community response to exogenous change. The labor force participation response describes how the community residents respond to increased employment opportunities. The local economic response describes how the local support sector responds to increased economic activity. This paper develops a method for estimating the local economic response in the face of large exogenous changes which incorporates the potential for change in the structure of local economic relationships.

The paper examines alternative models of local economic response estimated using pooled cross section time series data from Alaska coastal census divisions. These models examine three issues: (1) the applicability of a market size model versus the export base model; (2) the importance of lags in the relations; and (3) the ability of the model to project outside the size range of the areas in the data.

Evidence presented in this paper supports the use of the elasticities estimated in the market size model to estimate support sector employment growth in response to OCS activity. Employment growth in each support sector would be determined by growth in population and income and the appropriate elasticities. This should account for structural change which occurs in the growth process. The population and income used in the equations will be resident population and income adjusted for the effective residents generated by enclave interaction.

STRUCTURAL CHANGE AND THE LOCAL ECONOMIC RESPONSE
TO OCS DEVELOPMENT IN RURAL ALASKA

Introduction

The location of Alaska Outer Continental Shelf (OCS) petroleum resources dictates that the onshore activity associated with their development will occur near small, remote, rural communities. To understand the possible effects of OCS development on these communities, we must improve our understanding of the pattern of rural community response to major exogenous changes such as OCS development. The pattern of change is likely to be dominated by the size of the exogenous change relative to the community. When this change is large, as in most cases of OCS development in rural Alaska, the pattern of response may change as the structure of rural relationships change. The potential for structural change limits the usefulness of past responses for the explanation of the future.

This paper examines the local economic response to major exogenous change. It highlights the effect of structural change on this response and the causes of structural change. The local economic response is one part of the total community response to exogenous change. The labor force participation response describes how the community residents respond to increased employment opportunities. The local economic response describes how the local support sector responds to increased economic activity. This paper develops a method for estimating the local economic response in the face of large exogenous changes which incorporates the potential for change in the structure of local economic relationships.

Local Economic Response

The response of the local support sector to exogenous increases in economic activity is one major component of community economic response. The local support sector consists of that portion of the local economy which provides goods and services to the community. The sector consists of portions of the following industries: trade, service, finance, construction, transportation, communication, and utilities. .

The relationship between exogenous changes and the change in the local support sector is usually described by a multiplier. The multiplier shows the increase in local support or endogenous economic activity which occurs in response to changes in basic or exogenous activity. For marginal changes, this multiplier could be assumed to remain constant, and past relations could be assumed to describe the response. However, we would not expect the multiplier to be static in rural Alaska. Changes in the multiplier will reflect structural change.

Growth in rural Alaska follows a pattern similar to that described in economic base theory although the links between basic sector growth and support sector growth are not as direct. There are two reasons the links are not as direct. First, basic sector employment growth does not necessarily bring income growth to the local economy.

Secondly, there are other important external sources of income growth, such as transfer payments.

The creation of economic opportunities in rural Alaska is primarily a function of two activities, natural resource production and government spending. These are the basic sector industries, since their growth is determined and sponsored with funds from outside the region. Even local governments grow as a function of federal money, such as CETA, state funds, or rents generated by resource production.

Basic sector activities affect the support sector in two ways. First, some of the inputs for the industry will be purchased in the region. For example, transportation services may be purchased by oil exploration firms. Second, basic sector activity creates jobs which create incomes which are spent in the local economy. The links between resource firms and the local economy are limited by the form of the resource development. Development of the Prudhoe Bay petroleum facilities represents an extreme example of the type of resource development possible for rural Alaska, the enclave development. The resource enclave has the majority of its links outside the region. Both employees and goods and services are imported. This means that the direct links are primarily a function of the proportion of workers hired locally. The nature of production requires highly skilled workers not available in the region, and the seasonality of the work allows them to maintain residences outside the region. The lack of infrastructure and transport links between communities reinforces the isolated nature of the resource enclaves.

Two external sources of income also influence local support sector activity; these are transfer payments and the export of labor. Transfer payments include both government transfers and native regional corporation dividends. Labor has been a traditional export of Alaska's rural villages (Alonso and Rust, 1976). When employment opportunities are limited in the community, local residents may take jobs outside of the community for a short period while maintaining their community residence.

A broader description of the causes of support sector growth assuming local support sector growth is a function of growth in the local market. The market is determined by the income and number of local residents and purchases made by the local resource enclaves. The relation between basic sector growth and the growth of the local support sector is not as direct as traditionally assumed because of the possibility of enclaves, which means that employment growth does not necessarily increase the size of the market.

The above discussion centers on the demand side of the local support sector determinants; however, the supply side actually determines the size of the support sector response. It is the supply side which most readily allows an explanation of structural change and the pattern of change in the multiplier. The size of the local support sector is limited by the size of the market. The regional income determines the size of the market. The scale of the economy influences the goods and services available in the region, and so the extent of local sector growth for each additional dollar of income.

As the region grows, we expect more goods to be produced and more services provided in the region. The primary reasons for this is twofold. First, the growth in regional income will change the tastes of the residents; as incomes increase, the markets for income elastic products will expand. Second, as the markets expand, local producers will be able to achieve certain economies of scale which will allow them to compete with goods and services from outside the region which must absorb high transport costs. This structural change will mean the multiplier will change as the market expands.

MULTIPLIER ANALYSIS

This section describes the results of a series of empirical investigations. In each, models were estimated in an attempt to explain the relation between expansion of the markets in rural Alaska and expansion of the local support sector. The first set of models was estimated using time series data from the rural regions of Alaska. These models were estimated to examine the existing pattern of this support sector response in these areas. Since it is possible that these relations will change as the communities grow, we used a second set of data to examine the potential pattern of this change. The second set of models was estimated using cross-section data from counties in the rest of the United States. The approximately 50 counties in the sample were nonurban counties within the population range which include the range of potential growth of rural Alaska communities in response to OCS activity.

Ratio Analysis

In typical impact studies, historical ratios are used to represent the local economic response to exogenous change. These ratios may compare nonbasic to basic sectors, nonbasic employment to population, or some other similar components of economic activity. Either a recent representative year or some longer run average may be used. In many cases, this may be the only approach for which resources are available.

Table 1 shows the problem with this simple approach to estimating multipliers. Four ratios are shown for ten census divisions in coastal Alaska; they illustrate the response of two parts of the support sector to changes in basic sector employment and population. The table shows the highest and lowest ratios found during the period for each census division. The sign in parentheses indicates which occurred earliest--the high or low ratio. If it is negative, the change has been a decline in the ratio over the period; if it is a plus, the ratio has increased. In all cases, we observe a large variation in these ratios between 1970 and 1978. We also observe no consistent pattern in the multiplier, although the majority of the change has been positive.

The simple ratio approach will not provide an accurate description of the local economic response for two reasons. First, there is a great deal of variability among years, so that a simple ratio will not accurately describe the response over the projection period. Second, there is some evidence that these ratios change with growth, and a

TABLE 1. SUPPORT SECTOR RATIOS
(1970-1978)

Census Division	SS1[1]/Basic[3] High		SS1[1]/Basic[3] Low	SS2[2]/Basic[3] High		SS2[2]/Basic[3] Low	SS1l/Population High		SS1l/Population Low	SS2[1]/Population High		SS2[1]/Population Low
Aleutians	.237		.062	.255		.106	.078		.032	.042		.075
		(-)			(-)			(-)			(-)	
Bethel	.278		.181	1.085		.278	.035		.017	.153		.026
		(+)			(+)			(+)			(+)	
Bristol Bay	.283		.107	.368		.077	.053		.024	.072		.019
		(+)			(+)			(i-)			(+)	
Kobuk	.348		.165	.508		.251	.056		.027	.072		.031
		(-)			(+)			(+)			(+)	
Kuskokwim	.518		.182	.281		.171	.078		.020	.043		.020
		(+)			(+)			(+)			(+)	
Nome	.461		.165	.996		.344	.060		.026	.148		.039
		(-)			(+)			(+)			(i-)	
Wade Hampton	.113		.037	.696		.206	.015		,003	.051		.027
		(+)			(-)			(+)			(-)	
Kenai	.567		,287	.686		.457	.125		. 040	.111		.060
		(+)			(+)			(-t-)			(+)	
Kodiak	.205		.156	.446		.292	.058		.041	.146		.075
		(-)			(+)			(+)			(+)	
Seward	.196		.067	.633		.420	.057		,016	.142		.110
		(+)			(-)			(+)			(+)	

[1]SS1 includes employment in construction, transportation, communications, and utilities.

[2]SS2 includes employment in retail trade, wholesale trade, services, and finance.

[3]Basic includes employment in mining, manufacturing, government, agriculture, forestry and fisheries.

simple ratio will not describe growth over time. To accurately project the response of rural Alaska economies to OCS activity, we need a model which accounts for potential changes in the multiplier.

Regression Model

We used regression analysis to examine the underlying factors which determine support sector growth. There are problems with using such a method in rural Alaska. Data is often a problem. The small size of these places is the reason for a number of data problems. First, disclosure problems limit the extent of the data in any one region. Second, the. small size of the regions often means that nonmarginal disturbances will be observed in the data, limiting the observance of any normal relations. In addition to the small size of these economies, the years for which data are available are limited.

To get around these problems, a pooled time-series cross-section approach was used. This approach used data from ten census divisions for the period 1970 to 1978. This assumes that the variation in support sector activity both over time and across census divisions can be explained by our model. This approach has been tried successfully in other regions with similar problems (Conopask, 1978).

There are two related explanations for regional growth; each of these suggests a different empirical model. Economic base theory suggests that growth in the support sector can be explained by growth in the basic sector activity. Central place theory suggests that the size of support sector activity is a function of the market size. These theories are related since the size of the basic sector and the size of the population are related.

Table 2 presents regression results for each of these models. Model 1 is the central place model which describes the growth of support sector activity as a function of market size, where market size is determined by total income. In this model, the components of total income are separated and the effects of population and per capita income growth are examined.* Model 2 is the economic base model with disaggregate basic sectors. Model 3 is a hybrid which accounts for the influence of both market size and the type of activity. This model was an attempt to distinguish between the population and industrial demands of support sector demand. The regression results produce no significant difference when examined in terms of the proportion of variation (R^2) they explain. In all cases, the significant variables are of the expected sign. The regression does not distinguish any one model as a better representation of rural Alaska.

In cases such as these where the statistical analysis offers little help in choosing the appropriate model, the choice must be made based on the theoretical explanation which best fits the situation. In this

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*In this and all following models, per capita income is in real (1972) dollars.

TABLE 2. COMPARISON OF SUPPORT SECTOR EMPLOYMENT MODELS: REGRESSION COEFFICIENTS

Sector I

	1	2	3
Constant	-200.543	-23.382	-75.422
Population	.055 (17.5)		.030 (4.66)[1]
Per Capita Income	27.572 (3.39)		15.603 (1.59)[4]
Mining		1.287 (12.73)[1]	.722 (4.20)[1]
Manufacturing		.091 (1.461)[4]	.085 (1.64)[4]
Agriculture, Forestry, Fishing		.281 (.77)	
Government		.250 (3.33)[1]	
R^2	.775	.791	.810

Sector II

	1	2	3
Constant	-101.623	-73.822	2,733
Population	.073 (19.18)[1]		.059 (7.24)[1]
Per Capita Income	21.565 (2.20)[2]		-4.148 (.339)
Mining		1.331 (10.36)[1]	.186 (.865)
Manufacturing		.042	.211
Agriculture, Forestry, Fishing		.916 (1.99)[2]	
Government		.619 (6.515)[1]	
R^2	.806	.800	.824

[1]Significant at the .995 level. [2]Significant at the .975 level.
[3]Significant at the .950 level. [4]Significant at the .900 level.

case, the central place model is appropriate. The choice is made for a number of reasons. First, as has been noted, there are additional sources of income which are not related to basic sector employment growth in rural Alaska. Second, the possible enclave nature of basic economic activity means that the relation between basic sector employment and the local support sector will depend on the extent of the enclave. Because of this, historical relations will not hold and a more direct approach to making assumptions about the enclave multiplier is required. We will assume the market size or central place model provide an accurate description of local sector growth.

There are two additional issues which must also be addressed when modeling the local economic response. The first deals with the lags in the response of the local support sector to changes in the market size. The second deals with how the response varies as markets grow.

We may expect the response to exogenous change to lag the actual change for many reasons. The response of local businesses to new economic opportunities may depend on their expectations, which takes time to form. To the extent that new business responds to these opportunities, the speed of information flows will determine the response. A final reason for lags in response is the timing of investment; any response which requires investment will be lagged by the time required for construction.

A series of lagged response models were tested using the pooled Alaska data. Table 3 compares a one-year lag of total income (model 2) with a similar nonlagged model (model 1). Comparing these models shows little significant difference in the coefficients on total income as well as a reduction in the R^2 with the lag. These results suggest that the introduction of lags does not improve our ability to explain the local economic response. Both longer lags and other forms of lags were tried with no significant increase in explanatory power.

Model 3 in Table 3 illustrates another dynamic effect of the support sector response. Model 3 tests the hypothesis that the effect of total income differs between lagged income and the change in income. This model provides evidence that, in some cases, a significant difference exists between the components of income. This difference is significant in the construction/transportation sector of the economy. In this sector, a dollar increase in income generates about twice the employment a dollar of existing income does. This illustrates the accelerator effect of the construction industry; construction responds to changes in the level of activity. New buildings and housing are needed as a result of growing markets.

These results do not suggest that lags are important in explaining the past response of the local economy to expansion of markets. Ignoring the accelerator effect on construction will have little effect on the explanation of average growth. The inability to find significant lagged relationships is the result of two related characteristics of

TABLE 3. THE EFFECT OF LAGS ON SUPPORT SECTOR EMPLOYMENT
REGRESSION COEFFICIENTS

	Sector I			Sector II		
	1	2	3	1	2	3
Constant	160.46	-89.701	-108.212	-8.911	-1.748	-11.077
Total Income	.015 (18.75)[1]			.018 (15.0)[1]		
Total Income (-1)		.015 (13.52)[1]	.014 (15.33)[1]		.019 (13.87)[1]	.019 (13.07)[1]
Change in Total Income			.0255 (7.14)[1]			.013 (2.29)[2]
R^2	.796	.696	.817	.724	.706	.721

[1]Significant at the .995 level.

[2]Significant at the .975 level.

rural Alaska economies. First, these economies are small, and they provide only a limited set of goods and services. Because they produce little, the majority of response consists of simply expanding the supply of goods they import. Response in these cases does not require large investments and can be rapid. The second factor for finding no significant lagged relation is that there have been only marginal year-to-year changes in the economies in our sample.

Although there is no evidence of a significant lagged response in the historical data, the potential exists for lags to be important in future growth. Exogenous economic activities such as OCS development will be nonmarginal changes which may be greater than any change the economy has undergone in the past. Large changes which result from OCS development may introduce lagged responses in the future.

The second question concerning the support sector response is what happens to the structure of the response as the market size grows. Can we expect the response to growth in income and population to be the same independent of the size of the market? Theory would suggest that the response will differ at different market sizes. As markets grow, their support sectors deepen as well as expand proportionally. Deepening occurs as the economies provide more goods and services locally. Deepening is primarily a response to changing costs which result from expansion of the market. If the response does change, we would not expect our simple linear model to explain the change.

The cross-section time-series data set allows us to observe the response to both marginal changes and the response at different size places. The majority of our sample is of similar size (see Table 4). Kenai is the exception; Kenai is more than twice the size of the average census division in our sample.

TABLE 4. 1980 POPULATION OF CENSUS DIVISIONS IN ALASKA SAMPLE

Seward	2809
Aleutians*	5593
Bethel	9698
Bristol Bay	5710
Kobuk	4831
Kuskokwim	1301
Nome	6537
Kenai	22473
Kodiak*	9047
Wade Hampton	4665

*Important military component of the population.

- Table 5 compares the market size model for each sector estimated in three separate ways. Model 1 uses all census divisions in our sample; Model 2 is estimated across all divisions except Kenai; and Model 3 uses dummy variables to isolate the effect of each individual area. Comparison of Models 1 and 2 for each sector shows that the relations between market size of support sector are significantly different when Kenai is excluded from the data set. Model 3 also supports this conclusion.

TABLE 5. STRUCTURAL CHANGE IN RURAL COASTAL ECONOMIES REGRESSION COEFFICIENTS

	Sector I			Sector II		
	1	2	3	1	2	3
Constant	-200.543	-122.911	-306.559	-101.623	-253 519	-309.16
Population	.055	.[illegible]1	.043	.[illegible]73	.104	.[illegible]59
	(17.5)[1]	(12.05)[1]	([illegible] 84)[1]	(19.18)[1]	(11.159)[1]	(9.32)[1]
Per Capita Income	27.572	23.015	72.087	21.505	20.246	106.713
	(3.39)[1]	(7.15)[1]	(3.11)[1]	(2.20)[2]	(2.31)[2]	(4.58)[1]
Area Dummies						
Seward	-	-	-102.144	-	-	-92.702
			(1.03)			(.928)
Aleutians	-	-	-350.546	-	-	-745.419
			(1.81)[3]			(3.84)[1]
Bethel	-	-	-36.255	-	-	99.201
			(.46)			(1.24)
Bristol Bay	-	-	46.636	-	-	-104.103
			(.59)			(1.31)[4]
Kobuk	-	-	61.521	-	-	-51.018
			(.81)			(.668)

TABLE 5. STRUCTURAL CHANGE IN RURAL COASTAL ECONOMIES
(continued)

	Sector I			Sector II		
	1	2	3	1	2	3
Kobuk			61.521			-51.018
			(.81)			(.668)
Kuskokwim			40.787			-145.357
			(.50)			(1.78)[3]
Nome			13.016			72.307
			(.15)			(.88)
Kenai			280.169			176.654
			(2.09)[2]			(1.31)[4]
Kodiak			-1.254			159.72
			(.012)			(1. 58)[4]
R^2	.775	.695	.808	.806	.611	.884

[1]Significant at the .995 level.
[2]Significant at the .975 level.
[3]Significant at the .950 level.
[4]Significant at the .900 level.

The dummies indicate that there is a significant difference in the response in Kenai and the other places in our sample. The other places which show a significant difference are the Aleutians, Bristol Bay, and Kodiak; the importance of fisheries in these economies may explain the difference.

The results suggest that the simple linear model does not describe both the deepening and widening of the local support sector. Deepening occurs as the economy passes the threshold for various goods and services and these goods are provided in the local economy. As more types of goods and services are provided, the widening or proportional response will change. For small economies, like those in rural Alaska, we may expect this response to thresholds to be represented by a step function covering wide ranges of market sizes. For larger economies, the response may be smoother as the thresholds of various goods and services provide continual change.

The recognition of the change in the structure of the response offers two problems for projecting the impact of large exogenous changes in economic activity. The first is the technical problem of which functional form best represents this pattern of change. The second concerns projection of the response to change when that change may result in economies which are not represented by rural economies in the historic period, The functional form question is the easier of the two. We suggest that the log-log form of the equation best represents the pattern of both deepening and widening found in the local support sector. Ideally, a step function would best represent the pattern of change. There are two problems with using a step function. First, the empirical problem is defining the steps. We attempted to define steps based on population ranges with little success. The Model 3 in Table 6 shows that most census division in rural Alaska may be in one step. The log-log model provides a structure which changes the response to changes in the market size as the market size expands.

The second problem is more serious for projecting the response to OCS activity in Alaska. Our models explain the response over a very narrow range of population expansion. Most of the census divisions in our sample have populations of less than 10,000. Under certain assumptions about the dimension of enclaves, OCS activity may expand these economies beyond this size, Kenai may be seen as the economy toward which these others will grow with increased petroleum activity. Although we can describe the structure of the Kenai economy, we cannot say what the pattern of change will be. There is no historical examples of this range of growth.

The main question which must be addressed is whether we can expect the pattern of response when economies grow beyond 10,000 to be represented by the pattern found in the historical data. If not, can we estimate what the pattern of response will be? To address both questions, we examined economies outside of Alaska and observed how the local support sector changes with market size. The economies we examine are in the range of market sizes between the current level of rural Alaska economies "and Kenai.

Cross-section regressions were run over approximately fifty observations which represented county economies in the Lower 48 states, The counties were chosen from around the United States. They were chosen to be outside of metropolitan areas and labor markets. A wide variety of important basic sectors were included in the sample. Data came from the County Business Patterns for 1978. Examining this data provides some indication of the pattern of structural change in the likely range of population growth.

A series of equations which were similar to the Alaska equations in Table 5 were estimated using the other area data. The results for each sector are shown in Table 6. The equations were estimated for each industry with support sector components. In all cases, variation in the market size explains a substantial portion of the variation in support sector employment. In all cases, employment in these industries increases faster than the market is expanding. For example, a one percent increase in population results in a 1.67 percent increase in wholesale employment. Because of the log-log functional form, the coefficients are the appropriate elasticities which measure the percentage increase in employment given a one percent change in the variable.

TABLE 6. SUPPORT SECTOR EMPLOYMENT GROWTH
REGRESSION COEFFICIENTS

(non-Alaskan areas)

	Construction	Transportation	Wholesale Trade	Retail Trade	Finance	Services
Constant	-20.740	-24.811	-19.583	-15.441	-17.635	-20.786
Population	1.482	1.482	1.671	1.243	1.440	1.624
	(10.75)	(8.82)	(11.51]	(14.89)	(15.24)	(13.41)
Per Capita Income[1]	1.336	1.775	.959	1.167	.998	1.323
	(3.44)	(3.86)	(2.35)	(4.97)	(3.75)	(3.88)
R^2	.679	.622	.694	.804	.803	.764

[1]All variables are in natural logs.

[2]All coefficients are significant at the .99 level.

Tables 7 and 8 compare similar equations estimated across the Alaska and United States data sets. Table 8 illustrates the similarity between the two models. For each sector, the 95 percent confidence intervals for the elasticities on both population and per capita income overlap.

Income elasticities are much lower for the Alaska equations. The main reason for this may be the higher average per capita incomes in the United States data. At higher incomes, the income elastic goods and services may be more important for increasing support sector employment.

These results suggest that we could use our Alaska model (from Table 8) to project the response of local markets to OCS development over broader ranges of growth than represented by our sample. Comparisons with larger non-Alaska places show that the model represents the pattern of structural change in larger places than we included in our Alaska sample. The log-log form of the equation allows us to estimate the elasticities of population and per capita income change. These elasticities can be used to adjust existing levels of employment in each support sector to changes in the market size.

Enclave Multiplier

The possibility that OCS development will occur in industrial enclaves makes the size of the enclave multiplier important for discussing local OCS impacts. The problem with defining an enclave multiplier is the limited amount of information on enclave-community interaction.

TABLE 7. COMPARISON OF U.S. AND ALASKA SUPPORT SECTOR GROWTH REGRESSION COEFFICIENTS

	Us.		Alaska[1]	
	Sector 1	Sector 2	Sector 1	Sector 2
Constant	-22.470	-16.213	-12.902	-10.298
Population[2]	1.444	1.413	1.216	1.394
	(13.46)	(16.18)	(9.45)	(12.18)
Per Capita Income	1.656	1.155	.919	.500
	(5.48)	(.4698)	(7.29)	(4.46)
R^2	.779	.825	.623	.666

[1]Excludes Kenai from the data set.
‘All variables are in natural logs.

TABLE 8. COMPARISON OF ELASTICITIES AND 95 PERCENT CONFIDENCE INTERVALS

	Sector 1			Sector 2		
	Low	Mean	High	Low	Mean	High
Alaska						
Population	.964	1.216	1.468	1.170	1.394	1.618
Per Capita Income	.672	.919	1.166	.280	.500	.720
United States						
Population	1.234	1.444	1.654	1.242	1.413	1.584
Per Capita Income	1.064	1.656	2.248	.673	1.155	1.637

Previous enclaves have been totally self-contained (e.g., Prudhoe Bay) or extremely small (e.g., some military operations). This means that past resource developments are of little help in understanding enclave multipliers. The enclave multipliers used in any projection must be based on a set of assumptions. This section provides a range for such assumptions.

The size of the enclave multiplier depends on two things. The structure of the economy is the primary determinant. At one extreme, the limit is the local multiplier. Everything else equal, a more developed economy will have a larger enclave multiplier. The extent to which the local multiplier is also the enclave multiplier depends on the interaction between the enclave and local economy. If there is no interaction, the multiplier would be zero. The size of the enclave multiplier will be determined by the structure of the local economy and the level of interaction with the local economy.

The enclave multiplier has two parts: direct industrial requirements and personnel requirements. Direct industrial requirements describe the relation between OCS activity and other industries; the direct purchase of goods and services as inputs to the production process are the direct industrial requirements. Table 9 shows the relation between petroleum activity and other industries at the national level for those industries which exist in rural Alaska. These direct coefficients can be used as employment multipliers with adjustments for local economic structure and enclave-community interaction.

TABLE 9. NATIONAL DIRECT EMPLOYMENT MULTIPLIERS FOR OIL AND GAS

	Employment Ratio*	
	Drilling and Exploration	Production
Transportation		
Railroad	.0035	.0053
Truck	.0103	.0092
Water	.0007	.0067
Air	.0002	.0007
Utilities		
Communications	.0008	.0039
Electrical Utilities	.0001	.0129
Gas	.0000	,0041
Water and Sanitary	.0001	.0017
Trade		
Wholesale	.0173	.0275
Retail	.0176	.0395
Real Estate	.0013	.2052
Misc. Business Services	.0559	.0533
Misc. Professional Services	.0043	.0478
Auto Repair	.0039	,0049

* Employment per oil and gas employee.

SOURCE: U.S. Department of Labor, Historical and Projected I-O Tables, 1980.

The adjustment of the national coefficients to reflect local economic structure can be made using location coefficients or some other scaling technique. Location coefficients compare employment per dollar of income in the local area to the same ratio at the national level. The share the local ratio is of the national ratio can be used to adjust the national direct requirement coefficient for the industry. This adjusted coefficient will serve as the base for the local direct requirement multiplier.

The second required adjustment is for interaction. In the extreme, with no interaction, the direct requirement employment multiplier would be zero. This assumption must be based on the description of the specific case and could vary across both industries and phases of OCS activity. With the structure and interaction adjustments, the employment multiplier can be used to estimate the enclave generated secondary impact based on an estimate of the employment associated with OCS activity.

The personnel requirements of enclave residents require only an assumption about interaction. We can use the models developed in the previous sections to estimate the structure of the economy. An assumption about interaction can be used to develop effective resident population units from the enclave employment. For example, if in a projection we assume enclave residents will spend one-fourth of their income in the community, the number of effective residents equals one-fourth of the enclave employment. These effective residents can be incorporated into the support sector equations to estimate impact. Table 10 provides estimates of the national allocation of income to various commodities which may be available in rural Alaska. These shares may be useful in making estimates of the level of effective residents generated by OCS enclave activity.

Conclusion

Evidence presented in this section supports the use of the elasticities shown in Table 7 to estimate support sector employment growth in response to OCS activity. Employment growth in each support sector would be determined by growth in population and income and the appropriate elasticities. This should account for structural change which occurs in the growth process. The population and income used in the equations will be resident population and income adjusted for the effective residents generated by enclave interaction.

TABLE 10. SHARE OF INCOME SPENT ON VARIOUS ITEMS

	Total	Maximum Local
Food Away from Home	.0322	.0107
Nonalcoholic Beverages	.0035	.0017
Alcoholic Beverages	.0076	.0038
Tobacco and Smoking Supplies	.0039	.0019
Personal Care Products	.0039	.0019
Personal Care Services	.0044	--
Housekeeping Supplies	.0072	--
Trade and Services	.0627	.0200

Although no significant lags were seen in the regressions, we can assume that lags would develop if major, nonmarginal change occurred. To account for this, we suggest establishing a rule in SCIMP which limits the expansion of each sector to a certain percentage of existing employment. Excess employment growth above this maximum would occur in following years.

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III.
RURAL LABOR FORCE PARTICIPATION AND OCS DEVELOPMENT IN ALASKA

by

Lee Huskey

ABSTRACT

Rural Labor Force Participation and

OCS Development in Alaska

In this paper, we examined the local labor supply response to exogenous changes in economic opportunities. We examined the relationship between existing estimates of labor supply and the potential for future change in response to major increases in employment opportunities.

Labor force participation plays a key role in determining the full response to OCS-generated opportunities. The response of the local support sector depends on the increase in incomes of local residents which depends on which residents take OCS jobs. The population growth effect of OCS development will depend on how many of the jobs are not filled by local residents. The lack of correspondence between potential, actual, and desired labor force participation makes the projection of future economic and population growth less than straightforward. To describe future OCS-induced changes, we need to understand both how the actual labor force participation rate relates to the desired and how the desired rate moves to the potential. The paper examines the relation between potential actual and desired labor force participation in rural Alaska.

In addressing these issues, we depend importantly on a theory of labor market behavior developed in the paper. We also make use of certain observations from surveys to support hypotheses we develop.

The past provides little indication of the potential future changes in labor force participation. Changes will come both over time and as a response to OCS development. The importance of labor force participation to the impacts of OCS activity is the reason for estimating the pattern of change and response necessary.

The model of labor market behavior developed in the paper allows us to develop a series of hypotheses about future desired labor force participation. We would expect desired labor force participation to increase as employment opportunities increased, subsistence costs (both time and money) increased, tastes change in favor of market goods, and opportunities for spending money increase. We "test" these hypotheses by examining the results of surveys taken in rural Alaska. Finally, we suggest a method for estimating these changes in labor force participation as part of the SCIMP model projections of OCS impact.

RURAL LABOR FORCE PARTICIPATION AND OCS DEVELOPMENT IN ALASKA

Introduction

The total effect of OCS development on rural Alaska economies results not only from the creation of opportunities but it also depends on the local response to those opportunities. The total economic effect depends importantly on labor's response to the creation of job opportunities. To the extent that these employment opportunities are not filled by resident labor, in-migration is necessary. The multiplier effect discussed in the previous chapter depends on the resident response to these job opportunities. Since the market expands as existing residents take jobs and increase their incomes, the support sector expands in response to increases in local resident's labor force participation.

In this paper, we examine the local labor supply response to exogenous changes in economic opportunities. We examine the relationship between existing estimates of labor supply and the potential for future change in response to major increases in employment opportunities.

The labor supply response of the resident population has two components. The first component describes the willingness of local residents to take OCS jobs; this is their supply response. The second component describes the constraint to this response which results because of the lack of skills; this is the demand component of the response.

The main focus of this paper is on the labor force participation of rural residents, the supply response. The question of the rate of labor force participation is complicated by special characteristics in rural Alaska. By examining these characteristics, we hope to say something about the existing level of desired labor force participation. We expect that the structure of labor force participation will change in response to nonmarginal changes in the economy. Examples of this change can be seen in Alaska (see Kleinfeld, 1981) and in less-developed countries (see Hagen, 1980). The participation in the wage economy increases as a result of major developments.

The supply response to job opportunities is influenced most importantly by the fact that rural Alaska economies are not complete market economies. The transition from isolated subsistence economy to full participation in the market passes through four stages: (1) pure isolated subsistence, (2) subsistence with supplementary cash activity, (3) cash orientation with supplementary subsistence, and (4) complete market specialization (Fisk, 1975). The local economies in rural Alaska are in the transitional stages with mixed cash and subsistence economies. Table 11 shows the relative importance of subsistence activities in rural regions of Alaska. In all regions, close to 30 percent rely on subsistence for all of their food. The transitional stage (either 2 or 3) in which any local economy exists differs, with the larger communities prpbably having the more advanced cash component.

TABLE 11. SHARE OF FOOD FROM SUBSISTENCE ECONOMY

	Most	About Half	Some	None
Alaska[1]	30.5	27.7	28.9	11.6
Yukon-Porcupine[2]	27.0	28.0	24.0	21.0
North Slope[3]	30.0	15.0	42.0	13.0
Nunam Kitlutsisti[4]	29.1	29.6	33.2	8.2

[1]Nathan and Associates, 1974, T2A-6.
[2]ISER, 1978, T5-3.
[3]ISER, 1981, T5-13.
[4]PAL, 1981, TE-1.

CONCEPTS OF LABOR FORCE PARTICIPATION

There are three concepts of labor force participation: potential labor force participation, desired labor force participation, and actual labor force participation. Only in very rare cases will these concepts be the same. Desired and actual participation will, in most cases, be less than potential. The difference between desired and actual often depends on the conditions in the labor market and job rules.

Potential labor force defines the maximum possible labor supply available from a region. It defines those available who could work; potential labor force is determined by the age-sex distribution of the regional population. Age and health limit the ability to participate in the labor market; in the extreme, potential labor force would include everyone physically and legally able to work. In this sense, the potential labor force is a physical concept and changes in the potential labor force result from changes in the number of people in the region.

In another sense, potential labor force describes the labor force we would expect if the regional population acted like some other group. For example, we may define the potential labor force in rural Alaska to be equal to the labor force which would result if the rural Alaska population behaved like the national population as a whole. We would certainly assume this to be an upper limit to participation of a transitional group since it would represent the participation of a full-market economy.

Table 12 illustrates the changes in the national labor force participation. Between 1960 and 1978, the participation rates as a whole have increased slightly. This change results from changes in both the age structure of the population and the participation of specific population cohorts. The major participation change in this period has been the large increase in female labor force participation. These rates represent the potential labor force participation of rural Alaska Natives; they represent the limit which labor force participation will approach as the market economy expands.

The desired labor force participation is usually less than the potential participation; the difference results from the consumer's choice between income and leisure. Theoretically, given a wage rate, the

TABLE 12. NATIONAL LABOR FORCE PARTICIPATION RATES FOR SELECTED YEARS, 1947-1978

(annual averages)

Sex and Age	1960	1970	1978
BOTH SEXES			
16 Years and Over	59.2	60.4	63.2
MALE			
16 Years and Over	82.4	79.2	78.4
16 - 19 Years	58.6	57.5	63.5
20 - 24 Years	88.9	85.1	87.1
25 - 34 Years	96.4	95.0	95.5
35 - 44 Years	96.4	95.7	95.8
45 - 54 Years	94.3	92.9	91.3
55 - 64 Years	85.2	81.5	73.5
55 - 59 Years	88.9	88.0	82.9
60 - 64 Years	79.5	73.6	62.0
65 Years and Over	32.2	25.8	20.5
65 - 69 Years	45.8	40.7	30.1
70 Years and Over	23.5	16.9	14.2
FEMALE			
16 Years and Over	37.1	42.8	50.1
16 - 19 Years	39.1	43.7	54.0
20 - 24 Years	46.1	57.5	68.5
25 - 34 Years	35.8	44.8	62.2
35 - 44 Years	43.1	50.9	61.6
45 - 54 Years	49.3	54.0	57.1
55 - 64 Years	36.7	42.5	41.4
55 - 59 Years	41.7	48.4	48.6
60 - 64 Years	31.0	35.6	33.1
65 Years and Over	10.5	9.2	8.4
65 - 69 Years	17.0	16.4	14.9
70 Years and Over	5.4	5.0	4.8

SOURCE : Department of Labor Statistics and Employment and Training Report of the President, 1979, Table A-4, p. 240.

consumer works as long as the increase in income provides him with more utility than the loss of utility which comes from reducing the amount of time spent in other activities. Incomes provide utility by allowing the consumer to purchase goods. The consumer's tradeoff between goods which can be purchased with wage income and goods (such as leisure and subsistence products) which can be obtained when not working determines how much wage labor he will offer.

The desired labor force participation in any region is a function of individual and population characteristics. The amount of time a person wishes to spend in the labor force is a function of his tastes, the wages offered, and the prices of goods. The desired labor force participation will be a function of the total level of population which determines number of labor suppliers. It also depends on the age-sex structure of the population since both tastes and potential incomes change over a person's life cycle and sex.

The actual labor force participation rate is defined to be that share of the population either working or actively seeking work. This rate is related to but not always the same as the desired rate. In rural Alaska, there are two reasons why these may differ. First, and most important, is the discouraged worker effect. The labor force includes all those who are employed or looking for work. When there are only limited employment opportunities, people may drop out of the labor force because they know there is no chance of finding a job. Discouraged workers are those unemployed people who stop looking for work because they know there are no jobs available (Rims, 1980). In rural Alaska, the small size of the labor markets makes this information easy to get. This ease of acquiring labor market information and the poor market conditions make the discouraged worker effect important in rural Alaska.

The second reason actual and desired labor force participation may differ concerns the seasonal pattern of employment opportunities. Rural Alaska residents have an expressed seasonal employment preferences. The preferred pattern of labor force participation and the actual pattern of employment opportunities may not mesh, and rural residents may have to work in seasons in which they prefer not to work. In this case, actual participation may be less than desired participation because employment opportunities are not available in the season in which rural residents desire to work.

The difference between actual, desired, and potential participation is important for analysis of the effects of major changes in the local economy. At any point in time, what we observe is the actual labor force participation. With exogenous changes in employment opportunities, these rates will not necessarily describe the labor supply response. These rates cannot be expected to hold over time either; as the economy grows, we would expect the structure of labor force participation to change. Kleinfeld's description of the rapid increase in female labor force participation in response to the increase in employment opportunities is one example of this type of structural change (Kleinfeld, 1981).

Labor force participation plays a key role in determining the full response to OCS-generated opportunities. The response of the local support sector depends on the increase in incomes of local residents which depends on which residents take OCS jobs. The population growth effect of OCS development will depend on how many of the jobs are not filled by local residents. The lack of correspondence between potential, actual, and desired labor force participation makes the projection of future economic and population growth less than straightforward. To describe future OCS-induced changes, we need to understand both how the actual labor force participation rate relates to the desired and how the desired rate moves to the potential. The following sections of the paper examine the relation between potential actual and desired labor force participation in rural Alaska.

Actual and Desired Labor Force Participation

The labor force participation observed at any point in time is a function of existing labor market conditions. Because of this, the existing labor force participation rate provides only limited help in predicting how residents will react to changes which affect existing labor market conditions. The existing labor force participation rate will be less likely to describe future response, the greater the discouraged worker effect. Discouraged workers are those workers who drop out of the labor force because they know there are no jobs available. One response to increases in economic activity in rural areas of Alaska will be the entrance of discouraged workers into the labor force. This section will attempt to place limits on the size of this response.

The small size of rural labor markets and the limited economic activity in rural Alaska suggests that the discouraged worker effect would be significant. When labor markets are small, information about job opportunities is readily available, and residents have no need to enter the labor force if they know jobs are not available. Table 13 gives some indication of the extent of discouraged workers in rural Alaska. Although each survey describes the effect differently, we can see a substantial difference between the desired and actual participation in jobs which probably reflects similar levels of discouraged workers. Statewide in 1974, 16 percent of Natives wanted a job but did not have one, while almost 25 percent who would have liked full-time employment did not get it. The results of regional surveys support these findings. In 1976, about 16 percent more of those surveyed in the Yukon-Porcupine region wanted a year-round job than those who had one. Almost 90 percent of those surveyed in the Nunam Kitlutsisti region wanted more jobs, which is an indication of substantially fewer employment opportunities than desired. This information suggests that the discouraged worker effect in rural Alaska is considerable.

The only study which directly examines the extent of the discouraged worker effect is a study conducted in the Wade Hampton Census Division in Southwest Alaska (Alaska Department of Labor, 1981). This census

TABLE 13. DESIRED PARTICIPATION AND ACTUAL PARTICIPATION

Statewide	Percent
Had Job in Previous Year[1]	61.9
Wanted Job, Did Not Have One[1]	15.9
Had Full-Time Job[2]	29.4
Wanted to Work Full Time[3] (in home village)	53.9
Nunam Kitlutsisti[4]	
Want More Paying Jobs	87.2
Yukon-Porcupine[5]	
Had Year-Round Job, 1976	38.0
Wanted Year-Round Job	54.0

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[1]Nathan and Associates, 1974, T2H-4.

[2]Nathan and Associates, 1974, T2H-5.

[3]Nathan and Associates, 1974, T2H-6.

