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MISSING ELEMENTS IN ALASKA OUTER CONTINENTAL SHELF LEASE IMPACT ANALYSIS

by

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I. Introduction

A major thust of U.S. energy policy has been the rapid increase in leasing of federal government outer continental shelf (OCS) lands for petroleum exploration and production. Because Alaska is adjacent to a large proportion of the total U.S. continental shelf, much of the proposed and actual leasing activity has been scheduled to occur in Alaska OCS waters.

As a result of this, the state may anticipate far greater proportionate impacts, both positive and negative, from this aspect of U.S. energy policy than any other state. This is so not only because of the greater potential activity but because of the nature of the socio-cultural and economic structure of the state.

At first glance it seems clear that the perceived national benefits of expanded oil productions from Alaska OCS waters would substantially exceed attendant costs. This is certainly the conclusion reached in the environmental impact statements (EIS) that have accompanied both past sales and proposed five-year lease schedules. While such a conclusion may have some validity from a national perspective, it does not necessarily reflect concern over important issues regarding the distribution of benefits and costs associated with OCS development and related impacts.

Furthermore, the relative importance of regional impacts, when viewed from a national perspective, is sensitive to the magnitude of net benefits to the nation as a whole. It is easier to ignore regional or local consequences if the national benefits are large, rather than marginal.

While these concerns are not ignored in the assessment of impacts, as analyzed in the studies preparatory to the EIS document, the EIS itself, or the Secretarial Issues Document that accompanies each proposed lease, there are important deficiencies that deserve consideration.[1] It is the purpose of this paper to attempt to explore some of those deficiencies and to assess their significance from both a regional and national perspective.

The remainder of the paper is divided into four parts. In part two, the general dimensions of the OCS Program (in particular as it relates to Alaska) are set forth. Since the "net national benefit" is a critical element in the OCS lease decision, it is necessary to look closely at the definition and measurement of this concept. This is done in part three. In part four attention is focused on impacts at the Alaska level that appear to be inadequately addressed in current OCS impact analysis. Particular emphasis is placed on income

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[1]The perceived deficiencies are in part dependent upon the observer and the parameters within which the Department of the Interior conducts its analyses. While the author may suffer from a certain amount of geographically induced myopia, it is felt that the deficiencies may be of some national significance as well.

distribution effects and the implications of market failure. Finally, part five provides a synthesis of findings and a few summary remarks.

II. OCS in Alaska

Interest in Alaska OCS development derives primarily from the magnitude of unexplored acreage and the potential for finding major quantities of oil and natural gas. As reflected in Table 1, 43.9 percent of the estimated mean amounts of U.S. undiscovered recoverable offshore oil resources are located in Alaska OCS areas, with comparable estimates of natural gas at 38.7 percent.

The most recent proposed leasing schedule, summarized in Table 2, is indicative of the intent to aggressively pursue lease sales in Alaska, and represents an acceleration in both the number and timing of sales over previous five-year schedules. As a consequence, Alaska may anticipate greater relative impacts from this aspect of U.S. energy policy than any other state or region. Several dimensions of Alaska's sociocultural and economic structure support this contention.

First, the state's economy and population are small. The total population of the state is about 400,000 (1980 Census) with about 62 percent living in the major urban centers of Juneau, Anchorage, and Fairbanks. The remainder is widely scattered about the state in communities ranging in size from about 10,000 villages of 25 or 30 people.