[4]PAL, 1981, TB-4

[5]ISER, 1978, T5-2.

division is particularly representative of rural Alaska since it contains no major regional centers. The survey compared those saying they were unemployed by the conventional definition (looking for work) with those unemployed by a broader definition which includes those who want work but are not looking. The difference in these two definitions measures the discouraged worker effect. Table 14 shows the extent of this effect; the unemployment rate almost doubles under the broad definition, rising from 25 to 49 percent. This means in Wade Hampton, there are almost three times as many potential workers available than measured by the conventional definition. Ignoring the discouraged, worker would, in this case, seriously overstate the need for migrant workers to respond to OCS activity.

TABLE 14. DISCOURAGED WORKER
WADE HAMPTON

	Number of Unemployed	Unemployment Rate
Conventional Definition (actively looking for work)	282	24. 7%
Broad Definition (not looking for work)	820	48. 8%

SOURCE: Alaska Department of Labor, 1981, T8.

We might expect that the discouraged worker effect will not be distributed evenly across all groups in the population. Jobs may select for special characteristics of the population which means that while jobs are available for some, they are not available for all; for example, construction jobs may be available for young men but for no one else. We would expect discouragement to be greater for those entering the labor force for the first time. Table 15 shows the extent of the discouraged worker effect for groups in the population. As we can see, there is little difference in the effect between males and females, but a somewhat higher effect on both extremes of the age distribution.

TABLE 15. DISCOURAGED WORKER AGE-SEX CHARACTERISTICS
WADE HAMPTON

	Labor Force		Percent Difference
	Conventional	Broad	
Total	696	1,024	47.1
Male	384	571	48.7
Female	308	449	45.8
16 - 18 Years	52	117	125.0
19 - 21 Years	101	154	52.5
22 - 24 Years	100	136	36.0
25 - 29 Years	116	147	26.7
30 - 39 Years	134	191	42.5
40 - 49 Years	95	128	34.7
50 - 59 Years	57	89	56.1
60 - 65 Years	13	18	38.5
65 + years	8	13	62.5

SOURCE: Alaska Department of Labor, 1981, T9 and TIO.

Table 16 provides an indication of response of discouraged workers to increased job opportunities in rural Alaska. The employment elasticity in this table describes the percentage increase in the unemployment rate (unemployed/population) with an increase in the employment rate of one percent. These elasticities were estimated from a series of regression runs in each census division; the log of unemployment rate was regressed on the log of the employment rate in each census division for each quarter between 1975 and 1980.

If there were no discouraged worker effect, an increase in employment opportunities would result in a decline in unemployment. Instead, as shown by these regressions, an increase in employment leads to an increase in the unemployment rate. In all cases, labor force participation increases in response to increases in employment opportunities. The extent of the response can be seen to depend on the actual labor force participation in the region. The response is higher in regions with lower actual levels of participation. This finding supports the idea that there is a desired level of participation, since the higher the actual participation, the closer to the desired level, and the smaller the increase in unemployment rates as a response to employment opportunities.

Another aspect of Alaska's rural labor force participation is its seasonal nature. Table 17 shows that across all regions the preference of large sectors of residents is for less-than-full-year employment. The share wanting less-than-full-year employment ranged from

TABLE 16. LABOR FORCE EMPLOYMENT ELASTICITY

	1980			
	Labor Force[1]	Population	Labor Force Participation Rate	Employment Elasticity
Aleutians	2,179	5,5933	40.0	--
Bethel	2,795	9,698	28.8	.732*
Bristol Bay[2]	1,650	5,710	28.9	.624*
Kobuk	2,343	4,831	48.5	.532*
Kuskokwim "	816	2,822	28.9	.948*
Nome	3,120	6,537	47.7	.376*
Wade Hampton	1,352	4,665	30.0	.392*
Weighted Average (excludes Aleutians)				.589

[1]Labor force as of January 1980.

'Includes Bristol Bay Census Division and Borough.

[3]Excludes military.

~'Significant at the .95 level.

41 percent in the Yukon-Porcupine region to 75.2 percent in the Nunam Kilutsisti region. In 1974, for Alaska Natives, 46.1 percent wanted less-than-full-year employment; this may understate rural preferences since it included urban Natives.

TABLE 17. SEASONAL PREFERENCE

	Percent Who Want Less-than-Full-Year Employment
Nunam Kitlutsisti	75.2
Yukon-Porcupine	41.0
Alaska Natives	46.1
North Slope	55.8
Wade Hampton	61.8

Seasonality of employment preferences results from adjustments to special seasonal opportunity costs and to a general adjustment of desired time in the labor force. Workers decide both whether to enter the labor force and how much time to spend, Preference for less-than-full-time work may simply mean rural residents do not want to work twelve months in the cash economy. More important in explaining seasonal patterns of work preference may be the high opportunity costs in terms of the subsistence economy. Since subsistence activity has seasonal rhythms, workers may want to work less so that they can efficiently pursue subsistence activities in certain periods. The importance of each of these in determining seasonal preferences will influence the future change in labor force participation.

One additional aspect of the relation between actual and desired participation must be considered: the effect on migration. One way that actual and desired labor force participation may be brought into equilibrium is through migration. The traditional economic description of migration is that people migrate if there is a chance to improve their incomes; migration is seen as an investment in human capital where workers move if the discounted increase in income provides a reasonable rate of return on moving costs. Todaro pointed out that the most appropriate income measure was expected income which accounted for differences in income and in the probability of getting a job (Todaro, 1960). These traditional approaches suggest that there should be out-migration which is motivated by difference in expected income. If income were the sole determining factor, migration would eliminate the discouraged worker.

What explains the lack of migration to fulfill rural residents' employment preferences? The primary explanation is that migration is not totally determined by economic or monetary factors. Places differ in their physical and social characteristics so that there will be social and amenity costs as well as monetary costs from migration. The cultural differences between Native and non-Native Alaska impose large social costs on the migrant; these will limit the extent of migration for jobs. Table 18 describes the extent to which Natives are willing to trade employment opportunities for remaining in a familiar social and cultural environment. Except for Natives living in non-Native places, there is a substantial drop in desire for full-time work and months working if work can be found only outside their home village. This measures the perceived social costs of migration.

Tables 19 and 20 describe a special type of migration which is characteristic of rural Alaska. One of the principal exports of rural Alaska is labor; village residents work for short periods of time on projects away from the village (Alonso and Rust, 1976). Table 19 shows that at least in the NANA and Nunam Kitlutsisti regions, a majority of those surveyed would be willing to work elsewhere, Although the majority prefer similar surroundings in other villages or the regional center, a similar share would work outside the region or in non-Native construction camps. Table 20 shows the actual experience in two regions. In the Yukon-Porcupine region, 41 percent spent some time of the year working outside their village. In the Nunam Kitlutsisti region, 28 percent of the households had members working outside the region. Working outside the region is an important source of income for rural Alaska. The extent in any year depends on labor market conditions in the region, but it is another way actual and desired participation can be equated.

TABLE 18. MIGRATION - JOB TRADEOFF[1]
BY SIZE OF PLACE

	Average Mos. Wish to Work		Percent Who Want to Work Full Time	
	In Home Village	Away from Village	In Home Village	Away from Village
Native Village	9.6	5.8	56.6	24.2
Small	9.5	5.3	55.5	20.7
Medium	9.4	6.3	51.8	26.3
Large	10.5	5.7	72.2	27.8
Non-Native Place	8,9	8.2	45.6	44.0

[1]Nathan and Associates, 1974, T2H-6.

TABLE 19. WILLING TO WORK OUTSIDE OF VILLAGE

(Nunam Kitlutsisti Region and NANA Region[1])

	Nunam Kitlutsisti	NANA[2]
Work Elsewhere	60.9%	65.0%
Construction Camp	70.1	66.7
Regional Center	79.5	66.7
Other Village	83.8	
Outside the Region	71.6	59.5

[1]PAL, 1981, TB-7, B-9, B-10.

[2]Alaska Public Forum, 1978, T-11.

TABLE 20. WORK OUTSIDE OF VILLAGE

Yukon-Porcupine[1]

	Job Patterns 1976 (Percent)	
	Village	Elsewhere
Year Round	37	2
Summer	15	10
Other	7	4
Combination	- 25 -	

Nunam Kitlutsisti[2]

	Total	Time Away (Percent)		
		<3 Months	3 - 6 Months	6 Months<
Households with Members Employed Out of Region	28.0	14.8	6.5	6.5

[1]ISER, 1978, T4-4.
[2]PAL, 1981, TB-5, B-6.

In this section we have shown that desired and actual labor force participation differ in rural Alaska. This difference results from the lack of employment opportunities in rural areas, the seasonal employment preferences of residents, and the unwillingness of residents to migrate to get jobs. This pattern means that labor force participation may increase in response to increases in employment opportunities. This possibility limits our ability to use past measured actual participation rates to determine the future labor supply response to large changes in employment opportunities.

Desired and Potential Participation

Desired participation is less than potential. Can we expect desired labor force to grow toward this potential? What factors will influence the rate at which desired labor force will change? In this section, we will examine the pattern which we might expect desired labor force participation to follow in rural Alaska,

In answering these questions, we will depend importantly on a theory of labor market behavior described below. We will also make use of certain observations from surveys to support hypotheses we develop. As was the case with the multiplier (see Chapter 2), the past provides little indication of the potential future changes in labor force participation. Changes will come both as a result of changes over time and changes in response to OCS development. The importance of labor force participation to the impacts of OCS activity make some attempt at estimating the pattern of change and response necessary.

The traditional approaches to describing consumers' labor supply response emphasize the effect of wage changes on labor supply (see Rims, 1980). A wage increase has two simultaneous effects: it increases the consumer's income and increases the price of leisure (lost wages). The first effect increases the consumption of leisure and reduces the amount of work, while the second effect reduces leisure and increases work. The net effect of an increase in wages will depend on which effect dominates.

To analyze questions of labor force participation in rural Alaska, we need a more complex model of consumers' decision making which accounts for the special characteristics of the rural labor markets. The most important aspect of these labor markets is the importance of nonmarket work, subsistence activity. The traditional approach includes only market work and leisure as uses of time; ignoring the third use, subsistence, will overestimate the effect of market opportunities on labor force participation.

Mincer was the first to describe the effect of nonmarket work on the labor supplied in the market (Mincer, 1962). Once other uses of time are recognized, it is inappropriate to treat labor supply decisions simply in terms of labor-leisure choice; a tradeoff between market and nonmarket work is also possible. The effect of wage increases on market work will depend not only on the tradeoff between income and leisure but also on the ease with which substitution can take place in the production or consumption of nonmarket goods. This theory was originally designed to address the question of the increased labor force participation of women; it is helpful in discussing the question of the changing patterns of rural participation. The model is described below.

The basic points of our model are due to Gronau (Gronau, 1977):

(1) The consumer attempts to maximize his utility. The consumer's utility is a function of goods consumed and leisure.

(2) The consumer can produce goods by working in the market for them or by producing them at home, outside the market. For example, residents may work in the market and purchase food or hunt for food in the subsistence economy. We will ignore for now the effect of cultural differences in the goods consumed.

(3) The consumer attempts to maximize his utility subject to three simple constraints:

(a) If he produced goods at home, he is subject to a production function which describes how he can translate time into goods.

(b) The consumer cannot spend more on goods than he has income. Income can be earned by selling time in the market. Nonwage sources of income such as transfer payments are also possible.

(c) Finally, the consumer cannot spend more time on leisure, market work, and home production than he has total time.

The consumer's decision framework is described in Figure 1. The consumer maximizes his utility by equating the value he places on an extra hour of leisure to the value of goods he can get by giving up an hour of leisure. Curve I_oCI_o is a representative consumer indifference curve; it describes the consumer's preferences and shows the combinations of goods and leisure the consumer is indifferent between. The slope of this curve shows his value of leisure in terms of goods (how many goods the consumer would have to get to remain indifferent with one less hour of leisure). Curve ABE is the consumer's subsistence production function; it shows how many goods he can produce with a given amount of time. The curve is drawn to show diminishing marginal productivity; increases in work time will not produce proportional increases in goods production. The slope of the production function shows how the consumer can increase his goods consumption by spending one more hour working. The final curve, BCD, illustrates the consumer's production possibilities if he can work in the market. The slope of this line measures the consumer's market wage in terms of goods; it shows how many goods he could obtain by spending another hour working in the market.

Figure 1 shows a particular equilibrium for the consumer. A rational consumer will work at home only as long as he gets more goods for each hour working at home than he could by working in the market. He will work at home as long as the wage rate is less than his marginal product of homework (subsistence activity). When the marginal product of homework falls below the wage rate, the consumer will shift to market work. The ability to work both in and out of the market defines the opportunity set DCBE which describes how the consumer can trade time for goods.

The consumer's allocation between goods and leisure depends on his preferences; with indifference curve I_oCI_o, equilibrium is achieved at C where the consumer's ability and willingness to trade time for goods are equal. The consumer chooses OL_1 units of leisure and OG_2 units of goods. He divides his goods production between home and market by comparing his potential wage with his productivity at home. In Figure 1, the consumer works L_2E at home and produces OG_1 units of goods; he works L_1L_2 in the market and buys G_2G_1 goods in the market. This equilibrium depends entirely on the consumer's preferences; if

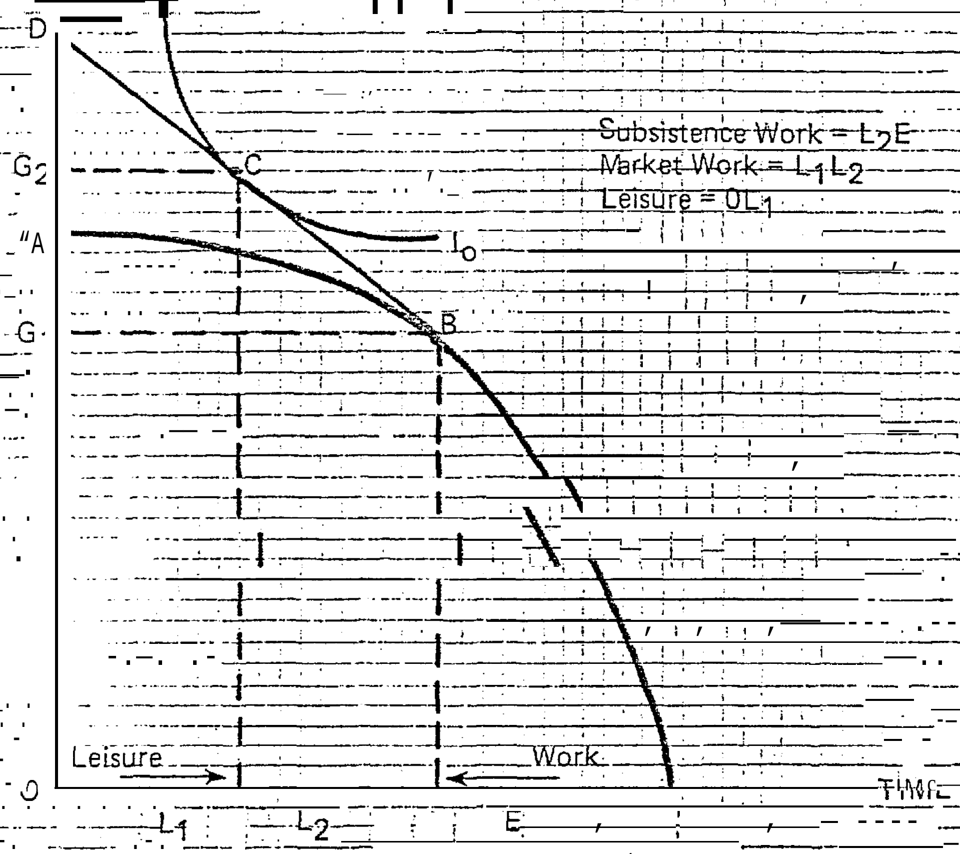

Figure 1

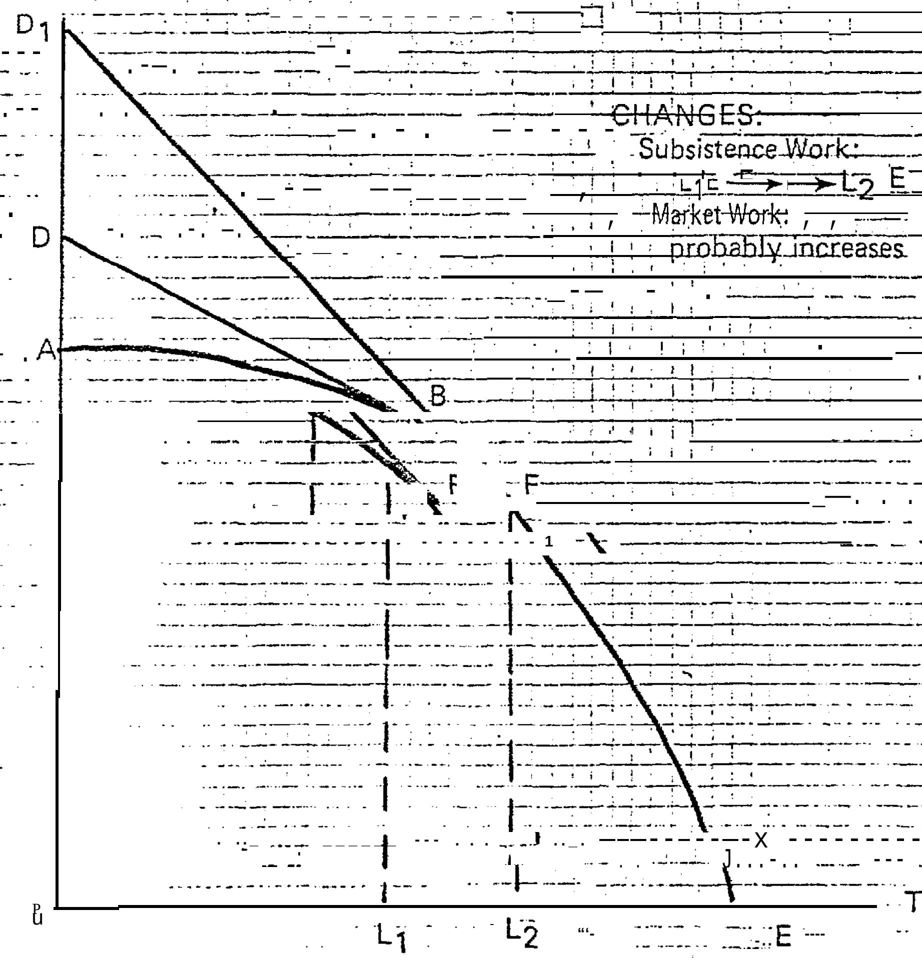

Figure 2

the consumer had a relatively greater preference for leisure, the indifference curve would shift to the left, and time spent working would decline.

By examining the comparative statics (the change in the equilibrium with a change in one of the parameters) of this model, we can suggest future changes in rural labor force participation. We will examine five potential changes in rural Alaska: increased wages, change in the cost of subsistence, change in productivity of subsistence, change in tastes, and change in the marginal utility of income.

Wage Increase. Increases in the real wage are described in Figure 2 by the increased slope of the market wage curve D_1F. Increases in real wage can result from three causes: an increase in the average hourly wage of those employed, a decrease in the local cost of living, or an increase in the probability of employment. The third cause relates to the discouraged worker; the important wage in this case is the expected wage which equals the chance of finding a job times the average wage. The increased wage has the effect of reducing time in home at work since it increases the opportunity cost of this work (lost wages). The effect on work in the market depends on tastes; the smaller the income elasticity of leisure, the more likely will be the increase in market work. At low levels of income, as in rural Alaska, we would expect the substitution effect to dominate and work in the market to increase.

Change in the Productivity in Subsistence. Figure 3 illustrates a reduction in subsistence productivity by the shift in the home production function to A_1B_1E; with the same amount of time, consumers can produce fewer goods at home. Given the same wage rate, the effect of this change will most likely be an increase in market work. The change depends on the exact way productivity shifts; if the curve flattens as in Figure 3, productivity inside the home will be less than in the market, and there will be less work at home. Since the change in productivity amounts to a decline in real income, we would also expect leisure to decline, and work in the market to increase. Productivity in subsistence will decline as more pressure is put on existing subsistence resources such as through population growth.

Changing Tastes. Two types of changes in tastes can occur. The first concerns the shift in relative preference between goods and leisure. This is shown in Figure 4 by the shift in indifference curves from I_1CI_1 ‘^{0} ^{1}0 ^{c}1^{l}0” This movement illustrates the effect of an increased preference for goods relative to leisure. The effect of this will be to increase work in the market at the cost of leisure, leaving non-market work the same.

The other form of taste change concerns the preference for subsistence goods relative to purchased goods. The difference in preference between subsistence and market goods can be incorporated into the production relations by making the goods produced effective units--subsistence good units equal the number of market goods which the

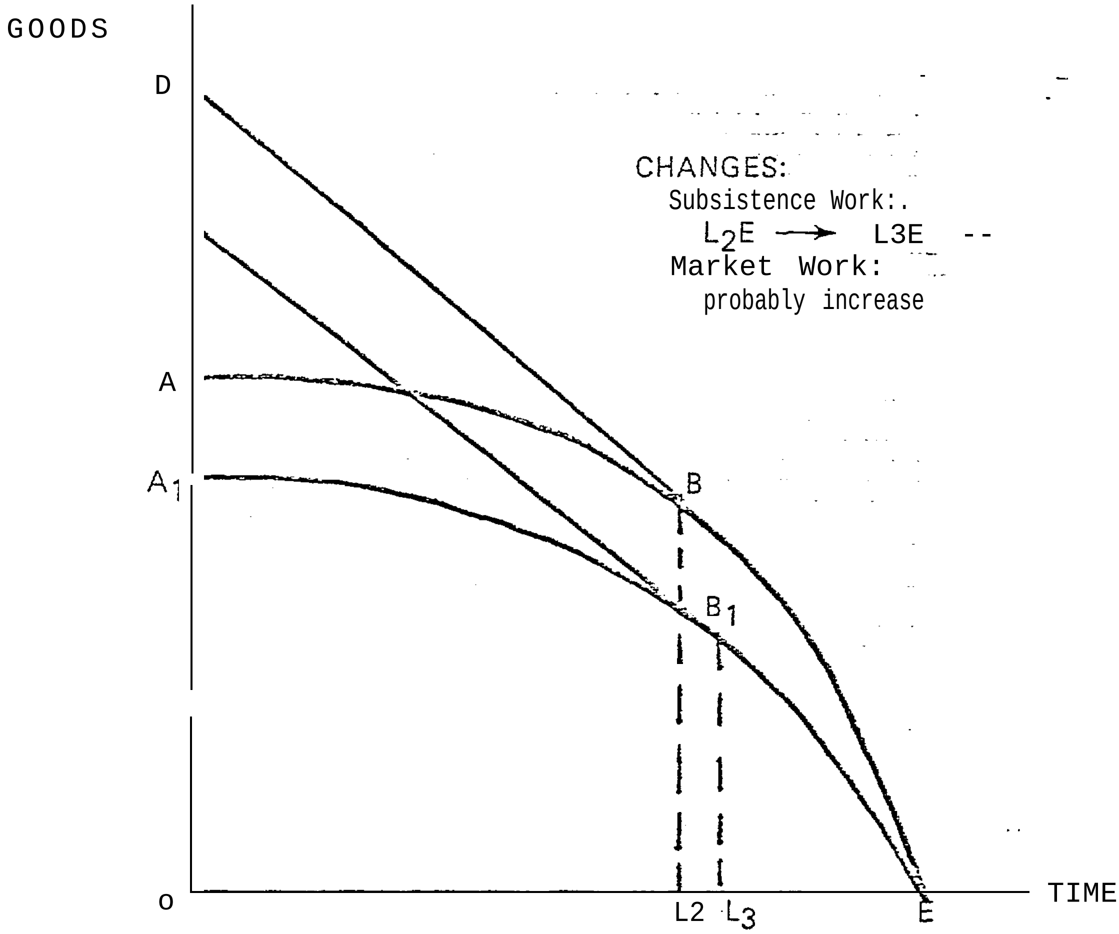

Figure 3

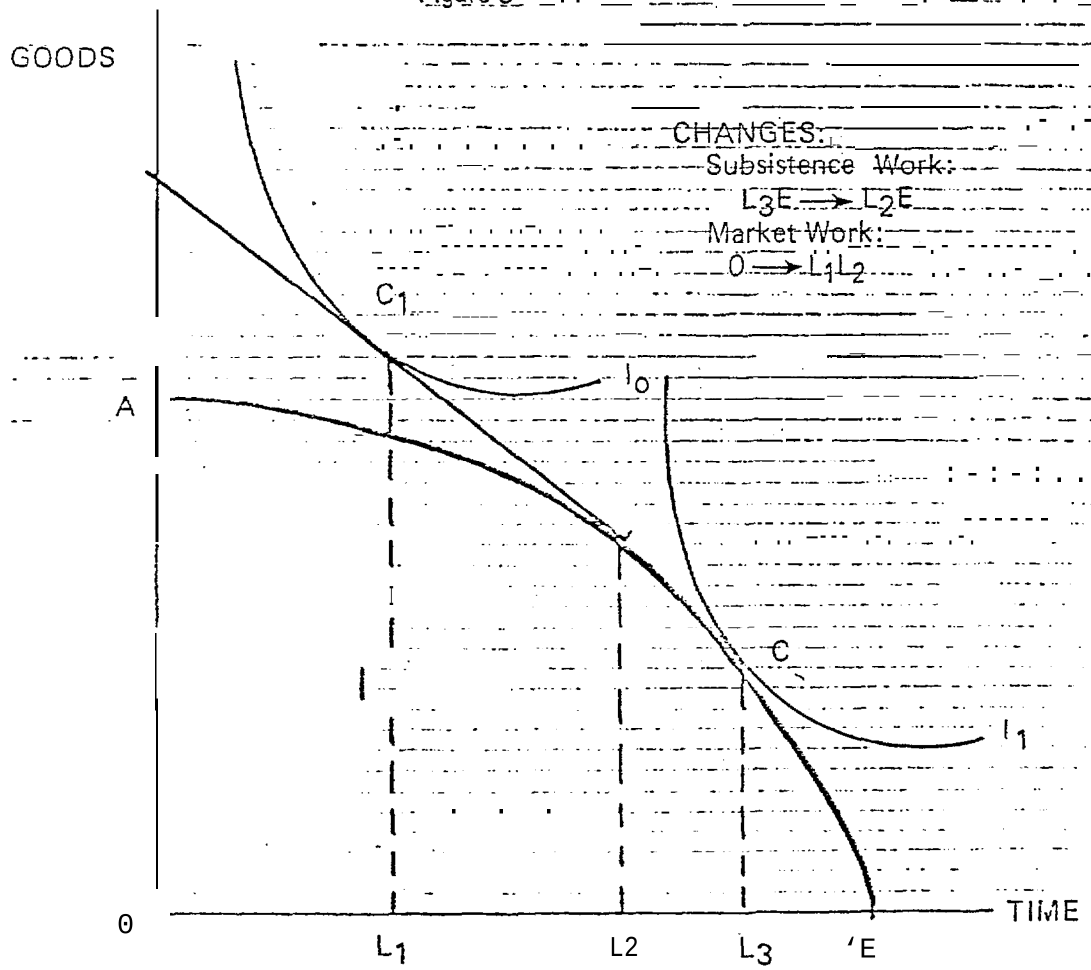

Figure 4

consumer would require in exchange for one unit of subsistence goods. A reduction in the relative preference for subsistence goods is illustrated by a drop in the home production function, and it will have the same type of effect shown in Figure 3, leading to an increase in market work.

<u>Change in the Cost of Subsistence</u>. Subsistence activity no longer operates independently of the market economy. Goods such as snow machines and rifles are used in subsistence. As the price of goods used in subsistence increases, the costs of subsistence production will go up., Residents questioned in 1974 about their view of future subsistence activity cited increased costs as a major reason their assessment of a future decline in subsistence activity (Nathan, 1974). Figure 5 shows the effect of an increase in the fixed cost of subsistence. The effect is to impose an amount of time, depending on the wage rate, which must be spent in the market; E_1E must be spent in the market in Figure 5 to earn OS subsistence goods. A_2E shows the opportunity curve if only market work occurs. As long as the shift in the subsistence production function allows some range where subsistence production is more efficient than market work (production function lies above A_2E), subsistence production will occur. Once the production function falls below the market opportunity curve, no subsistence would take place. We would expect increases in subsistence costs , which lead to a fall in real income, to result in a drop in leisure and a rise in market work.

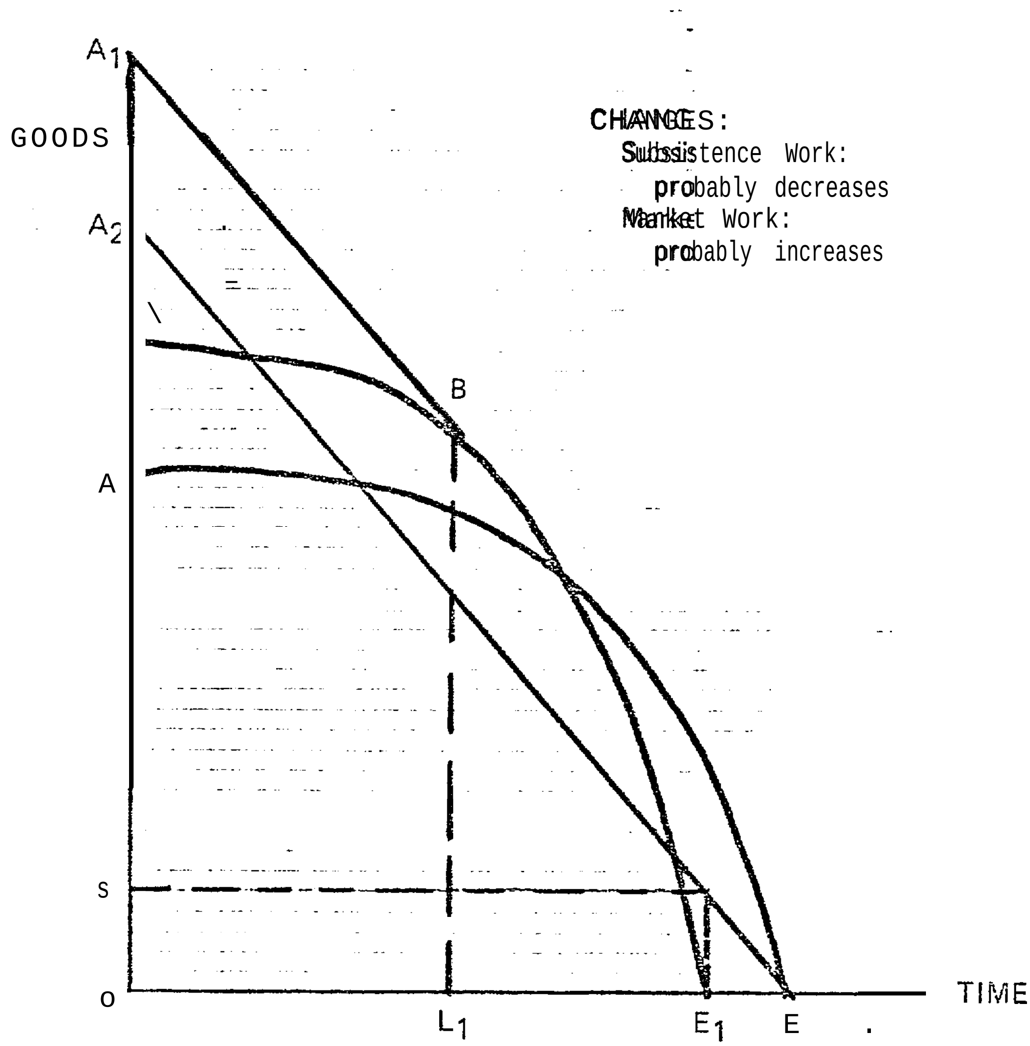
A1
GOODS
A2
B
A
s
o
L1
E1
E
TIME
CHANGES:
Subsistence Work:
probably decreases
Market Work:
probably increases

Figure 5

Change in the Marginal Utility of Income. This last change was originally suggested by Fisk (1975) and relates to the linkage between the scale of market activity and the labor force participation. Undeveloped rural regions have both limited employment opportunities and limited opportunities for spending money. The first characteristic makes the ability to earn money low; the second makes the utility value of money low. The utility value of money is low because there are few goods and services to buy, and the ones available are expensive. As the community grows, two things happen. First, the opportunities for employment expand. Secondly, as the range of goods and services available increases and their prices fall, marginal utility of income increases. The expansion of the range of goods and services depends on economies of scale which result from the expansion of the market. As the marginal utility of income increases (this may in our model be interpreted as an increase in the real wage), we would expect a shift to market work.

The model of labor market behavior examined above allows us to develop a series of hypotheses about future desired labor force participation. We would expect desired labor force participation to increase as employment opportunities increased, subsistence costs (both time and money) increased, tastes change in favor of market goods, and opportunities for spending money increase. We can "test" these hypotheses by examining the results of surveys taken in rural Alaska. We would expect that those factors which would increase preference for market work are related to living in the regional centers. Certainly, wages and employment opportunities are greater. The range of goods and services may also be greater. Greater population may also mean more pressure on subsistence resources. Tables 21 and 22 support our hypotheses. In Table 21, we see that the share of the population depending on subsistence food declines between the region and regional center.

Table 22 shows that the number preferring full-time work also increase as the size of place gets bigger, This provides some support to our model results and suggests that the changes which will take place over time, especially those which occur with OCS development, will lead to an increase in the participation in the wage economy.

Tables 23 and 24 suggest that tastes may also change in the future, supporting the trend toward increases in labor force participation. Table 23 shows that preference for year-round work is much greater among high school students in Barrow than among adults. This may indicate a shift in tastes toward market goods. Similarly, Table 24 shows that the preference for spending time in subsistence is less for younger people. This may also indicate an increased relative preference for market goods relative to both home production and leisure. As these younger people grow up, they will dominate the labor force participation pattern found in rural Alaska.

TABLE 21. SHARE OF FOOD BY SIZE OF PLACE

		Most	Half	Some	None
1.	Bethel [1]	10.4	23.2	32.1	34.4
	Nunam Region	29.1	29.6	33.2	8.2
2.	Fort Yukon [2]	14	28	27	31
	Other Villages	38	28	22	12
3.	Barrow [3]	23	18	48	11
	Other Villages	33	14	39	14
4.	Native Village [4]				
	Small	43.2	34.0	15.6	7.0
	Medium	44.3	29.3	21.5	4.2
	Large	24.0	38.6	24.8	11.4
	Non-Native Place				
	Village	14.1	24.3	44.1	16.1
	Urban Place	8.8	17.8	47.3	23.5

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[1] PAL, 1981, TE-1.

[2] ISER, 1978, TS-3.

[3] ISER, 1981, TS-13.

[4] Nathan, 1974, T2A-6.

TABLE 22. EFFECT OF SIZE OF PLACE ON WORK PREFERENCE

(percentage)

Prefer Full-time Employment		
1.	Bethel [1]	78.6
	Nunam Region	56.8
2.	Fort Yukon[2]	62.0
	Other Yukon-Porcupine Villages	46.0
3.	Native Villages in Alaska[3]	56.6
	Smal 1	55.5
	Medium	51.8
	Large	72.2

[1]PAL, 1981, TB-3.

[2]ISER, 1978, TS-2.

[3]Nathan, 1974, T2H-6.

TABLE 23. WORK PREFERENCE, BARROW

(percent)

	Adults		High School Students	
	Male	Female	Male	Female
Year-Round	28	44	46	67
Part Year	72	56	54	33

SOURCE: ISER, 1981B, T7.

TABLE 24. EFFECT OF AGE ON WAGE ECONOMY-SUBSISTENCE TRADEOFF In Yukon-Porcupine Region[1] (Percent)

	18-30	30-39	40-49	50+
Time Preference				
Subsistence	4	6	14	26
Wages	22	15	7	19
Both	74	79	79	55
Source of Income				
Subsistence	17	27	36	28
Wages	61	67	50	64
Both	22	6	14	8

[1]ISER, 1974, T5-1.

The evidence presented suggests that desired labor force participation will increase over time. For our purposes, we need to estimate the pattern and extent of this increase. As in our analysis of the multiplier, historical change provides only limited help in describing what will happen. We examined cross-section evidence to illustrate the potential pattern of change of desired labor force participation.

Employment growth is a proxy for many of the factors we describe as increasing participation. More employment is related to higher effective wages; it also means more population; and it also is related to a larger economy with a greater range of goods and services. Each of these, theoretically, leads to a greater participation in the wage economy. By observing how labor force participation grows across census divisions as employment grows, we can estimate the potential future pattern of growth in the wage economy participation. This analysis assumes that the pattern of change in actual labor force participation across census divisions describes the pattern of change in desired participation as the economy grows.

For this analysis, the pattern as well as the rate of change is important. This means that in a regression analysis, the selection of a functional form becomes important. Research in the area of the diffusion of technical change has suggested that the logistic curve is the characteristic diffusion path for new technologies. Although most studies have examined historical change, some (see Jarvis, 1981) have suggested that by estimating the logistic curve which describes the initial changes, we can project what the overall diffusion path will be. The diffusion of technology is similar in many respects to our problem--the diffusion of labor force participation. In each case, a maximum is reached--the population is the limit of the labor force. We would also expect, as in the spread of a new technology, the speed of increase in labor force participation will change, being slow initially, then rapid, and finally slowing as the maximum is approached,

The logistic curve is defined as:

$$(1) \qquad LF = \frac{POP}{1 + e^{-c-\phi E}}$$

where LF is the labor force; POP is the population; ϕ is the rate of diffusion; and E is employment. By rearranging (l), we obtain

$$(2) \qquad \frac{LF}{POP - LF} = e^{c+\phi E}$$

which can be estimated linearly in logarithms. The results of the regression run using pooled time-series cross-section data for rural, coastal Alaska census divisions are shown below.

$$(3) \qquad \left(\frac{LF}{POP - LF}\right) = -.8251 + \underset{(3.26)}{.00026} * E \qquad \bar{R}^2 = .15$$

The number in parentheses is the t statistic, and the variable is significant at the 99 percent level. Although the $\bar{R}^2$ is low, the equation does provide some information on the pattern of change. Using this equation, the labor force is projected to reach 75 percent of population at a level of employment of 7,400 which is approximately the size of Kenai. If we assume that desired labor force participation" expands along this path, rural Alaska labor force participation will reach its potential at about the size of Kens'i. This seems to be a reasonable result.

Conclusions

The relationship between potential, desired, and actual participation is important both for determining labor supply and economic migration. The analysis presented in this paper suggested that actual participation may underestimate desired participation and that desired participation may increase in response to economic growth. The following conventions could be incorporated into SCIMP to deal with these changes:

1. Potential labor force participation will be described by U.S. national age-sex rates. Assuming these represent full-years participation, these rates represent the share of 12-month work years. The rural rates will grow to these national rates, which will serve as an upper bound.

2. Desired rates will be based on the survey conducted by the Alaska Department of Labor in the Wade Hampton Census Division. Table 25 shows the pattern of desired participation. These are desired rates of participation, but they do not show the months of participation. These rates will be adjusted to reflect part-time participation. In this region, it has been estimated than an average of six-to-eight months describes preferences, which is supported by the 1974 survey results These desired rates will be assumed to grow on a path

defined by the diffusion curve estimated above. The rates will expand until they reach the potential rates; expansion will be in response to employment growth.

3. Actual labor force participation and the official unemployment rate define the tolerance in rural Alaska for remaining unemployed instead of out-migrating. Economic out-migration will occur when unemployment defined by the actual labor force participation exceeds some equilibrium unemployment rate. Actual labor force participation will be assumed to expand at the same rate as desired labor force participation. The actual rate is important for defining the tolerance for unemployment.

TABLE 25. DESIRED LABOR FORCE PARTICIPATION

	(percent wishing to work some amount of time)
Total	72.4
Male	76.1
Female	68.1
Age	
16 - 18	73.1
19 - 21	80.2
22 - 24	92.5
25 - 29	81.7
30 - 39	84.9
40 - 49	71.9
50 - 59	55.6
60 i-	23.3

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IV.
PATTERNS OF RESIDENT EMPLOYMENT IN ALASKA'S OUTER CONTINENTAL SHELF INDUSTRY

by

Will Nebesky

ABSTRACT

Patterns of Resident Employment in

Alaska’s Outer Continental Shelf Industry

This study investigates resident patterns of direct project employment for Outer Continental Shelf (OCS) lease sales. The purpose of this research was to expand on earlier research performed in conjunction with MAP model impact analysis of future OCS lease sales in Alaska’s offshore areas, and to produce a reliable method for estimating the proportion of total OCS lease-sale employment that remain or become Alaska residents. Particular attention was paid to patterns of settlement among resident OCS employees in communities located near leased tracts.