TABLE 1. MEAN ESTIMATES OF U.S. UNDISCOVERED RECOVERABLE OIL AND GAS RESOURCES BY PETROLEUM REGION

	Offshore			
	Crude Oil (billion bbl)		Natural Gas (trillion cu ft)	
Region	Offshore	% of Total	Offshore	% of Total
Alaska[1]	12.3	43.9	64.6	38.7
Pacific Coast	3.8	13.6	6.9	4.1
Gulf of Mexico	6.5	23.2	71.9	43.1
Atlantic Coast	5.4	19.3	23.6	14.1
Total Offshore	28.0	100.0	167.0	100.0

	Onshore			
Region	Offshore	% of Total	Offshore	% of Total
Alaska	6.9	12.6	36.6	8.6
Other U.S.	47.7	87.4	390.3	91.4
Total Onshore	54.6	100.0	426.9	100.0

	Combined Onshore & Offshore			
Region	Offshore	% of Total	Offshore	% of Total
Alaska	19.2	23.2	101.2	17.0
Other U.S.	63.4	76.8	492.7	83.0
Total	82.6	100.0	593.9	100.0

[1]Includes some amounts that are considered recoverable ony with technological development that permits exploration beneath the Arctic pack ice.

SOURCE: USGS Open-File Report 81-192.

TABLE 2. DISTRIBUTION OF LEASE SALES IN PROPOSED 1981-1986 OCS LEASING SCHEDULE

Region	Number of Leases	% of Total
Alaska	16	43.2
Atlantic Coast	6	16.2
Gulf of Mexico	10	27.0
California, Washington, & Oregon Coast	5	13.5
Total	37	100.0

SOURCE: Federal Register Volume 46, No. 74, Friday, April 17, 1981.

It is in these smaller communities that most of the direct impact of OCS will be felt. Of the sixteen sales on the April 1981 schedule, fifteen occur in western and northern waters adjacent to coastal areas where the population is largely Native, communities are small and relatively isolated, and there is a high dependence on marine resources for subsistence and commercial economic activity. Access is either by air or water, and community infrastructure is minimal. In no case does community size exceed 2500, and in most instances the figure is much less.

The state's work force is also small, numbering about 192,000, with an unemployment rate of about 8.7 percent. About 50 percent of total employment is in support sector activity (transportation, communications and public utilities, trade; finance;and services) with another 32 percent accounted for by local, state, and federal government. Manufacturing, largely related to fisheries and timber resources (7 percent of employment), construction (7.5 percent), and mining, including and oil and gas (3.4 percent) account for the remainder of employment.

In other words we are looking at an area that is vast geographically but limited in economic scope. Local supply elasticities are small and changes of a magnitude implied by the OCS leasing scheduled suggested that significant migration and strains on economic and social infrastructure will occur, particularly in the rural regions. This is a situation not unlike that experienced by regions in the

western United States that have undergone major change in the face of energy resource development.[2]

III. Social Benefits in OCS Analysis

Before looking specifically at OCS evaluations of proposed lease sales, it is necessary to consider on what, from an economic perspective, such an analysis should focus. Fundamentally, the question is one of how a specific policy action, or set of policy actions, affects the Pareto optimal allocation of resources over time and how intertemporal economic welfare is affected by these changes. In this context, the consequences (or impacts) of a particular policy set can be viewed as the difference between Pareto optimal states of the economy (over time) that result from the "with policy" and "without policy" courses of action.

Implicit in this approach is a comparison of general equilibrium and welfare (benefit) streams over time. Our ability to conduct such analyses is restricted by inadequate imperical knowledge and capabilities. Furthermore, comparison of welfare streams (or distributions) is hampered by the lack of an intertemporal social welfare function.

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[2]For example, see Murdock and Leistritz (1979) and Gilmore (1976) for a description of energy development impacts in western U.S. rural areas.

As a result, analysis of policy actions usually falls far short of the "ideal." The problem of "welfare" is dealt with by proxy (e.g. net income or other measures of net benefits). Intertemporal comparisons are handled by discounting at a rate that imperfectly reflects a social time preference. Income distributions, if treated at all, are described, but not evaluated. Finally, analyses are prone to reflect partial, rather than general, equilibrium treatment.

These concerns are not new, nor are any significant remedies proposed. The critical point is that because we cannot fully deal with these weaknesses but conduct policy analysis in any event, the interpretation and use of these analyses should be tempered with more caution than is often the case.

Let us now consider the OCS program in more detail. The OCS Lands Act and ammendments establish the basic goals of the program. These include expedited exploration and development of oil and gas resources of the OCS to "achieve national economic and energy policy goals, assure national security, reduce dependence on foreign oil, and maintain a favorable balance of payments in world trade . . ," all of which is to be accomplished so as to ensure the public a fair return, preserve competition, and balance orderly energy resource development with protection of the human and physical environment (U.S. Department of the Interior, Secretarial Issue Document, 1980).

To assess the contribution of a proposed lease sale to the above goals, analyses are undertaken that lead to an estimate of social benefits and social costs associated with the sale. Included in the calculation of social benefits are the economic value of the oil and gas and national security benefits. Social costs include impacts on the marine and coastal environments and on the human environment (encompassing cultural resources, lifestyle, and economic and infrastructure stress).

Social benefits are measured in dollar terms. On the other hand, social costs are typically dealt with qualitatively be ranking impacts according to the probability of high ecological or high social cost. A decision rule by which the choice is made to proceed, or not to proceed, with the sale is not stated, but it appears that if social benefits exceed social costs, the sale will occur.

It is not the purpose of this paper to engage in a detailed critique of the OCS program. However, there are certain points that should be raised regarding national benefits that are of direct significance in evaluating the social costs to be largely borne by Alaska.

As stated above, social benefits include a measure of the economic value of the resource and a national security benefit. The economic value is estimated by considering two possible outcomes. In the first case, it is assumed that the point estimate of recoverable oil

and gas is discovered and produced over an assumed production profile. In this instance, the economic value is defined as the current landed market price of world oil less transportation, exploration, development, and production costs, all appropriately discounted. This is conceptually equivalent to the present value of the economic rents, assuming that the specified amounts of oil and gas are found.

The second outcome assumes that oil and gas is not discovered in commercial quantities and that the leases are abandoned. In this outcome, the incurred exploration costs (which may differ from the "discovery" outcome) are discounted to find the present value. Finally, the two outcomes are weighted by the probability of discovering the estimated quantities of oil and gas (P) and the probability of no commercial finds (1-P). The result is an estimate of the expected present value of the lease sale (Rose, 1979).

While this is a fairly standard procedure for evaluating resource potential in public policy analysis, it is important to be aware of potential shortcomings. These fall in two general categories: underlying assumptions and specific values of the variables used, and what the technique does not measure.

First, the choice of the risk factor heavily influences the expected present value. In Rose's paper, he assumes a certain outcome (probability of discovery = 1.0), obtaining an expected value of 857 million dollars for a mid-Atlantic lease sale. With a risk factor

of 20 percent (P = .2), the expected value is negative if exploration costs exceed 214 million dollars (compared to exploration costs of $919 in the event of a discovery).

The expected value of a Gulf of Alaska sale (Sale 55) was estimated to be 7.8 billion dollars, the figure used in policy decision making. This figure was also unrisked. When adjusted to reflect the U.S.G.S. estimate of the likelihood of finding the specified amounts of oil and gas, the expected value drops to something less than 1.6 billion dollars. Since the time of Sale 55, it appears that policy has changed and estimates are being appropriately risked.

The uncertainty of the risk factor remains, however. The fact that industry bids are frequently less than OCS estimates suggests that there is room for substantial uncertainty, particularly in unexplored frontier areas.

Second, the use of two outcomes, rather than a probability distribution of possible outcomes, can introduce a biased result. Whether the bias is positive or negative cannot be determined a priori and may vary from sale to sale. Rose argues that economies of scale derived from larger-than-expected finds result in an underestimate of present value. However, in at least one instance, economies of scale appear to be limited.