Several factors were analyzed to estimate the Share of Employment that are Alaska Residents (SEAR). They are:

(1) Phase of the Project’s Development

(2j On/Offshore Status

(3) Skill Requirements

(4) Scale of Project

(5) Oil Company Employment Policies

(6) Characteristics of Local Labor Supply

(7) Characteristics of the Project

A literature review was also conducted with an emphasis on resident patterns of petroleum employees in other countries, and on resident patterns of nonpetroleum industries within the United States.

This research suggests that the SEAR factors used in earlier MAP model OCS impact analyses were reasonable approximations of resident patterns. The most important determinant of resident status is the phase of the project and whether a given work task is on or offshore.

PATTERNS OF RESIDENT EMPLOYMENT IN ALASKA'S OUTER CONTINENTAL SHELF INDUSTRY

Introduction

The purpose of this study is to improve the methodology used to adjust total direct project employment for an OCS lease sale to include only those employees that become permanent residents of the state. The original methodology was developed in December 1978 in a report entitled, "A Procedure to Determine the Share of OCS Employment to Alaskan Residents" (SEAR). The SEAR adjustment amounts to a set of factors that are applied directly to lease sale project employment to net out the. nonresident component. The SEAR factors are broken into 16 categories reflecting the job structure of on- and offshore OCS employment. Several employment characteristics were taken into account to construct the SEAR factors. They are the phase of project development (i.e., exploration, development, and production), the rotation factor, the duration of the job, and other implicit estimates of residency such as employment multipliers. The SEAR factors also change over time to capture the effect of developing skills and expanding labor supply in a growing economy. The original SEAR adjustment factors are shown in Table 26.

The original SEAR assumptions divide employment into resident and nonresident (enclave) categories, given total direct employment. The SEAR assumptions do, however, take into consideration the effect of the project's phase on residency employment patterns. For example,

TABLE 26. ORIGINAL SEAR ADJUSTMENT FACTORS FOR OCS EMPLOYMENT

(SHARE OF EMPLOYMENT TO ALASKAN RESIDENTS)

1 Employment Activity	2 Phase of Development[2]	3 Rotation Factor[3]	4 Duration[4]	5 Potential AK Resident Share from Industry[5]	6 Employment Multiplier	7 Payments Allocation Coefficients	7 Share to AK Residents[8] in Years: 1	5	10	8 Estimate Share of Employment To Alaskan Residents (SEAR) 1979-84	1985-09	1990 +
ONSHORE												
1. Service Base	Exploration Development Production	1 1 1	P	-,15[a] .2 1,0	1.5	,7		NA		1.0 1.0 1.0	1.0 1.0 1.0	1.0 1.0 1.0
2. Helicopter Service	Exploration Development Production	2 1.5[a] 1	P	.2 (.3)[b]	1.5	1		NA		.5 .5 1.0	.525 .525 1.0	.578 .578 1.0
3. Service Base Const.	Development	1.11	T	.5	1.5	1 "	.25	.25	.25	.5	.525	.578
4. Pipe Coating	Development	1.11	T	.2	1.1	.2	.25	.25	.25	.2	.21	.231
5. Onshore Pipeline Const.	Development	1.11	T	.2	1.1	.2	.25	.25	.25	.2	.21	.231
6. Oil Terminal Const.	Development	1.11	T	.5	1.1	.2	.25	.25	.25	.5	.525	.578
7. LNG Plant Const.	Development	1.11	T	NA	1.1	.2	.25	.25	.25	.5	.525	.578
8. Concrete Platform Const.[10]	Development	NA	NA	NA	NA	NA	.25	.25	.25	NA	NA	NA
9. Oil Terminal Operations	Production	1	P	1.0	1.5	1	.75	.75	.75[9]	1.0	1.0	1.0
10. LNG Plant Operations	Production	1	P	1.0"	1.5	1	.75	.75	.75[9]	1.0	1.0	1.0
OFFSHORE												
11. Surveys	Exploration	1	T	.2	1.1	.2	.15	,55	.55	.2	.21	.231
12. Rigs	Exploration	2	T	.1	1.1	.2	.15	,55	.55	.2	.21	.231
13. Platforms	Development Production	2 1	P	.1 (.3)[b] 1.0	1.2[c] 1.4*	.4 .8	.75	.75	.759	.1 1.0	.3 1.0	.33 1.0
14. Platform Installation	Development	2	T	.1	1.1	.2	.25	.25	.25	.1	.105	.116
15. Offshore Pipeline Const.	Development	2	T	.1	1.1	.2	.25	.25	..25	.1	.105	.116
16. Supply-Anchor-Tugboats	Exploration Development Production	1.5 1.5 1.5	T	.15 .15 .5	1.2[c] 1.4[d] 1.4[d]	.4 .8 .8		NA		.4 .8 .8	.42 .88 .88	.462 .968 .968

[a]Approximation [b]Numbers in parentheses indicate second 5-year period

TABLE NOTES

Original SEAR Adjustment Factors for OCS Employment

1. These are the employment sectors (or tasks) requested by Tom Smythe of Alaska Consultants in his November 21 correspondence with Richard Schmidt of Peat, Marwick, Mitchell and Co.

2. Dames and Moore, "Alaska OCS Socioeconomic Studies Program, Northern Gulf of Alaska, Petroleum Development Scenarios," Draft Report, Task 9BA, October 24, 1978, Table 5-4, pages 119-122.

3. Ibid.

4. Based on discussions found in Planning for Offshore Oil Development, Gulf of Alaska OCS Handbook, Division of Community Planning, ADCRA, 1978, pages 40-41 and 223-224. Note: P = permanent; T = temporary.

5. Interview: Max Beazley, Staff Engineer at Mobil Oil Corporation, Exploration and Producing. Mr. Beazley is currently working in the Purdhoe Unit, a planning team for future development in Prudhoe Bay.

6. "Planning for Offshore Oil Development," Division of Community Planning, Alaska Department of Community and Regional Affairs, October 1977, Table 12, pages 17-18.

7. Column 6 shows the task-specific employment multipliers assumed by Community and Regional Affairs (left-hand number). The right-hand number in this column is the implicit proportion of resident employment when a resident multiplier of 1.5 is assumed.

8. "A Social and Economic Impact Study of Offshore Petroleum and Natural Gas Development in Alaska: Phase 11," Mathematics Science Northwest, Inc., and Alaska Consultants, Inc., for BLM, October 1976, page 19.

9. Amendments suggested by Ed Phillips, Alaska DNR.

10. Concrete Platform Construction is not considered feasible in the Gulf of Alaska.

exploratory crews typically work as teams and operate in units from site to site. They represent the more classical version of enclave employment. Development well drilling and pipeline, platform, and shore-base construction are the principal activities in the development phase. Here the distinction between on- and offshore employment is important. Offshore development-phase employment was assumed to retain characteristics similar to exploratory work crews and, thus, exhibit modest residency patterns, Onshore development includes various types of construction employment. Although the work tasks are generally seasonal, the potential for civil construction jobs by Alaskan contractors is more likely than that of offshore development or of exploration, particularly as the overall sphere of OCS activity broadens. Production phase employment is generally less specialized, more routine, and better suited for trained entry-level employees than other OCS employment. Table 27 summarizes the original SEAR assumptions according to project phase and on/offshore activities.

TABLE 27. ALASKA RESIDENT EMPLOYMENT AS A PROPORTION OF TOTAL DIRECT OCS EMPLOYMENT BY PHASE

(percent)

Phase	OnShore	OffShore
Exploration	10 - 20	10 - 20
Development	40 - 50	10 - 20
Production	100	100

Thus, between 10 and 20 percent of OCS offshore development employment for a given lease sale is assumed to reside in Alaska.

The groundwork that has already been performed in connection with the SEAR assumptions has several weaknesses. First, the original SEAR assumptions do not distinguish whether OCS employees are hired from within Alaska or outside, nor do they take account of the proximity of leased tracts to communities where settlement could occur. Second, the bulk of the data that was used to analyze residency patterns of OCS employment was not directly applicable to the question at hand: the share of direct OCS employees that will reside in Alaska. Third, only one oil industry representative--an engineer from Mobil Corporation--was interviewed on the subject. Fourth, no attempt was made to borrow either from the experience of offshore petroleum development in other places such as the United Kingdom, Norway, and Venezuela or from the settlement patterns of workers connected with large energy projects elsewhere in the United States.

Several issues are also present in connection with the SEAR assumptions. First, by excluding enclave workers totally from resident-adjusted project employment, we risk the possibility of negatively biasing the induced impacts generated by the Man-in-the-Arctic Program (MAP) model. Second, as mentioned above, we presently do not distinguish between resident employment that is drawn from local labor supply versus project employment that migrates from outside and settles permanently in Alaska.

The subject of OCS resident patterns is important for two reasons. First, seasonal transient employment is no novelty in Alaska. Yet, historically, those transient workers affected Alaska's economy by spending some of their wages during their seasonal work shift. The offshore petroleum industry, on the other hand, is a somewhat special case because transient "enclave" workers are much less apt to impact Alaska's economy at all, except perhaps in the transportation and communication sectors. Thus, a clear picture of OCS resident patterns is critical to an accurate assessment of the probable induced impacts of OCS activity. Second, while the MAP model can transmit the induced effects of exogenous, transient, project employment such as TAPS construction, it cannot accurately transmit the impacts of extreme enclave employment such as that found in offshore activity. Thus, OCS direct employment must be adjusted for residency prior to its inclusion in the MAP model.

Our approach in this study is, first, to outline and describe those factors that determine the resident share of OCS project employees. The descriptive analysis in Part II will follow from in-depth discussions with industry contacts and other knowledgeable individuals and from a thorough review of literature germane to the subject. Second, based on an updated, more comprehensive examination of OCS resident patterns, we ask the question: should the original SEAR factors be changed? A simple algorithm is developed to modify the OCS resident adjustment using the original SEAR factors as a starting point.

In addition to the phenomenon of enclave versus resident employment, Alaska's labor market is also characterized by considerable intrastate migration.

In Part III, we take a closer look at petroleum-worker resident patterns on a regional and local level with the objective of developing a set of local-resident assumptions to use in conjunction with the statewide resident adjustments in Part II.

Statewide Resident Patterns

There are several characteristics of OCS employment that relate to the question of resident status. They include such factors as phase of project development, on/offshore status, skill requirements, and duration of employment. These and other job characteristics outlined below factor into the residency decision:

1. Phase of the project
   a. Exploration
   b. Development
   c. Production

2. On/Offshore status

3. Skill requirements
   a. Unskilled
   b. Semiskilled
   c. Specialized

4. Scale
   a. Alaska petroleum industry
   b. Alaskan economy

5. Oil company employment policies
   a. Rotation leave
   b. Covered transportation expenses
   c. Local hire
   d. Training
   e. Wages

6. Characteristics of local labor supply
   a. Skills
   b. Degree of labor-market competition

7. Characteristics of nonlocal labor supply
   a. Skills
   b. Family size

8. Characteristics of the project
   a. Distance from major trade center
   b. Distance from major population center
   c. Size of project
   d. Duration of project and job task

Some characteristics may be more important than others, and some are interrelated. For example, offshore employment during the exploratory phase of project development is typically more highly skilled than routine, entry level onshore production phase employment. Offshore exploratory drilling crews are likely to be nonresidents that travel worldwide, job-after-job, under contract with several oil companies and have very little direct interaction with the local or state economy. Another possibly important consideration is whether the OCS worker is an oil company employee or belongs to an oil service company that is under contract with the oil company.

Although the ultimate question is how many OCS lease sale project employees reside in Alaska, it is important to know whether these emp?oyees/residents migrated in from outside the state and settled or were drawn directly from Alaska’s available labor supply. The following diagram provides a conceptual framework that distinguishes between the origin of potential OCS employees/ residents and whether they settle near the leased tracts or elsewhere in Alaska.

Each employment category in the following diagram will involve some mix of the eight residency-decision characteristics listed above. The number of local residents that take OCS jobs, E_{RL}, depends most importantly on the compatibility of job skill requirements and the local supply of available skilled labor. Because subsistence production continues to play a vital role in most remote communities, oil company policies involving rotation leave, job duration, and wages should not be overlooked. For some OCS tasks, training programs could also significantly influence the quantity of local hire.

OCS Employees by Origin and Residency
ORIGIN

	Alaska Residents	From Outside Alaska
Local to Leased Tracts	‘RL	E_{OL}
NonLocal	‘RN	‘ON
Enclave		‘E

‘here ‘D’ total direct project employment is equal to

E_{LR} + ‘LD + E_{NR} + ‘NO + ‘E

The number of nonlocal Alaska residents that take OCS jobs (E_{RN}) and commute to the workplace after rotation leave depends on oil company policies concerning rotation leave privileges (e.g. , whether the company will pay for round trip transportation to Anchorage or Fairbanks during rotation leave). The extent of other related petroleum development activity occurring in Alaska will also influence the availability of skilled resident labor at the time a given lease sale occurs.

The number of OCS employees from outside Alaska that ultimately become residents and settle in the work place location (E_{OL}) or in other areas of the state (E_{ON}) will depend on the size of the project, the duration of the job task, oil company employment policies, the distance of the nearest community to the regional population and trade hub, and the physical and social characteristics of the community nearest the lease tracts (where shore-base facilities are likely to be placed).

The remaining employment category (E_E) refers to "enclave" OCS employees that maintain nonresident status and simply commute to their homes outside of Alaska during rotation leave.

The analysis of statewide residency patterns will pertain primarily to petroleum industry activity in order to develop a deterministic model of residency patterns for on- and offshore OCS employment. The development of a lease sale is typically divided into three distinct phases: exploration, development (construction), and production. The following discussion will follow this pattern for several reasons. First, although some overlap occurs between development phase activity and that of exploration and production, the phases themselves are generally self-contained. They exhibit characteristics that are unique and that are important determinants of the structure of overall employment. For example, offshore petroleum exploration requires skills wholly different from those of well production once a discovery is made and the field is developed.

Second, the. phase-of-development breakdown provides a logical denominator to illustrate the residency characteristics of OCS employment. Most other determinants of residency can conveniently be placed under one of the three development-phase categories.

In general, when we speak of "OCS activity,'! we refer to extreme offshore conditions. Near-shore operations do not require the degree of preparedness and capital intensity of full offshore operations. For example, Parker Drilling Company, the largest land-based drilling company in the United States, has operated in the Upper Cook Inlet (near shore) but has no intentions of ever extending their operations to extreme offshore areas such as the Northern Gulf and Bering Sea.

The historical experience of petroleum operations in the Upper Cook Inlet is possibly not a good model for future OCS activity. It is both near shore and in the proximity of Alaska's largest population center. However, the Upper Cook Inlet is one of only a few actual petroleum scenarios from which the State of Alaska can draw experience. Thus, we intend to use employment data from Upper Cook, tempered slightly to fit the characteristics of future OCS activity.

Although not offshore, Prudhoe Bay is probably more representative of future OCS activity because of the extreme nature of other environmental circumstances. However, Prudhoe's extensive land-based terminal and isolated community is still, in the eyes of one Atlantic Richfield Company (ARCO) official, not very representative of future offshore activity.

With the exception of some offshore exploration in Lower Cook Inlet, the Northern Gulf, and the Bering Sea, Alaska OCS has no actual experience that carries through al? phases of petroleum development from exploration to production. The approach taken in this study is to draw from all available Alaskan data pertaining to the residency patterns of petroleum industry employment and to qualify the applicability of that data to the extreme offshore situation at hand. We also borrow from residency patterns of large energy and construction projects elsewhere in the United States to help improve the reliability of our assumptions concerning resident patterns of Alaska OCS workers.

EXPLORATION PHASE

We have located three primary sources of data pertaining to residency patterns of OCS employment during the exploration phase. They are (1) oil company exploratory plans, (2) Alaska OCS Office Technical Report No. 55 on oil exploration activities in the Lower Cook Inlet for the Alaska OCS Socioeconomic Studies Program (Northern Resource Management, 1980), and (3) several exploration plans for Continental Offshore Stratographic Test (COST) wells in four western Alaska extreme offshore locations. Although the data is somewhat fragmented, each of these reports provides some hints about residency patterns of OCS exploratory-phase employment.

Employment data from the exploration plans of several oil companies involving tracts in the Lower Cook Inlet, Northern Gulf of Alaska, and Beaufort Sea is summarized in Table 28. About 90 percent of total exploration-phase employment is contracted through oil and gas service companies. There are two main groups that contract their services to oil companies during exploration: drilling companies and other, more general, oil and gas service companies (e.g., air and marine services, cementing, mud logging, and catering). Data from the exploration plans suggest that roughly 50 percent of total exploration employment is contract drilling. The types of services provided by drilling contractors include drilling rig supervisor (tool pusher) drillers, derrick men, floor hands, and roustabouts. These employees usually work a rotation shift with days off equal to the number of days on shift (e.g., one month on, one month off). In most cases, total

TABLE 28, EXPLORATION EMPLOYMENT PLANS

(CAUTION: These are not FTE jobs.
They must be adjusted for length of duration.)

Employment	Lower Cook Inlet			N. Gulf Sale #39			Beaufort
	Phillips (1 rig)	ARCO (1 rig)	Marathon	Texaco	ARCO	Shell	Exxon
TOTAL	145	170	135	137	150	172	62[a]
Oil Company							
Headquarters	2	NA	NA	NA	2	NA	NA
Onshore	3	8	6	5	1	NA	4
Offshore	4	8	4	2	16	10	5
Total Oil Company	9	16	10	7	19	10	9
Percent of Total	6%	9%	7%	5%	13%	6%	15%
Services (contracted)	120	105	97	102	100	116	53
(percent of total)	83%	62%	72%	74%	67%	67%	85%
Onshore	0	3	4	4	10	16	
Offshore	120	102	93	98	90	100	53
Drilling	88	70	74	70	70	70	38
(drilling as a percent of total)	61%	41%	55%	51%	47%	41%	61%
Transportation	18	49	28	28	31	46	NA
(transportation as a percent of total)	12%	29%	21%	2%	21%	27%	NA
Total Services	136	154	125	130	131	162	53
(service as a percent of total)	94%	91%	93%	95%	87%	94%	85%
Alaska Resident							
(Contract)	(NA)	(36)	(20)		(NA)	(NA)	
Site Local	14	7	3		17	15	
Anchorage	30	44	22		14	14	
(Anchorage as a percent of total)	68%	85%	88%		45%	48%	
Nonlocal	0	1	0		NA		
Total Alaska Resident	44	52	25	NA	31	29	
(Alaska resident as percent of total)	30%	31_%	19%		21%	17%	?
Alaska Resident							
Onshore	4	1				NA	
Offshore	32	NA				15	
Transportation	8	1				14	
Additions to Local Population (F = Family)	1F	0	5F		16F	10F	
Nonresident	103	118[a]	110[a]		119		

[a] All contract personnel

drilling contractor employment is twice the number of a single change-over crew. Relief crews should nevertheless be counted in total employment since over the long run, they work a full-time equivalent number of hours. In some cases, the drilling contractor is also responsible for supply and support logistics, as well as electrical and mechanical support. Otherwise, the operator (i.e., oil company) contracts those services. At all times, the oil company supervises the entire drilling operation by placing a drilling foreman on the rig.

In general, oil and gas service companies and drilling companies perform the bulk of the work in offshore exploration. This characteristic hints at the very specialized nature of offshore petroleum exploration and offers partial explanation as to why, according to exploration plan estimates, only between 17 and 30 percent of total on- and offshore exploration employment is likely to be an Alaska resident.

The data suggest further that in the Lower Cook Inlet sale, the greatest proportion of total resident employment (between 68 and 88 percent) would be expected to live in Anchorage and to commute to the rig on a rotation basis. On the other hand, slightly less than half of exploratory-phase, resident employment in the Northern Gulf was expected to live in Anchorage. The remainder would migrate to and settle in Yakutat or would be drawn from the local Yakutat-based labor force. The data suggest that the share of Alaska resident employment declines as the distance of the leased tracts from Anchorage increases. The data also suggest, however, that if a reasonable-size community (say, 500 permanent residents) exists in the proximity of an offshore lease sale area, then a greater proportion of resident employment will be concentrated in the locally situated community. However, a Parker Drilling official cautioned that the prospects for a remote, enclave-type camp (from here on called "enclaves") increase when the locally situated community's services, transportation, and housing infrastructure are unable to accommodate a relatively large block of temporary OCS exploratory employment such as that which occurred in Yakutat during exploration activity in the late 1970s.

The data in Table 28 is summarized below in Table 29. Note that the figures in Table 29, expressed as a percent of total employment, indicate the range of selected employment characteristics that occurs from activity in all lease sale areas shown in Table 28. The figures in the right-hand column are mid-point approximations for each corresponding range.

The level of detail covered in the exploration plans used to construct Tables 28 and 29 was not sufficient to enable the authors to draw conclusions about the resident patterns of specific types of employment such as drilling or other oil and gas service company employment. However, one can infer from the data in Tables 28 and 29 that virtually all nonresident employment (about 99 percent) would be contract personnel. A smaller proportion of resident employment (about 75

TABLE 29. SUMMARY CHARACTERISTICS OF EXPLORATION EMPLOYMENT FOR ALL LEASE SALE AREAS IN TABLE 28

(percent of total employment)

	Range	Approximate Mid-Point
Oil Company Personnel	5-15	7
Contract Employment	85-95	93
Drilling	41-61	51
Transportation	12-29	21
Other	17-26	22
Alaska Resident Employment	17-31	24
Alaska Resident and Contract Employment	15-21	18
Nonresident Employment	69-83	76
Both Nonresident and Contract Employment	69-81	75

SOURCE: Table 3 and text.

percent) would be contracted. On the other hand, about 86 percent (6÷7) of oil company personnel (about 10 percent of total employment) would be Alaska residents. Thus, most oil company personnel are residents, and most contract employees are nonresidents of Alaska. The relationship between resident and contract employment is summarized in Figure 6 based on mid-point approximations from the data in Tables 28 and 29.

The matrix in Figure 7 summarizes the relationship between residency and on/offshore work tasks from nine exploration-plans data. Several patterns emerge from this data. The proportion of onshore employment (23 percent) is roughly the same as the proportion of resident employment (24 percent) out of the total workforce. Over 60 percent of total project employment is both nonresident and offshore. This represents about 80 percent of all nonresident employment (.61÷.76). By comparison, only 67 percent of total resident employment is offshore. Thus, if you are employed in OCS exploratory activity, then your chances of working offshore are slightly less than if you were a nonresident OCS employee.

How close did the oil company exploration plans compare to actual experience? Exploratory activity by three petroleum companies in the Lower Cook Inlet from October 1977 to January 1980 was recorded by Northern Resources Management (1980) for the Alaska OCS Socioeconomic Studies Program. Figure 8 condenses data contained in that study in a matrix similar to Figure 6 comparing residency and contract employment patterns. Of course, the data in Figure 8 pertain strictly to the Lower Cook Inlet and are not directly comparable to the summary data in Figure 6 which include the Northern Gulf and the Beaufort Sea. Nevertheless, the comparison reveals a fairly consistent pattern between the planned (Figure 6) and actual experience (Figure 8). One observes that nearly all oil company personnel (5 percent of total project employment) were residents of Alaska. The major difference between actual and planned activity is the shift toward a greater

FIGURE 6. PLANNED EXPLORATION EMPLOYMENT BREAKDOWN BY RESIDENT AND BY CONTRACT PERSONNEL

(percent of total project employment)

	Resident	Nonresident	
Contract (Drilling & Service Company)	18	75	93
Oil Company	6	1	7
	24	76	

SOURCE: Tables 28 and 29 and text.

FIGURE 7. PLANNED EXPLORATION EMPLOYMENT BREAKDOWN BY RESIDENT AND BY ON- OR OFFSHORE STATUS

(percent of total project employment)

	Resident	Nonresident	
Onshore	8	15	23
Offshore	16	61	77
	24	76	

SOURCE: Tables 28 and 29 and text.

overall percentage of resident employment (29 versus 24 percent of total). This shift toward greater resident participation occurred exclusively among contract employment (24 versus 18 percent). It is possible that the oil companies underestimated the extent of industry development among oil service companies in the Kenai Peninsula and Anchorage Boroughs.[1]

The pattern of on- and offshore employment exhibited in the actual data for three oil companies in the Lower Cook Inlet shown in Figure 9 suggests a similar shift toward higher residence participation than was originally planned (Figure 7). In this case, the increased resident employment (29 versus 24 percent) was distributed somewhat evenly between onshore and offshore workers.

The largest discrepancy between planned and actual activity occurs in the on/offshore status of nonresident OCS employment. Whereas 15 percent of total nonresident project employment was expected to remain onshore, the actual data from all three oil companies reveal that nonresident OCS workers did not participate in any onshore activity in the Lower Cook Inlet. They were employed strictly offshore. As a result, a much higher proportion of nonresident OCS employment (71 versus 61 percent) was engaged in offshore activity than was originally anticipated.

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[1]Of the 34 oil-well service companies listed in the Alaska Petroleum Industry Directory (1980), ten (29 percent) were based in Alaska, twenty (59 percent) were based outside with Alaska branches, and four (12 percent) were based outside with no local branch office.

FIGURE 8. SUMMARY OF RESIDENT AND CONTRACT EMPLOYMENT PATTERNS FROM EXPLORATION ACTIVITY IN THE LOWER COOK INLET

(percent of total project employment)

	Resident	Nonresident	
Contract	24	71	95
Oil Company	5	0	5
	29	71	

SOURCE: Northern Resources Management, Monitoring Oil Exploration Activities in the Lower Cook Inlet, Alaska OCS Studies Program, July 1980, Tables 12-14. (Also see Table 30, below.)

The data suggest generally that the residency patterns of OCS employees are closely related to both on/offshore status and to whether workers are contracted or are oil company personnel. However, one is not able to discern from the data so far discussed how the job structure itself (that is, the breakdown of on/offshore work tasks) relates to residency.

To address this question, a more detailed breakdown of job structure and residency patterns was constructed in Table 30 from actual exploration activities in Lower Cook Inlet (Northern Resources Management, 1980). Several aspects of the data in Table 30 must be qualified. First, the figures represent number of jobs rather than employment expressed in annual full-time-equivalent (FTE) units. Thus, the duration of work for many work tasks is not built into the data. For example, although the rotation schedule of most drilling crew employees was one month on and one month off, the length of employment (whether it was six months or two years steadily) is not known. This concern is magnified in the case of part-time employment, which in terms of number of jobs represents between 10 and 15 percent. Because the number of jobs may not accurately reflect FTE employment, we view the figures in Table 30 with caution. However, the possible discrepancy between total FTE employment and number of jobs may be less critical when the figures are viewed as a proportion of total employment (i.e., jobs). We consider this interpretation useful and representative for the purpose of a more detailed examination of residency patterns. Plus, we have few alternatives from which to choose.

FIGURE 9. SUMMARY OF RESIDENT AND ON/OFFSHORE EMPLOYMENT PATTERNS FROM EXPLORATION ACTIVITY IN THE LOWER COOK INLET

(percent of total project employment)

	Resident	Nonresident	
Onshore	10	0	10
Offshore	19	71	90
	29	71	

SOURCE: Northern Resources Management, Monitoring Oil Exploration Activities in the Lower Cook Inlet, Alaska OCS Studies Program, July 1980, Tables 12-14. (Also see Table 30, below.]

TABLE 30. EMPLOYMENT AND RESIDENCY FOR EXPLORATION ACTIVITIES
OCTOBER 1977 "TO JANUARY 1980 IN THE LOWER COOK INLET

	Marathon Diamond M Dragon				Phillips OceanBounty				ARCO Dan Prince			
	Anchorage	Local	Outside	Total	Anchorage	Local	Outside	Total	Anchorage	Local	Outside	Total
.OFFSHORE												
Operator			4	4			4	4	4			4
Drilling Contractor	1		69	70	1		71	72	1		49	50
Ship Crew			(12)	(12)			(14)	(14)				
Drilling Crew	(1)		(53)	(54)	(1)		(43)	(44)	(1)		(49)	(50)
Other			(4)	(4)			(14)	(14)				
Catering Contractor			11	11			11	11			11	11
USGS	2			2	2			2				
Service Companies	4		10	14	9	1	4	14	10	1	4	15
SUBTOTAL: FULL TIME ON DRILLING VESSEL	7	0	94	101	12	1	90	103	15	1	64	80
Supply Vessel	2		36	38	7		27	34	5		29	34
Part Time	7	3	_	10	9	3	_	12	_	15	_	15
SUBTOTAL: OFFSHORE	16	3	130	149	28	4	117	149	20	16	93	129
ONSHORE												
Operator	5	1		6		3		3	3	2		5
Drilling Contractor	1	2		3	5			5	4			4
Aircraft Contractor	4	3		7	4	4		8	4	2		6
Supply Vessel	_	_	_	_	1	_	_	1	_	1	_	1
SUBTOTAL: ONSHORE	10	6	0	16	10	J	0	17	11	5	0	16
TOTAL OFFSHORE/ ONSHORE	26	9	130	165	38	11	117	166	31	21	93	145
ESTIMATED TOTAL MAN MONTHS	216	73	1,890	2,179	571	158	1,564	2,2'33	201	38	558	797

SOURCE: Northern Resource Management, Monitoring Oil Exploration Activities in the Lower Cook Inlet, Alaska OCS Socioeconomic Studies Program, July 1'380, Tables 12-14.

Second, the authors of the study from which Table 30 was derived (Northern Resources Management, 1980) produced an estimate of total man months for total employment. This may be a more accurate measure of FTE employment but is available only for aggregate employment and not for the more specific work task breakdown.

Several patterns emerge from the data in Table 30. Drilling vessel employment, including oil company personnel, the drilling and catering contractor, USGS engineers, and service company employment, comprise between 55 and 62 percent of total project jobs. Nonresident OCS workers fill between 80 and 93 percent of those jobs. As a result, drilling vessel employment alone is responsible for roughly half of the overall nonresident workforce. Note that within this drilling vessel category, catering employment representing 7 to 8 percent of total is filled entirely by nonresident labor. Offshore service company employment, consisting primarily of cementing and mud engineering, absorbed between 8 and 10 percent of total employment. The resident share of this cateogry was less consistent across different oil companies. While Phillips and ARCO recorded that about two-thirds of service company jobs were taken by residents, Marathon recorded only about one-third resident participation. Cementing was consistently performed by nonresident service companies for each operator. Mud logging was performed by an outside company for Marathon only.

Offshore part-time jobs were performed exclusively by Alaska residents. These jobs consisted of site visits by oil company engineers and service company jobs such as logging, cementing, diving, and casing. Overall, part-time employment comprised between 6 and 10 percent of total jobs. As discussed above, another work task category held exclusively by Alaska residents is onshore jobs. These include primarily logistics and administrative support for offshore drilling operations. As a proportion of total employment, onshore jobs comprise about 10 percent.

In Table 31, the work tasks shown in Table 30 are divided into three categories: resident, nonresident, and both. The table shows the proportion of total employment used by each category. For those work task categories that exhibit both resident and nonresident status, Table 31 shows the share of resident employment allocated to that dual category.

This table provides a convenient summary of residency patterns from the Lower Cook Inlet exploratory drilling. Work tasks that use strictly resident employees comprise about 19 of the total OCS workforce. It shows those work tasks contributing exclusively to nonresident employment--using nearly half of total OCS jobs. And it shows those work tasks that historically employ both residents and nonresidents--comprising roughly one-third of total OCS jobs, of which 7 percent were held by Alaska residents. In the aggregate, the data from Table 31 imply that 26 percent of all OCS jobs were held by residents and 74 percent by nonresidents.

TABLE 31. RESIDENT BREAKDOWN OF OCS EMPLOYMENT IN THE LOWER COOK INLET (1977 to 1980)

Resident		Nonresident		Resident and Nonresident		
Worktask	Percent of Total Employment	Worktask	Percent of Total Employment	Worktask	Percent of Total Employment	Share of Worktask Category to Alaskans (percent)
Onshore	10	Catering	7	Operator	2	33
Operator	3					
Drilling	3	Drilling Contractor	42	Service Companies	8	49
Aircraft	4			Supply Vessel	22	13
USGS Engineer	1					
Part-Time	8					
Total	19		49		32	7

SOURCE: Northern Resources Management, Monitoring Oil Exploration Activities in the Lower Cook Inlet, Alaska OCS Socioeconomic Studies Office, July 1980, Tables 12-14.

There are several reasons why residency patterns pertaining to exploration activity in the Lower Cook Inlet are not representative of residency patterns that can be expected to occur in other more extreme offshore areas of Alaska. First, as discussed above, the Lower Cook Inlet tracts are more properly characterized as near shore rather than offshore. Ice pack in Lower Cook is not so extensive as that which occurs in the Bering Sea and Arctic Ocean. Similarly, other environmental factors such as proximity to developed shore-side facilities distinguish Lower Cook Inlet from extreme offshore lease sale areas of the Bering Sea, Arctic Ocean, and Northern Gulf.

Second, the Lower Cook Inlet is fairly close to Alaska’s largest population and distribution center: Anchorage. Although by no means simple, the logistics advantages implied by Lower Cook’s proximity to Anchorage and capital markets as well as the availability of equipment and supplies are considerably more accommodating than those of the Northern Gulf or the Bering Sea.

Third, the oil and gas service industry, situated on the Kenai Peninsula, has had two decades of petroleum development experience from Upper Cook Inlet exploration, development, and production. The Kenai Peninsula Borough planners estimated that the 37 oil and gas service companies that responded to their survey questionnaire represented about half of the Borough's existing service company base.[2] One would expect exploration activity in the Lower Cook to draw from locally situated, established service bases for a greater share of its employment and logistics requirements than that which would occur in more remote areas of Alaska.

For these reasons, it is likely that the residency patterns of Lower Cook offshore exploration represent a boundary condition on the upper end of the spectrum of possible resident participation in direct OCS project employment.

The resident patterns of exploration-phase employment in the Lower Cook Inlet can be tempered somewhat with employment data pertaining to four continental offshore stratographic test COST wells that ARCO had planned to drill in Summer 1981. Four offshore sites were planned in the Bering Sea: the Norton, North Aleutian, Navarin, and St. George basins. The drilling rig is a Dolphin which was leased by ARCO for two years at about $100,000 per day. COST wells drilling techniques are similar to those used for oil and gas exploratory drilling, but the purpose is quite different in each case. The drilling time for each COST well is planned for about 111-to-126 days with one or two weeks of mobilization and demobilization. As with regular exploratory

[2]Conversation with Taryn Methvin, Economic Development staff of the K.P.B., September 1981.)

drilling, marine, ground, and air support are the main elements of COST well logistics. In some cases (North Aleutian and St. George), the support bases for marine and air activity are in different locations. Equipment for marine support usually would include one large supply barge, one barge tender, two supply boats (three for the Navarin COST well), and one full/water vessel. Air support would be performed by two helicopters. Hangers, warehouse, office space, and lodging facilities for twenty-to-thirty persons would usually be located at the site of the air support base (e.g., Nome, Cold Bay, and Dutch Harbor). Total planned manpower would be between 93 and 105 persons, having the approximate work task/resident breakdown averaged over all four COST wells shown in Table 32.

Furthermore, a sizable portion of local-resident employment is part-time, which further reduces the effective resident share. Out of an estimated total of 94 jobs, 72 jobs (or 77 percent) would be filled by imported, skilled oil field specialists. Of the remaining 22 positions, 64 percent would be taken by persons from the local labor force. The residency patterns of planned COST well exploratory-drilling employment would suggest slightly lower resident participation compared to the actual residency patterns of Lower Cook Inlet exploratory drilling. The reader is reminded, however, that the COST well data is prospective; the actual resident patterns could vary substantially from ARCO's expectations. This may especially be the case for exploratory employment that draws from local labor supply which depends closely on the composition of local labor skills.

TABLE 32. EMPLOYMENT BREAKDOWN SUMMARY FOR FOUR BERING SEA COST WELLS

Work Task Breakdown	Number of Jobs	
	94	
Nonresidents		
Skilled Oilfield Specialists		
Drilling	60	
Supply boats	12	
Supply barge		
Total Imported (approximately)	72	
Residents		
ARCO Personnel		
Supervisors	2	
Material expediter	1	
Pilots	4	
Mechanic	1	
Warehouseman	1	local
Barge Tenders	5	local
Full/Water Liters	8[a]	1 ocal
Total Resident (approximately)	22	

[a]Part-time, 2 days/week

SOURCE: "Environmental Report(s) for North Aleutian, Norton, Navarin, and Norton Sound COST Well(s)," by Woodward-Clyde Consultants for ARCO Alaska, Inc., January 30 to March 6, 1981.

Thus far, resident participation in OCS exploration-phase employment (jobs) varies from a low of 23 percent (COST wells) to a high of 26-to-29 percent (actual Lower Cook Inlet). The onshore component captures the largest proportion of resident employment with between 35 and 100 percent of onshore positions filled by Alaska residents. Yet, onshore employment comprises only 10-to-23 percent of total OCS employment.

The opinion of industry representatives and government offices are roughly commensurate with these data. Paul Cunningham, a planner for the Department of Community and Regional Affairs, revealed the uncollaborated opinion of most industry experts: While 90 percent of off-shore federal lease sale employment is highly skilled and, therefore, imported, between 80 and 90 percent of onshore employment will be drawn from Alaska’s resident workforce or will ultimately settle in Alaska.

Ken Willits, an industry consultant from Drilling Services Company in Anchorage, said that between 75 and 90 percent of future offshore drilling crew personnel will be nonresident where the 90-percent bracket pertains to extreme offshore conditions such as the Gulf of Alaska. Mike Balich of Parker Drlling Company indicated that all exploratory drilling activities that have occurred in the Northern Gulf were performed by Lower 48 drilling contractors.

A report produced by the Alaska Department of Natural Resources (1981) indicated that even under near-shore conditions in the Upper Cook Inlet, 90 percent of offshore exploratory activities were performed by non-Alaskan workers, and that there was a 50/50 split between resident and nonresident onshore employees.

In summary, about 93-to-95 percent of total, direct, exploration-phase employment is contracted and about three-fourths of contracted employment is nonresident. Although oil company personnel represent a very modest proportion of total project employment, they would usually be Alaskan residents. About 90 percent of overall exploratory employment would be offshore and, therefore, highly skilled. Historically, offshore drilling has always been performed by international drilling companies. There are not any Alaska-based drilling companies that operate in extreme offshore areas. Besides drilling, catering was the other exploration-phase work task that would be performed exclusively by nonresident employment. Though a small segment of total project employment, virtually all onshore employees would be residents of Alaska. Air transportation, USGS, and part-time personnel would usually be residents of Alaska. Service-company contract employment other than offshore drilling, catering, and cementing was generally split 50/50 between residents and nonresidents. Note, however, that this abridged category' of service-company employment would amount to only 8 percent of total exploration-phase direct employment.

Based on these findings, we recommend the following adjustments to the original SEAR factors in Table 26 for exploration-phase employment. Helicopter service (activity no. 2) during exploration should be increased to 100 percent (1.0) from 0.5 (1979-1984). Offshore survey (activity no. 11) should be increased to 100 percent (1.0) from 0.2 (1979-1984). Exploratory drilling (activity no 12) should be reduced to zero from 0.2 (1979-1984). The new adjusted SEAR factors are shown in Table 43 in Part IV below.