In an analysis of the proposed St. George Basin sale, the equivalent amortized cost per barrel for oil is about $24.00 per barrel for a field size of 50-100 million barrels. For a field of 350 million barrels, the costs drop to about $20.00, a 20 percent reduction for an increase in field size of 460 percent. Since the range of uncertainty on these cost estimates is about -20 percent to +25 percent, it would be hard to ascribe any statistical significance to the difference in costs (Bureau of Land Management, Alaska OCS Office, Technical Report 56; hereafter referred to as TR 56).

Third, the results are sensitive to assumed prices and the structure of costs, as well as to the choice of discount rates. The use of a constant real price results in a downward bias if we believe that real prices are going to continue to rise. Given the experience of the last decade, it is somewhat difficult to argue that real prices might decline, but we are looking at 30-40 year projections. Some sensitivity analysis to alternative price assumptions would be of interest.

Estimates of costs are also highly speculative, as suggested above. The range of -20 percent to +25 percent indicates substantial uncertainty and would seem to imply a greater possibility for costs to exceed the estimated costs. Experience with other major projects in Alaska, such as the trans-Alaska pipeline, suggests that there is a substantial propensity for actual costs to exceed projected costs.

The pipeline, originally estimated to cost about 2 billion dollars was finally completed at a cost close to 10 billion dollars.[3] In this instance, cost increases can be attributed to a variety of circumstances, including delay in the start of construction due to environmental and Native land claims litigation, inflation, design changes to meet increasingly stringent environmental protection measures, and unanticipated physical conditions.

The magnitude of the overrun probably exceeds that which should be anticipated for OCS activity. At the same time, OCS costs are sensitive to several of the same causal factors.

Alaska OCS environmental conditions at best are somewhat more difficult than other U.S. OCS areas. In addition, the majority of proposed sales occur in western and northern regions where seasonal or annual ice conditions may increase the difficulty and cost of activity. Furthermore, the fact that these are frontier areas, geographically remote, introduces further cost uncertainties.

While the effects of inflation on costs can be estimated, the timing of activity is also uncertain. Constant litigation has hampered and slowed almost all Alaska OCS activity, resulting in increased costs. While the motives for litigation are mixed, they reflect in part a perceived failure to adequately address social costs of the

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[3]See Cicchetti (1972) or Krutilla and Fisher (1975) for a detailed discussion of preconstruction era estimates.

sale. The acceleration of leasing schedules will exacerbate this problem.

The timing and number of sales will also play a significant role in the size of costs, although it appears that OCS estimates of economic value assume an infinitely elastic supply schedule of exploration, development, and production effort (Rose, p. 7106). Simultaneous or overlapping activity resulting from multiple lease sales may lead to substantial cost increases. In past Alaska experience, oil development costs have increased from 20-30 percent annually. Similar experiences have occurred in North Sea development (TR 56, p. 16).

In short, there is substantial room for error in the estimation of future prices and costs. In an attempt to deal with this problem, the Dames and Moore Study (TR 56) conducted a Monte Carlo study in which the per-barrel equivalent amortized cost of oil field development (EAC) is analyzed in relation to a variety of cost and price assumptions. The result is a range from $21.78 to $31.73 per barrel, with an expected value of $25.69.

It should be noted that these figures do not reflect real economic costs since producer taxes and royalties are treated as costs. Neither do these cost figures include exploration costs. However, they are indicative of the sensitivty of the analysis to relatively modest changes in cost and price assumptions.

Before concluding this section, there are three final issues regarding the measurement of social benefits. First, the methodology represents a form of partial equilibrium analysis that assumes "other factors held constant." In particular, it is assumed that the level of effort reflected by the sale in no way diminishes industry effort elsewhere. This is a highly implausable conclusion, particularly if considered in the light of many sales, rather than one. The supply of exploration, development, and production effort is not infinitely elastic, especially in the short run. Thus, in addition to potentially understating costs, we are measuring the gross value of economic rents, not the net gain.