DEVELOPMENT PHASE

Once a discovery having commercial potential is made, development drilling commences and preparations are made for the installation of a platform to house the development drilling crew and production workers to provide a more permanent structure for ongoing support and supply operations. The resident pattern of development-phase employment is not expected to vary appreciably from those of exploratory drilling. The skill requirements for development phase jobs are still highly specialized.[3] In addition to development drilling and platform installation, the development phase also includes on- and offshore pipeline construction, pipe coating (onshore], and service base and oil terminal construction. Thus, a variety of construction activity occurs during development, most of which would be highly skilled. In

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[3]These statements are based on notes from personal conversations with several industry representatives, especially Mike Balich of Parker Drilling Company and Ken Will its of Drilling Services Company.

fact, with the exception of development drilling, activity in the development phase is essentially construction. According to estimates of total direct project employment for the St. George Lease Sale No. 70 by the Alaska OCS Office, FTE construction employment amounted to 80 percent of peak development-phase employment. For three years of the eight-year St. George construction period, during which shore-base, terminal, and pipeline construction would occur, construction employment would account for over two-thirds of total direct project employment.

On the other hand, projected construction employment for Sale No. 71 in the Beaufort Sea (also Alaska OCS Office) was markedly different from the St. George sale because most existing shore-base and terminal facilities at Prudhoe Bay could be shared. Thus, gravel island and pipeline construction would require a smaller labor input of only 23 of total FTE employment. All construction activity would be performed in four years, including a small amount of construction activity in 1984 prior to exploratory drilling.

The resident pattern of future development-phase OCS employment can be divided into two general categories commensurate with the employment work task breakdown: development drilling and construction (including platform installation and terminal, service base, and pipeline construction). The resident patterns of development drillers will probably parallel those of exploratory drillers (Mike Balich, Parker Drilling). Construction employment would draw partly from Alaska's labor force during slack periods when the reserve of skilled construction workers is higher. The Department of Natural Resources (1981) predicts that 25 percent of onshore construction employment that would occur in response to a moderate commercial discovery in Lower Cook Inlet (Sale No. 33) would consist of Alaska residents. On the other hand, the Kenai Peninsula Borough (1978) estimated that 100 percent of onshore construction employment in an earlier federal lease sale in the Lower Cook would be Alaska residents.

The Bureau of Economic Analysis (BEA) provides another source of resident adjustment for construction workers in Alaska.[4] Normally, about 85 percent of Alaska's construction workforce are residents of Alaska. This adjustment factor to total construction employment is based on 1957 BEA income tabulations for resident and part-time construction workers in Alaska. Using data on pipeline workers' earnings from 1974 to 1977, the BEA estimated that 35 percent of total pipeline wages accrued to Alaska residents.

Of course, the structure of Alaska's economy has undergone considerable change since 1957, and, too, pipeline construction inland is a wholly different technology than offshore platform and pipeline installation. Furthermore, there are many similarities between pipe-

[4]Correspondence from Jeanne S. Goodman, BEA Economist, October 3, 1978.

line construction work tasks whether inland or offshore, such as welding and coating. Also, because of the large size and remote siting of many portions of the Trans-Alaska Pipeline System (TAPS), the logistics requirements and construction technology of TAPS offer a reasonable model for many characteristics of offshore construction employment.

The estimates of resident patterns of construction employment, summarized in Table 33 suggest a wide range of possibilities depending on the nature of the construction activity itself.

TABLE 33. COMPARATIVE ESTIMATES OF ALASKA RESIDENT PROPORTIONS DURING DEVELOPMENT-PHASE ACTIVITIES
(Percent)

		SOURCE		
Development-Phase Activity	Industry	Dept. of Nat. Res. (1981)	Kenai Peninsula Bor. (1978)	Bureau of Econ. Analysis
Offshore Development Drilling	0 (Same as Exploratory Drilling: 100% non-resident)			
Construction		25 (Lower Cook Sale 33)	100 (Lower Cook Federal Sale 1978)	85 Average for AK 35 TAPS

, SOURCE: See text.

Using these estimates as guidelines, we recommend the following adjustments to the original SEAR factors corresponding to development-phase activities in Table 26. Onshore service-base development activities involve development drilling, steel jacket and concrete installations, pipeline and gravel island construction, longshoring, maintenance and repairs, and other tasks. Many of these tasks are specialized and would be performed by contractors. Thus, the SEAR factor for service-base development-phase employment (activity no. 1) should be reduced from 100 percent to a level comparable to the TAPS construction experience--35 percent. Similarly, pipecoating and onshore pipeline construction (activities no. 4 and 5) should be increased to 35 percent (0.35) from 0.2 (1979-1984). Helicopter service during development (activity no. 2) should be increased to 100 percent to be consistent with exploration phase assumptions.

Service base, oil terminal, and LNG plant construction (activities no. 3, 6, and 7) are not changed since these activities are not as high-skilled as other development-phase activities and could abosrb a higher proportion of Alaskans than that which occurred in TAPS.

Offshore platforms (activity no. 13) consists primarily of development drilling and should receive SEAR equal to zero, reflecting the resident patterns of exploratory contract drilling. Platform installation and offshore pipeline construction (activities 14 and 15) would require specialized construction crews and would probably draw the smallest amount of labor from Alaska's workforce. We increase the SEAR factor to the DNR estimate of 25 percent from the original 10 percent level for both activities.

As with the exploration phase, supply-anchor-tugboats (activity no. 16) during development is expected to be largely nonresident. The SEAR factor should be reduced from 80 percent to 15 percent (1979-1984).

PRODUCTION PHASE

The resident patterns of production-phase OCS employment is considerably different from that of employment during the earlier phases of exploration and development. The difference stems mainly from two employment characteristics that are unique to production-phase activity: production employment is more permanent and less skilled than exploration and development-phase employment. Production employment is better suited for unskilled and semi-skilled, entry-level positions having comparatively routine work tasks. As a result, the potential for filling production-phase jobs from local and regional labor supply is higher. Furthermore, the permanent nature of production employment (oil terminal operations, air and marine supply and support, and administration) encourages some settlement in the proximity of offshore production such as in nearby communities and regional hubs.

In Upper Cook Inlet, the first commercial discovery was made in the early 1960s. By 1964, the first platform was in place with production beginning soon thereafter. Currently, there are fourteen operating platforms in Upper Cook Inlet. According to a July 1981 survey conducted by the Kenai Peninsula Borough (KPB), nine oil companies employ a total of 881 production-phase personnel. In 1977, the Alaska Oil and Gas Association (AOGA) estimated that 85 percent of all petroleum company workers resided in the KPB.[5] The remaining 15 percent would probably reside primarily in Anchorage with some (percentage unknown) residing outside the Anchorage and Kenai Boroughs.

In addition to oil company personnel, 52 oil and gas service companies reported a total of 413 employees, an average of eight persons per company. Only one of these service companies was based out of state. Taryn Methvin of the KPB indicated that only half of the service companies based in KPB that do business in the Upper Cook Inlet responded to KPB's 1980 survey. She believed that not less than 90 percent of total service company employees are Alaska residents. If the 50 percent response rate is valid, then a tota? of 826 service company employees plus 881 oil company personnel are involved in oil and gas production in Upper Cook Inlet (about 1,700 total production-phase employees). This implies an average of 122 jobs per platform (not FTE employment].

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[5] A Profile of the Oil and Gas Industry Kenai Peninsula Borough, Overall Economic Development Program, Kenai-Peninsula Borough, July 1978, p. 17.

Again, assuming a 50 percent response rate from oil and gas service companies based in the KPB, it is apparent that as field development progresses from exploration to production, oil company participation increases at the expense of contract work through oil and gas service companies. Returning "to Figure 8, oil company personnel comprise roughly 5 percent of exploration-phase employment. The present employment configuration in the Upper Cook Inlet suggests that as a proportion of total production-phase employment, oil company personnel constitute at least half of all on/offshore OCS employment.

Ken Will its of Drilling Services, Inc., suggests that a much higher porportion of total Cook Inlet platform employment--90 percent--is composed of oil company personnel, all of whom reside in Alaska. The remaining 10 percent are contracted oil and gas service company personnel.

The effect that this shift has on changes in overall resident patterns depends on the extent to which the resident patterns of oil company and oil and gas service company personnel differ. So far, the data we have seen suggest that oil company personnel are more likely to reside in Alaska than employees of considerably smaller, specialized service companies. The resources available to locally based oil and gas service companies for "logistics and other forms of support activity are limited compared with the larger producers. Oil and gas service companies would probably be geographically confined and, therefore, more susceptible to economic shifts associated with marginal discoveries. Mike Balich of Parker Drilling admitted that despite Parker's prominence as the largest land-based drilling company nationwide, its Alaska branch is still vulnerable to the continuity of ongoing land-based exploration. Despite the extensive schedule of federal OCS lease sales in Alaska, Parker will not venture into the offshore drilling arena. Balich notes further that job stability is an important determinant of the resident decision. As field development progresses toward oil and gas production, resident status increases because employment becomes increasingly more permanent, and more stable oil company personnel comprise a greater share of total direct OCS workforce. Specialized exploration- and development-phase employment, in contrast to that of the production phase, is inherently less stable as it shifts from one site to the next on a global scale. Even as a land-based drilling company, Balich notes that 450 of an anticipated 600 Parker employees will be imported for exploratory drilling in Fall 1981.

Prudhoe Bay production employment is probably the best example of future, ongoing OCS production-phase resident patterns, even though Prudhoe is not offshore. Because Prudhoe production activity is likely to share many of the extreme environmental conditions of offshore production, we use the Prudhoe experience as a benchmark for resident patterns of offshore production employment. In Fall 1980, Sohio and ARCO reported to the Alaska Department of Labor on residence of Prudhoe Bay workers. Their results, summarized in Table 34, suggest that a very high proportion of production employees are Alaska residents.

TABLE 34. RESIDENCE OF PRUDHOE BAY WORKERS

	Total Employment	Alaska Residents		Out-of-State Residents	
		Number	% of Total	Number	% of Total
Sohio	469	446	95	23	5
ARCO	647	639	99	8	1

Returning to the original SEAR factors in Table 26, we recommend that onshore production-phase employment in activities 1, 2, 9, and 10 remain at their existing 100 percent levels. Offshore production-phase platform employment (activity no. 13) should be reduced to 95 percent from 100 percent, based primarily on the Prudhoe experience. Similarly, supply-anchor-tugboats (activity no. 16) should be increased to 95 percent from the original 80 percent level (1979-1984).

SUMMARY

As a broad indication of the changes we recommend for the original set of SEAR factors, Table 27, showing the relationship between the phase of OCS development and on/offshore activity, is placed next to a similar table that summarizes the findings discussed in Part II. This comparison is shown in Table 35. The results are fairly consistent.

With the exception of development-phase resident patterns, which exhibit a wider range than originally assumed, most of the revised assumptions are quite close to their original counterparts.

TABLE 35. COMPARISON OF ORIGINAL AND REVISED ASSUMPTIONS ON ALASKA RESIDENT EMPLOYMENT AS A PROPORTION OF TOTAL DIRECT OCS EMPLOYMENT BY PHASE AND ON/OFFSHORE STATUS

(percent)

ORIGINAL

	Onshore	Offshore
Exploration	10 - 20	10 - 20
Development	40 - 50	10 - 20
Production	100	100

REVISED

	Onshore	Offshore
Exploration	8 - 10	16 - 19
Development	35 - 85	15 - 25
Production	100	95

Local Labor Supply and Settlement Patterns

Knowledge of statewide resident patterns of OCS petroleum workers is an important first step toward understanding their economic impact. In Alaska, where economic growth tends to be geographically concentrated and is patterned after characteristics unique to a given region, the regional and local distribution of resident employment is equally critical to impact analysis. In Part III, we identify those factors that are important determinants of local labor supply and settlement. Having determined the overall share of OCS project employment that lives in Alaska, we now examine how much of that resident employment would probably be drawn from the labor force situated in the proximity of an OCS project and how much resident employment would ultimately settle in the proximity of an OCS project.

Local labor supply and settlement patterns depend in part on characteristics of the community: size, degree of isolation, level of community services, and cost of living (Nickels, cd., 1976, and Lewis and McNicoll, 1978). Factors related to the oil industry are also important determinants of local residency. These include the extent of prior OCS activity in the area and the amount of available skilled local labor, the specific nature of OCS development (e.g., exploration versus shore-base construction), and oil company policy regarding training, rotation leave, wage rate, and settlement options. As in the case of statewide resident patterns, personal factors such as the degree of past worker mobility (high for oil industry personnel), occupational aspirations, job security, and job stability are also important.

The following discussion of local resident patterns will attempt to address these and other factors, borrowing whenever possible from similar experience elsewhere in the United States, from petroleum development in other countries, and from petroleum development in Alaska.

In Part III, we essentially present two somewhat opposing examples of local resident patterns of OCS employment as possible models of future OCS development in Alaska. These models are based primarily on the recent history of petroleum development in Alaska and in the North Sea. Before the specifics of these models are discussed, we proceed with a more general discussion of labor supply and settlement patterns of large construction/energy projects in the Northern Great Plains (NGP) states to see if trends there are applicable to Alaska.

SETTLEMENT AND LABOR SUPPLY PATTERNS IN THE NORTHERN GREAT PLAINS

Settlement patterns of construction and operations workers in the Northern Great Plains were analyzed by Wieland, Leistritz, and Murdock (1977) for large-scale energy projects situated in rural areas of North Dakota, South Dakota, Montana, and Wyoming. The authors developed a model of local labor supply and settlement based on employment data from fourteen power plants and coal mines. Their model used a two-step procedure. First, a labor supply model determines the number and allocation of workers supplied locally from communities situated near the projects. Here, local labor supply is a function of the size of a local community, its distance from the project site, and the project's total employment.

Second, the remaining employment is filled by nonlocal workers who migrate into and take on residence in the vicinity of the project. The primary question is to determine their allocation among communities near the project. The allocation of remaining nonlocal workers is determined by a residential prediction model which measures the relative attractiveness of a community. The attractiveness of an individual community is a function of the responsiveness of nonlocal workers to the community's population, its commuting distance from the project, and its distance from the nearest regional trade center. Wieland et al. interpreted population as the primary measure of a community's availability of services. The residential prediction model was estimated separately for construction and for operations workers under the hypothesis that the characteristics of each type differ enough to matter. Ordinary least squares coefficient estimates for the labor supply and the residential prediction models suggest several patterns in local hire and settlement among Northern Great Plains construction and operations workers that could apply to Alaska OCS employment. They are:

1. Local labor supply is more positively responsive to project employment for operating jobs than for construction jobs (mainly because construction jobs are more specialized and require skilled temporary employment. Operating workers receive more on-the-job training). Each construction job would generate 0.014 local workers, while each operations job would generate 0.12 local workers, or about seven times as many.

2. A community's distance from the project site has a greater negative effect on the supply of workers for permanent operations jobs than for temporary construction jobs. Each additional mile from the project site reduces locally supplied operating employment by 0.55 persons while construction employment falls by only 0.32 persons, about 60 percent less than operating employment.

3. A nonlocal worker's responsiveness to the project's distance from the nearest trade center is less for construction than for operations employment, although distance to a regional trade center is not a statistically important explanatory variable in the determination of residential choice.

4. The ability of a community to absorb new residents is primarily a function of size.

5. Community size as a measure of attractiveness is more important to construction workers than to operations workers. A one percent increase in community population would attract 0.45 percent nonlocal employees for operating jobs compared to 0.61 percent nonlocal employees for construction jobs.

Resident Patterns in Kenai. Alaska

Just how applicable are Wieland's local hire and resident prediction models to the petroleum industry in Alaska? To illustrate the use of the local hire and residential prediction models, we apply the estimation results derived by Wieland et al. (1970) to specific energy-project data for the Kenai area. Chevron operates a refinery producing 18,000 barrels per day of North Slope crude. The refinery employs 20 operators residing in either Kenai or Soldotna.

According to George Day of Chevron USA, all 20 operating employees were hired locally. If we constrain Wieland's local hire model to allocate all 20 Chevron employees to either Kenai or Soldotna and apply 1980 population estimates and distances, then the model predicts that 19-out-of-20 operating employees would be hired from Kenai and only one from Soldotna. The actual distribution of employment is 16 from Kenai and 4 from Soldotna, suggesting a 15 percent allocation error (3/20).

The Pacific Alaska LNG natural gas liquification plant has an estimated peak construction workforce of 1,323 persons in 1984 with an ongoing operations workforce of 60 persons starting in 1986. Again using population estimates and distance measures to the plant, we apply Wieland's local hire model to allocate peak construction employment. This time, we include Anchorage along with Kenai and Soldotna. The relevant input data is shown in Table 36.

TABLE 36. POPULATION AND DISTANCE TO PACIFIC ALASKA LNG PLANT FOR KENAI, SOLDOTNA, AND ANCHORAGE

City	1980 Population (Census)	Approximate Distance (by road) to Proposed LNG Plant
Kenai	4,324	7
Soldotna	2,320	20
Anchorage	173,017	160

Peak Construction Employment: 1,324

Direct application of Wieland's model indicates that out of total annual construction employment, 30 percent (398 persons) would be hired locally in Kenai, Soldotna, and Anchorage. The remaining 70 percent (926 persons) would consist of nonlocal employees that migrate from outside of Alaska or from other areas in the state and settle in the three target communities according to the resulting allocation shown in Table 37 below.

TABLE 37. APPLICATION OF LOCAL HIRE AND RESIDENTIAL CHOICE MODEL (WELAND ET. AL. , 1977) TO PROPOSED PACIFIC ALASKA LNG PLANT CONSTRUCTION EMPLOYMENT

	Local Hire		Migration and Settlement		Total Employment	
City	Number	Percent	Number	Percent	Number	Percent
Kenai	44	3	326	25	370	28
Soldotna	37	3	120	9	157	12
Anchorage	317	24	480	36	797	60
Total	398	30	926	70	1,324	100

These results are fairly consistent with resident patterns of TAPS construction employment. Recall the BEA estimates discussed which suggest that 65 percent of TAPS construction employment was drawn from outside of Alaska.

To some extent, the Northern Great Plains (NGP) data base used to develop the local hire and resident prediction model has similar physical and socioeconomic characteristics to that of Alaska. The projects share similar features in terms of relative size and remoteness. Like the projects used to construct the NGP data base, the Pacific Alaska LNG project proceeds in phases starting with relatively high wage construction employment. Alaska’s recent history of petroleum development suggests that like the NGP communities, Kenai's economy remains tied to one or two natural resources but has had several decades of infrastructure development to alter its structure from that of an isolated economy to a regional trade center and a focal point for a large cross section of Alaska’s oil and gas service sector.

In many respects, however, the city of Kenai and the Pacific Alaska LNG project represent special cases that are not representative of characteristics that are relevant to either OCS activity or to remote shore-base sites that are likely to be used in future OCS exploration and development.

With two decades of industry expansion and infrastructure development, Kenai is a far cry from the limited availability of in-place services and skilled employment in most other areas of the state. Between 1964 and 1968, when on- and offshore oil and gas exploration, development, and production was the primary economic activity driving Kenai's economy, substantial growth occurred in most sectors of Kenai's economy. As shown in Table 38, employment increased at an average rate of 52 percent per year, almost double the rate of population growth over the same period. The number of housing units increased to 1,100 from

TABLE 38. CITY OF KENAI

	1964[a]	1968[c]	Average Annual Rate of Growth
Population	1,577	4,500	30%
Employment	316	1,673	5 %
Construction (%)	7%	36%	
Mining (%)	11%	28%	
Services (%)	12%	10%	
School Enrollment	782	1,504	18%
Housing Units	420[b]	1,100	27%
(vacancy)	less than 5%		
Average Household Size	3.6	3.5	- 0.7%
Total Annual Electricity Use (kwh)	2.7 million	12 million	45%

SOURCES:

[a]Alaska State Housing Authority, Kenai Comprehensive Development Plan, 1965.

[b]Real Estate Research Corporation, Economic Development Base, City of Kenai, Alaska. For Alaska State Housing Authority, 1965.

[c]Department of Economic Development, "Standard Industrial Survey," 1968.

420, or 27 percent per year. Note also that even in 1964, vacancy was considerably less than 5 percent. Similarity, total electricity consumption grew at an annual rate of 45 percent, indicating a substantial 56 percent increase in per capita electricity consumption between 1964 and 1968. Average household size declined somewhat, suggesting a change in the demographic structure of Kenai's population. This change was probably induced by settlement of in-migrants such as construction workers having different demographic characteristics than the existing resident population. Note, for example, that construction workers in the NGP data base had an average family size of 2.5, compared to 3.4 for operations employees. By 1977, the average household size of Kenai residents fell to 3.3 persons. Concerning migration itself, nearly 50 percent of Kenai's resident population in 1977 was living outside of Alaska in 1970.

Will the economic growth that Kenai experienced in response to oil and gas development occur in other resource-rich OCS regions of Alaska? If so, then the resident patterns of Upper Cook Inlet petroleum workers shown below in Table 39 are representative of resident patterns that other communities tied in some way to future OCS activity could approach, but probably could not exceed. The figures in Table 39 show that a fairly high percentage of Upper Cook Inlet on- and offshore petroleum workers presently reside in the Kenai Peninsula Borough.

TABLE 39. PERCENTAGE OF EMPLOYEES RESIDING IN KENAI PENINSULA BOROUGH

Type of Job	Percent in Kenai Peninsula Borough
OFFSHORE	
Platforms and Supply Boats	80[a]
Barges and Exploration Rigs	0
ONSHORE	
Service Bases	100
Administrative	0
Rig Service	50
Platform Service	50
Terminal Operation	67
Construction	100

[a]Workers who reside in Kenai Borough but work offshore.

SOURCE: Offshore Oil Development in Lower Cook Inlet Implications for the Kenai Peninsula. CH2M Hill for the Kenai Peninsula Borough, 1978, pp. 2-14.

In order to. account for the effects on resident patterns of economies less developed than Kenai 's, an adjustment factor was applied to the proportions in Table 39. The adjustment factor may be thought of as a measure of relative economic development. It is equal to the ratio of mining plus construction employment in a community that is situated near future OCS sale areas to mining plus construction employment in the city of Kenai. The resulting adjustment factors are shown in

Table 40. They lie within a range of 10-to-35 percent of Kenai construction and mining employment in 1974. If we select 10 percent as a representative adjustment, then, for example, 6.7 percent of onshore terminal operations employment in Table 39 would be drawn from the local labor force and from local settlement. The remaining 92.3 percent of resident terminal operations would consist of Alaskans that commute to their place of permanent residence during periodic rotation leave,

TABLE 40. THE RATIO OF MINING PLUS CONSTRUCTION EMPLOYMENT IN SEVERAL COMMUNITIES TO MINING PLUS CONSTRUCTION EMPLOYMENT IN KENAI IN 1974

Community	Construction Plus Mining Employment in 1974	Percent of Kenai Mining and Construction Employment
Kenai	910	100
Nome	316	35
Dutch Harbor	10	1
Kotzebue	96	11
Emmonak	NA	NA
Yakutat	110	12
St. Matthew Island	Uninhabited	NA
Barrow	90	10

SOURCE: Department of Commerce and Economic Development, "Profile of Alaskan Communities," 1974-1975.

The 10 percent adjustment to Kenai resident proportions is probably reasonable, particularly for communities with little or no past petroleum activity. The city of Nome represents a somewhat special case since it is linked by road to several areas of the Seward Peninsula; functions as a primary trade, service, and distribution center; and is strategically situated near offshore operations in the Norton Sound and possibly other areas of the Bering Sea.

Before the discussion continues, it is worth noting that there are several reasons why Wieland's local labor-supply and settlement model and Kenai's economic development are" not representative or applicable to residency patterns of OCS workers elsewhere in Alaska. First and foremost, most rural Alaska communities are linked to regional trade centers only by air and marine transportation. Alaska's limited road network in rural coastal areas poses a significant discrepancy in the overall comparability of Northern Great Plains local hire and settlement patterns, no matter how similar other features of coastal Alaska and NGP may be. This important physical characteristic also distinguishes Kenai (linked by road to Anchorage) from coastal communities in western and northern Alaska. It limits the ability of inhabitants of communities surrounding the site of a shore-base facility to commute regularly for employment. A potential onshore OCS employee from a nearby isolated community would be required to move wholly to the shore-base facility location to participate in a regular 8-hour-a-day work shift. The problem is not as critical for offshore workers who regularly spend lengthy periods on a platform, both during and between work shifts.

Second, the advanced technology required for exploratory and development phase OCS activity implies more rigorous skill requirements than that found in the NGP construction employment data base. Third, Wieland's (1977) local hire and labor settlement models do not explicitly account for the availability of specific community services such as adequate housing, nor do they account for company policies regarding local hire and settlement.[6]

Even if Wieland's model were estimated with Alaska data, serious shortcomings still remain regarding its applicability to OCS resident patterns in rural Alaska.

North Sea Resident Patterns

The effects of North Sea oil development on resident patterns in Scotland present an interesting and possibly useful model for residential patterns of Alaska OCS workers. However, several important differences temper the compatibility of Scottish and Alaskan OCS development. Lewis and McNicoll (1978) point out that roughly half of Scotland's total direct oil-related employment is involved in platform and module fabrication, suggesting an extra dimension to Scotland's offshore petroleum industry not found in Alaska.

[6]One could argue that these and other factors are implicitly embedded in the community size variable which was used as a proxy for community attractiveness including the community's ability to deliver basic services.

Furthermore, within Scotland's nonmanufacturing sector, oil companies stipulate that changeover crews for platforms are required to hire within 20 miles of the shore-base port of entry, a policy that in many cases would not be practical in Alaska. The effect of such a policy may be reflected in the Scottish community of Aberdeen which, like Kenai, is situated close to offshore activity and already had in place a somewhat developed housing, finance, and service infrastructure at the time of initial offshore commercial discoveries. Between 60 and 80 percent of offshore platform employment for several North Sea operations resided in Aberdeen.

In addition to the effects of oil company resident-location policies, Lewis and McNicoll observed that training programs were not widespread in the Scottish offshore oil industry. Oil companies typically offer high wages to attract skilled labor from other companies and communities. Sometimes in outlying regions with predominantly unskilled labor, oil companies will instigate large-scale "green labor" training programs. Firms that are only partially involved in oil-related work exhibit considerably more training effort. Apprentices of partially involved companies accounted for 66 percent of the workforce, compared to only 1.5 percent for apprentices in "wholly involved" firms.

Scotland's Shetland Islands function as a "forward" onshore link for offshore operations in a complex of North Sea discoveries. Situated about 100 miles north of Scotland, Shetland represents a remote, isolated and underpopulated area having social and geographic similarities to several of Alaska's prospective shore-base sites for future OCS lease sales. The Shetland site provides a forward location for transportation, communication, storage, and warehousing services but does not function as a main service base. As shown in Table 41, only a modest proportion of annual expenditures made by local oil and gas operations affects Shetland's economy. The "leakage" reflected in Table 41 (about 85 percent) probably represents a conservative measure of the nonlocal offshore employment that was transient to Shetland's local economy.

The forward. logistics function exhibited by the Shetland's oil support base suggests a plausible model for several remote Alaska communities favorably situated near future offshore 'lease sale areas. Based on the analysis of Tremont (1981), a wide range of development scenarios could occur in the Bering Sea and Norton Sound, depending on the timing, extent, and configuration of discoveries and the environmental challenges unique to each lease sale area.

TABLE 41. THE PROPORTION OF ANNUAL EXPENDITURES MADE IN THE SHETLAND ISLANDS, BY LOCAL OIL ACTIVITY

Local Oil Activity	Proportion of Total Annual Expenditures
Service Base Purchases	15%
Terminal	15%
Oil-related Construction	1 %

SOURCE: T. M. Lewis and I. H. McNicoll, North Sea Oil and Scotland's Economic Prospects (London: Groom Helm, 1978).

The exploration-phase support infrastructure could range from forward, marine and air transport, shore-base sites at one extreme to floating warehouse barges anchored near the drill site. The principal shore-base locations sited by Tremont (1981) for Bering Sea and Norton Sound OCS development include Nome, Dutch Harbor, and St. Matthew Island. According to Tremont, the floating warehouse alternative would be supplied by shipments from distribution centers outside of the sale area, thus shifting much of the downward support function and the probable resident employment impacts away from shore-base communities. The floating warehouse option would be preferred over a shore-base location because of shallow ocean depth, excessive seismicity, harbor congestion, and isolated discovery.

During development and production, the key shift variable to the forward support base concept is whether offshore loading or processing is favored over the emplacement of a shore-base storage and processing terminal. In either case, the construction and ultimately production workers will be housed in temporary quarters near the construction site or hotel platforms such as those used in the North Sea. The local community employment and infrastructure impacts may be further reduced by placing terminal facilities several miles outside of the immediate city limits such as at Cape Nome, 12 miles east of the city of Nome.

In the event of successive multiple commercial discoveries in adjacent sale areas (e.g., Norton Sound and Navarin Basin), Tremont (1981) suggests that an existing forward support structure located near one discovery would be sufficient to handle the logistics requirements of another, possibly confining the range of community impacts and the extent of local employment.

To summarize, even in the event of sizable commercial discoveries, the forward logistics function exhibited at the Shetland Islands as a jumping-off point for North Sea operations would probably be used in communities near Alaska OCS sale areas, although to a lesser extent if the floating warehouse and offshore loading options are exercised.

Meanwhile, Anchorage and Kenai would continue to function in their respective capacities as permanent bases for oil company headquarters and oil service companies that operate in offshore Alaska waters. George Day of Chevron USA expects that Kenai service companies will be bidding on conventional onshore support activities such as pipework, buildings fabrication, and professional and technical services related to future exploration and development in western Alaska offshore areas. Day noted that several service companies headquartered in Kenai are presently performing contract work on the North Slope. Day tempered his expectations by noting that future offshore exploratory activity will probably not draw much employment from Alaska's labor force.

To the extent that resident employment does occur, the forward-support concept suggests that it will draw primarily from the resident population of Anchorage and Kenai and remain largely transient to local communities in the proximity of lease sale areas, especially during exportation and construction.

SUMMARY

In summary, the thrust of the above discussion on local hire and settlement revolved around two plausible models of community development in the context of future OCS activity. The first model--the Kenai case--suggests that a full and comprehensive oil and gas service sector would gradually develop and become capable of servicing many petroleum development functions. The expansion of this service company industrial base would be coincident with the pace of oil and gas resource development in the adjacent offshore areas. The proportion of OCS employment that would be drawn from local labor supply or would migrate into the community would be a function primarily of the size of the service base relative to other economic activity in the community (measured by employment) and relative to the size of the community itself. Furthermore, the share of resident employment from Upper Cook Operations (Table 39) acts as an upper limit which other oil-impacted communities would approach but not surpass over the course of OCS development.

The alternative model borrows from the North Sea experience and the limited logistics role played by the Shetland Islands "forward" support base. Alaska's geography and climate and its marine/air dependent transportation network are two reasons why a central operations base for industry and service company headquarters in Kenai and Anchorage, supported by a network of forward links to direct offshore activity, is both plausible and possibly advantageous from a logistics standpoint. Except for a major discovery, it is unlikely that oil and gas service companies will settle in relatively remote sites to conduct operations. Given the vast regions of OCS activity in Alaska, it would be more advantageous to operate centrally rather than to be confined to a single high-risk location. By providing increased mobility in OCS regions, the forward support link concept would help to reduce the capital investment required by numerous companies to develop a commercial resource. Of course, the possible investment savings would be counterbalanced to some degree by the high cost of transporting extra nonlocal labor.

The effect of forward support on local hire and settlement would at best be limited. During exploration and development, most resident OCS employees would probably commute to Anchorage and Kenai during changeover shifts. Production crews may eventually occupy the same temporary facilities previously used by construction employees (Tremont, 1981), although a somewhat larger local-hire component would be expected during the production phase. In general, we do not expect the local hire and settlement employment out of total production-phase, OCS employment to exceed 15 percent, the proportion of local, oil-related expenditures captured by Shetland's local economy.

Using the employment task breakdown in Table 39 for Kenai, we have developed a set of estimates for the proportion of total direct OCS employment that would be drawn from local labor supply and settlement. These are shown in Table 42 for the full support base and forward support base scenarios. The estimates are based on the adjustment factors derived from relative measures of basic sector activity in several prospective OCS communities, using Kenai construction and mining employment in 1974 as a reference point. In the full support base scenario, the mid-point (22 percent) and upper-bound (35 percent] measures were used to adjust the Kenai resident OCS employment proportions from Table 39. In the forward support base scenario, the lower-bound measures (10 percent) were applied. The estimates in Table 42 are admittedly arbitrary and have no statistical foundation. These limitations reflect the relatively early stage, dynamic technology, and frontier nature of OCS petroleum development both in Alaska and elsewhere.

The primary distinction between the full service base and forward support base scenarios is in the quantity of local employment generated under each. Furthermore, the full service base scenario has an inherently greater potential for growth as more oil and gas service companies establish branch offices or permanent bases in a given community.

TABLE 42. LOCAL RESIDENT OCS EMPLOYMENT ESTIMATES
(Percent)

Employment Category	Full Service Base	Forward Support Base	
		Shorebase	Floating Warehouse and Offshore Loading
OFFSHORE			
Platforms and Supply Boats	18 - 28	8	0
Barges and Exploration Rigs	0	0	0
ONSHORE			
Service Bases	22 - 35	10	0
Administrative	0	0	0
Rig Service	11 - 18	5	0
Platform Service	11 - 18	5	0
Terminal Operation	15 - 23	7	0
Construction	22- 35	10	0

SOURCE: See text..

<u>Oil Company Policy</u>

Before closing, we would like to address the role of oil company hiring and employment policies as a determinant of resident status, discussed briefly in Part III. Clearly, the oil companies and oil and gas service companies will influence resident patterns through the mix of incentives they create with a variety of employment benefits. One important determinant of residency patterns is the amount of travel expense companies are willing to cover for their employees.

Representatives of both ARCO Alaska, Inc., and Parker Drilling indicated that their company's rotation leave policies cover transportation to major distribution points in Alaska, mainly Anchorage and Fairbanks. Jim Posey of ARCO indicated that even Kenai residents are responsible for transportation costs from Anchorage to Kenai, just as residents of Lower 48 cities would have to cover travel costs between Anchorage and their home port.

Mike Balich of Parker Drilling commented that despite this policy, Parker Drilling crews typically maintain permanent residence outside of Alaska and work part of the year in their home states and part of the year in Alaska. Most out-of-state Parker employees continue to commute to their out-of-state homes during rotation leave. Balich added that wages in the range of $60-to-$65 thousand for eight months of work are usually sufficient to justify the personal expense. He argued that job stability was a more critical determinant of residency than company leave benefits, According to Balich, when Parker dismisses its employees at the completion of a drilling job, they literally disperse to their homes or to other drilling jobs in the Lower 48. Even with the high wages, Balich is uncertain about the likelihood of rehiring those highly skilled people when the next major job begins.

The comments made by Bal ich and others tend to confirm the highly mobile offshore drilling labor market, a characteristic explained at least in part by a consistent U.S. oil company policy of high wage premiums to attract skilled, experienced labor without favoring one residential location over another. The U.S. offshore oil industry exhibits a policy of non-interference in resident status as compared with the offshore industry in Scotland which, in some cases, stipulates resident location boundaries.

Another potentially important determinant of OCS resident patterns is oil company policy toward training. There presently does not appear to be a major industry-wide effort to train offshore craft labor. Instead, wage premiums appear to be the usual device used by the oil industry to attract skilled labor to increasingly remote and technically demanding geographic petroleum-development areas. The oil industry, however, faces high turnover and mobility in both professional and craft personnel which can leave an oil region critically short of available skilled labor. The mobility of the oil-industry workforce is also costly in terms of local and regional labor market disruption caused by large workforce shifts and by wage adjustments.

Although not involved in offshore drilling, VECO-NANA Development Corporation of Alaska has trained and provided jobs for 24 Kotzebue area residents working on North Slope drilling rigs. Native residents of the Kotzebue region receive eight weeks of training at the Seward Skill Center and receive jobs on drilling rigs contracted by North Slope operators. According to Bill Zachares of NANA Development Corporation, it is difficult for Native residents of Kotzebue that have completed training to fully integrate into the permanent and rigorous, on/off, 100-hour-work week that North Slope drilling requires. Currently, there are about 40 Kotzebue residents working steadily on the Slope. On average, those with training are upgraded sooner than those without. Zachares indicated that despite the high attrition rate, virtually all Kotzebue residents that work on the Slope return to Kotzebue during rotation leave. In this case, VECO-NANA covers transportation costs to Kotzebue, the home base.

The authors were unable to learn of any other training programs for extreme offshore drilling in Alaska. It is possible that some onshore drilling skills could be applied to an offshore situation during the production phase. Major inroads in local hire from training for offshore exploratory and development drilling employment are not likely in the foreseeable future.

Conclusion

The main purpose of this study is to examine critically the original SEAR assumptions and, if possible, to improve them. The findings in Part II have resulted in several adjustments to the original statewide SEAR factors. The original and revised estimates are summarized in Table 18. Note that in the original SEAR assumptions, a modest growth factor was applied to the current resident proportions to account for changes over time induced primarily by an expanding supply of labor and by gradual shifts toward Alaska residence. For the time being, we have omitted this kind of trend assumption in order to focus attention on current resident patterns. In effect, we assume that over the long run, OCS resident patterns do not change appreciably.

On the whole, the revised SEAR factors do not differ significantly from the originals. The biggest changes occur primarly during the exploration and development phases. In two cases, the revised SEAR was reduced to zero, meaning that strictly nonresidents will work on those activities--both related to offshore exploratory and development drilling. The overall effect of these revisions is not likely to change appreciably past impact analyses under the original SEAR assumptions.

Broadly speaking, the most important historical determinants of Ocs resident status in Alaska are the phase of the project and whether the work task is on- or offshore. Both of these key variables capture the effects of job task duration and skills. Other characteristics of the project such as scale and distance from base and population centers play a less certain role in determining resident patterns in this rapidly changing, specialized branch of the petroleum industry. The only work task categories that have historically exhibited exclusive resident contributions are oil company personnel, government, air support, and part-time employment--comprising about 20 percent of total direct project employment.

The local community resident patterns discussed in Part III add a new dimension to the regional SEAR assumptions. The estimates in Table 43 can function as guidelines to the development of resident patterns on the regional and local level. The thrust of the discussions on local resident patterns suggests that Anchorage and the immediate surrounding area will continue to function as the primary location for industry headquarters and resident OCS employees. The role played by local communities will depend critically on the size and specific location of a discovery.

In general, the number of resident employees in future OCS lease sale projects will probably not grow appreciably. Offshore drilling is too specialized, and Alaska's OCS petroleum potential still remains too uncertain to expect a significant resident contribution.

TABLE 43. SHARE OF OCS EMPLOYMENT TO ALASKAN RESIDENTS: ORIGINAL AND REVISED

Employment Activity	Phase of Development	Original SEAR Factor	Revised SEAR Factor
ONSHORE			
1. Service Base	Exploration	1.0	1.0
	Development	1.0	.35
	Production	1.0	1.0
2. Helicopter Service	Exploration	.5	1.0
	Development	.5	1.0
	Production	1.0	1.0
3. Service Base Construction	Development	.5	.5
4. Pipe Coating	Development	.2	.35
5. Onshore Pipeline Const.	Development	.2	.35
6. Oil Terminal Construction	Development	.5	.5
7. LNG Plant Construction	Development	.5	.5
8. Concrete Platform Const.	Development	NA	NA
9. Oil Terminal Operations	Production	1.0	1.0
10. LNG Plant Operations	Production	1.0	1.0
OFFSHORE			
11. Surveys	Exploration	.2	1.0
12. Rigs	Exploration	.2	0
13. Platforms	Development	.1	0
	Production	1.0	.95
14. Platform Installation	Development	.1	.25
15. Offshore Pipeline Const.	Development	.1	.25
16. Supply-Anchor-Tugboats	Exploration	.4	.15
	Development	.8	.15
	Production	.8	.95

NA = Not Applicable

SOURCE: See text.

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V.

STRUCTURAL CHANGE, ECONOMIC GROWTH, AND THE ALASKA ECONOMY

by

Lee Huskey

ABSTRACT

Structural Change, Economic Growth,

and the Alaska Economy

This paper focuses on the relation between the Alaska economy's structure and its growth. The economy's structure and its growth are related in two ways. First, the structure will be affected by its growth. The scale of the economy and the type of growth genersting activity affect the level and type of supporting activity. Secondly, the structure will affect the economy's growth. The economic growth generated in response to exogenous change, such as the introduction of new industry, 'will depend on the economy's structure. The structure may also determine which exogenous activities take place in a region by its influence on costs.