Whether or not the difference between gross and net gains is significant is a matter of speculation. It seems clear, however, that some additional oil and gas would be found even if OCS leases were not made available. Some support for this contention is seen in Table 1. Undiscovered recoverable resource estimates for onshore oil are nearly double those of offshore resources. Even if we allow for land status and acquisition complications and other difficulties of development, it is hard to justify the assumption that no other oil and gas would be found at some positive value, from domestic sources.

A second question is whether or not current lease schedules reflect in any way an optimal pattern with respect to the timing and ordering of sales. In a study of OCS energy production potential, Prato and Miller (1981) analyze the March 1979 schedule. Using the present

value of economic rents as the objective function, an optimum lease schedule is developed for the 1982-1985 period. It is not possible to completely match their schedule with the April 1981 schedule, but it is clear that both the timing and order differ.

Finally, it is worth asking how the net social benefit measured relates to the purported goals of the OCS program. Does potential OCS production significantly increase national security or reduce our dependence on foreign energy imports? Implicit in the discounting process is a reflection of future generations' values. Without getting into the endless debate on social discount rates, it is at least worth raising the issue of how accelerated depeletion of domestic resources leads to greater independence from world resources.

Further, as Prato and Miller conclude in their study, after reviewing potential levels of production from an optimized lease schedule, the United States cannot rely on increased OCS production to offset declines in U.S. production. Clearly, we are going to be dependent on foreign oil or gas, with or without OCS production.

In summary, this section has raised several critical issues with respect to the evaluation of lease sale benefits. The uncertainty associated with the process as well as its failure to measure net gains suggests that at best the results be used with caution. Because of this, it is appropriate to give greater weight to potential social costs that may result from a sale. Implications of this are considered in the next section.

VI. OCS Impacts in Alaska

It has been suggested above that anticipated OCS activity will have a major impact on Alaska. Whether or not these impacts are positive or negative depend in part on the observer. To the extent that changes in economic activity reflect the normal functioning of the market system in allocating goods and services the impacts should not be of particular concern, except for possible income distribution consequences.

In addition, exogenous (to Alaska) changes of a large magnitude over a relatively short time span may also result in externalities that impose social costs of production largely born by the impacted population, who at the same time participate only marginally in the benefits. As reflected in OCS analyses, these external costs may be environmental, social, or economic in nature. While it is relatively easy to identify potential externalities, it is usually difficult, if not impossible, to place a meaningful market value on these effects. Thus, comparison of social benefits with social costs introduces a great deal of subjectivity.

Before exploring these problems in more detail, it will be helpful to look at the overall economic implications of prospective OCS

activity in Alaska. This is accomplished by using a statewide econometric model of the Alaska economy known as the MAP (Man-in-the-Arctic Program) model.[4] Use of the model for impact analysis involves construction of two scenarios, the base case and the impact case. In the present instance, the base case utilized was one currently being used for evaluation of the impact of a pending lease sale in Alaska, the St. George Basin (Tuck and Huskey, 1981). Projections cover the 1980-2000 period.

The impact case includes the base case, and adds to that a scenario that reflects direct exogenous OCS employment and taxable capital for an hypothetical cumulative OCS leasing effect over the 1982-1990 period. The sales in the scenario include all but one (St. Matthew-Hall) of the sales on the April 1981 schedule, as well as three additional sales from 1988-1900. A full listing of the sales is included in the appendix.

After developing the list of sales and their timing, direct OCS employment and taxable capital investment was estimated for each sale, using data from previous proposed sale analyses that appeared comparable with sales in the present listing. These data were then aggregated to obtain the cumulative series for the 1980-2000 period. Taxable capital investment includes only that portion of total investment

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[4]For a detailed discussion of the model see Scott Goldsmith, Man-in-the-Arctic Program: Alaska Economic Model Documentation.

that falls within the taxing jurisdiction of the State of Alaska and consists mainly of onshore facilities and portions of the platform-to-shore pipelines. As such, taxable capital reflects only a small proportion of total investment.

Because of the nature of OCS activity it is worth commenting on the pattern of employment that accompanies a particular lease sale. Exploration is carried out by internationally mobile crews and equipment that are largely self-supporting. Demands on the local economy are limited. It is during the development phase that impacts are greatest. Intensified drilling activity, coupled with construction of production platforms, other field development, and transportation facilities lead to a large bulge in labor requirements over a relatively short period (of perhaps 3-5 years). In addition, a significant proportion of the work requires specialized labor on a temporary basis. As a result, this phase of activity will be accompanied by a high level of labor migration. Finally, employment during the production phase is relatively stable but at levels well below the development phase.

As an example of this pattern we can consider projected average annual employment projected for the St. George Basin sale scheduled for 1982. Exploration begins in 1983, with total direct OCS employment of 480 persons, of which 160 persons are Alaskan residents. Employment grows rapidly to 5924 persons in 1987. At this point resident employment is about 30 percent of the total. Employment declines

thereafter until 1991, at which point it stabilizes at about 1800 persons, of which some 88 percent are residents of the state (Tuck and Huskey, 1981).

One other dimension of this activity needs to be mentioned. It is anticipated, based largely on the Prudhoe Bay experience that housing and other support of labor will be facilitated by enclave development adjacent to the site of OCS activity. In this approach shore-based workers are housed in work camp or dormitory facilities during their work tour (of anywhere from one-to-nine weeks) and then transported directly to one of the urban centers or out of the state. Drilling crews (who live on the rigs) are handled in a similar fashion. In the Prudhoe Bay case, the motive for this approach (as opposed to full-scale community development where no community existed) appears to have been based on economics.

Because the nonresident component of the work force is supported in enclaves, their impact on the economy is minimal.[5] Hence, employment estimates for the MAP model runs have been adjusted to exclude the nonresident component of total direct OCS employment. Because the coefficients used in the adjustment process were developed to reflect

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[5]While this has been the experience in the Prudhoe Bay case the situation may differ if future enclaves are situated adjuacent to existing communities, as may be the case in some OCS sales.

a single sale, it is likely that the resident component will be understated in a cumulation of sales. The resulting estimates of resident OCS employment and taxable capital are presented in Table 3.

Table 3. Estimated Direct Resident OCS Employment and Taxable Capital: Alaska 1980-2000

	Employment[1]				
Year	Mining	Construction	Transportation	Total	Taxable[2] Capital
1980	0.0	0.0	0.0	0.0	0.0
1981	0.0	0.0	0.0	0.0	0.0
1982	0.0	0.0	0.0	0.0	0.0
1983	0.137	0.018	0.088	0.243	10.0
1984	0.323	0.100	0.146	0.569	10.0
1985	0.731	0.270	0.419	1.420	20.0
1986	0.927	0.427	0.665	2.019	15.0
1987	1.378	1.681	0.932	3.991	649.0
1988	1.645	1.978	1.695	5.318	1652.0
1989	2.306	3.716	1.941	7.963	3702.0
1990	3.421	4.500	2.377	10.298	4886.0
1991	4.774	3.843	2.842	11.459	5533.0
1992	6.888	2.707	2.658	12.253	4745.0
1993	7.928	2.967	2.531	13.426	2681.0
1994	7.786	2.848	2.567	13.201	1054.0
1995	8.655	1.006	2.672	12.333	1377.0
1996	9.033	2.119	2.774	13.926	918.0
1997	9.215	1.946	2.878	14.039	1146.0
1998	10.179	1.874	2.982	15.035	458.0
1999	10.045	1.545	3.098	14.688	0.0
2000	10.846	0.186	3.202	14.234	0.0

[1]Average annual resident employment, in thousands.

[2]Millions of 1980 dollars.

SOURCE: See text.