The paper focuses on the relation between structure and growth because a change in the structure may be an important response of the Alaska economy to OCS development. The relatively immature character of the Alaska economy increases the probability that the structure will change.

The paper examines the primary reasons for structural change: changes in demand, changes in technology, export expansion, and import substitution. The focus is on export expansion and import substitution as the primary reasons for regional structure change. The importance of the link between the size of the market, production costs, and import substitution is examined.

Past economic growth is examined for evidence of structural change. Shifts in the share of employment indicate that structural change has occurred. The major type of structural change was in response to the increase in the size of the market. The major sector experiencing structural change is the service sector.

The extent of future change was examined by comparing the structure projected by the MAP model with the structure of places of similar size (population was used as a proxy for market size). The MAP model projections seemed reasonable in the comparison. The model projects a limited structural change when compared to historical change.

STRUCTURAL CHANGE, ECONOMIC GROWTH, AND THE ALASKA ECONOMY

Introduction

The structure of an economy is defined by the relation between its various industrial sectors. These relationships determine the flow of goods and services in the economy. The structure influences the magnitude of income and employment as well as the economy's seasonal and cyclical stability.

The structure of the economy changes as the economy matures. Structural change is one of the traditional measures of economic development. Economic development is the process of self-sustaining growth. Self sustaining growth requires that the economy have the ability to shift from one activity to another as resources and markets change. Structural change occurs because of variations in sectoral growth rates.

This paper will focus on the relation between the Alaska economy's structure and its growth. The economy's structure and its growth are related in two ways. First, the structure of the economy will be affected by its growth. The scale of the economy and the type of growth-generating activity affect the level and type of supporting activity. Secondly, the structure will affect the economy's growth. The economic growth generated in response to exogenous change such as the introduction of a new industry will depend on the economy's structure. The structure may also determine which exogenous activities take place in the region because it influences costs.

Our concern with the relation between structure and growth is heightened because of the scale of the Alaska economy. The Alaska economy is small when measured in terms of population, income, or employment. In small economies, exogenous activities, such as resource development, are nonmarginal and will affect the economy's structure.

When nonmarginal change occurs, the traditional approach to estimating the total effect of that change on the economy may be inaccurate. The traditional approach to impact projection uses a multiplier to forecast the effect of an exogenous change in the economy. The simple multiplier analysis assumes no change in the structure of the economy. If growth affects the structure of the economy, then the traditional multiplier analysis may incorrectly estimate the response of the economy to exogenous change. This problem is not unique to Alaska but also exists in other relatively sparsely settled, resource-rich regions. Understanding the relation between economic growth and structural change will help our explanation of the impact of major economic activity on an economy.

The next section will present a theoretical description of structural change in a small economy. Historic change in the Alaska economy will be examined to test hypotheses developed in the first section. Finally, cross-sectional analysis will be applied to examine the structural change projected by the MAP state model.

Determinants of Structural Change

Structural change results because of variation in growth across sectors. If all sectors grew proportionally, there would be no change in the economy's structure. In most cases, however, proportional growth does not occur. This section will examine the major reasons for nonproportional sector growth.

Chenery (Chenery, 1979) has identified four reasons for the variation in growth across sectors. These are export expansion, changes in the pattern of domestic demand, changes in technology, and import substitution. In most models of regional growth, growth is generated by increases in exports to other regions. As the type of exports change, the structure of the economy will change both because the export industry is different and because the inputs this industry uses are different. The economy of Alaska changed substantially as it shifted from a fisheries to an oil based economy.

As income and prices change, the structure of consumption will change. Changes in incomes and prices can be expected as a result of economic growth. Kuznets suggested that changes in demand were an important determinant for the changes he found examining countries both over time and cross sectionally (Kuznets, 1959). If demand changes and those products are produced locally, this will result in changes in the industrial structure of the economy.

Technical change is another reason for changes in industrial structure. Changes in technology may change the type of goods consumed and the way goods are produced. Changes in the resources used may change the location of production. Shifts in the production function will affect the location of production and the structure of the regional economy.

The final reason for structural change is import substitution. Import substitution is the replacement of goods which were previously imported to the region by local production. The establishment of local firms which produce these goods and services changes the structure of the economy.

In reality, structural change occurs because of the complex interaction of each of these. The four determinants described above will most likely work in combination. Technological change may make import substitution or export expansion possible; recent innovations have allowed steel production to move into smaller regional economies. Changes in demand may expand local markets in such a way that local production of a good becomes profitable. Export expansion may affect domestic demand because of the type of population which enters the region as a result of the production.

In this analysis, we will be most interested in analyzing the effect of export expansion and import substitution on the structure of the Alaska economy. This is not to say that technological change and changing domestic demand are not important; our limited interest in these is a result of two factors. First, changing technology and tastes are primarily national phenomenon. The second reason for emphasizing export expansion and import substitution is the ultimate purpose of this study. We wish to develop an understanding of the process of structural change which can be incorporated into a traditional regional modeling approach to economic forecasting. The traditional approach treats regional economic growth as the response of the local support sector to exogenous changes. The primary exogenous change is export expansion, while the response of the support sector is affected by import substitution. For these reasons, we will concentrate on the effects of import substitution and export expansion on structural change in the Alaska economy.

The Growth of the Alaska Economy

Traditionally, regional economic growth is described by some form of economic base theory. The major tenet of economic base theory is that regional economies grow as a result of increased export activity. The determinants of export activity and regional growth are external to the region. Although refinements to the theory have been made, such as expanding the list of growth determinants to all income-generating activity, export growth is assumed to be a major reason for regional growth.

Economic base theory describes an economy in terms of two general sectors, the export sector and the local support sector. The local support sector is assumed to be a passive sector which serves the export sector and associated population. The support sector is assumed to grow in response to growth in the export sector. The relationship between the export sector and the local support sector is described by a multiplier similar to the Keynesian income or foreign trade multiplier, The multiplier shows how much the support sector will grow in response to growth in the export sector.

Economic base theory has many problems, both theoretical and analytical. One primary theoretical problem is that it ignores the effect of supply factors such as transport costs and wages on the size of the export sector. These costs are a function of the size and diversity of the local support sector. This introduces the concept of a feedback between the support sector and export growth (Tiebout, 1956). A major analytical problem is the definition of export and support sectors; all industries have export and support functions, and it is difficult to distinguish which part of the industry plays which role (Leven, 1964). In spite of these problems, economic base theory is widely used in regional analysis.

In most applications, the multiplier is assumed to be static; it does not change in response to a change in export activity. This assumption is not adequate for examining nonmarginal changes. Our interest in this study is in the structural change which accompanies growth: in other words, how the multiplier changes as the economy expands. The concepts of economic base theory provide a useful shorthand which we will use through the study. We will examine how the relation between the support sector and export sector changes with economic growth.

The changing relationship between export and support sectors is the result of different rates of sector growth. Both import substitution and export expansion affect the economy's structure by causing different sectors to expand at different rates. Import substitution results in a nonproportional expansion of the local support sector as local production replaces imports. Export expansion leads to nonproportional growth of certain sectors in two ways. First, the importance of various exports changes with changes in market forces, resulting in different rates of growth for different export sectors. Secondly, the inputs used by different export sectors differ so that growth in those industries which support export activity directly will differ. What follows is a description of the economic growth process at work in Alaska which emphasizes the determinants of export expansion and import substitution.

EXPORT EXPANSION

Alaska is an immature, frontier economy; these attributes affect the character of the economy's growth. Alaska's economy is immature, not underdeveloped. Underdeveloped is too strong a term since it usually connotes low incomes and underemployment of labor. Alaska, except for some rural areas, has incomes similar to other areas of the United States. The economy is immature because it does not provide the full range of economic services.

The contradiction between the existence of high incomes and the immaturity of the economic systems results from the frontier nature of the economy. A frontier is a region beyond the settled areas; frontier regions are lightly populated. The most important economic effect of the low population density is that these regions have a high level of resources per capita. This accounts for the high incomes, while the low density accounts for the economy's immaturity,

The primary cause of growth in frontier regions is the development of natural resources. Alaska has followed this pattern, with natural resource development being the major reason for growth; the exploitation of furs, fish, gold, and Alaska's strategic position all resulted in major expansions of the economy. More recently, petroleum development has provided the growth impetus.

A major economic result in frontier economies is that most capital and labor used in the production of these resources must be imported. This results primarily from the low levels of population and economic activity in these regions. The importation of these inputs is a primary part of the growth process.

Canadian economists, beginning with Harold Innis (Watkins, 1972), have developed a theory which describes growth in frontier-type economies. In describing the historical growth of the Canadian economy, the Staple Theory of Economic Growth was developed. The theory describes the important links between economic growth and structural change.

How does economic development occur in frontier economies? Staple (natural resource) exports are the leading sector of economic growth. Growth occurs as capital and labor are imported to develop these resources. Economic development occurs as the process of diversification around the staple base.

The diversification of the economy around the production of natural resources is part of the process of structural change. Staple theory describes the diversification in more detail than traditional economic base theory. The diversification is determined by the characteristics of the staple export. The production function, which describes the way the staple is produced, determines the extent of the economic development effects of staple production. Such things as the nature of the technology used, the degree that factors can be substituted, and the nature of returns to scale determine the incomes generated, population impact, and demand for intermediate goods and services.

The economic development effects of resource production can be described in terms of three linkage effects. First, backward linkages to the resource production may occur if there is an inducement to produce inputs used by the resource production. These backward linkages will be influenced by the size of resource production which determines the market for these inputs. Backward links will also depend on the cost of producing these inputs in the region. Backward linkages are also affected by the organizational structure of the resource industry. Chinitz (Chinitz, 1961) has pointed out the relation between industrial structure and local support sector growth; larger corporate firms may provide more of the services they need internally and provide limited reason for support sector growth.

The second linkage is the forward linkage. Forward linkages occur if there is an inducement to invest locally in industries which use the resource output as the input. The same set of conditions will influence the strength of the forward linkages, although in different ways. The size of the local market for the product and the relative costs of shipping the raw and processed product will affect the use of the resource as an input. If the local market is large enough to allow profitable production, forward linkages will occur. If the production process results in significant reduction in transport costs, such as by weight or bulk reduction, we would expect local production independent of the size of the local market. Cost of production will also be affected by the size of the resource production.

The third linkage described by staple theory is the final demand linkage. As labor is imported into the region to produce the resource, this labor will require consumer goods and services. The final demand linkage is the inducement to invest in the local production of consumer goods and services. The strength of the final demand linkage depends on the effects of resource production on employment and income distribution. The number of employees, the residency of employment*, and the level of income earned in these industries determines the size of the local market. The important point is that there is no necessary direct link between resource production and market size. Each resource will have a different effect, not only because of the size of development, but also because of the type of people brought to the region. Rogers points to the importance of this in describing the economic effects of the post-World War II military government in Alaska:

> The people who came with military Alaska were not independent, self-sufficient agricultural pioneers of past centuries, but members of mid-twentieth century America's urban-industrial society. They required and expected the same standards of community living and services available elsewhere, and the economic prosperity which accompanied their coming made it possible to meet these demands. This expansion and change in nature of Alaska's population increased the importance of political development and brought to life movements culminating in the signing of the State Proclamation by President Eisenhower on 3 January 1959. (Kresge, et al, 1977, p. 45)

Each natural resource produced affects the structure of the economy differently, depending on its size, input demands, and affect on population.

The structure of the local economy also affects the growth of the export sector through its effect on costs. The cost of production will determine the extent of resource production in the region. The

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*Resource development may occur in enclaves which have no real economic links with the region in which the development occurs. In this case, the employees' final demand effects occur where they live, which may be outside of the region.

development of support services to the industry and population affects the cost of production and so the natural resource export sector. The lack of a well-developed support sector results in high costs of production which limit the export production in Alaska to only the most valuable [highest "grade) exports.

IMPORT SUBSTITUTION

Import substitution is one of the major factors responsible for the changing pattern of industrial production during economic development (Chenery, 1960). As a region grows, there are two types of responses in the local support sector: expansion and deepening. Expansion results in the proportional increase in the size of the sector as those activities which are in the region expand to serve the increased population. Support sector deepening occurs as economic activities which were not previously in the economy are developed. Support sector deepening is the process of import substitution; this section will discuss the determinants of import substitution in the Alaska economy.

As a region's economy grows, the market for various goods and services grows. The market for a good is determined by the demand for the good in the region. The demand for the good depends on the price of the good, the income of the residents, the number of residents, and the residents' tastes. Growth will primarily affect the income and number of residents. Growth of each of these will affect the market for different goods differently.

Growth in total regional income results from some combination of increasing per capita income and increasing population. An illustration of the different effects of different types of growth can be obtained by examining the extremes. If only population increased, the market for goods and services would expand proportionately. If only per capita incomes increased, the expansion of markets for goods and services would depend on how individuals allocate their increased incomes across different goods and services. This is measured by the goods income elasticity; income elasticity is a measure of the proportional increase in consumption of a good with a one percent increase in income. For example, haircuts may have an income elasticity of zero; so that as the population increased, the number of haircuts demanded would increase, but if only per capita incomes increased, there would be no increase in the demand for haircuts.

Economies of Scale

Alaska is an open economy which affects the extent of import substitution which occurs. An open economy has little control of the flow of goods and services over its borders. Since Alaska is part of the U.S. economy, it cannot control the flow of goods and services from other regions in the United States. In open economies, changes in demand which result from growth may only change the distribution of imports unless supply conditions result in local production of the good.

Growth does alter the supply conditions within a region. The primary reason for changes in regional production conditions as an economy grows is the existence of economies of scale in production. Scale economies exist when the average cost of production decreases as the number of units produced increases. The usual description of a firm's cost assumes a declining average cost over some portion of production which reaches a minimum at some point. Scale economies do not exist in all production processes, nor do they exist uniformly. There is no reason to believe the rate of decline in average cost or minimum cost point should be the same for all goods and services.

There are three important classes of economies of scale: those internal to the firm, those internal to the industry, and those which are external to any industry. Each type affects import substitution differently; the first two are specific to the expansion of a particular market while the third type results from the general expansion of the economy.

When the market for a firm's product expands, the firm can increase its production. Increasing production allows a per unit cost reduction as the firm specializes the use of its inputs. Division of labor, as Adam Smith pointed out, allows workers to gain proficiency in their tasks and to reduce time lost by shifting among tasks. Technological cost reductions result from allowing the use of specific machines in production and a more efficient use of different machines with differing optimal levels of production. Larger scale by reducing the proportional costs of investing in machinery may allow a qualitative change in equipment.

The expansion of an industry in a region will also lower the cost of production to individual firms in the industry. The primary reason for this is the expansion of the input markets which serve these firms. For example, as the industry expands, a large skilled-labor pool will become available to the industry, which reduces both training costs and time lost in hiring. Markets for other inputs specific to the industry, both raw materials and produced goods, may also form as industry grows. As the industry expands, it allows specialization among the producers of its inputs which reduces their cost. Each of these changes has the effect of lowering the firms' average cost of production.

In addition to the economies of scale associated with the growth in the market for a particular good or service, a firm's per unit costs can be reduced by the growth of the general economy. There are three primary reasons for this effect. First, as an economy grows, the services provided to a firm will improve. Improved transport services, a large more flexible labor market, increased commercial and financial services, and improved public services all help to reduce a firm's per unit cost.

Secondly, more firms in one place allow a finer specialization of functions among firms which results in a lower average cost of production. For example, a firm can rent equipment instead of buying it. Specialists such as lawyers, engineers, and business consultants are also available.

Finally, larger markets reduce the fluctuations in supply and demand that a firm faces. Sales and purchases fluctuate in many firms and industries. If these fluctuations are not correlated among all industries in a region, the larger markets will reduce the fluctuations the firm faces in its sales. ‘This allows firms to hold smaller inventories and employ smoother production schedules.

Firms will move into a region if they can profitably operate there; the size of the market where this occurs is called the firm’s threshold. Profitability will be determined by the price which can be charged and the cost of producing the product. Economies of scale provide a mechanism which changes costs as the market grows. Prices which can be charged in an open region are determined by the price of imports which is a function of the cost of producing the good and transporting it from outside the region. The extent of import substitution is determined by the nexus of production costs in each region and the cost of transportation between regions.

Limitations

Since we have seen that growth works to affect the cost of production, can we assume growth will always lead to import substitution? Two factors affect the relation between increasing scale and import substitution; these are the effect of scale on transport costs and technology (Nourse, 1968). Transport costs also change with the scale of markets. Larger markets allow specialization in transportation services such as port facilities or freight consolidation and make more efficient systems available. This effect on costs may counteract the decrease in costs of production enough to eliminate the potential for import substitution. In fact, since transport costs serve as protection for the local production, increased scale may lead to the elimination of certain activities as transport costs are lowered.

The second factor affecting the relationship between import substitution and scale is technology. Technological improvements to transportation which lower costs will have effects similar to those described above. Technology also changes the cost of production. Improvements in the way things are produced lower the cost of production. Technology may reduce production costs for all levels of production. If these effects occur independent of region, this will tend to delay the threshold of import substitution. Technology may also influence cost just over certain ranges of production. If technological advancement reduces costs over smaller ranges of production such as has occurred for some steel-making processes, this will lower the threshold for import substitution. Technology has been hypothesized to be biased toward large-scale production since this is the range of production with the greatest return from cost savings. If this is the case, technology would be biased against import substitution.

The process of import substitution is not automatic. The forces of market size are permissive forces which, while they allow the process of import substitution to occur, they do not guarantee its occurrence. There are two general, related reasons import substitution is not automatic: the entrepreneur and historical relations. Each explains why profitable opportunities may not be undertaken in a region.

Entrepreneurship is the capacity for innovation, investment, and activist expansion in new markets, products, and techniques. Entrepreneurs both perceive the market opportunities and are willing to take the risk involved with investment. The supply of entrepreneurs is an important factor in taking advantage of the opportunities for import substitution. The possible limitation on entrepreneurial talent in small economies like Alaska may be responsible for an underinvestment in import substituting activities. There are many feasible explanations for a limited supply of entrepreneurs in small economies. Not everyone possesses the skills and desires to be an entrepreneur; the small population would, in an actuarial sense, reduce the supply of potential entrepreneurs. The supply of entrepreneurs may also be limited by the alternative opportunities. Small, growing economies provide the ability to earn high incomes in other activities, for example, high wages may be earned with no risk or high returns may be achieved in rent-seeking activities such as land speculation.

Limits on the flow of information between regions and the uncertainties which occur because of distance limit the flow of entrepreneurs from other regions. Entrepreneurs, because they wish to limit the uncertainty they face, search for investment in regions they know. This constraint means that the supply of local entrepreneurs is important for import substitution.

Historic relationships between the region and national economies which were created when local markets were smaller may continue to give dominance to outside production even as local markets become large. This dominance occurs primarily through the investment of capital. Capital, although it is usually assumed to be perfectly mobile, may not flow to new regions. Capital is highly immobile; capital quickly takes a stock form such as buildings; replacement takes place only incrementally. The existence of fixed capital affects future regional investment decisions. Subjective preferences of investors may result in their investing where they feel more comfortable, rather than where they maximize their return. Capital may flow to areas with higher average (not marginal) rates of return because of assumed high risks in those areas in which marginal returns are higher.

Pattern of Economic Growth and Structural Change in Alaska

The model of Alaska economic growth developed above illustrates the relationship between the expansion of the export and support sectors. The leading sector in the economy's growth is natural resource production. As this grows, the local support sector grows, but this change is not simply a proportional expansion. The support sector expansion depends on the size of the local market and the type of resource produced. Finally, the support sector, because it affects costs of production, will influence the future resource production.

This model suggests why the structure of the economy will change with growth. We would expect the following to be true of Alaska growth and structural change:

1. The response of the support sector will depend on the extent growth occurs through" increasing incomes or population.
2. The response of the support sector will depend on which export sectors expand.
3. Technological innovations will be a reason for past differences in the extent of structural change.
4. We would expect the following types of industries to appear earlier in the Alaska economy:
    a. Industries with large transport cost components.
    b. Industries which gain economies of scale at low levels of production.
    c. Industries which are linked to those basic sector activities which expanded in the region.

Past Structural Change

Table 44 shows that structural change has been a phenomenon which has accompanied the growth of the Alaska economy. Between 1960 and 1978, total nonagricultural wage and salary employment has approximately tripled, growing by 106,300. This growth has not occurred proportionately across the sectors, but different sectors have grown at different rates. Major changes can be seen in those sectors traditionally assumed to be support sectors: trade, services, transportation, and finance. These sectors as a whole increased from 38 percent of total employment in 1960 to 50 percent in 1978. This nonproportional expansion is primarily a result of import substitution.

The structure of the basic sector has also changed during this period. Although the share of government has remained fairly constant throughout the period, the state and local government have increased their share while the share of federal government has declined. The construction of the TransAlaska Pipeline between 1974 and 1976 increased the share of construction relative to the other industries in the state during that period. Mining has increased its share from 1.9 to 3.4 percent over the period. These differential growth rates have changed the character of the basic sector.

The response of the support sector industries of trade, transportation, finance, and services to growth generated by the construction of the pipeline and associated petroleum development offers insight to

TABLE 44. CIVILIAN EMPLOYMENT, 1960, 1970-1978, BY BROAD INDUSTRY CLASSIFICATION
(percentage)

	1960	1970	1971	1972	1973	1974	1975	1976	1977	1978
Nonagricultural Wage and Salary Employment	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Mining	1.9	3.2	2.5	2.0	1.8	2.3	2.3	2.3	3.0	3,4
Contract Construction	10.4	7.5	7.6	7.5	7.0	10.9	15.8	17.4	11.7	7.5
Manufacturing	10.1	8.4	8.0	7.7	8.5	7.4	5.9	5.9	6.6	7.0
Food Processing	4.9	4.0	3.7	3.5	4.1	3.3	2.6	2.9	3.3	3.9
Logging, Lumber, and Pulp	3.9	3.0	2.9	2.7	2.9	2.8	2.1	1.8	2.1	1.1
Transportation, Communications, and Public Utilities	12.0	9.8	10.0	9.5	9.4	9.6	10.1	9.1	9.4	11.0
Trade	13.5	16.6	16.5	16.2	16.5	16.3	16.0	15.9	17.2	17.6
Finance, Insurance, and Real Estate	2.5	3.4	3.3	3.5	3.8	3.8	3.7	4.1	4.7	5.0
Services	9.8	12,3	12.8	13.3	13.7	14.1	15.3	16.0	16.5	16.9
Government	39.9	38,5	38.9	39.6	38.5	34.9	30.2	28.6	30.5	32.0
Federal	27.4	18,5	17.7	16.3	15.5	13.9	11.2	10.3	10.7	11.1
State	6.9	11.2	12.0	12.6	12.4	10.9	9.5	8.1	8.4	8.8
Local	5.6	8.8	9.2	10.6	10.7	10.1	9.7	10.1	11.5	12.1

SOURCE: Alaska Department of Labor, Statistical Quarterly, various issues.

the process of structural change in Alaska. Two features of this process can be isolated. First, certain parts of the sector increased because of backward linkages to the basic sectors. The most obvious are those portions of transportation and service industries which were a direct part of the Alyeska project (see Goldsmith and Huskey, 1978). A second feature of the pipeline induced structural change concerns the growth of the support sector after 1976. Employment in these sectors did not decline in response to the decline in construction activity. There are two explanations for this pattern. First, the lack of decline in these sectors can be explained by a combination of lags and expectations. Employers didn’t reduce employment proportionately because they expected a future, near term expansion associated with the gas line construction, or because there are lags in the adjustment to declining employment. Another explanation may be that the pipeline increased the flow of information about the Alaskan markets. This may have encouraged entrepreneurs to enter with economic activities which had not been available previously, but which were profitable. Each of these factors was probably important and emphasizes the importance of information, entrepreneurs, and expectations in the process of structural change.

In our discussions of the structure of the Alaska economy, we use employment as a proxy for the structure of output. This convention is an accepted one in regional economics, since employment is the primary data available for regional economies. For the most part, changes in the structure of employment will represent the changes in the structure of production. There is an important case where employment may underestimate structural change which should be noted. When the technology of production changes, more production could take place with the same employment. The structure of production may change without a change in employment. Since the change in the size of market is the primary reason for structural change, employment growth may underestimate the extent of this structural change. Employment growth may also understate the importance of changes in basic sectors. Growth of total employment is a proxy for market expansion. If high income employment replaces low income employment, the market could expand with the total basic employment remaining constant.

Table 45 examines the detailed structural change in the Alaska economy. We will use this table to explore some hypotheses about structural change in the Alaska economy. In this table employment growth between 1970 and 1979 is examined for industries at the two and three digit SIC code levels.

Table 45 helps to isolate the pattern and causes of structural change in Alaska between 1980 and 1979. The table compares the growth of employment in specific industries to the expansion implied under two definitions of market size. Columns three and four describe the level of employment in each industry which would have been obtained if employment expanded at the rate of population growth during the period. Columns five and six describe the level of employment which would have been obtained if employment expanded at the rate of growth in real income. (This is shown only for those industries in which the change is greater than population growth.)

TABLE 45 DETAILED STRUCTURAL CHANGE
1970-1979

	Employment 1970	Employment 1979	Population: 1979 Proportional Growth*	Population: Net	Income: 1979 Proportional Growth**	Income: Net
Basic						
Mining						
Oil & Gas	2,640	5,354	3,431	1,923	959	964 (18. 0)
Other	354	419	460	- 41		
Manufacturing						
Fish and Seafood	3,390	6,779	4,405	3,374	1,231	1,143 (16.9)
Logging	1,055	1,221	1,371	- 150		
Sawmills	609	727	791	- 64		
Paper and Pulp	1,015	1,152	1,319	- 167		
Petroleum Refining	52	180	68	112	19	93 (51.7)
Federal Government	17,111	17,915	22,235	- 4,320		
Mixed Basic and Support						
Construction						
General	2,092	2,790	2,718	72	759	- 657
Heavy	-2,424	2,800	3,150	- 350		
Special Trade	2,377	4,502	3,089	1,413	863	550 (12.2)
State & Local Gov't	18,439	36,617	23,962	12,655	6,695	5,960 (16.3)
Transformation						
Air	3,070	5,000	3,989	1,011	1,115	- 104
Water	830	1,235	1,079	516	301	- 145
Other	273	1,734	355	1,379	99	1,200 (73.8)
Services						
Hotels, Motels	1,450	3,280	1,884	1,396	526	870 (26.5)
Holding & Investment	17	1,117	22	1,095	6	1,089 (97.5)
Retail						
Eating & Drinking	2,796	8.161	3,633	4,528	1,015	3,513 (43.0)
Support						
Population Serving						
Manufacturing						
Food	351	359	456	- 97		
Millwork, Wood Bldgs, Misc.	78	151	101	50	28	22 (14.6)
Printing & Publishing	558	971	725	246	203	43 (4.4)
Transportation						
Local Passenger	609	1,036	791	245	221	24 (2.3)
Communication						
Telephone	150	1,969	194	1,775	54	1,721 (87.4)
Radio & Television	280	748	364	384	102	282 (37.7)
Services	1,425	1,540	1,852	- 312		
Utilities	817	1,404	1,062	342	296	46 (3.3)
Retail Trade						
General Merch.						
Dept. Store	1,573	2,029	2,044	-15		
Other	1,356	1,047	1,762	- 715		
Food	1,714	3,602	2,227	1,375	622	753 (20.9)
Auto	1,676	2,491	2,178	313	608	. 295
Apparel	424	1,059	551	508	154	354 (33.4)
Furniture	346	706	450	256	126	130 (18.4)
Misc. Retail	1,638	3,650	2,189	1.521	595	926 (25.4)
Finance, Insurance, Real Estate						
Banking	2,355	2,975	1,761	1,214	492	722 (24.3)
Credit Agencies	329	788	427	361	119	242 (30.7)
Security, Commodity Brokers	53	105	68	37	19	18 (17.1)
Insurance Carriers	248	913	322	591	90	501 (54.9)
Insurance Agents	388	691	504	187	141	46 (6.7)
Real Estate	711	1.443	924	519	. 258	261 (18.1)

*If employment grew at average annual rate of population.

**If employment grew in proportion to real income.

TABLE 45 DETAILED STRUCTURAL CHANGE
1970-1979
(Continued)

	Employment 1970	Employment 1979	Population: 1979 Proportional Growth*	Population: Net	Income: 1979 Proportional Growth**	Income: Net	
Services							
Personal	853	1,126	1,108	18	310	- 292	
Auto Repair	430	778	559	219	156	63	(8.1)
Misc. Repair	216	445	281	164	79	85	(19.1)
Motion Picture	291	331	378	- 47			
Amusement and Recreation Service	241	486	313	173	87	86	(17.7)
Health							
Physician Offices	546	1,216	710	506	198	308	(25.4)
Dentist Offices	206	561	268	293	73	220	(39.2)
Hospitals	1,175	2,690	1,527	1,163	427	736	(27.4)
Other Health	247	1,267	321	946	90	856	(67.6)
Educational	656	626	845	- 219			
Membership Organization	1,727	3,291	2,244	1,047	627	420	(12.8)
Other	1,071	6,228	- 1,392	4,836	389	4,447	(71.4)
Industry Serving							
Manufacturing							
Stone, Clay, Glass	256	227	333	- 106			
fabricated Metal	16	171	21	150	6	144	(84.2)
Machinery (non-electric)	51	361	66	295	18	277	(76.7)
Transport Equipment	63	89	82	7	23	- 16	
Other	394	430	448	- 18			
Transport							
Trucking	1,241	1,755	1,613	142	451	- 309	
Warehousing & Terminals	415	283	539	- 256			
Wholesale Trade							
Motor Vehicles	265	405	344	61	96	- 35	
Electrical Goods	258	532	335	197	94	103	(19.4)
Hardware	123	335	160	175	45	130	(38.8)
Machinery	999	1,742	1,298	444	362	82	(4.7)
Drugs	191	111	248	- 137			
Groceries	455	1,026	591	435	165	270	(26.3)
Other	953	1,360	1,238	122	346	- 224	
Retail Trade							
Lumber	351	664	456	208	127	81	(12.2)
Paint, Glass, Wallpaper	44	115	57	58	16	42	(36.5)
Hardware	128	220	166	54	46	8	(3.6)
Other Building Materials and Garden Supplies	66	134	86	48	24	24	(17.9)
Services							
Business Services							
Advertising	28	102	36	66	10	56	(54.9)
Credit Reporting	105	209	136	73	38	35	(16.7)
Services to Bldgs	699	1,129	908	- 221			
Misc. Business Svcs	1,077	2,052	1,400	652	391	261	(12.7)
Other	87	1,282	113	1,169	32	1,137	(88.7)
Legal	337	1,246	438	808	122	686	(55.1)
Miscellaneous	192	720	249	47	70	- 23	
Total Nonagricultural Wage & Salary	92,467	166,406	120,158	462,268	33,572	12,696	(7.6)

SOURCE: Alaska Department of Labor, Statistical Quarterly, 1970 through 1979.

Two related reasons in addition to increasing market size have also been isolated as responsible for structural change. First, the differential expansion of various export sectors directly changes the structure. Secondly, since export sectors relate differently to the support sector, a differential expansion of the basic sector will change the market for those support industries which serve the basic sector. To account for these factors, Table 45 is separated in four groups of industries: basic, mixed basic, industry serving support, and population serving support. The first three groups will be affected by the type of export industry growth.

Total nonagricultural wage and salary employment increased at about the rate of the increase in the market (defined by increased real income). Total employment was less than 10 percent greater than what it would have been if it had increased at the rate of market growth. This difference could be accounted for by the lag and expectation effects which are part of the workings of a market economy.

The basic sector and mixed basic sector show substantial change. Those sectors connected with the lumber industry grew substantially less than the market as did federal government. Employment in oil and gas mining and petroleum refining, which is a forward linkage from oil and gas, grew substantially more than the market. Fish and seafood processing employment also grew more rapidly. These sectors each have a different effect on support sector growth since they represent both differences in both incomes and employment residency.

Growth in the mixed basic sector is a result of both increases in local markets and an increase in demand from outside the region. In this sector of the economy, only heavy construction employment failed to grow at the rate of population and all but three other industries were greater than what they would have been if they had grown at the rate the real income expanded. Since construction is affected by cycles; its lack of growth may simply reflect the low point of a cycle in 1979. Technological change may also have affected the growth of employment in construction; the change in the type of building and the way buildings are built may have changed the relation between output and employment. Changes in technology may also explain the expansion of air and water transportation less than the market. Improved efficiency may have reduced the level of employment needed to produce a given output. The growth of hotels and eating and drinking places partly reflects the growth of the tourist industry.

The mixed basic sector growth illustrates the effect of certain events on the structure of the economy. The two industries with the largest excess growth are other transport and holding and investment companies. Other transport is primarily pipeline employment; the growth of this industry occurred with the construction and operation of the TransAlaska pipeline. The growth of holding and investment companies can be attributed to the establishment of the Alaska Native Corporations as a result of the Alaska Native Claims Settlement Act. Finally, the nonproportional expansion of state and local government is primarily a result of the growth in petroleum revenues generated by oil production at Prudhoe Bay. The growth of each of these industries was connected with petroleum development at Prudhoe Bay; and each may be considered a forward linkage from petroleum development.

There are three possible patterns of support sector growth. First, employment in an industry can expand less than the market (defined in terms of population). Secondly, employment can expand greater than the market (defined in terms of real income). Finally, employment can expand at the same rate as the market (somewhere between the rate of population growth and the rate of growth in real income). The second type of growth is support sector deepening, while the third is support sector expansion. Employment growth at less than the growth in the market means a declining share of the economic activity. Failure to expand with the market could result from changes in taste whch reduces the demand for the output of these sectors, but more likely explanations are changes in technology and the existence of scale economies. Changes in technology, which make production cheaper in other regions or reduce the transportation costs from other regions, will limit the growth of industries, even as the market expands. Non-seafood food manufacturing did not grow in the 1970s. This may primarily be the result of increased competition from outside producers as the result of reduced transport costs. Scale effects result if there is a large fixed employment for some minimal level of operation. When scale economies are present in employment, output can increase with no increase in employment. Motion pictures may be the most representative of this type of industry.

Growth of the market is a function of growth in population and growth in per capita incomes. The relation between employment growth and the expansion of per capita income depends on the income elasticity of demand for these products. If the income elasticity is less than one, employment growth will be greater than population but less than the market. If income elasticity is equal to one, activity would expand at the same rate as the market. Fourteen industries represent expansion with the market when this is defined as being within 15 percent of the population or income defined growth. These include millwork, local passenger transportation, utilities, department stores, auto stores, insurance agents, auto repair, membership organizations, other manufacturing, motor vehicle equipment, machinery equipment, and supplies and lumber.

The final type of response to growth in the market size is an increase in employment greater than the market expansion, support sector deepening. Most sectors in the Alaska support sector follow this pattern. The simplest explanation for this type of growth is that the products of these industries have income elasticities greater than one, so that the market for these goods will experience a greater than proportional increase in employment.

A second explanation of deepening is economies of scale. An actual change in the structure of the support sector occurs through deepening as activities not present in Alaska enter the economy. As the market crosses the threshold size of each activity, activity previously imported is produced in the region. The actual introduction of new activities into the region is impossible to observe. The employment data does not provide the detail to observe the change. More importantly, the introduction of new activities may not occur dramatically, but may take place gradually with the possible introduction and failure of new activities prior to the optimal market size (i.e., Prinz Brau brewery).

Imperfections in information flows may be another reason for nonproportionate growth. The economic structure observed in 1970 may not have taken advantage of all the profitable opportunities, because entrepreneurs didn't know about the opportunities. This means that a part of the nonproportional growth may occur as entrepreneurs observe the opportunities which were available in 1970.

The final reason for nonproportional support sector growth is backward linkages from growing basic sectors. The markets for the products of certain support industries are increased by the demand from the basic sector. Table 46 illustrates the potential for these linkages. This table shows the share of total inputs (output net of value added) which accrues to those industries which grew more than proportionally to the market. This share ranges from 20 percent in oil and gas production to approximately 50 percent for nonresidential building. This table is based on national industries, so the proportions probably overestimate Alaska demand. They are meant to indicate the potential for the backward linkage effect in explaining structural change.

TABLE 46. U.S. SHARE OF INPUTS PER DOLLAR OUTPUT
(NET OF VALUE ADDED)
1973

	Petroleum & Natural Gas	Oil & Gas Exploration	State & Local Government	Nonresidential Building Construction	Public Utility Construction
Manufacturing					
Millwork, Etc.		.002		.037	.044
Fabricated Metals	.010	.008	.001	.206	.176
Machinery	.040	.067	.003	.017	.025
Transportation					
Local Passenger					
Communication					
Telephone	.003	.003	.011	.003	.003
Radio and Television					-
Utilities	.035	.002	.277	.002	.001
Retail Trade "	.010	.021	.004	.033	.023
Wholesale Trade	.013	.041	.015	.037	.029
Finance, Insurance, Real Estate					
Banking	.011	.006		.006	.005
Credit-Agencies, Financial Brokers, Holding & Invest					
Insurance	.007	.010	.034	.011	.009
Real Estate	.480	.015	.041	.015	.013
Services					
Auto Repair	.003	.013	.007		-
Misc. Repair			.001		
Amusement					-
Health			.001		
Education			.003		
Nonprofit Org.	.001	.003		.003	.002
Legal & Other Services	.625	.011	.011	.096	.041
Advertising		.022	.001	.003	.002
Misc Business Services	.027	.141	.074	.024	.035
	.666 (.201)*	.347	.484	.493	.408

*Proportion if real estate reduced to a more normal share (.015).

SOURCE: U.S. Department of Labor, Historical and Projected 1-0. Tables of the Economic Growth Project: Vol 1, 1980.

Even though we cannot observe the actual introduction of new activities, the extent that growth was greater than the increase in the market (defined by real income) may indicate the presence of structural change. We will assume that growth greater than 25 percent of the increase in the market size indicates the introduction of new activities. There are four industries which show this type of growth, communications, finance, business services, and health services. Although certain retail and wholesale trade industries increased greater than the market, these four industries, along with legal services, account for the greatest increase.

Those sectors in which structural change is evident are basically service rather than goods producers. The primary characteristic of service producers is that the customer goes to the firm for service. In this case, the transport costs are very high and growth of the market will allow these costs to be eliminated by local production. In the one case where goods are produced, communications, the location of the production is necessarily where the customers are. The service sector may also represent firms which reach scale economies at smaller sizes. This allows them to reach competitive sizes with smaller markets than for other industries.

Theory of structural change suggests that as market size increases, firms achieve scale economies, and this allows them to produce in the region. If this is the case, we would expect to see a shift in the size distribution of firms as one indication of structural change.

Table 47 illustrates the change in the size of firm for industries in which we expect structural change to have occurred. In each of these sectors, there is a noticeable shift to large size firms which would indicate that firms are taking advantage of the existing economies of scale with larger markets.

The above analysis has outlined the structural change which has occurred in the Alaska economy. We have shown that a significant part of employment growth cannot be explained by growth in market, and therefore, indicates a change in the structure of the economy. We have explored our hypotheses of structural change by examining the specific industry growth. Further examination of these hypotheses would require industry specific studies. This analysis and our theoretical analysis will serve as the basis for discussion of potential future structural change.

TABLE 47. FIRM SIZE DISTRIBUTION
1971 & 1977
(Percent)

	Less than 10 Employees		Between 10 and 50		Between 50 and 249		Greater than 250	
	1971	1977	1971	1977	1971	1977	1971	1977
Communications and Utilities	4.6	5.0	19.3	19.9	37.8	35.4	38.3	39.7
Trade								
Wholesale	31.0	21.5	50.1	49.7	18.9	28.8		
Retai 1	30.7	22.0	39.3	38.5	18.7	27.2	11.3	12.3
Finance, Insurance, Real Estate	27.4	20.4	40.0	26.7	13.4	30.5	19.2	22.6
Services								
Hotels	22.2	8.8	39.0	32.7	22.6	39.1	16.2	19.4
Personal Services	43.6	45.9	38.1	29.1	18.3	25.0		
Business Services	24.4	18.7	41.2	37.1	34.4	38.5		5.7
Medical Services	28.1	21,1	20.4	16.9	32.4	24.8	19.1	37.2
Other	39.4	28.3	37.7	34.5	16.8	30.1	6.1	7.1

SOURCE: Alaska Department of Labor, Statistical Quarterly, 1971 and 1977.

The Future Pattern of Structural Change in Alaska

During the period since 1970, the Alaska economy's support sector grew faster than the other sectors of the economy. Between 1970 and 1979, trade, service, finance, and transport has grown at an average annual rate of 8.7 percent compared to 5.1 percent for the remainder of the economy. Although the growth has fluctuated as a result of exogenous events, like the construction of the TransAlaska pipeline, the growth of the support sector reflects a long run change in the structure of the economy.

The support sector in Alaska has not responded in a proportionate manner to growth in the basic sector as suggested by economic base theory. This fact suggests that the pattern of future structural change is important in any discussion of the future growth of the Alaska economy. In this section, we will examine the possible future pattern of structural change in the Alaska economy. We will also examine the specific question of how well the MAP (Man in the Arctic Program) model projects the potential pattern of structural change; whether the MAP model overestimates the growth of the Alaska support sector in response to growth in the market.

The past growth of the support sector in Alaska has been rapid. We may not expect this sector to expand at the rate it has in the past, , but there is still potential for growth in the support sectors. The expansion of markets for various goods and services which will allow them to operate profitably in Alaska will guarantee the growth of this sector. As the market size allows economies of scale to be achieved and local production to be substituted for imports, growth may occur faster than in the remainder of the economy.

We can assume the past rate will not continue. The support sector has been increasing its share of total nonagricultural wage and salary employment at a rate of approximately 1.8 percent a year. If this rate were to continue, the support sector would account for almost 75 percent of total employment by 2000, and 100 percent by 2018. This cannot happen, since even if export activity is not the only reason for growth, it is reasonable to assume that in small regions some export activity is necessary for growth.

If the support sector will not continue to grow at its historic rate, what can we expect the limit of this growth to be? An upper bound of Alaska structural change may be the structure of the U.S. economy. If we assume the consumption patterns of everyone in the United States is similar, we would expect the structure of the U.S. economy to reflect consumption patterns in Alaska. In this case, as economies of scale are achieved, the structure of the regional economy will approach that of the United States.

Table 48 compares the structure of the United States and Alaska economies. This comparison shows that Alaska has a smaller share in

TABLE 48. COMPARISON OF THE STRUCTURE OF THE U.S. AND ALASKAN ECONOMIES

	U.S.[1] Percent	Alaska[2] Percent
Transportation, Communication and Utilities	5.2	10.0
Trade	22.3	17.7
Finance	5.2	4.8
Services	18.9	17.0

[1] Percent of total civilian employment. U.S. Department of Labor, Employment Projections for the 1980s, 1979.

[2] Alaska Department of Labor, Statistical Quarterly, 1979.

three support sector industries. The United States has a greater share of employment in finance, trade, and services. Only in transportation is Alaska's share bigger. The physical extent of the state and the important basic component of transportation explain this difference.

While the U.S. economic structure may represent the region's pattern of consumption, this is not a good assumption for future growth of its regional economies. The United States as a whole imports relatively little of its consumption, while trade among regions is important. The nonuniform location of resources and agglomeration economies lead to trade among regions, so economic consumption and production patterns will differ. The extent of this difference will cause regional economic structures to differ from the U.S. structure.

If we assume that market size is the dominant determinant of support sector growth, examining how economies change as they grow may allow us to say something about the future pattern of structural change in Alaska. Table 49 shows the range of employment shares in each support sector industry found by examining approximately 30 Bureau of Economic Analysis Functional Economic Areas. These areas consist of groups of counties which form integrated labor markets. The most remarkable finding of this table is the limited variation in employment shares across population groups. Both the median and low shares are similar in all three population groups. The high share would be expected to vary since any industry may include a substantial export component in a particular region. Attempts to use multivariate regression analysis

TABLE 49. THE EFFECTOF MARKET SIZE ON
THE ECONOMIC STRUCTURE OF
BEA FUNCTIONAL ECONOMIC AREAS
(Percent of Employment in Sector)

	Population		
	400-600,000	600-800,000	800,000<
Retail Trade			
High	18.94	20.74	17.11
Medi um	16.68	16.54	16.37
Low	14.73	14.88	13.42
Wholesale Trade			
High	8.51	6.18	7.30
Medi urn	3.88	4.77	5.00
Low	2.53	4.15	3.35
Finance, Insurance, Real Estate			
High	5.81	7.29	6.91
Medi urn	3.78	3.58	4.05
Low	2.68	3.23	3.17
Services			
High	19.93	21.25	21.23
Medi urn	19.24	17.30	17.67
Low	14.64	15.54	14.73
Transportation, Communication, and Utilities			
High	7.51	5.84	7.14
Medi urn	4.45	5.02	5.37
Low	2.94	3.71	3.70
n	9	10	10

SOURCE: Bureau of Economic Analysis, Regional Economic Information Systems, Printout 1981.

to estimate the effects of population, per capita income, and basic sector components provided little information because of the lack of variability in the employment shares. This limited variability was also observed on the state level (see Goldsmith and Huskey, 1978).

The MAP model projects a pattern of growth which includes an element of structural change. This pattern follows the pattern we would hypothesize. Compared to historical changes in the structure of the economy, this projected structural change may appear conservative. Table 50 compares the projected structural change with indicators of limits of this change.

Table 50 shows that the MAP model projects an increase in the total share of support sector employment from 40 to 42 percent by 2000. In this period, only transportation reduces its share, and this reduction is not significant. The MAP model structural change appears reasonable when compared with the structure of the United States and other area economies. Only transportation is greater than the other areas. The unique role of transportation in the state accounts for this difference, especially when the current larger share is considered.

An increase in the share of total employment is projected for trade, finance, and services. The share of finance is projected to grow by less than a percent. Service and trade are each projected to increase their shares by slightly over one percent. These are conservative increases compared to the historical growth.

TABLE 50. PROJECTED STRUCTURAL CHANGE
MAP MODEL MODERATE PROJECTIONS
(Percent of Employment in Sector)

	1979 Alaska[1] %	2000 MAP[2] %	Other Economic Areas[3] Low %	Median %	High %	Us. %
Trade	14.4	15.7	19.0	21.3	26.9	22.3
Transportation	7.7	7.4	3.7	5.0	5.8	5.2
Finance	3.9	4.2	3,2	3,6	7.3	5.2
Services	13.9	15.1	15.5	17.3	21.3	18.9
TOTAL	39.9	42.4	41.4	47.2	61.3	51.6

[1]Based on Alaska Department of Labor, Statistical Quarterly, 1979.

[2]MAP projection of population growth to 673,000 in 2000.

[3]From Table 49 for population group 600,000 to 800,000.

Finance and services are projected to be within the range defined by other regions. Finance is projected to grow to slightly above the median value in other areas. Services is projected to grow to the lower bound defined by other economic areas.

Trade, although its share increases by the greatest amount, remains significantly below the share found in other areas. There are both technical and theoretical explanations for this pattern of growth. The technical definition of total employment differs between Alaska and the other economic areas. Total nonagricultural wage and salary employment is the concept used in other areas, while total employment is used for Alaska. This was because of what was felt to be the nontypical size and importance in Alaska of fisheries, which has a large component not covered by nonagricultural wage and salary employment.

Theoretical reasons are more important. There are three theoretical reasons why trade lags behind other regions of similar size. The first reason is the physical extent of the state. The other areas are primarily metropolitan regions; the population of these regions is physically closer. This density of population may result in certain economies which are not possible in less dense Alaska. The spread of population may also mean that many parts of the state are served from regional centers outside of the state; for example, much of southeastern and western Alaska is served from Seattle.

A second reason for the smaller retail share in Alaska is related to the type of economic activity we have here. The large corporation provides many of its goods and services internally. Both oil and government provide many goods and services within their organization, which other types of organizations would purchase from other firms.

Finally, much of the wholesale activity takes place at the main trans-shipment points which are outside the state. Wholesale trade is an important component of trade. The limited wholesale sector would explain part of the difference in trade.

Conclusion

This paper has examined the reasons for structural change, the past structural change, and the projected future change. Past change has been rapid and has" resulted primarily from increasing market size. An important reason for the growth of the market was increases in real income which resulted from a shift to a higher income basic sector (petroleum). This led to expansion of support sector employment shares. If the similar pattern of basic sector growth is projected to occur in the future, the income effect on support sector growth will not be as great, and employment shares should not grow as fast.

The extent of structural change in the future projected by the MAP model is limited when compared to the past growth. Comparison to other areas shows that this is reasonable. The MAP projected shares of support industries are within the range of those found in similar size economic areas.

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VI.
PETROLEUM INDUSTRY EXPANSION IN ALASKA AND STRUCTURAL CHANGE

by

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ABSTRACT

Petroleum Industry Expansion in Alaska and Structural Change

The central question that the study addresses is what, if any, changes in the structure of the Alaska economy may result from forward and backward linkages between Alaska industry and expanded OCS activity.

The potential for structural change depends primarily upon the strength of forward and backward linkages between the petroleum industry and other sectors of the economy. Analysis of input-output tables for the United States and various oil and gas producing regional economies indicate that direct backward linkages are relatively weak. Intermediate inputs are drawn from a small subset of manufacturing industries, including steel, mining and construction equipment, chemicals, and from a diverse array of support sector industries.

Manufacturing industry inputs appear to be imported by the regional economies, and offer only limited opportunities for import substitution. Linkages with support sector industries generally lead to expansion of existing industries and limited entry of new industry.

Direct forward linkages occur primarily with refining, petrochemicals, and public utilities (via natural gas sales). However, development of these industries is also highly sensitive to a wide variety of locational factors in addition to resource availability.

Major conclusions of the study include the following:

1. Structural change in response to expanded petroleum and OCS activity will be quite limited, and for the most part will be of an "add-on" type.

2. Forward linkages appear to be stronger than backward linkages in the regional economies studied, which suggests that some expansion of refining and petrochemical activity may occur. Such expansion will likely be constrained by locational factors.

3. Because of the acid-on nature of structural change and the projection methodology of the MAP model, induced structural change does not appear to be a major problem with MAP projections.

Introduction

Continued growth of the Alaska petroleum industry and the possibility of significant expansion of OCS activity in the state raise a variety of questions related to growth and structural change in the Alaska economy. In general, structural change may take one of two forms. The first of these is due to add-ens to the existing industry structure, in other words, the entry of new types of industry. The second form is a change in the relative importance of elements of the overall structure. In turn, these changes may result either from changes in the composition of final demand or from changes in the level of inter-industry dependency.

We can also distinguish between changes that occur in response to an overall increase in economic activity and those that are directly linked to changes in specific industry activity such as petroleum industry activity. It is the analysis of foreward and backward linkages between expanded petroleum industry activity (and in particular OCS development) and the rest of the Alaska economy that is the focus of the present study.

The study is divided into several parts. In Part 11, conceptual and empirical problems in the identification and measurement of linkages are addressed. The petroleum “industry” to which linkages are to be attached is also defined.

The primary approach to the study of linkages is that of input-output analysis. In Part III, several input-output studies are analyzed. A more general approach is to review the experiences of other regions that may have undergone similar changes. This, and a discussion of the Alaska experience to date, is the subject of Part IV. Finally, Part V provides a summary and conclusions.

Delineation of the Industry and Potential Linkages

The term "petroleum industry," as generally used, encompasses a diversity of activity. Exploration, drilling, construction of production facilities, production, various oil and gas field services, wholesaling, transportation, refining, and petroleum production have all been considered as part of the industry in one context or another.

In the present study, a much narrower definition is adopted and is based upon the Standard Industrial Classification Manual definiton of industry 1311: "Establishments primarily engaged in operating oil and gas field properties."[1] While this may seem like an unnecessarily restrictive definition, it is appropriate in the context of the present analysis. This is so because it is the linkages between production (the objective of industry activity) and associated activity that are the focus of the study.

I. Standard Industrial Classification Manual, Office of Management and Budget (Washington, D.C., 1972), p. 37.

With this definition, it is possible to develop a listing of potential linkages. Before so doing, it is necessary to be more explicit as to the meaning of linkages. In general, there are two classes of linkages, forward and backward linkages. These may be further subdivided into direct and indirect linkages (either forward or backward).

A direct backward linkage occurs when an industry sells (or provides) an input to the reference industry (in this case SIC 1311). Examples would include the rate of contract drilling or exploration services to SIC 1311. A direct forward linkage is represented by the sale of output of the reference industry (again SIC 1311) to a user industry (e.g., refining or petrochemicals). Indirect backward linkages occur when an industry sells to another industry which, in turn, sells directly to the reference industry. Indirect forward linkages are similarly defined.

The introduction of indirect linkages also raises a further possibility--that of an industry that has both forward and backward linkages with the reference industry. For example, exploration services (a backward-linked industry) is also forward linked because it uses the processed output of the reference industry. Given the nature of production, such relationships will be fairly common.

Because of the likelihood of both forward and backward indirect linkages, the strength of the linkage becomes of more critical concern than its simple existence. Measuring the strength of indirect linkages is usually accomplished through input-output analysis; further discussion of this approach will be deferred to Part 111. However, there are several other points related to the measurement and interpretation of linkages that need to be considered now.

Since measurement of a linkage is equivalent to the measurement of the flow of goods and services between two industries, the question of the units in which the transaction is measured must be addressed. When data are available, the usual measure is the dollar value (at producer prices) of the transaction. The primary alternative, usually found in regional analyses, is to measure output flows in terms of employment. In some circumstances, it may also be possible to measure interindustry transactions in terms of the physical flows of goods and services, although this approach will lead to some “adding up” problems.

The significance of the interindustry transactions, with respect to assessing the potential for structural change, depends on several factors. First, and perhaps most important, is the regional linkage effect relative to the total linkage effect. For example, expansion of SIC 1311 activity will require increased exploration activity, contract drilling, construction, etc. The initial linkage impact on the regional economy will depend on the proportion of production produced by firms indigenous to the region. In other words, the regional impact depends on the extent to which total production requirements are met by imports and how much is provided by producers within the region. This suggests that, in addition to measuring interindustry transactions, it is necessary to identify the import component of such transactions.

Where measurement of interindustry transactions specifically identifies the import component, two purposes are served. First, direct impacts upon regional production can be identified, and these linkage effects may be quite different from the aggregate linkage effects. Secondly, the potential for import substitution via entry of new activities into the regional economy can be seen.

It is important to note that the potential for new entry does not imply that such entry will necessarily occur, but only that the demand for certain types of production has now increased or now exists where it did not before. The decision to enter will be dependent upon an analysis of comparative advantage.

It is also worth observing that the strength of linkages between industries may be independent of the regional employment and income effects resulting from expansion of the reference industry. For example, it is conceptually possible that a strong link may exist between the reference industry and some indigenous regional industry, but one with very low value added. A weaker link with a regional industry with high value added may result in greater regional economic impact.

With this discussion of linkages, we can now proceed to an initial identification of industries linked with the petroleum industry as defined above (SIC 1311). Two approaches will be used. The first is an ad hoc effort, based upon general knowledge of the industry and its production relationships. For example, the dominant backward linkages are reflected in the industry classification of projected employment related to proposed OCS lease sales. The second approach utilizes input-output tables and will be set forth in Part 111.

Activity directly related to the petroleum industry can generally be expected to include several functions:

Backward Links	Geological and geophysical exploration Exploratory drilling Development drilling Other field development activities, including construction Production and production support services
Forward Links	Petrochemical and refining Manufacturing activity based on petrochemical production Public utilities

Using this as a general guide, backward and forward links would be likely to occur in the following -SIC industry groupings:

Backward links include

SIC 1381 - Drilling Oil and Gas Wells
SIC 1382 - Oil and Gas Field Exploration Services
SIC 1389 - Oil and Gas Field Services, Not Elsewhere Classified
SIC 15, 16, 17 - Construction
SIC 401 - Rail Transportation
SIC 421 - Motor Freight and Warehousing
SIC 442 - Deep Sea Domestic Transportation
SIC 451 - Air Transportation
SIC 452 - Air Transportation, Noncertified Carriers
SIC 5084 - Wholesale Trade-Industrial Machinery and Equipment

Forward linkages include

SIC 28 - Chemicals and Allied Products
SIC 29 - Petroleum Refining and Related Industries
SIC 49 - Electric, Gas, and Sanitary Services

With the exception of SIC 13 groups and SIC 29, the industry classifications do not reflect activity exclusively related to the petroleum industry. Neither is this a complete listing, although it would seem that the major direct linkages (with the exception of manufacturing) are represented. We can now proceed to the analysis of linkages via input-output analysis.

Input-Output Analysis and Structural Change

Since the concept of forward and backward linkages is an outgrowth of input-output analysis, it is appropriate next to consider the identifications of linkages and the strength of linkages as reflected by various input-output studies. The first of these reviewed is the input-output analysis of the U.S. economy for the year 1972.[2]

There are two basic approaches, via input-output analysis, to viewing linkages. The first is based on the table of direct requirements which shows the purchases of inputs by the reference industry from all other industries as well as value added. The second approach looks at various multipliers or indexes of linkages derived from the table of direct and indirect requirements. There are several industries in the 1972 study that are of direct interest. These are summarized in Table 51.

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[2]The primary reports on this analysis are contained in the following studies. "The Input-Output Structure of the U.S. Economy, 1972," Survey of Current Business (February 1979); "Dollar Values Tables for the 1972 Input-Output Study," Survey of Current Business (April 1979); and The Detailed Input Output Structure of the U.S. Economy, Vol I & II (U.S. Department of Commerce, Bureau of Economic Analysis, 1979).

Crude petroleum and natural gas (I-O 8.0000) is comparable to our earlier definition, except for the inclusion of SIC 1321 (natural gas liquids) and part of SIC 138 (apparently SIC 1389, oil and gas field services not elsewhere classified; i.e., services exclusive of drilling and exploration). As will be seen shortly, I-O 11.0503 (drilling) and I-O 11.0504 (exploration) are not measured as inputs to I-O 8.0000 but are treated as gross investment (part of final demand]. However, their obvious importance, particularly in frontier areas, requires that they be looked at. Finally, I-O 12.0215 is a direct input to (with 100 percent of its output going to) I-O 8.0000.

TABLE 51. DIRECT PETROLEUM-RELATED INDUSTRIES IN THE 1972 U.S. INPUT-OUTPUT STUDY

I-O Industry	Comparable SIC Industry
8.0000 Crude Petroleum and Natural Gas	SIC 131, 132, part 138
1.1.0503 New Petroleum and Natural Gas Well Drilling	Part SIC 138 (SIC 1382)
11.0504 New Petroleum, Natural Gas, and Solid Mineral Exploration	Part SIC 138 and Other Non-Petroleum Industry Mining Exploration
12.0215 Maintenance and Repair of Petroleum and Natural Gas Wells	Part SIC 138

SOURCE: The Detailed Input-Output Structure of the U.S. Economy, Vol. I, p. 4. The SIC codes are, respectively, as follows: 131, Crude Petroleum and Natural Gas; 132, Natural Gas Liquids; and 138, Oil and Gas Field Services. (A full listing of the I-O industry codes and comparable SIC groupings is included in the appendix.)

In short, these are the industries in the 1972 I-O study that are separately identifiable as elements of petroleum-related activity. However, there are other elements such as construction of oil and gas field facilities that cannot be directly identified, and because this activity is also treated as investment, it will not show up as an input to I-O 8.0000.

Appendix Tables A.1 through A.4 provide a listing of purchased inputs as a percent of total industry output (intermediate inputs plus value added) for each of the identified I-O industries. These figures may also be interpreted as cents of purchased inputs per dollar of output. Only inputs that account for at least 0.1 percent of the value of output have been included. Table 52 summarizes these results at a more aggregate level.

Inspection of these tables reveals several interesting points. First, the composition of inputs is highly diversified. This, of course, depends on the degree of disaggregation. The appendix tables are based on the 496 industry I-O tables. In only four instances did an industry account for more than 5 percent of total inputs: Real estate to petroleum and natural gas (15.2 percent), steel mills (17.0 percent) and miscellaneous business revenues (5.3 percent] to drilling, and steel mills (5.3 percent) to maintenance and repair. At the other extreme, 74 of the 107 observations represented less than 1 percent of inputs to the various industries. It is worth noting that “real estate” includes royalty payments, which might also be considered as part of value added.

TABLE 52. SUMMARY TABLE OF DIRECT REQUIREMENTS PER DOLLAR OF INDUSTRY OUTPUT: INDUSTRIES 8.0000, 11.0503, 11.0504, AND 12.0215

[percent)

Input from I-O Commodity*	Percent of Total Direct Requirements			
	8.0000	11.0503	11.0504	12.0215
8.0000 Crude Petroleum and Natural Gas	3.346	--	--	--
12 Maintenance & Repair Constr.	4.123	--	--	--
Manufacturing, Total	4.210	34.362	9.472	25.712
27 Chemicals and Selected Chemical Products	.633	3.599	4.374	3.106
31 Petroleum Refining & Prod.	.368	2.132	3.622	1.773
32 Rubber & Miscellaneous Plastics Products	--	.611	.537	.909
36 Stone and Clay Products	--	3.974	--	3.560
37 Primary Iron & Steel Mfg.	.630	17.025	--	5.348
40 l-teat, Plumb., & Fabricated Metal Products	--	--	--	.909
42 Other Fabricated Metal Products	.436	.184	.188	1.515
43 Engines & Turbines	.255	--	--	--
45 Const. & Mining Machinery	.606	5.577	.590	6.955
49 Gen'l Industrial Machinery and Equipment	.355	.679	--	.561
50 Miscellaneous Machinery, Except Electrical	.414	--	--	--
53 Electrical Trans. and Dist. Equipment	.513	.145	--	--
59 Motor Vehicles & Equip.	--	.171	.161	--
65-68 Trans., Communication, and Utilities	2.042	2.859	1.583	3.698
69 Wholesale-Retail Trade	.463	4.760	2.951	3.773
70 Finance and Insurance	.545	.688	.939	.939
71 Real Estate and Rental	15.222	.103	.805	1.061
73-75 Selected Services	2.893	7.107	6.762	4.454
SUM, Selected Inputs	32.844	49.879	22.512	39.637
Total Intermediate Inputs	34.201	50.895	23.209	41.348
Value Added	65.799	49.105	76.791	58.652

*See appendix for detailed industry titles.

SOURCE: Compiled from Tables A-1 through A-4.

At a somewhat more aggregate level of analysis, some other features become apparent as indicated in Table 52. Inputs from manufacturing account for a high percentage of intermediate inputs except in the case of petroleum and natural gas (I-O 8.0000), with chemicals, stone and clay products, primary iron and steel manufacturing, and construction and mining machinery being the dominant items. Petroleum refining and related products are slightly less important, but also apparent.

Other sectors that are consistently noted include transportation, communications, and utilities; wholesale-retail trade and services (particularly miscellaneous business and professional services). Maintenance and repair construction as an input for petroleum and natural gas is also important.

There are several implications of this that are of interest with respect to the potential for structural change in Alaska. However, before discussing these, a cautionary note should be injected. The data, at best, can be expected to approximate only roughly the structure of the Alaska petroleum industry. In the survey year, only Cook Inlet (and limited onshore gas and oil) was in production.

It is reasonable to expect offshore production technical coefficients to differ from onshore production which dominates U.S. production. Secondly, production of Alaska wells is significantly greater than that of average U.S. wells. It would also be reasonable to expect that transportation inputs would be higher in Alaska while utility purchases would probably be less. There have also been major OPEC-related changes in the price of crude oil since 1972 which have probably affected the relationship between value added and intermediate inputs.

Returning to the question of potential linkages, several points are of interest. The strongest overall linkages are with the manufacturing sector and indicate only limited potential for induced development in Alaska. For example, primary iron and steel manufacturing and construction and mining machinery and equipment are the dominent elements of manufacturing, followed by chemicals and selected chemical products. All of these represent heavy industry with large-scale economies and would appear to be unlikely candidates.

Stone and clay products primarily reflect hydraulic cement and ground or treated minerals. Again, cement production involves substantial scale economies, and while cement production has been discussed in Alaska, it would not occur in response solely to expanded petroleum industry activity. Ground or treated minerals appear to be primarily linked to drilling needs. Minor amounts of barite have been produced in Alaska for use in drilling mud, but production has been suspended. Future production will. depend upon discovery of economically viable additional barite resources. The remainder of the manufacturing sector industries also appear to offer only limited potential for entry.

It is in the support sectors that other direct linkages are most apparent, particularly within wholesale and, to a lesser extent, retail trade and in various services. Wholesale trade exhibits strong (relatively speaking) links in all but I-O Industry 8.0000. The same is also generally the case with miscellaneous business and professional services although it is not possible to identify the specific nature of the services from the I-O tables.

As suggested earlier, the data probably understate the importance of transportation, particularly air and water transportation. The level of detail does not show components of air or water transportation, so it is not possible to identify commercial versus specialized contract services; but the Alaska experience to date suggests a greater role for specialized transportation services than that indicated in the I-O tables.

In summary, this preliminary look at direct backward linkages suggests that there are few strong backward links, and those which might induce entry into Alaska are even more limited. It is also of interest to note that the backward links in general are few, with only between 4 and 7 percent of the 496 total industries providing significant inputs to the industries reviewed. This would seem to indicate that we are looking at a highly specialized group of industries. It also tentatively suggests that structural change (especially new industry) resulting from an expended petroleum sector may be quite insignificant. Changes are also likely to be scattered within these sectors rather than concentrated in a small handful of industries.

This initial look at the structure of petroleum sector activity has been based on national tables. As such, it provides a holistic perspective of the industry. At the same time, it may hide important regional dimensions of activity. To deal with this problem, several regional I-O analyses are also reviewed. These include studies of Texas, Alberta, and Alaska.

The Texas input-output study was initially carried out using a combination of direct survey and secondary data for the year 1967 and has been updated to 1972. Industry activity has been grouped into 175 industries. Of particular interest are industries 18, Crude Petroleum (SIC 1311), and 20, Oil and Gas Field Services (SIC 138). Imports are separately identified, so the transactions and direct requirements tables reflect the structure of the domestic Texas economy.[3]

Tables 53 and 54 summarize the direct requirements for intermediate inputs and value added for the two industries of interest. Looking specifically at Table 53, it should be noted that the industry definitions are not entirely comparable. For the United States, industry 8.0000 includes both SIC 1311 (crude petroleum and natural gas) and SIC 1321 (natural gas liquids) as well as part of SIC 138 (oil and gas field services). In the Texas study, industry 18 (crude petroleum and natural gas) is composed only of SIC 1311.

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[3]For details, see H.W. Grubb, The Structure of the Texas Economy, Vols. I & 11 (Office of the Governor; Austin, Texas) March 1973, and The Texas Input-Output Model, 1972 (Texas Department of Water Resources) March 1978.

TABLE 53. DIRECT REQUIREMENTS PER DOLLAR OF OUTPUT: CRUDE PETROLEUM AND NATURAL GAS, TEXAS, 1967 AND 1972

(percent]

Industry Supplying Input*		Input as Percent of Total Output 1967	1972
18	Crude Petroleum and Natural Gas	0.124	.123
20	Oil and Gas Field Services	8.514	8.449
·⁻	Chemicals	.106	.115
63	Petroleum Refining	.189	.190
91	Mining Machinery and Equipment	.166	.181
114	Railroad Transportation	.103	.137
116	Motor Freight Transportation	.081	.109
118	Water Transportation	.238	.237
122	Telephone and Telegraph	.124	.087
126	Electric Services (utilities)	.267	.345
--	Wholesale Trade	.142	.150
--	Retail Trade	.107	.132
146	Banking and Credit Agencies	.065	.101
147	Insurance Carriers	.262	.479
148	Finance, Insurance, and Real Estate, m.e.c.	.320	1.028
149	Legal Services	.061	.127
157	Other Business Services	.278	.252
166	Education (public & private)	4.334	4.720
167	Colleges and Universities	.803	1.468
	SUM	16.286	18.430
	Total Intermediate Inputs, Texas	16.981	19.309
	Imports	7.621	7.756
	Total Intermediate Inputs & Imports	24.602	27.065
	Value Added	75.398	72.935

*A full listing of industry titles and corresponding SIC classifications is included in the appendix. Only industries that accounted for at least 0.1 percent of total direct requirements in at least one of the two years were included. Chemicals, wholesale trade, and retail trade have been aggregated to more closely correspond to Table 52.

SOURCE: 1967, The Structure of the Texas Economy, Vol. II, Office of the Governor (Austin, Texas), March 1973.

1972, The Texas Input-Output Model, 1972, Texas Department of Water Resources, March 1978.

TABLE 54. DIRECT REQUIREMENTS PER DOLLAR OF OUTPUT: OIL AND GAS FIELD SERVICES, TEXAS, 1967 AND 1972

(percent)

Industry Supplying Input*		Input as Percent of Total Output 1967	1972
20	Oil and Gas Field Services	5.225	6.250
26	Maintenance & Repair Construction	.493	.695
50	Manifold Business Forms	.104	.160
--	Chemicals	.458	.668
63	Petroleum Refining	1.555	1.860
87	Valves and Pipe Fittings	.289	.326
88	Other Fabricated Metal	.231	.301
91	Mining Machinery & Equipment	1.698	2.345
98	Electrical Instruments & Apparatus	.091	.119
100	Electronic Communications Equip.	1.932	2.304
116	Motor Freight	.365	.798
118	Air Transportation	.316	.370
122	Telephone and Telegraph	.300	.285
125	Gas Service (utilities)	.124	.081
126	Electric Services (utilities)	.113	.150
--	Wholesale Trade	2.952	4.484
--	Retail Trade	1.364	2.242
146	Banking and Credit Agencies	1.149	1.319
147	Insurance Carriers	.201	.378
148	Finance, Insurance, and Real Estate, n.e.c.	.391	1.290
149	Legal Services	.048	.102
150	Lodging Services	.119	.158
152	Advertising	.578	.714
157	Other Business Services	.300	.389
159	Automobile Rental Services	.141	.175
161	Electrical Repair	.093	.149
162	Miscellaneous Repair Services	.098	.124
163	Physician and Dentist Services	.098	.130
166	Education (public and private)	.539	.858
167	Colleges and Universities	.312	.585
170	Accounting, Auditing, and Bookkeeping	.196	.256
172	Other Services	.519	.608
	SUM	22.392	30.672
	Total Intermediate Inputs, Texas	23.213	31.710
	Imports	25.100	10.464
	Total Intermediate Inputs & Imports	48.313	42.174
	Value Added	51.687	57.826

SOURCE AND NOTES: See Table 53.

Conceptually, it would be possible to obtain a more precise comparison of natural and Texas petroleum industry structures by selective aggregation of industry components. For the national tables, the sum of industries 8.0000, 11.0503, and 12.0215 would provide a close approximation of SIC 13, oil and gas extraction. The sum of Texas industries 18, 19, and 20 (crude oil and natural gas, natural gas liquids, and oil and gas field services) would also constitute SIC 13.

There are two reasons for not doing this. First, the computations would be quite time consuming. Second"ly, while the results would shed additional light on the comparability of the U.S. and Texas petroleum industries, they would not convey significant additional information on Alaska industrial structure.

With these differences in mind, some generalizations are possible. First, the same groups of industries are reflected in both the Texas and U.S. tables. Second, the percentage share of specific inputs is usually lower in the Texas tables than for the United States, partitularly in the case of manufacturing and chemicals. Third, the percentage share of total intermediate inputs is less for Texas than for the United States although a substantial proportion of this difference would be eliminated if royalty payments in the U.S. table were shifted from real estate to value added, as appears to be the case in the Texas tables.

Finally, as was the case in the national tables, intermediate inputs from the manufacturing industries are specialized and, if imports are primarily from these industries, account for a sizable proportion of intermediate inputs. The remainder of intermediate inputs are drawn from a wide array of support sector industries, most of which are not specialized with respect to the petroleum industry.

Since the stability of coefficients over time is of interest, it is also worth looking at changes in Industry 18 between 1967 and 1972. In several cases, the coefficients are quite similar in both years. In other cases, some substantial discrepancies exist. In three instances, inputing industries (motor freight, banking, and legal services) which did not meet the 0.1 percent "test" in 1967 did meet it in 1972. In one instance (telephone and telegraph) the reverse occurred. As a part of total inputs, these changes were minor. In four other cases, inputs (as a percent) appear to have risen substantially (insurance, nonbank finance, and real estate, n.e.c., and purchases from education and colleges and universities).[4] Overal 1 purchase of intermediate inputs increased by 13.7 percent. Again, the major changes appear in the support sector.

Whether these changes reflect structural change in the production functon or changes in prices of inputs (or statistical error) cannot

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41t should be noted that "purchases" from education in actuality reflect the designated tax payments of industry as well as a pro-rated share of other taxes going to education.

be determined directly. However, a review of the Census of Mineral Industries for 1967 and 1972 suggests that the changes could reflect both changing prices and input quantities.[5]

Total energy production (crude oil and natural gas production measured in BTU equivalents) increased by 15.07 percent while the total value of shipments increased by 32.87 percent. At the same time, total (SIC 1311) employment increased 3.8 percent while production, development, and exploration worker manhours actually declined (from 39.5 to 31.5 million hours). Total payrolls increased by 45.8 percent, The overall implication is that while labor input per unit of output declined, labor costs rose relative to total output. Some structural change is implied by this in real terms. In the absence of more detailed price information, it is not possible to be more specific about real input changes in purchased inputs.

Turning to Table 54, we again face the problem of noncomparability with the U.S. tables. However, the similarity with respect to types of inputs is clear. Chemicals and other manufacturing inputs are quite similar, reflecting the specialized inputs of the industry. A wide variety of nonspecialized inputs from the support sector is again apparent.

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[5] 1967 Census of Mineral Industries: Crude Petroleum and Natural Gas and 2972 Census of Mineral Industries: Crude Petroleum and Natural Gas.

Of particular interest is the sharp increase in the share of intermediate inputs and decline in imports. Inspection of the data indicates that the increase occurs across a broad spectrum of inputs, both in chemicals and other manufacturing and within the support sector. Overall, intermediate inputs, as a share of total inputs, increase by almost 37 percent.

In the absence of price data, it is again impossible to precisely analyze the reasons for these sharp changes. Analysis of census data may shed some light on these changes, however.[6] Drilling activity, measured in footage drilled, increased by 157 percent between 1967 and 1972. At the same time, total SIC 1381 employment (drilling oil and gas wells) increased by only 4.6 percent while the census measure of value added increased by 37 percent.

Over the same period, exploration activity (measured in manhours) increased by 15.3 percent while value added increased by 61.5 percent. Employment in SIC 1389 (oil and gas field services, n.e.c.) actually declined 12.5 percent while SIC 1389 value added increased by 43.7 percent. The percentage change in the value of shipments and receipts increased roughly by the same percentage amounts as did value added in each of the sectors.

[6]1967 and 1972, Census of Mineral Industries: Oil and Gas Field Services.

Overall, this is a confusing picture. Two explanations may account for some of the changes. First, the census value added for SIC 138 increased by 42.6 percent while value added, as measured in the Texas I-O studies, increased by 58 percent. While the two measures are not strictly comparable, this seems to be a fairly large discrepancy. Hence, one possible explanation is statistical error.

A second explanation may relate to changes in capacity utilization. For example, while footage drilled increased by 157 percent, employment rose by only 4.6 percent. While this was occurring, SIC 1389 employment declined although drilling, exploration activity, and production of oil and gas were all increasing. These figures could indicate that substantial excess capacity 'existed in 1967.

A third possibility remains, which is significant technological change and increases in productivity. However, with present data this cannot be determined. In any event, the data for both years again indicate the industry's reliance upon selected components of chemicals and other manufacturing and a diversified array of inputs from the support sector.[7]

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[7] A telephone conversation with Dr. Grubb, who directs the Texas I-O effort, sheds additional light on these questions. The 1972 sampling of industries was more limited than the 1967 effort. In his opinion, the changes probably reflect sampling error to some extent. In addition, there has been an increase in steel fabrication and manufacturing (although these changes certainly do not account for the major overall changes), He was also of the opinion that there were no significant technological changes over the five-year period that would account for the changes in technical coefficients.

In addition to the studies above, there are two I-O analyses of Alaska that are of interest. A fair amount of caution must be employed in interpreting the tables since neither of the transaction tables are based on survey data. The Logsdon table is derived from a Washington State table through the use of location quotients. The Math Science table is largely judgmental.[8] By comparison, both tables are also highly aggregate. Considerable expansion of the petroleum industry has also occurred since the base year of the tables (1972) as well. In spite of these limitations, they do provide some light on the structure of the Alaska economy.

Turning to Table 55, the general pattern of purchases for support sector industries observed in the Texas and national studies is apparent. The dependence on imports is also evident. Somewhat disconcerting is the absence of any intra-industry transactions in petroleum and gas.

A comparison with Table 56 reveals some major differences, some of which are probably due to differences in industry definitions and levels of aggregation. Even allowing for these considerations, major differences remain. Intra-industry transactions are observed in Table 56, and the differences between the coefficients for construction, transportation, communication and utilities, and services, for

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[8]See Tables 55 and 56 for references.

TABLE 55. DIRECT REQUIREMENTS PER DOLLAR OF OUTPUT: OIL AND GAS, ALASKA, 1972

(percent)

Industry Supplying Input*	Input as Percent of Total Output
Manufacturing*	0.071
Construction	0.146
Transportation	0.337
Communications/Utilities	0.678
Finance, Insurance, and Real Estate	0.861
Trade	0.173
Services	3.390
State and Local Government	14.045
Total Intermediate Inputs	19.700
Imports	13.466
Value Added	66.834

*All manufacturing, except lumber, pulp, and fish processing. Other industries are based on SIC industry groupings.

SOURCE: Logsdon, Charles L., et al., "Input-Output Tables for Alaska's Economy: A First Look," (University of Alaska, School of Agriculture and Land Resources Management), December 1977.

TABLE 56. DIRECT REQUIREMENTS PER DOLLAR OF OUTPUT: MINING, PETROLEUM EXPLORATION, AND PETROLEUM AND CHEMICAL MANUFACTURING, ALASKA, 1972

(inputs as percent of total output)

Industry Supplying Input*	Mining	Petroleum Exploration	Pet./Chem. Manufacturing
Mining	2.500	0.000	61.728
Petroleum Exploration	0.000	0.000	0.000
Construction	3.167	3.195	0.154
Food Production	0.100	0.564	0.000
Forest Products	0.000	0.000	0.000
Chem./Petroleum Manufacturing	0.100	0.564	0.617
Other Manufacturing	0.167	0.940	0.154
Transportation	0.667	1.316	1.235
Communications/Utilities	3.000	1.128	13.735
Trade	0.833	0.188	0.154
Finance, Insurance, Real Estate	0.333	0.376	0.000
Services	1.667	1.880	0.309
Total Intermediate Inputs	12.533	10.150	78.086
Imports	20.067	29.699	1.698
Value Added	67.400	60.150	20.216

*Industry definitions are based on SIC groupings. Mining includes SIC 10-14, exclusive of SIC 1382, which is Petroleum Exploration.

SOURCE: Mathematical Science Northwest, Inc., and Human Resources Planning Institute, Inc. A Social and Economic Impact Study of Offshore Petroleum and Natural Gas Development in Alaska (March 8, 1976).

example, are uncomfortably large. The same is true with respect to differences between total intermediate inputs and imports.

However, even allowing for substantial error, the relative significance of support sector industries remains. The absence of major transactions in manufacturing, in contrast to the national tables, is also apparent.

Before turning to an analysis of potential forward linkages, it will be helpful to summarize our observations regarding direct backward linkages. At the U.S. level, intermediate inputs were drawn from a diverse, but small, subset of the total range of industries. Generally, intra-industry transactions and inputs from ten-to-twelve manufacturing industries accounted for a substantial proportion of purchased inputs, with the remainder being drawn from a wide number of support sector industries, especially transportation, communications, utilities, trade, and selected services. At the regional level (Texas and Alaska), the significance of manufacturing drops substantially while the support sector inputs much more closely parallel the national tables, especially in the case of Texas. Also noticeable is the importance of imports at the regional level, even in the case of Texas.