We can now consider some of the impacts implicit in the cumulative OCS scenario.[6] The results are of interest for two reasons. First, they provide a measure of the aggregate demographic and economic consequences of a sustained leasing effort. Second, it is also possible to compare the impacts of the aggregate program impacts with those of a single sale.[7]

Population, compared to the base case, has increased by 139 thousand (20.9 percent) by the year 2000, and represents an increase in the annual rate of population growth from 2.6 percent to 3.6 percent. Of this total increase, 107 thousand (77 percent) reflect inmigration. These figures are in sharp contrast to the comparison between the base case and the St. George Basin sale analysis in which the population difference between the base and sale case was 15 thousand (2.2 percent above the base case), with net migration of 10 thousand.

It is also of interest to look at personal income and per capita personal income (both in 1980 dollars). In the aggregate case real personal income is 2.8 billion dollars (21.5 percent) above the base case figure of 13.0 billion dollars in 2000. Per capita income also rises above the base case, with the difference increasing from 16 dollars in 1983 to 1566 dollars in 1990, but dropping thereafter to

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[6]Output tables are included in the appendix.

[7]The specific sale used for comparison is the St. George Basin sale analysis (Tuck and Huskey, 1981).

105 dollars in 2000. The substantial increase during the middle of the projection period reflects a combination of high levels of construction activity and the high wages associated with that activity. The pattern is similar in the St. George case, although the increase peaks at 376 dollars and actually becomes negative by 51 dollars by 2000.

These changes in per capita income reflect two phenomena of the Alaska economy. First, it is an open economy, subject to large labor migration. Second, major gains in total economic activity have little impact on long-run trends in per capita income. The primary economic gain to the state from OCS activity (personal income) appears to be largely captured by the construction sector, and to a lesser extent the mining industry.

Furthermore, these changes in the relative structure of employment and income may result in a less uniform distribution of income. This effect has been observed in Alaska in response to other major projects, and specifically, with regard to construction of the trans-Alaska pipeline (Tuck and Huskey, 1981). In this case the redistribution effect resulted from growth of support sector activity relative to total activity, in conjunction with growth in real wage differentials between construction and mining and other sectors.

The final part of the MAP projections that is of interest relate to state government revenues. Revenue impacts occur as the result of

property taxes on OCS-related investment within the taxing jurisdiction of the state (onshore property and property within the three-mile limit--primarily pipelines). Production and corporate income resulting from production in federal waters is not taxable.

Additional revenues are derived from the general expansion of economic activity. Since the state does not have a personal income tax, these revenues are derived from corporate income taxes and other business-related taxes. Further revenues result from earnings on the general fund surplus.

Direct petroleum-related revenues from OCS increase from 0-to-455 million dollars (in real terms) by 1997, and begin to decline thereafter. Other revenues rise steadily over the projection period, to 388 million dollars in 2000. By the year 2000 total state government general fund revenues are 811 million dollars above the base case.

While these are substantial increases, state government expenditures also increase in response to rising population. In the present analysis these are exogenously determined to increase so as to maintain a constant real per capita level of expenditures. As a result real expenditures increase over the base case by 926 million dollars, (115 million dollars above revenue increases) in the year 2000.

While the assumption of constant per capita government expenditures appears to ignore possible economies of scale, there are other reasons to believe that this assumption may be justified. In the first place, real per capita government expenditures have been increasing at least this fast for the past decade. Secondly, economies of scale would most likely be observed when population increases are marginal, and concentrated in areas with an already existing level of high government services. However, we are not looking at marginal increases, and the distribution of population in the state may be affected by the magnitude of the projected OCS-related increases.

Finally, it must be recognized that the state is not starting from a position of a high level service. While the major urban areas may enjoy government services comparable to other areas of similar size, social infrastructure in the rural region of the state is only beginning to develop towards acceptable levels. When this factor is coupled with the high costs of delivery of services to rural regions, it is unlikely that scale economies of any significance will be observed. In other words, the situation is one of extending services to previously unserved areas, rather than one of simply expanding services to meet population growth in established urban areas.