Two general conclusions can be drawn from the above. First, direct backward linkages for the various SIC 13 industries observed do not appear to be strong. It seems that a substantial proportion of intermediate inputs are drawn from specialized manufacturing industries where scale economies are large.

The existence of major import components and the lower level of manufacturing inputs in the regional tables suggests that manufacturing industry inputs account for the bulk of imports. Since the Texas economy--both with respect to the petroleum industry and in general--is a mature economy relative to Alaska, it is apparent that limits exist in the degree of import substitution. Hence, it seems unlikely that even greatly expanded petroleum industry activity in Alaska will lead to major induced expansion in manufacturing.

The second conclusion that is suggested by the analysis of I-O tables is that, at the regional level, the most significant impact of petroleum industry is dispersed throughout the support sector. In part, this implies that a major portion of general increases in activity will occur within existing industries, leading to expansion of their activity rather than inducing entry of new types specific to the industry. In other words, the associated structural change is more likely to be one of changing the relative shares of existing industries rather than leading to major shifts because of new industries.

At the same time, it must be recognized that this conclusion depends in part on the level of aggregation of industries. For example, growth of the petroleum industry in Alaska has led to the entry of wholesaling firms dealing specifically in petroleum industry supplies and equipment. These firms are classified as SIC 5084 (Industrial Machinery and Equipment: Wholesale Trade), a classification that includes many nonpetroleum-related industries as well. Thus, expansion of this sector could reflect either increased sales of other types of goods or entry of petroleum industry-specific wholesaling.

The discussion of linkages has so far addressed direct backward linkages related to components of the petroleum industry. It is also of interest to look at the direct forward linkages, or the sales of the industry to other industries as to final demand. In the case of the national tables, the pattern is quite simple. For I-O industries 11.0503 (drilling) and 11.0503 (exploration), total output is to gross domestic investment (final demand), while the output of I-C) industry 12.0215 (maintenance and repair) goes entirely to I-O industry 8.0000 (crude oil and natural gas).

Output of I-O 8.0000 is directed primarily to three industries: refinery and related products, 77.4 percent; gas production and distribution (natural gas utilities), 19.0 percent; and crude oil and natural gas (i.e., intra-industry use), 3.1 percent. The remaining 0.5 percent goes largely to chemicals manufacturing.

In short, the forward linkages, as reflected by direct sales, are extremely specific and limited. The primary areas in which industrial structure would be altered "in these instances would be the expansion of existing or entry of new refining capacity or petrochemicals production.

As events of the last several years indicate, the location decision with respect to petrochemicals and refining is extremely complex and subject to a wide range of factors (primarily the existence of markets, prices, and costs of production) in addition to the availability of crude oil or natural gas inputs. On the other hand, it is clear that refining could play a significantly greater role. Analysis of the Texas 1972 transaction table indicates that about 41.6 percent of crude oil and natural gas production is processed by Texas refineries.

It must be emphasized, however, that while the I-O structure of a more mature economy may indicate the direction of industrial change, it does not assure such change. The role of comparative advantage in the location decision cannot be ignored. It is perhaps worth observing that less than 0.1 percent of sales are to petrochemicals.[9] In summary, the range of direct forward linkages is highly limited. Furthermore, the availability of crude oil and gas inputs is no guarantee of expansion or entry; but at least for Alaska, it appears to be a necessary condition.

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[9]To put this figure in perspective, it must be noted that natural gas liquids (SIC 132) is a major sector in Texas and supplies substantial inputs to petrochemicals. The importance of SIC 132 in Texas, in turn, is due to the importance of natural gas production, which on a BTU basis is roughly equivalent to crude oil production.

At the beginning of this section, it was suggested that there are two approaches to the analysis of linkages through I-O studies. Having considered linkages evidenced by the direct coefficient tables, we now turn to the second approach--that of forward and backward linkage indexes.

Linkage indexes are of interest for two reasons. First, they are computed from the table of direct and indirect coefficients (the $[I-A]^{-1}$, or inverse matrix) which reflect not only direct input requirements but the induced interindustry transactions to meet changes in final demand. In other words, the inverse measures both direct and indirect production requirements per dollar of delivery to final demand and, thus, provide a more comprehensive picture of interindustry relationships. Secondly, the indexes provide a means of comparing the relative strength of overall linkages, both forward and backward, for each industry in the transaction table.

More specifically, a backward linkage index (denoted as B_j for the "j" industry) provides a measure of the jth industry's demands for inputs from other sectors. In other words, it measures the response of output in other sectors to an increase in output of the jth sector. The forward linkage index for the jth industry (F_j) reflects that industry's dependence on output of other industries.[10] Basically, the

[10] In general, the backward linkage index for industry j is defined as the (sum of the jth column elements of the inverse, divided by the number of rows) ÷ (sum of all elements of the inverse, divided by the square of the number of rows). The forward linkage is similarly defined, except that the numerator is equal to the sum of the

greater the value of the index, the greater is the strength of the linkage. Also, the index may be Interpreted as reflecting above-average strength if its value exceeds one, and less-than-average strength if its value is less than one.

In a study comparing the structures of the Texas and Alberta economies linkage indexes were computed from I-O tables for the respective economies for the years 1967 and 1972 (for Texas) and for 1966 and 1971 in the Alberta case.[11] The tables contained 38 industries. The Texas tables were aggregations of the Texas tables discussed earlier.

Of particular interest are the results with respect to petroleum-related industries as summarized in Table 57. Regarding backward linkages, it is clear that structural differences exist as reflected by the relative strengths of the linkages. For Texas, the strongest backward links are in the manufacturing industries, with oil and gas production and related services ranking quite low. Alberta, less mature and with a younger petroleum industry, does not exhibit quite the strength in downstream manufacturing while its linkages in primary production are somewhat stronger.

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jth row elements divided by the number of rows. In the case of the backward linkages, this is equivalent to comparing the jth industry final demand multiplier to the average of all final demand multipliers. For a fuller discussion of the indexes, see Watkins & Fong, "Comparisons in Economic Development: Alberta and Texas" in the Journal of Energy and Development [Autumn, 1980).

[11]See Watkins and Fong, op. cit.

TABLE 57. TEXAS AND ALBERTA LINKAGES FOR SELECTED INDUSTRIES

	Texas				Alberta			
	1967		1972		1966		1971	
Industry	B.	Rank	B.	Rank	B.	Rank	B.	Rank
Mineral Fuels	0.897	28	0.888	28	0.998	13	1.060	11
Services to Mining	0.934	22	0.971	21	1.008	11	0.965	21
Rubber & Plastics	1.234	4	1.165	7	0.985	18	0.982	16
Petroleum & Coal Products	1.334	1	1.329	1	1.301	3	1.347	3
Chemical & Chemical Products	1.215	5	“1.211	5	1.127	6	1.146	6
	Forward Linkages							
	F.	Rank	F.	Rank	F.	Rank	F.	Rank
Mineral Fuels	1.745	1	1.309	5	1.116	9	1.193	9
Services to Mining	0.905	22	0.826	28	0.742	28	0.750	24
Rubber & Plastics	0.863	26	0.866	25	0.751	26	0.742	27
Petroleum & Coal Products	1.271	6	1.171	9	0.999	14	0.987	14
Chemicals & Chemical Products	1.245	7	1.249	8	1.116	9	1.012	12

Note: Mineral fuels: crude oil, natural gas, and natural gas liquids
Services to mining: SIC 138, Oil and Gas Field Services
Rubber & Plastics and Chemicals & Chemical Products include various petrochemicals and manufacturing
Petroleum and Coal Products: primarily refining.

SOURCE: Watkins and Fong, *op. cit.*

To the extent that convergence of the two structures may occur, then it is apparent that the relative backward linkage strengths in petroleum mining and related mining services tend to decline and become quite weak. This, in turn, suggests that structural change in Alaska induced by backward links between petroleum mining (and related oil and gas field services) and the rest of the economy is likely to be quite limited.

Backward linkage indexes were also computed for the two Alaska I-O tables. For the Mathematical Sciences Northwest table, the strongest links were (1) petroleum manufacturing, (2) food processing, and (3) forest products. Mining (primarily oil and gas) and exploration ranked 12 and 13 (out of 14 industries), respectively. This reflects a similar ordering in the Texas and Alberta tables. In the Logsdon table, fish processing ranked second, while oil and gas mining was ranked sixth. Petroleum manufacturing was not identified separately; but manufacturing, exclusive of forest products and fish processing, was ranked tenth (out of 16 industries). Given the empirical methods used to construct these tables, it is not clear how much significance should be attached to either. However, the Mathematical Sciences Northwest indexes in particular are of some interest.

Turning now to the indexes of forward linkage, a somewhat different pattern emerges. Recalling that a forward linkage index measures the relative degree to which an industry's output serves as an input to other industries, it is clear that mineral fuels production may be important. For Texas, mineral fuels ranked number one in 1967 and fifth in 1972. For Alberta, the linkage ranked ninth in both years. Refining and petrochemicals also ranked relatively high for both regions, but were higher in each case in Texas. Again, to the extent that the structure of the more mature economy reflects that to which the less mature economy may converge, the analysis suggests that forward linkages may develop in the identified industries.

A critical question is whether or not there is a tendency for convergence. Watkins and Fong, in a more detailed analysis of industry rankings, conclude that there has been some limited tendency of the Alberta economy to "converge" toward the structure of the Texas economy (which exhibited greater structural stability over the period). If a greater span of time had existed between the reference years, it is reasonable to expect that a stronger tendency toward similar structures would have been observed.

Other "comparative structure" type I-O studies tend to reinforce this conclusion. Two aspects of structural similarity are particularly worth noting. First, the hierarchy of production, as observed by triangularization of the direct coefficient matrix, reveals substantial similarity between national and regional structures.

Secondly, while the hierarchical ordering tends to be similar, the degree of interdependence may vary substantially. With respect to this last point, it is also worth noting that the coefficient tables based in domestic transactions may vary considerably from tables based on technological relationships because of the differing relative importance of impacts between regions.

In short, we may expect to see the same general technological structural relationships emerge as a region develops. At the same time, the degree of interdependence, as reflected by the size of the technical coefficients, may vary considerably where this variation depends both upon the extent of specialization and the role of imports in the regional economy.[12]

In summary, the analysis of linkages suggests several conclusions with respect to petroleum-industry-induced structural change in Alaska. First, crude oil and natural gas production exhibit relatively weak backward linkages, and these tend to decrease relatively with increased diversification elsewhere in the economy. On the other hand, forward linkages related to crude oil and natural gas production appear to be high and to increase as the degree of industrial diversification increases.

It is in the area of refining and petrochemicals that the strongest combined linkages (both forward and backward) emerge. These industries show a high dependence on the output of crude oil and natural

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[12] For a further discussion of this point, see Watkins and Fong, op. cit., and F. Harrigan et. al, "A Comparison of Regional and National Technical Structures," Economic Journal, December 1980 (Vol. 90, No. 360), pp. 795-810.

gas and at the same time provide a wide range of impacts to other sectors.

These conclusions suggest that the major structural changes in the Alaska economy that may result from growth of petroleum and natural gas production lie in the downstream, or manufacturing, sectors. It must be kept in mind that these conclusions are based, in part, on the comparative input-output structures of the Texas and Alberta economies.

It is important, in attempting to extrapolate the present Alaska structure towards either that of Alberta or Texas, to recognize the significance of location factors. Both of these economies are substantially larger than the Alaska economy in terms of production and population. Both economies are far more diversified, especially in manufacturing and agriculture, than in Alaska. Finally, both are in much closer proximity to major national markets. Thus, while a comparison of I-O structures is indicative of the potential direction of structural change, locational factors may substantially dampen the magnitude of such change and the degree of interindustry specialization that develops.[13]

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[13]See McGilvray, "Linkages, Key Sectors, and Development Strategy," in Structure, System, and Economic Policy for further discussion of this point.

Other Perspectives on Structural Change

The foregoing discussion has focused almost exclusively upon input-output analyses. There are two primary reasons for this. First, the input-output framework, by its very nature, provides a detailed picture of industrial structure and interindustry dependence. As such, it is particularly suited for structural change analysis. Second, an extensive literature search failed to uncover any studies that specifically focused on structural change in response to offshore or OCS development.[14]

Some general comments regarding the influence of location factors on OCS-related activity were encountered. In view of prior comments regarding the significance of location factors in interpreting comparative input-output studies, it is worth noting some of these conclusions.

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[14]As part of the literature search, letters requesting references to studies treating structural change in response to offshore or OCS development were sent to a wide selection of universities and government agencies in states adjacent to historic or projected offshore petroleum development. While several responses provided reference to studies dealing with the general impact of offshore development, structural change was not explicitly treated. In those instances where inferences might be drawn, the implications were quite similar to those already reached in the input-output analysis sections, and nothing substantive would be added to our general conclusions. However, some insight was gained regarding location aspects of various industry activities and is commented upon in the text.

Several sources indicated that refining activity is strongly market oriented. The basis of this assertion, in part, relates to transportation. In general, crude oil is more easily and safely transported than refined products. This, in part, has been evidenced by the growth of the size of crude-carrying vessels relative to product-carrying vessels. Some consideration is also given to the fact that some volume is gained in the refining process, although the gain is small. The existence of substantial domestic capacity, utilizing foreign crude imports, also suggests that increased domestic production may displace foreign crude imports rather than lead to increased refinery capacity. Finally, the tendency in the United States has been to expand or modify existing refineries rather than to develop totally new facilities.[15]

With respect to petrochemicals, somewhat similar conclusions are implied although there are some fundamental differences, Three basic levels of petrochemical activity may be identified: basic petrochemicals (using feedstock from petroleum refining or natural gas or natural gas liquids), intermediate processing using the output of basic level activity, and end products such as fibers, plactic resins, etc. There appear to be two fundamental locational pulls on the general industry.

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[15]In particular, see the following: Research and Planning Consultants, Inc., Offshore Oil: Its Impacts on Texas Communities (Vol. III); New England River Basin Commission (NERBC-RALI); and U.S. Department of Commerce Resource and Land Investigations Program, Onshore Facilities Related to Offshore Oil and Gas Development: Factbook; and Devanney, J.W. III, "Georges Bank Petroleum and New England Regional Income," in New England and the Energy Crisis.

The first is the availability of feeds tock. This has been the basis for the limited petrochemical development that has already occurred in Alaska and also in stimulating interest in further petrochemical development. In both instances, it is the availability of natural gas or gas liquids that have been the driving force.

The second is the pull of downstream processing which, in turn, exhibits a strong market orientation. Scale and agglomeration economies are also important, as is access to deep water transport. On balance, it is not clear which of the two general locational attractions dominates. However, in the case of the United Kingdom, there is some indication that the availability of feedstocks will dominate and that substantial petrochemical development may locate near feedstocks in Scotland. However, the existence of significant markets in relative proximity is also important.[16]

There are also some backward linkage effects that may be of interest. In addition to direct links with exploration drilling, and development, which are detailed in OCS scenarios, the question frequently arises as to what support services may develop. Activities such as repair and maintenance yards and offshore drilling rig and platform fabrication yards are examples. Only the Texas and NERBC/RALI shed any light on these activities, and the implications for Alaska are far from conclusive.

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[16]In particular, see Research and Planning Consultants, Inc., op. cit., and Gaskin et al., The Economic Impact of North Sea Oil on Scotland.

With respect to offshore drilling rigs, the probability of Alaska construction seems highly remote. Platform construction (for production platforms) appears to exhibit a fairly strong attraction to producing areas and may be particularly sensitive to the total development effort. However, it would appear that success on more than one sale, and perhaps on several, would be required before the prospects should be seriously considered.

Establishment of permanent repair and maintenance yards for both supply boats and platform equipment servicing appears to be characteristic of areas in which development proceeds to the production stage. It is also suggested that service time is particularly critical, and presumably this implies that the disadvantages of higher costs associated with locating such activity in remote areas is more than offset by the reduction in downtime faced by producers. In short, the general implication is that we should expect to see development of a variety of service and maintenance facilities adjacent to significant offshore producing regions. It is certainly clear that this phenomenon has already occurred in the Kenai/Cook Inlet region and at Prudhoe Bay.

The other general area of literature search focused on the experiences of North Sea development, particularly in relation to Scotland. Only fragmentary information was obtained, in part, due to the relative inaccessibility of the literature. However, an opportunity to meet with staff of the Scottish Economic Planning Department in Edinburgh during August 1981 provided additional background.

A few general conclusions are possible. First, the focus of much of the research has been on the socioeconomic and environmental impacts of North Sea development and planning to deal with these impacts. No studies dealing specifically with structural change were uncovered although some current input-output analysis is underway that may prove informative.

Second, there are major differences in economic size and economic structure that make comparisons with Alaska hazardous. Perhaps, the most relevant comparisons are at the small region level, where conflict with traditional activity and "congestion effects of rapid development may exhibit some similarities with Alaskan experiences. However, this is outside of the scope of the present analysis.

With regard to structural change, two observations are of some interest. In a paper dealing with the Shetland economy (with a population of about 17,500 in 1975), I.H. McNicoll discussed the effects of oil industry development on the Shetland economy.[17] Three related phenomena were observed in relation to oil industry impact. First, oil activity over the 1971-1976 period generated a substantial increase in aggregate activity and helped offset declines in the traditional industries. As a result, structural change, as measured by relative industry shares of employment, changed rather dramatically.

[17] McNicoll, I.H., "An Updated Evaluation of Oil and the Shetland Economy," a paper presented at the North Sea Oil Panel Seminar at Heriot Watt University, May 15, 1981.

Second, the demands of the oil and gas industry were very unevenly distributed among existing industries and tended to exacerbate problems in the traditional fisheries and knitwear industries. Finally, there was a noticeable lack of interindustry transactions between most of the existing industrial sectors and the oil industry. In other words, the basic structural change was that of adding sectors to the economy but not with the effect of increasing intersectoral flows.

A second paper, one looking at the aggregate Scottish economy, ethos some of the same conclusions.

> ". . . The direct impact of North Sea oil activities was not sufficient to transform Scottish living standards or the dominance of the traditional industrial structure . . . Experience of the second half of the 1970s has tended to confirm this judgment."[18]

These findings and, in particular, those related to the Scottish economy need to be put in perspective before developing analogous predictions for Alaskan structural change (or absence thereof). First, as pointed out earlier, the Scottish economy is far larger than the Alaska economy; it is much more diversified; and it has a much longer history. Second, the development of North Sea oil is relatively recent. Many of the structural changes that might be expected to occur are related to forward linkages and the ?ags involved in the emergence of these linkages may be substantial.

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[18]Baxter, C.M., "North Sea Oil, the Economic Impact on Scotland," a paper presented to the North Sea Oil Panel Seminar, Heriot Watt University, May 15, 1981.

Before concluding this section, it is also worth looking briefly at structural change that may have occurred in Alaska in response to petroleum industry activity. As suggested earlier, there are two general dimensions to structural change. The first is essentially "add-on" change that reflects entry of new types of industrial activity. The second type is a change in intersectoral or inter-industry dependence and, in general, would reflect heightened specialization and diversification of overall economic activity.

It is apparent that both of these factors have been occurring in Alaska. There are a variety of indications that support this contention. For example, an analysis of employment data by broad industry classification indicates some general shifts in the composition of activity. Over the 1960-1978 period, employment in mining (predominantly oil and gas) rose from 1.9 percent to 3.4 percent; trade, from 13.5 percent to 17.6 percent; and services, from 9.8 percent to 16.9 percent. At the same time, other sectors were declining in relative importance: contract construction (10.4 percent to 7.5 percent), manufacturing (10.1 percent to 7.0 percent), and government (39.9 percent to 32.0 percent).[19]

While these shifts were occurring in employment, substantial changes were occurring in the oil and gas industry. A tally of the number of

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[19]The data are from Tuck, B.H., and Lee Huskey, St. George Basin Petroleum Development Scenarios: Economic and Demographic Analysis (Institute of Social and Economic Research, University of Alaska; April 1981) p. 12.

firms in various categories of petroleum industry-related activity is shown in Table 58.

TABLE 58. NUMBER OF FIRMS, SELECTED SIC INDUSTRIES: ALASKA, 1965, 1970, and 1979

Industry	1965	1970	1979
All SIC 13	42	90	114
SIC 1311	13	13	23
All SIC 138	29	77	91
SIC 1381	10	24	NA
SIC 1382	13	23	NA
SIC 1389	6	30	NA

SOURCE: For 1965, 1970: Alaska Industrial Directory of Employees (Alaska Department of Labor). 1979 data from the Statistical Quarterly (Alaska Department of Labor). The Statistical Quarterly data are numbers of reporting units. Since some firms have more than one reporting unit, the numbers may exceed the actual number of firms. NA means not available.

The data are of interest for two reasons. First, they indicate the substantial entry of firms into the industry. Secondly, the relative growth of SIC 138 firms and, especially, SIC 1389 (oil and gas field services, exclusive of exploration and drilling) indicate one of the primary backward linkages of SIC 1311 as production expands.

An earlier study also sheds light on some of the less visable linkages between SIC 1311 and other sectors. From an analysis of the Alaska Petroleum and Industrial Directory, represented firms were assigned a

SIC number. In the 1970-71 period, there were thirteen firms in the construction sector that specialized in oil and gas field construction, forty-nine firms wholesaling oil and gas field equipment, nineteen firms providing oil and gas field equipment repair and maintenance services (SIC 7394), and seventy-four firms providing various specialized business and professional services (SIC 8911 and SIC 8999).[20]

The continuation of this spread effect appears to have been occurring through the 1970s. Onshore drilling rigs have been constructed in Alaska. Support, supply, and transportation facilities specializing in oil and gas industry requirements and specialized manufacturing have all evidenced both growth and diversification.[21] At the same time, many of these activities have been relatively small in scale. For example, the combined employment at the Prudhoe Bay mud plant and insulation plant probably does not exceed ten people. Purchased intermediate inputs appear to be imported from outside the state as well.

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[20]Tuck, B.H., The Economic Impact of the Petroleum Sector on the State of Alaska, 1960-1970. Unpublished Ph.D. dissertation (Boston University, 1972).

[21]For a general description of some of these changes, see Alaska Industry (October 1980). Also of interest is the Dead Horse Business Directory (May 1981) which lists over 150 business and government offices, ranging from oil and gas field services to gold nugget jewelry. Also included are several manufacturing firms, ranging from sheet metal work to drilling muds to insulation.

In looking at the overall experience of the state, three general conclusions seem warranted. First, the shifts in relative employment shares can reflect either add-on effects or increased interdependence (or both), and there is no way to separate the effects with existing data. Second, it is clear that substantial entry of industry activity within the SIC 13 group, or in an array of industries directly dependent upon SIC 1311 activity, has been taking place' since the early 1960s. The emergence and expansion of small-scale refining and petrochemicals is also evidence of limited forward linkage effects. Finally, there is no basis for determining to what degree the overall structural change that may have occurred is a result of expanded petroleum industry activity.

Summary and Conclusions

The study has attempted to explore linkages between petroleum industry activity expansion and potential changes in the structure of the Alaska economy. A more specific interest has been potential structural change due to growth of OCS activity. The absence of information dealing specifically with OCS-induced structural change has meant that the study has had to emphasize general industry relationships rather than those specific to OCS activity.

However, there is some justification for expecting a substantial degree of technological similarity between onshore and offshore activity. Drilling wells is a similar activity requiring comparable inputs whether the well is drilled from a platform or a gravel pad.

Many of the maintenance and service requirements are similar, regardless of where the activity is occurring. Forward linkages (e.g., inputs to refineries and petrochemicals) appear to be largely independent of whether the oil and gas is produced on- or offshore.

The primary differences occur in the specialized requirements of offshore activity (platforms, underwater gathering lines and well completions, and marine transportation services, for example). Overall, the similarities seem to be much greater than the dissimilarities. In short, at the level of aggregation at which the present study has dealt, it is reasonable to expect "a fair degree of homogeneity in general structural relationships. It is equally likely that some degree of variation would be observed in the magnitude of various technical coefficients and the composition of detailed interindustry transactions.

In looking at these relationships and the potential for structural change, two general approaches have been pursued. The first of these has concentrated on input analysis. By looking at input-output tables for the national economy and regional tables for both developed and developing petroleum regions, it is possible to accomplish two tasks. First, by viewing the interindustry structure, it is possible to observe the general interdependencies that exist between the oil and gas industry and the rest of the economy. Secondly, by comparing structures over time and at various stages of development, some inferences may be drawn regarding the potential for structural change.

Comparing structures at different stages of development provides an indication of the extent of structural change that might occur but cannot, by itself, serve as a predictor of what change will actually occur. This is so because the structure is only a reflection of interindustry relationships that have developed in response to a vast array of comparative advantage and locational factors. Thus, projections of structural change based on input-output analysis must be tempered by a consideration of the influence of market size, costs of production, geography, and other location influences.

The second general approach was to look at ttte experiences of regions that had undergone significant offshore development. Information relating specifically to structural change was quite limited, but of some interest.

With these general dimensions of the study in mind, we can now turn to the general conclusions of the analysis. In regard to backward linkages, the analysis revealed that, at the national level, linkages were weak. Ten-to-twelve manufacturing industries accounted for a substantial fraction of inputs, with the remainder being drawn from a wide number of support sector industries. At the regional level, the significance of manufacturing drops substantially while imports assume importance. A fair degree of similarity exists between support sector relationships at both the regional and national levels. The direct forward links are almost entirely related to refining, public utilities (natural gas transmission and distribution), and petrochemicals.

While direct linkage effects provide an indication to technological relationships, they do not provide an overall measure of interindustry dependence or relative importance of specific industries. These broader questions were dealt with through indexes of backward and forward linkages. Indexes for Alberta and Texas again reveal the relatively weak backward linkages indicated by the. analysis of direct coefficients. Forward linkages between oil and gas production and downstream activities are much stronger--more so for Texas than for Alberta. Also, of interest was the strength of both forward and backward linkages related to refining and petrochemicals. Again, these linkages were stronger for the Texas economy than for Alberta.

These findings suggest several conclusions regarding potential structural change on Alaska. First, expansion of oil and gas production will probably not result in significant structural change related to backward linked industries. While expansion of oil and gas field services will occur, only limited structural change will result, and this will largely be of an add-on nature. This is not to say that the level of activity in other sectors will not increase but only that significant changes in technical coefficients will not take place.

Second, the comparison of the Alberta and Texas economies indicate that the major structural changes that might occur relate to forward linkages, primarily in relation to refining and petrochemicals and . further related manufacturing. However, this inference must be tempered with a consideration of the influence of locational factors. Important differences exist between Alaska and the Texas and Alberta economies, including levels of aggregate production and population, market size, the existing degree of industrial diversification, and the proximity to national markets. In addition to these considerations, it appears that a strong locational "market attraction" exists both with respect to petrochemicals and refining. Overall, these factors suggest a much lower level of downstream development than that indicated solely by comparison of input-output structures.

The general conclusions reached through input-output analysis were generally reinforced by a review of the Alaska and United Kingdom experiences to date. While major' aggregate economic and social impacts have been experienced (particularly at the small region level), these have not resulted in any clearly discernible trends. The primary structural changes that have been observed tentatively suggest that at least a major portion of the changes are attributable to add-on effects rather than induced changes in interindustry relationships.

One specific implication of these general conclusions relates to the validity of MAP model projections. Specifically, if change in interindustry relationships is largely additive, then the structural relationships of the model should also be stable, particularly when equations are updated periodically. In other words, induced structural change does not appear to be a significant problem at this time and should not be a significant source of error in the projections.

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APPENDIX A

TABLE A-1. DIRECT REQUIREMENTS PER DOLLAR OF INDUSTRY OUTPUT: INDUSTRY 8.0000, CRUDE PETROLEUM AND NATURAL GAS

(percent)

Input from I-O Commodity*		Percent of Total Direct Requirements**
8.0000	Crude Petroleum and Natural Gas	3.346
12.0201	Maint. & Repair, Nonfarm Buildings	.419
12.0215	Maint. & Repair, Petroleum and Natural Gas Wells	3.704
27.0100	Industrial Chemicals	.421
27.0406	Chemical Preparations, m.e.c.	.212
31.0100	Petroleum Refining Products	.368
37.0101	Blast Furnaces and Steel Mills	.630
42.0800	Pipe, Valves, and Pipefittings	.328
42.1100	Fabricated Metal Products, m.e.c.	.108
43.0200	Internal Combustion Engines, m.e.c.	.255
45.0300	Oilfield Machinery	.606
49.0100	Pumps and Compressors	.249
49.0500	Power Transmission Equipment	.106
50.0002	Machinery, except Electrical, m.e.c.	.414
53.0400	Electrical, Motors and Generators	.513
65.0300	Motor Freight Transportation & Warehousing	.131
65.0500	Air Transportation	.331
66.0000	Communications, except Radio and TV	.260
68.0100	Electric Services (utilities)	.883
68.0200	Gas Production and Distribution (utilities)	.219
68.0300	Water Supply and Sanitary Services	.218
69.0100	Wholesale Trade	.463
70.0100	Banking	.337
70-0400	Insurance Carriers	.208
71.0200	Real Estate	15.222
73.0100	Miscellaneous Business Services	1.454
73.0300	Miscellaneous Professional Services	.729
74.0000	Eating and Drinking Places	.566
75.0000	Automobile Repair and Services	.144
	SUM	32.845
	Total Intermediate Inputs	34.201
	Value Added	65.799

*See following page for notes and source.

TABLE A-1. NOTES AND SOURCE

*The 1972 I-O tables differ from past analyses because of the introduction of commodity classifications as well as industry classifications. A commodity may be produced by more than one industry and includes the primary output of the industry bearing the industry classification number identical to the commodity number as well as secondary output of other industries, In the present analysis, the distinction does not appear to make any real difference.

**Only commodities that account for at least 0.1 percent of total inputs have been included.

SOURCE: The Detailed Input-Output Structure of the U.S. Economy: 1972 (Vol. I), Table 1.

TABLE A-2. DIRECT REQUIREMENTS PER DOLLAR OF INDUSTRY OUTPUT: INDUSTRY 11.0503, NEW PETROLEUM AND NATURAL GAS WELL DRILLING

(percent)

Input from I-O Commodity*		Percent of Total Direct Requirements**
27.0100	Industrial Chemicals	1.483
27.0406	Chemical Preparations, m.e.c.	2.116
30.0000	Paints and Allied Products	.124
31.0100	Petroleum Refining and Related Products	2.132
32.0100	Tires and Inner Tubes	.611
36.0100	Cement, Hydraulic	2.769
36.1900	Minerals, Ground or Treated	1.205
37.0101	Blast Furnaces and Steel Mills	17.025
41.0100	Screw Machine Products	.141
42.0800	Pipe, Valves, and Pipe Fittings	.184
45.0100	Construction Machinery and Equipment	.714
45.0300	Oilfield Machinery	4.863
49.0100	Pumps and Compressors	.679
53.0600	Welding Apparatus	.145
59.0302	Motor Vehicle Parts and Accessories	.171
65.0100	Railroads and Related Services	1.427
65.0300	Motor Freight Transportation and Warehousing	.996
65.0400	Water Transportation	.436
69.0100	Wholesale Trade	4.132
69.0200	Retail Trade	.628
70.0400	Insurance Carriers	.688
71.0200	Real Estate	.103
73.0100	Miscellaneous Business Services	5.346
75.0000	Automobile Repair and Services	1.761
	SUM	49.879
	Total Intermediate Inputs	50.895
	Value Added	49.105

NOTES AND SOURCE: See Table A-1.

TABLE A-3. DIRECT REQUIREMENTS PER DOLLAR OF INDUSTRY OUTPUT: INDUSTRY 11.0504, NEW PETROLEUM, NATURAL GAS, AND SOLID MINERAL EXPLORATION

(percent)

Input from I-O Commodity*	Percent of Total Direct Requirements**
27'.0100 Industrial Chemicals	.859
27.0403 Explosives	3.515
31.0100 Petroleum Refining and Products	3.622
32.0100 Tires and Inner Tubes	.537
42.0201 Hand and Edge Tools, m.e.c.	.188
45.0100 Construction Machinery and Equipment	.590
59.0302 Motor Vehicle Parts and Accessories	.161
65.0100 Railroads and Related Services	.268
65.0300 Motor Freight Transportation and Warehousing	.724
65.0400 Water Transportation	.215
66.0000 Communications, except Radio and TV	.376
69.0100 Wholesale Trade	2.388
69.0200 Retail Trade	.563
70.0100 Banking	.402
70.0400 Insurance Carriers	.537
71.0200 Real Estate	.805
73.0100 Miscellaneous Business Services	4.213
73.0300 Miscellaneous Professional Services	.510
74.0000 Eating and Drinking Places	.590
75.0000 Automobile Repair and Services	1.449
SUM	22.512
Total Intermediate Inputs	23.209
Value Added	76.791

NOTES AND SOURCE: See Table A-1.

TABLE A-4. DIRECT REQUIREMENTS PER DOLLAR OF INDUSTRY OUTPUT: INDUSTRY 12.0215, MAINTENANCE AND REPAIR OF PETROLEUM AND NATURAL GAS WELLS

(percent)

Input from I-O Commodity*		Percent of Total Direct Requirements**
20.0600	Veneer and Plywood	.788
23.0400	Wood Partitions and Fixtures	.182
27.0100	Industrial Chemicals	1.318
27.0406	Chemical Preparations, m.e.c.	1.788
31.0100	Petroleum Refining and Products	1.773
32.0100	Tires and Inner Tubes	.333
32.0400	Miscellaneous Plastics Products	.576
36.0100	Cement, Hydraulic	2.212
36.1100	Concrete Products, m.e.c.	.318
36.1900	Minerals, Ground or Treated	1.030
37.0101	Blast Furnaces and Steel Mills	5.348
40.0600	Fabricated Plate Work (boiler shops)	.348
40.0700	Sheet Metal Work	.561
41.0100	Screw Machine Products	.106
42.0201	Hand and Edge Tools, m.e.c.	.273
42.0500	Miscellaneous Fabricated Wire Products	.424
42.0800	Pipe, Valves, and Pipe Fittings	.818
45.0100	Construction Machinery and Equipment	2.879
45.0300	Oilfield Machinery	4.076
49.0100	Pumps and Compressors	.561
65.0100	Railroads and Related Services	1.061
65.0300	Motor Freight and Warehousing	1.485
65.0400	Water Transportation	.152
66.0000	Communications, except Radio and TV	.500
68.0300	Water Supply and Sanitary Services	.500
69.0100	Wholesale Trade	3.015
69.0200	Retail Trade	.758
70.0100	Banking	.530
70.0400	Insurance Carriers	.409
71.0200	Real Estate	1.061
73.0100	Miscellaneous Business Services	2.182
73.0300	Miscellaneous Professional Services	.789
74.0000	Eating and Drinking Places	.789
75.0000	Automobile Repair and Services	.697
	SUM	39.637
	Total Intermediate Inputs	41.348
	Value Added	58.652

NOTES AND SOURCE: See Table A-1.

TABLE A-5. Industry Classification of the 1972 Input-Output Tables'

titles in bold face represent the groupings of industries used for the summary version of the 1972 tables.

Industry number and title	Related Census-SIC codes (1972 edition)
[AGRI]CULTURE, FORESTRY, AND FISHERIES	
1 Livestock and livestock products.	
Dairy farm products	0241, pt. 0191, pt. 0259, pt. 0291
Poultry and eggs	025 (excl. 0254 and pt. 0259), pt. 0191, pt. 0219, pt. 0291
Meat animal	021 (excl. pt. 0219), pt. 0191, pt. 0259, pt. 0291
Miscellaneous livestock	027, pt. 0191, pt. 0219, pt. 0259, pt. 0291
2 Other agricultural products	
Cotton	0131, pt. 0191, pt. 0219, pt. 0259, pt. 0291
Food grains	pt. 011, pt. 0191, pt. 0219, pt. 0259, pt. 0291
Feed grains	pt. 011, pt. 0139, pt. 0191, pt. 0219, pt. 0259, pt. 0291
[illegible]	[illegible] 02) [illegible] pt. 0291
Tobacco	0132, pt. 0191, pt. 0219, pt. 0259, pt. 0291
Fruits	pt. 017, pt. 0191, pt. 0219, pt. 0259, pt. 0291
Tree nuts	0173, pt. 0179, pt. 0191, pt. 0219, pt. 0259, pt. 0291
Vegetables	0134, 0161, pt. 0119, pt. 0139, pt. 0191, pt. 0219, pt. 0259, pt. 0291
Sugar crops	0133, pt. 0191, pt. 0219, pt. 0259, pt. 0291
Miscellaneous crops	pt. 0119, pt. 0139, pt. 0191, pt. 0219, pt. 0259, pt. 0291
Oil bearing crops	0116, pt. 0119, pt. 013, pt. 0173, pt. 0219, pt. 0259, pt. 0291
Forest products	pt. 018, pt. 0191, pt. 0219, pt. 0259, pt. 0291
Greenhouse and nursery products	pt. 018, pt. 0191, pt. 0219, pt. 0259, pt. 0291
3 Forestry and fishery products	
Forestry and fishery products	081-4, 091, 097
4 Agricultural, forestry, and fishery services	
Agricultural, forestry, and fishery services	0254, 07 (excl. 074), 085, 092
G	
5 Iron and ferroalloy ores mining	
Iron and ferroalloy ores mining	101, 106
6 Nonferrous metal ores mining	
Copper ore mining	102
Nonferrous metal ores mining, except copper	103-5, pt. 108, 109
7 Coal mining	
Coal mining	1111, pt. 1112, 1211, pt. 1213
8 Crude petroleum and natural gas	
Crude petroleum and natural gas	131, 132, pt. 138
9 Stone and clay mining and quarrying	
Stone and clay mining and quarrying	141-5, pt. 148, 149
10 Chemical and fertilizer mineral mining	
Chemical and fertilizer mineral mining	147
[CONST]RUCTION	
11 New construction	
New residential 1-unit structures, nonfarm	pt. 15, pt. 17
New residential 2-4 unit structures, nonfarm	pt. 15, pt. 17
New residential garden apartments	pt. 15-17
New residential high rise apartments	pt. 15-17
New residential additions and alterations, nonfarm	pt. 15, pt. 17

[Foot]note at end

Industry number and title	Related Census-SIC codes (1972 edition)
11.0106 New hotels and motels	pt. 15-17
11.0107 New dormitories	pt. 15, pt. 17
11.0201 New industrial buildings	pt. 15-17
11.0202 New office buildings	pt. 15, pt. 17
11.0203 New warehouses	pt. 15, pt. 17
11.0204 New garages and service stations	pt. 15, pt. 17
11.0205 New stores and restaurants	pt. 15, pt. 17
11.0206 New religious buildings	pt. 13, pt. 17
11.0207 New educational building	pt. 15, pt. 17
11.0208 New hospital and institutional buildings	pt. 15, pt. 17
11.0209 New other nonfarm buildings	pt. 15, pt. 17
11.0301 New telephone and telegraph facilities	pt. 16, pt. 17
11.0302 New railroads	pt. 16, pt. 17
11.0303 New electric utility facilities	pt. 16, pt. 17
11.0304 New gas utility facilities	pt. 16, pt. 17
11.0305 New petroleum pipelines	pt. 16, pt. 17
11.0306 New water supply facilities	pt. 16, pt. 17
11.0307 New sewer system facilities	pt. 16, pt. 17
11.0308 New local transit facilities	pt. 16, pt. 17
11.0400 New highways and streets	pt. 16, pt. 17
11.0501 New farm housing units and additions and alterations	pt. 15, pt. 17
11.0502 New farm service facilities	pt. 15, pt. 17
11.0503 [illegible] natural gas well drilling	pt. 138
11.0504 New petroleum, natural gas, and solid mineral exploration	pt. 108, pt. 11[illegible] 1213, pt. 138
11.0505 New military facilities	pt. 15-17
11.0506 New conservation and development facilities	pt. 15-17
11.0507 Other new nonbuilding facilities	pt. 15-17
11.0508 New access structures for solid mineral development	pt. 108, pt. 11[illegible] 1213, pt. 148
12 Maintenance and repair construction	
12.0100 Maintenance and repair, residential	pt. 15, pt. 17
12.0201 Maintenance and repair of other nonfarm buildings	pt. 15, pt. 17
12.0202 Maintenance and repair of farm residential buildings	pt. 15, pt. 17
12.0203 Maintenance and repair of farm service facilities	pt. 15, pt. 17
12.0204 Maintenance and repair of telephone and telegraph facilities	pt. 16, pt. 17
12.0205 Maintenance and repair of railroads	pt. 16, pt. 17
12.0206 Maintenance and repair of electric utility facilities	pt. 16, pt. 17
12.0207 Maintenance and repair of gas utility facilities	pt. 16, pt. 17
12.0208 Maintenance and repair of petroleum pipelines	pt. 16, pt. 17
12.0209 Maintenance and repair of water supply facilities	pt. 16, pt. 17
12.0210 Maintenance and repair of sewer facilities	pt. 16, pt. 17
12.0211 Maintenance and repair of local transit facilities	pt. 16, pt. 17
12.0212 Maintenance and repair of military facilities	pt. 15-17
12.0213 Maintenance and repair of conservation and development facilities	pt. 15-17
12.0214 Maintenance and repair of highways and streets	pt. 16, pt. 17
12.0215 Maintenance and repair of petroleum and natural gas wells	pt. 138
12.0216 Maintenance and repair of other nonbuilding facilities	pt. 15-17
MANUFACTURING	
13 Ordnance and accessories	
13.0100 Complete guided missiles	3761
13.0200 Ammunition, except for small arms, n.e.c.	3483
13.0300 Tanks and tank components	3795
13.0500 Small arms	3484
13.0600 Small arms ammunition	3482
13.0700 Other ordnance and accessories	3489
14 Food and kindred products	
14.0101 Meat packing plants	2011
14.0102 Sausages and other prepared meats	2013
14.0103 Poultry dressing plant	2016
14.0104 Poultry and egg processing	2017
14.0200 Creamery butter	2021
14.0300 Cheese, natural and processed	2022
14.0400 Condensed and evaporated milk	2023
14.0500 Ice cream and frozen desserts	2024
14.0600 Fluid milk	2026
14.0700 Canned and cured seafoods	2091
14.0800 Canned specialties	2032
14.0900 Canned fruits and vegetables	2033
14.1000 Dehydrated food products	2034
14.1100 Pickles, sauces, and salad dressings	2035
14.1200 Fresh or frozen packaged fish	2092
14.1300 Frozen fruits and vegetables	2037-8
14.1401 Flour and other grain mill products	2041
14.1402 Cereal preparations	2043
14.1403 Blended and prepared flour	2045
14.1501 Dog, cat, and other pet food	2047
14.1502 Prepared feeds, n.e.c.	2048
14.1600 Rice milling	2044
14.1700 Wet corn milling	2046
14.1801 Bread, cake, and related products	2051
14.1802 Cookies and crackers	2052
14.1900 Sugar	2061-3
14.2001 Confectionery products	2065
14.2002 Chocolate and cocoa products	2066
14.2003 Chewing gum	2067
14.2101 Malt liquors	2082
14.2102 Malt	2083
14.2103 Wines, brandy, and brandy spirits	2084
14.2104 Distilled liquor, except brandy	2085
14.2200 Bottled and canned soft drinks	2086
14.2300 Flavoring extracts and sirups, n.e.c.	2087
14.2400 Cottonseed oil mills	2074
14.2500 Soybean oil mills	2075

SOURCE: Reproduced from The Detailed Input-Output Structure of the U.S. ECONOMY: 1972.

Industry number and title	Related Census-SIC codes (1972 edition)
...e oil mills, n.e.c.	2076
...and marine fats and oils	2077
...d coffee	2095
...ing and cooking oils	2079
...ured ice	2097
...ni and spaghetti	2098
...reparations, n.e.c.	2099
15 Tobacco manufactures	
...tes	211
[illegible]	212
...g and smoking tobacco	213
...stemming and redrying	214
...road and narrow fabrics, yarn and thread mills	
...oven fabric mills and fabric finishing plants	221-3, 2261-2
...fabric mills	224
...lls and finishing of textiles, n.e.c.	2269, 2281-3
...mills	2284
...iscellaneous textile goods and floor coverings	
...verings	227
	2291
	2292
...and upholstery filling	2293
...textile waste	2294
[illegible]	[illegible]
[illegible]	[illegible]
...d twine	2298
...en fabrics	2297
...oods, n.e.c.	2299
18 Apparel	
...'s hosiery, except socks	2251
...n.e.c.	2252
...erwear mills	2253
...derwear mills	2254
...g mills, n.e.c.	2259
...nit mills	2257-8
...made from purchased materials	231-8, 39996
Miscellaneous fabricated textile products	
...s and draperies	2391
...urnishings, n.e.c.	2392
...bags	2393
...products	2394
...g and stitching	2395
...tive and apparel trimmings	2396
...machine embroideries	2397
...ted textile products, n.e.c.	2399
...umber and wood products, except containers	
...camps and logging contractors	2411
...ls and planing mills, general	2421
...od dimension and flooring mills	2426
...product sawmills, n.e.c.	2429
...rk	2431
	2434
...and plywood	2435-6
...al wood members, n.e.c.	2439
...ated wood buildings	2452
...reserving	2491
...allets and skids	2448
...board	2492
...roducts, n.e.c.	2499
21 Wood containers	
...ntainers	2441, 2449
22 Household furniture	
...ouse-hold furniture	2511
...ld furniture, n.e.c.	2519
...TV and radio cabinets	2517
...ered household furniture	2512
...ouse-hold furniture	2514
...es and bedsprings	2515
23 Other furniture and fixtures	
...ffice furniture	2521
...ffice furniture	2522
...uilding furniture	2531
...artitions and fixtures	2541
...artitions and fixtures	2542
...shades, and drapery hardware	2591
...re and fixtures, n.e.c.	2599
...r and allied products, except containers and boxes	
...lls	261
...mills, except building paper	262
	263
...es	2642
...y paper products	2647
...g paper and board mills	266
...ating and glazing	2641
...xcept textile	2643
...paper and board	2645
...and molded pulp goods	2646
...ery products	2648
...ted paper products, n.e.c.	2649
2... Paperboard containers and boxes	
...ard containers and boxes	265

...s and

Industry number and title	Related Census-SIC codes (1972 edition)
26 Printing and publishing	
26.0100 Newspapers	271
26.0200 Periodicals	272
26.0301 Book	2731
26.0302 Book printing	2732
26.0400 Miscellaneous publishing	274
26.0501 Commercial printing	2751-2, 2754
26.0502 Lithographic platemaking and services	2795
26.0601 Manifold business forms	276
26.0602 Blankbooks and looseleaf binders	2782
26.0700 Greeting card publishing	277
26.0801 Engraving and plate printing	2753
26.0802 Bookbinding and related work	2789
26.0803 Typesetting	2791
26.0804 Photoengraving	2793
26.0805 Electrotyping and stereotyping	2794
27 Chemicals and selected chemical products	
27.0100 Industrial inorganic and organic chemicals	281 (excl. 28195), 2865, 2869
27.0201 Nitrogenous and phosphatic fertilizers	2873-4
27.0202 Fertilizers, mixing only	2875
27.0300 Agricultural chemicals, n.e.c.	2879
27.0401 Gum and wood chemicals	2861
27.0402	2891
27.0403 [illegible]	2892
27.0404 [illegible]	2893
27.0405 Carbon black	2895
27.0406 Chemical preparations, n.e.c.	2899
28 Plastics and synthetic materials	
28.0100 Plastics materials and resins	2821
28.0200 Synthetic rubber	2822
28.0300 Cellulosic man-made fibers	2823
28.0400 Organic fibers, noncellulosic	2824
29 Drugs, cleaning and toilet preparations	
29.0100 Drugs	283
29.0201 Soap and other detergents	2841
29.0202 Polishes and sanitation goods	2842
29.0203 Surface active agents	2843
29.0300 Toilet preparations	2844
30 Paints and allied products	
30.0000 Paints and allied products	285
31 Petroleum refining and related industries	
31.0100 Petroleum refining and miscellaneous products of petroleum and coal	291, 299
31.0200 Paving mixtures and blocks	2951
31.0300 Asphalt felts and coatings	2952
32 Rubber and miscellaneous plastics products	
32.0100 Tires and inner tubes	301
32.0200 Rubber and plastics footwear	302
32.0301 Reclaimed rubber	303
32.0302 Fabricated rubber products, n.e.c.	306
32.0400 Miscellaneous plastics products	307
32.0500 Rubber and plastics hose and belting	304
33 Leather tanning and finishing	
33.0001 Leather tanning and finishing	311
34 Footwear and other leather products	
34.0100 Footwear cut stock	313
34.0201 Shoes, except rubber	3143-4, 3149
34.0202 House slippers	3142
34.0301 Leather gloves and mittens	315
34.0302 Luggage	316
34.0303 Women's handbags and purses	3171
34.0304 Personal leather goods	3172
34.0305 Leather goods, n.e.c.	319
35 Glass and glass products	
35.0100 Glass and glass products, except containers	321, 3229, 323
35.0200 Glass	3221
36 Stone and clay products	
36.0100 Cement, hydraulic	324
36.0200 Brick and structural clay tile	3251
36.0300 Ceramic wall and floor tile	3253
36.0400 Clay refractories	3255
36.0500 Structural clay products, n.e.c.	3259
36.0600 Vitreous plumbing fixtures	3261
36.0701 Vitreous china food utensils	3262
36.0702 Fine earthenware food utensils	3263
36.0800 Porcelain electrical supplies	3264
36.0900 Pottery products, n.e.c.	3269
36.1000 Concrete block and brick	3271
36.1100 Concrete products, n.e.c.	3272
36.1200 Ready-mixed concrete	3273
36.1300 Lime	3274
36.1400 Gypsum products	3275
36.1500 Cut stone and stone products	328
36.1600 Abrasive products	3291
36.1700 Asbestos products	3292
36.1800 Gaskets, packing and sealing devices	3293
36.1900 Minerals, ground or treated	3295
36.2000 Mineral wool	3296
36.2100 Nonclay refractories	3297
36.2200 Nonmetallic mineral products, n.e.c.	3299
37 Primary iron and steel manufacturing	
37.0101 Blast furnaces and steel mills	3312
37.0102 Electrometallurgical products	3313

Industry number and title	Related Census SIC codes (1972 edition)
Steel wire and related products	3315
Cold finishing of steel shapes	3316
Steel pipe and tubes	3317
Iron and steel foundries	332
Iron and steel forgings	3462
Metal heat treating	3398
Primary metal products, n.e.c	3399
38 Primary nonferrous metals manufacturing	
Primary copper	3331
Primary lead	3332
Primary zinc	3333
Primary aluminum	3334, 28195
Primary nonferrous metals, n.e.c.	3339
Secondary nonferrous metals	334
Copper rolling and drawing	3351
Aluminum rolling and drawing	3353-5
Nonferrous rolling and drawing, n.e.c	3356
Nonferrous wire drawing and insulating	3357
Aluminum castings	3361
Brass, bronze, and copper castings	3362
Nonferrous castings, n.e.c.	3369
Nonferrous forgings	3463
39 Metal containers	
Metal cans	3411
[illegible]	[illegible]
40 Heating, plumbing, and fabricated structural metal products	
Metal sanitary ware	3431
Plumbing fixture fittings and trim	3432
Heating equipment, except electric	3433
Fabricated structural metal	3441
Metal doors, sash, and trim	3442
Fabricated plate work (boiler shops)	3443
Sheet metal work	3444
Architectural metal work	3446
Prefabricated metal buildings	3448
Miscellaneous metal work	3449
41 Screw machine products and stampings	
Screw machine products and bolts, nuts, rivets, and washers	345
Automotive stampings	3465
Crowns and closures	3466
Metal stampings, n.e.c	3469
42 Other fabricated metal products	
Cutlery	3421
Hand and edge tools, n.e.c	3423
Hand saws and saw blades	3425
Hardware, n.e.c	3429
Plating and polishing	3471
Metal coating and allied services	3479
Miscellaneous fabricated wire products	3495-6
Steel springs, except wire	3493
Pipe, valves, and pipe fittings	3494, 3498
Metal foil and leaf	3497
Fabricated metal products, n.e.c	3499
43 Engines and turbines	
Steam engines and turbines	3511
Internal combustion engines, n.e.c	3519
44 Farm and garden machinery	
Farm machinery and equipment	3523
Lawn and garden equipment	3524
45 Construction and mining machinery	
Construction machinery and equipment	3531
Mining machinery, except oilfield	3532
Oilfield machinery	3533
46 Materials handling machinery and equipment	
Elevators and moving stairways	3534
Conveyors and conveying equipment	3535
Hoists, cranes, and monorails	3536
Industrial trucks and tractors	3537
47 Metalworking machinery and equipment	
Machine tools, metal cutting types	3541
Machine tools, metal forming types	3542
Special dies and tools and machine tool accessories	3544-5
Power driven hand tools	3546
Rolling mill machinery	3547
Metalworking machinery, n.e.c	3549
48 Special industry machinery and equipment	
Food products machinery	3551
Textile machinery	353"
Woodworking machinery	3553
Paper industries machinery	3554
Printing trades machinery	3555
Special industry machinery, n.e.c	3559
49 General industrial machinery and equipment	
Pumps and compressors	3561, 3563
Ball and roller bearings	3562
Blowers and fans	3564
Industrial patterns	3565
Power transmission equipment	3566, 3568
Industrial furnaces and ovens	3567
General industrial machinery, n.e.c.	3569

[illegible] at end of Appendix I.

Industry number and title	Related Census SIC codes (1972 edition)
50 Miscellaneous machinery, except electrical	
50.0001 Carburetors, pistons, rings, valves	3592
50.0002 Machinery, except electrical, n.e.c	3599
51 Office, computing, and accounting machines	
51.0101 Electronic computing equipment	3573
51.0102 Calculating and accounting machines	3574
51.0200 Typewriters	3572
51.0300 Scales and balances	3576
51.0400 Office machines, n.e.c	3579
52 Service industry machines	
52.0100 Automatic merchandising machines	3581
52.0200 Commercial laundry equipment	3582
52.0300 Refrigeration and heating equipment	3585
52.0400 Measuring and dispensing pumps	3586
52.0500 Service industry machines, n.e.c.	3589
53 Electric transmission and distribution equipment and industrial apparatus	
53.0100 Instruments to measure electricity	3825
53.0200 Transformers	3612
53.0300 Switchgear and switchboard apparatus	3613
53.0400 Motors and generators	3621
53.0500 Industrial controls	3622
53.0600 Welding apparatus, electric	3623
[illegible]	[illegible]
[illegible]	[illegible]
54 Household appliances	
54.0100 Household cooking equipment	3631
54.0200 Household refrigerators and freezers	3632
54.0300 Household laundry equipment	3633
54.0400 Electric housewares and fans	3634
54.0500 Household vacuum cleaners	3635
54.0600 Sewing machines	3636
54.0700 Household appliances, n.e.c	3639
55 Electric lighting and wiring equipment	
55.0100 Electric lamps	3641
55.0200 Lighting fixtures and equipment	3645-8
55.0300 Wiring devices	3643-4
56 Radio, TV, and communication equipment	
56.0100 Radio and TV receiving sets	3651
56.0200 Phonograph records and tape	3652
56.0300 Telephone and telegraph apparatus	3661
56.0400 Radio and TV communication equipment	3662
57 Electronic components and accessories	
57.0100 Electron tubes	3671-3
57.0200 Semiconductors and related devices	3674
57.0300 Electronic components, n.e.c	3675-9
58 Miscellaneous electrical machinery, equipment, and supplies	
58.0100 Storage batteries	3691
58.0200 Primary batteries, dry and wet	3692
58.0300 X-ray apparatus and tubes	3693
58.0400 Engine electrical equipment	3694
58.0500 Electrical equipment, n.e.c	3699
59 Motor vehicles and equipment	
59.0100 Truck and bus bodies	3713
59.0200 Truck trailers	3715
59.0301 Motor vehicles	3711
59.0302 Motor vehicle parts and accessories	3714
60 Aircraft and parts	
60.0100 Aircraft	3721
60.0200 Aircraft and missile engines and engine parts	3724, 3764
60.0400 Aircraft and missile equipment, n.e.c	3728, 376-
61 Other transportation equipment	
61.0100 Ship building and repairing	3731
61.0200 Boat building and repairing	3732
61.0300 Railroad equipment	374
61.0500 Motorcycles, bicycles, and parts	375
61.0601 Travel trailers and campers	3792
61.0602 Mobile homes	2451
61.0700 Transportation equipment, n.e.c	3799
62 Professional, scientific, and controlling instruments and supplies	
62.0100 Engineering and scientific instruments	3811
62.0200 Mechanical measuring devices	3823-4, 382-
62.0300 Automatic temperature controls	3822
62.0400 Surgical and medical instruments	3841
62.0500 Surgical appliances and supplies	3842
62.0600 Dental equipment and supplies	3843
62.0700 Watches, clocks, and parts	387
63 Optical, ophthalmic, and photographic equipment and supplies	
63.0100 Optical instruments and lenses	383
63.0200 Ophthalmic goods	385
63.0300 Photographic equipment and supplies	386
64 Miscellaneous manufacturing	
64.0101 Jewelry, precious metal	3911
64.0102 Jewelers' materials and lapidary work	3915
64.0104 Silverware and plated ware	3914
64.0105 Costume jewelry	3961
64.0200 Musical instruments	393
64.0301 Games, toys, and children's vehicles	3944
64.0302 Dolls	3942

Industry number and title	Related Census-SIC codes (1972 edition)
porting and athletic goods, n.e.c.	3949
ns and mechanical pencils	3951
ad pencils and art goods	3952
arking devices	3953
arbon paper and inked ribbons	3955
rtificial trees and flowers	3962
uttons	3963
eedles, pins, and fasteners	3964
rooms and brushes	3991
ard surface floor coverings	3996
urial caskets and vaults	3995
gns and advertising displays	3993
anufacturing industries, n.e.c.	3999 (excl. 39996)
ORTATION, COMMUNICATION, AND UTILITIE	
65 Transportation and warehousing ²	
ailroads and related services	40, 474, pt. 4789
ocal, suburban, and interurban highway passenger transportation	41
otor freight transportation and warehousing	42, pt. 4789
ater transportation	44
ir transportation	45
pe lines, except natural gas	46
ransportation services	47 (excl. 474 and pt. 4789)
66 Communications, except radio and TV	
ommunications, except radio and TV	48 (excl. 483)
67 Radio and TV broadcasting	
adio and TV broadcasting	483
68 Electric, gas, water, and sanitary services ²	
lectric services (utilities)	491, pt. 493
as production and distribution (utilities)	492, pt. 493
ater supply and sanitary services	494-7, pt. 493
SALE AND RETAIL TRADE	
69 Wholesale and retail trade	
holesale trade	50, 51 (excl. manufacturers' sales offices)
etail trad	52-7, 59, 7396, 8042
E, INSURANCE, AND REAL ESTATE	
70 Finance and insurance	
anking	60
redit agencies	61 (excl. pt. 613), 67
ecurity and commodity brokers	62
nsurance carriers	63
nsurance agents and brokers	64
71 Real estate and rental	
wner-occupied dwellings	not applicable
eal estate	65-6, pt. 1531
Es	
s and lodging, personal and repair services (except a	
otels and lodging places	70 (excl. dining)
ersonal and repair services, except auto repair and be and barber shops	72 (excl. 723-4), 762-4, pt. 7699
eauty and barber shops	723-4
73 Business services	
[illegible]	731
Miscellaneous professional services	81, 89 (excl. 8922)
74 Eating and drinking places	
ating and drinking places	58, pt. 70
75 Automobile repair and services	
utomobile repair and services	75
76 Amusements	
otion pictures	78
musement and recreation services	79
h, educational, and social services and nonprofit organizations	
octors and dentists	801-3, 8041
ospitals	806
ther medical and health services	074, 8049, 805, 807-9

Industry number and title	Related Census-SIC codes (1972 edition)
77.0300 Educational services	82
77.0500 Nonprofit organizations	81, 86, 8922
77.0600 Job training and related services	8331
77.0700 Child day care services	8351
77.0800 Residential care	8361
77.0900 Social services, n.e.c.	8321, 8399
GOVERNMENT ENTERPRISES	
78 Federal Government enterprises	
78.0100 U.S. Postal Service	4311
78.0200 Federal electric utilities	pt. 491
78.0300 Commodity Credit Corporation	pt. 613
78.0400 Other Federal Government enterprises	several³
79 State and local government enterprises	
79.0100 Local government passenger transit	pt. 41
79.0200 State and local electric utilities	pt. 491
79.0300 Other State and local government enterprises	several³
DUMMY AND SPECIAL INDUSTRIES	
80 Noncomparable imports	
80.0000 Noncomparable imports	
81 Scrap, used, and secondhand goods	
81.0000 Scrap, used, and secondhand goods	
82 Government industry	
82.0000 Government industry	
83 Rest of the world industry	
83.0000 Rest of the world industry	
84 Household industry	
84.0000 Household industry	
85 Inventory valuation adjustment	
85.0000 Inventory valuation adjustment	
VALUE ADDED AND FINAL DEMAND	
V.A. Value added, total	
88 Employee compensation	
89 Indirect business taxes	
90 Property-type income	
91 Personal consumption expenditures	
91.0000 Personal consumption expenditures	
92 Gross private domestic fixed investment	
92.0000 Gross private domestic fixed investment	
93 Change in business inventories	
93.0000 Change in business inventories	
94 Exports	
94.0000 Exports	
95 Imports	
95.0000 Imports	
96 Federal Government purchases, national defense	
96.0000 Federal Government purchases, national defense	
97 Federal Government purchases, nondefense	
97.0000 Federal Government purchases, nondefense	
98 State and local government purchases, education	
[illegible]	
99 State and local government purchases, other	
99.1000 State and local government purchases, health, welfare, and sanitation	
99.2000 State and local government purchases, safety	
99.3000 State and local government purchases, other general government	
OTHER SYMBOLS	
Outputs	
T.I.U. Total intermediate use	
T.F.D. Total final demand	
T.C.O. Total commodity output	
Inputs	
T.I.I. Total intermediate inputs	
V.A. Value added	
T.I.O. Total industry output	

1. Industry classification is generally identical with that for the commodity which is the product of the industry. However, for some industries the primary product, or a [illegible] thereof, is [illegible] primary product of another industry. In such cases, [illegible] output is [illegible] industry most definitively associated with the commodity, usually the largest producer.

2. Excluding government enterprises.

3. In the 1972 SIC, government enterprise activities are generally classified [illegible] private activity. In I-O, activities of enterprises are classified in groups 78 and 79 [illegible] corresponding SIC's are shown except for 78.0400 and 79.0300, each of which [illegible] of SIC's and several activities for which no comparable SIC exists.

APPENDIX B

THE TEXAS INPUT-OUTPUT MODEL, 1972

by

Planning and Development Division

Texas Department of Water Resources

LP-24

February, 1978

Appendix Table 1. Input-Output Sector Names and Definitions, 1972 1/

Sector Number	Sector Name	SIC Code or Description
Agriculture. Forestry and Fisheries		
1	Irrigated cotton	0131
2	Irrigated food grains	0111, 0112
3	Irrigated feed grains	0115, 0119
4	Other irrigated crops	0116, 0133, 0134, 0139, 0161, 0171, 0172, 0173, 0174, 0175, 0179, 0191
5	Dryland cotton	0131
6	Dryland food grains	0111, 0112
7	Dryland feed grains	0115, 0119
8	Dryland crops and livestock not elsewhere classified	0116, 0133, 0134, 0139, 0161, 0171, 0172, 0173, 0174, 017s, 0179, 0191, 0271, 0272, 0279, 029[illegible]
9	Range livestock production	0212, 0214, 0219
10	Feedlot livestock production	0211, 0213
11	Dairy	0241
12	Poultry and eggs	0251, 0252, 0253, 0254, 0259
13	Agricultural supply except farm machinery	5191
14	Cotton ginning	0724
15	Agricultural services	0711, 0721, 0722, 0723, 0729, 0741, 0742, 07[illegible], 0752, 0761, 0762, 0781, 0782, 0783, 0971
16	Primary forestry	0811, 0821, 0843, 0849, 0851

(Continued)

endix Table 1. Continued/

ctor Number	Sector Name	SIC Code or Description
17	Fisheries	0912, 0913, 0919, 0921
ning		
18	Crude petroleum and natural gas	1311
19	Natural gas liquids	1321
20	Oil and gas field services	1381, 1382, 1389
21	Other mining and quarrying	1011, 1021, 1031, 1051, 1061, 1081, 1092, 1094, 1099, 1211, 1213, 1411, 1422, 1423, 1429, 1442, 1446, 1452, 1453, 1454, 1455, 1459, 1472, 1473, 1474, 1475, 1476, 1477, 1479, 1481, 1492, 1496, 1499
construction		
22	Residential construction	1521, 1522, 1531 plus subcontractors parts of two-digit SIC 17
23.	Commercial, educational, and institutional construction	1542, plus subcontractors parts of two-digit SIC 17
24	Industrial construction	1541, plus subcontractors parts of two-digit SIC 17
*25	Facility construction	1611, 1622, 1623, 1629
26	Maintenance and repair	Maintenance and repair part of two-digit SIC 17
lanufactur in		
27	Meat products	2011, 2013

(Continued)

Appendix Table 1. Continued[1/]

Sector Number	Sector Name	SIC Code or Description
28	Poultry products	2016, 2017
29	Dairies	2021, 2022, 2023, 2024, 2026
30	Grain milling	2041, 2043, 2044, 2045, 2046
31	Animal feeds	2047, 2048
32	Bakery products	2051, 2052
33	Canned, preserved, pickled, dried and frozen foods	2032, 2033, 2034, 2035, 2037, 2038, 2091, 2092
34	Other food and kindred products	2061, 2062, 2063, 2065 2066, 2067, 2074, 2075 2076, 2077, 2079, 2095, 2097, 2098, 2099, 2121
35	Beverages	2082, 2084, 2086, 2087
36	Textile mill products	2211, 2221, 2231, 2241 2251, 2253, 2254, 2257 2258, 2259, 2261, 2262 2269, 2271, 2272> 2279 2281, 2283, 2284, 2291 2292, 2293, 2294, 2295 2296, 2297, 2298, 2299
37	Mens and boys, women and misses and children furnishings	2311, 2321, 2322, 2323 2327, 2328, 2329, 2331 2335, 2337, 2339, 2341 2342; 2351, 2352; 2361 2363, 2369
38	Related apparel	2371, 2381, 2384, 2385, 2386, 2387, 2389, 2391 2392; 2393; 2394; 2395 2396, 2397, 2399
39	Logging	2411
40	Lumber mills	2421, 2426, 2429

(Continued)

dix Table 1. Continued[1/]

or Number	Sector Name	SIC Code or Description
41	Millwork and wood products	2431, 2434, 2435, 2436, 2439, 2441, 2448, 2449, 2452, 2491, 2492, 2499
42	Wood furniture and fixtures	2511, 2512, 2515, 2517, 2519, 2521, 2531, 2541, 2591, 2599
43	Metal furniture and fixtures	2514, 2522, 2542-
44	Paper and paper mills	2611, 2621, 2631, 2661
45	Paper products except boxes and containers	2641, 2642, 2643, 2645, 2646, 2647, 2648, 2649
46	Boxes and paper containers	2651, 2652, 2653, 2654, 26S5
47	Newspapers	2711
48	Publishing	2721, 2731, 2741
49	Printing	2732, 2751, 2752, 2753, 2795
50	Manifold business forms	2761
51	Other printing and publishing	2771, 2782, 2789, 2791, 2793, 2794
52 "	Chlorine and alkalies	2812, 2813
53	Cyclic crudes and intermediates and inorganic pigments	2865
54	Organic chemicals	2861, 2869
55	Inorganic chemicals	2816, 2819
56	Fibers, plastics	2821, 2823, 2824
57	Synthetic rubber	2822
58	Drugs	2831, 2833, 2834

(Continued)

Appendix Table 1. Continued[1/]

Sector Number	Sector Name	SIC Code or Description
59	Agricultural chemicals	2873, 2874, 2875, 2879
60	Soaps, cleansers and toiletries	2841, '2842, 2843, 2844
61	Paints and varnishes	2851
62	Other chemicals	2891, 2892, 2893, 2895, 2899
63	Petroleum refining	2911
64	Other petroleum products	2951, 2952, 2992, 2999
65	Tires	3011
66	Fabricated rubber products	3021, 3041, 3069
67	Plastics products	3079
68	Leather and leather products	3111, 3131, 3142, 3143, 3144, 3149, 3151, 3161, 3171, 3172, 3199
69	Glass	3211, 3221, 3229, 3231
70	Clay	3251, 3253, 3255, 3259, 3261, 3262, 3269
71	Cut stone and other clay and shell products	3281, 3291, 3292, 3293, 3295, 3296, 3297, 3299, 3274, 3275
72	Cement and concrete products	3241, 3271; 3272, 32″7
73	Blast furnaces	3312
74	Primary steel and iron	3313, 3315, 3316, 3317
75	Foundries	3321, 3322, 3324, 33[illegible]
76	Nonferrous primary and secondary smelting	3331, 3332, 3333, 3339 3341
77	Aluminum smelting and nonferrous rolling and drawing	3334, 3351, 3353, 3354 3356, 3357

(Continued)

ndix Table 1. Continued[1/]

or Number	Sector Name	SIC Code or Description
78	Castings and forgings	3361, 3362, 3369, 3398, 3399
79	Fabricated steel	3441
80	Plate work	3443
81	Sheet metal and architectural	3444, 3446, 3448, 3449
82	Metal doors	3442
83	Fabricated metal products	3411, 3412, 3421, 3423, 3425, 3429
84	Plumbing	3431, 3432, 3433
85	Bolts, nuts, and screws	3451, 3452, 3461, 3462, 3463, 3465; 3466, 3469
86	Electroplating, coating and engraving	3471, 3479
87	Valves and pipe fittings	3.494, 3498
88	Other fabricated metal	3493, 3495, 3496, 3497, 3499
89	Farm , construction and industrial machinery	3523, 3524, 3531, 3537
90	Materials handling machinery and equipment	3534, 3535, 3536
91	Mining machinery and equipment	3532, 3533
92	Engines	3511, 3519
93	Metal working machinery	3541, 3542, 3544, 3545, 3546, 3547, 3549
94	Industrial processing machinery	3551, 3552, 3553, 3554, 3555, 3559

(Cent inued)

Sector Number	Sector Name	SIC Code or Description
95	General industry machinery	3561, 3562, 3563, 3564 3565, 3566, 3567, 3568 3569
96	Refrigerator machinery	3585
97	Computers, accounting, office and service industry machinery	3572, 3573, 3574, 3576 3579, 3581, 3582, 3586 3539, 3592, 3599
98	Electric instruments and apparatus	3612, 3613, 3621, 3622 3623, 3624, 3629, 3641 3643, 3644, 3645, 3646 3647, 3648
99	Electric household equipment	3631, 3632, 3633, 3634 3635, 3636, 3639
100	Electronic communications equipment	3651, 3652, 3661, 3662, 3671, 3672, 3673, 3674 3675, 3676, 3677, 3678 3679
101	Other electrical apparatus	3691, 3693, 3694, 3699
102	Aircraft	3721, 3761
103	Aircraft engines	3724, 3764
104	Other aircraft	3728, 3769
105	Motor vehicles and parts	3711, 3713, 3714, 3715
106	Ship and boat building	3731, 3732
107	Other transportation equipment	3743, 3751, 3792, 3799 2451
108	Scientific instruments	3811
109	Mechanical measuring devices	3821, 3823, 3824, 3829 3825
110	Medical instruments	3841, 3842, 3843
111	Photographic time and optical instruments	3832, 3851, 3861, 3872

(Continued)

endix Table 1.   Continued[1/]

ctor Number	Sector Name	SIC Code or Description
112	Games and toys	3942, 3944, 3949
113	Other manufacturing industries	3911, 3914, 3915, 3931, 3951, 3952, 3953, 3955, 3961, 3962, 3963, 3964, 3991, 3993, 3995, 3996, 3999
ansportation		
114	Railroad transportation	4011, 4013, 4041
115	Intercity rural highway transportation	4131
116	Motor freight transportation and local trucking and storage	4212, 4213, 4214, 4222, 4224, 4225, 4226, 4231
117	Water transportation	4411, 4421, 4441, 44S2, 4453, 4454, 4459, 4463, 4464, 4469
118	Air transportation	4511, 4521, 4582, 4583
119	Pipeline transportation	4612, 4613, 4619
120	Local and suburban transportation	4111, 4119, 4121
121	Other transportation services	4141, 4142, 4151, 4171, 4172, 4712, 4722, 4723, 4742, 4782, 4783, 4784, 4789
mmunication		
122	Telephone and telegraph	4811, 4821
123	Radio and tv	4832, 4833
124	Other communications	4899

(Continued)

Sector Number	Sector Name	SIC Code or Description
Utilities		
*125	Gas services	4922, .4923, 4924; 4925 4932
*126	Electric services	4911, 4931
*127	Water and sanitary services	4941, 4952, 4953, 4959 4961
Wholesale Trade		
128	Wholesale auto, parts and supplies	5012, 5013, 5014
129	Wholesale groceries and related products	5141, 5142, 5143, 51[illegible] 5145, 5146, 5147, 5148 5149
130	Wholesale farm products and farm product warehousing	4221, 5152, 5153, 5159
131	Wholesale livestock	5154
132	wholesale machinery, equipment and supplies	5081, 5082, 5084, 5085 5086, 5087, 5088
133	Wholesale petroleum and petroleum products	5171, S172
134	General wholesale	5021, 5023, 5031, 5039 5041, 5042, 5043. 5051 5052; 5063; 5064; 50[illegible] 5072, 5074, 5075, 5078, 5093, 5094, 5099, 5111 5112, 5113, 5122, 5133 5134, 5136, 5137, 5139 5161, 5181, 5182, 5194 5198, 5199"
Retail Trade		
135	lumberyards	5211

(Continued)

or Number	Sector Name	SIC Code or Description
136	Farm machinery and equipment	5083
137	Hardware, paint and wallpaper	5231, 5251
138	Department and variety stores	5311, 5331, 5399, 5961
139	Food stores	5411, 5422, 5423, 5431, 5441, 5451, 5462, 5463, 5499
140	Automotive dealers and repair shops	5511, 5521, 5531, 7531, 7534, 7535, 7538, 7539, 7542, 7549
141	Gasoline service stations	5541
142	Apparel and accessory stores	5611, 5621, 5631, 5641, 5651, 5661, 5681, 5699
143	Furniture	5712, 5713, 5714, 5719, 5722, 5732, 5733
144	Eating and drinking places	5812, 5813
145	Other retail	5261, 5271, 5551, 5561, 5571, 5599, 5912, 5921, 5931, 5941, 5942, 5943" 5944, 5945, 5946, 5947 5948, 5949, 5962, 5963 5982, 5983, 5984, 5992 5993, 5994, 5999
ance, Insurance and Real Estate		
146	Banking and credit agencies	6011, 6022, 6023, 6024, 6025, 6026, 6027, 6028, 6032, 6033, 6034, 6042, 6044, 6052, 6054, 6055, 6056, 6059, 6112, 6113, 6122, 6123, 6124, 6125, 6131, 6142, 6143, 6144, 6145, 6146, 6149, 6153, 6159, 6162, 6163

(Continued)

Sector Number	Sector Name	SIC Cede or Description
147	Insurance carriers	6311, 6321, 6324, 6331, 6351, 6361, 6371, 6399, 6411
148	F.I.R.E. not elsewhere classified	6211, 6221, 6231, 6281, 6S12, 6513, 6514, 6515, 6517, 6519, 6531, 6541, 6552, 6553, 6611, 6711, 6722, 6723, 6724, 6725, 6732, 6733, 6792, 6793, 6794, 6799
149	Legal services	8111
150	Lodging services	7011, 7021, 7032, 7033, 7041
151	Personal services	7211, 7212, 7213, 7214, 7215, 7216, 7217, 7218, 7219, 7231, 7241, 7251, 7261, 7271, 7299
152	Advertising	7311, 7312, 7313, 7319
153	Duplicating and addressing	7331, 7332, 7339
154	Employment agencies private	7361
155	Photographic services	7221, 7333, 7813, 7814, 7819, 7823, 7824, 7829, 739s
156	Research and development	7391, 8922
157	Other business services	73.21, 7341, 7342 7349, 7351, 7362, 7369, 7392, 7393, 7394, 7395, 7396, 7397, 7399
158	Motion picture, amusement and recreation services	7832, 7833, 7911, 7922, 7929, 7932, 7933, 7941, 7948, 7992, 7993, 7996, 7997; 7999

[Cent inued)

ndix Table 1. Continued[1/]

tor Number	Sector Name	SIC Code or Description
159	Automobile rental services	7512, 7513, 7519
160	Automobile parking	7523, 7525
161	Electrical repair	7622, 7623, 7629
162	Miscellaneous repair services	7631, 7641, 7692, 7694, 7699
163	Physicians and dentists services	8011, 8021, 8031, 8041
*164	Hospital and laboratory services	8062, 8063, 8069, 8071, 8072
*165	Other health services	8042, 8049, 8081, 8091
*166	Education (public and private)	8211
*167	Colleges and universities	8221, 8222
*168	Other educational services	8231, 8241, 8243, 8244, 8249, 8299
169	Engineering and architectural services	8911
170	Accounting, auditing, and bookkeeping	8931, 7372, 7374, 7379
171 .	Other professional services	8999
172	Other services	8321, 8331, 8351, 8361, 8599, 8411, 8421, 8611, 8621, 8631, 8641, 8651, 8661, 8699
ner Manufacturing		
173	Ordnance and ordnance accessories	3482, 3483, 3484, 3489, 3761, 379S

[Continued)

Appendix Table 1. Continued[1/]

Sector Number	Sector Name	SIC Code or Description
Other Services		
**174	Outdoor recreation	The Total Public funds spent in the operation and administration of outdoor recreation facilities by the Texas Parks and Wildlife Department, plus those funds spent by counties, cities, and municipalities for the same purpose,
175	Scrap	Used and second hand goods .
Final Payments		
176	Households	Wages, salaries, rents, interest, and dividend paid to households and personal incomes of sol proprietors.
177	Property payments (residual)	Total revenue minus total expenditures (residual income, retained earnings, etc.).
**178	Federal Government[2/]	Taxes and other payments to Federal Government-.
**179	State Government[3/]	Taxes and other payments to State Government.
**180	Local Government[4/]	Taxes and other payments to Local Government.
181	Depreciation	Capital consumption allowances for plant and equipment for current production,

(Continued)

ndix Table 1. Continued[1/]

tor Number	Sector Name	SIC Code or Description
182	Imports	Payments for goods and services produced outside Texas.
al Demand		
176	Households	Purchases by individual consumers.
**177	Federal Government Defense	Expenditures of the Department of Defense.
**178	Federal Government Non-Defense[2/]	Federal expenditures other than DOD expenditures.
**179	State Government[3/]	State Government expenditures.
**180	Local Government[4/]	Expenditures of Local Government.
181	Exports	Out-of-state sales of goods and services produced in Texas, including sales in Texas to out-of-state buyers.
182 "	Capital formation	Value of capital purchased by Texas sectors that will be depreciated in future years.
183	Inventory change	If negative, the current sales made from inventory, if positive, the value of production added to inventory.

* This sector contains both Private and Government owned establishments.

** This sector contains only Government owned establishments.

1/ Contrary to the 1972 SIC Manual, Government owned establishments were excluded from the content of the 1972 Standard Industrial Classification Codes listed here unless otherwise specified. This approach was used to align the 1967 and 1972 I-O Models for comparative purposes.

2/ Expenditures for Federal Facility Construction and Health are excluded from this sector.

3/ Expenditures for State Facility Construction, Health, Education, and expenditures by Texas Parks and Wildlife in the operation and administration of outdoor recreation facilities are excluded from this sector.

4/ Local expenditures for Facility Construction, Utilities, Health, Education, and funds spent by counties, cities, and municipalities for the operation and administration of outdoor recreation facilities are excluded from this sector.