A final dimension of the fiscal impact of OCS development is observed in the value of the general fund balance. This variable reflects the cumulative excess of state government revenues over expenditures (including interest earnings). The general fund surplus is

almost entirely a direct result of revenues derived from Prudhoe Bay production and reflects the state's monetization of nonrenewable natural resource wealth.

If this stock of public wealth is viewed as a source of future income for residents of Alaska (in the form of future publicly provided goods and services), then substantial population migration to the state, in response to OCS development, represents a dilution of wealth and a shift in income to migrants. In the present case, OCS activity results in a projected increase in the real value of the surplus of about 1,043 million dollars by 2000. However, on a per capita basis the fund balance differs by about 14 percent ($11,281 vs. $9,716).

The fiscal impact of OCS activity is also sensitive to the level of taxable capital investment. In the more remote regions of OCS development, it is quite possible that assumed values of taxable capital have been overstated, since the economic feasibility of offshore storage and transportation increases with increasing distances from shore. Hence, a second run has been made reflecting the extreme case in which no onshore investment is made. While this situation would not be expected, it does serve to bracket the range of fiscal impacts, at least on the low side.

In this scenario state government revenue gains (over the base case) peak at 141 million dollars in 2000. Because induced activity

revenues are not adequate to maintain per capita government expenditures, the general fund balance is drawn down, reducing earnings on the fund balance as well. As a result the real value of the surplus is diminished by 3.7 billion dollars by the year 2000. Furthermore, the per capita value of the fund is 29 percent below that of the base case ($7,980 vs. $11,281). This clearly reflects a sizable reduction in the claims of the pre-impact population on the wealth (and future income) of the state.

If we assign a yield of five percent (in rela terms) in perpetuity to the diminished per capita fund balance, then the implicit decline in income ranges between 78 dollars and 165 dollars. Comparing this to the increase in per capita personal income of 105 dollars in the year 2000, it is apparent that the net difference is small. Thus, whether or not these combined changes (in either scenario) represent a net redistribution of income from pre-impact residents depends on the amount of private income created by OCS activity that is earned by pre-impact residents.

This issue is explored in some detail in a paper by Huskey and Porter (forthcoming). Looking at private and public income effects conceptually similar to those discussed above, they conclude that unless pre-impact residents capture at least 40 percent of private income (direct and indirect) resulting from OCS activity, those residents incur a net economic burden. Furthermore, the 40 percent share will only be achieved if migrants earn substantially less than the

average Alaska income. While this analysis was based on the combined effect of only four proposed sales, their conclusions would appear to extend to the present analysis since their per capita personal income effects appear at least as large; and the effect on the fund balance in their study is substantially less.

In summary, it would appear that the aggregate impacts of OCS activity are substantial. In particular there are important implications with regard to the distribution of income and wealth. It is quite probable that pre-impact residents suffer a net economic loss as a result of OCS induced changes in the economy. Furthermore, the state incurs a net fiscal burden as well.

OCS analyses have not dealt with this problem in substantial fashion. In part this is because other OCS areas of the nation are likely to be adjacent to some heavily populated areas when the private income distribution effects may be less significant. In addition, the public wealth and income effects in Alaska are somewhat unique in the U.S. However, from the state's perspective these are an important consideration and are the basis for some of the Alaskan concern with and resistance to OCS development. In addition to this concern is the potential cost of externalities that may be incurred as a result of OCS development.

The OCS program has opted to deal with externalities in a qualitative manner, relying upon a descriptive probablistic approach to

evaluation of socioeconomic and environmental impacts. The reason given for this choice is the problem of empirically estimating economic values of the externalities. This problem derives from the high degree of uncertainty surrounding potential impacts, as well as methodological inadequacies related to fully measuring these impacts, even if known. However, significant progress has been made, both theoretically and empirically, in dealing with various dimensions of the economics of the environment. Presumably, some of these techniques could be brought to bear on OCS issues.

As an illustration, the "willingness to pay" criterion may have some applicability. The substantial efforts of various environmental groups, the State of Alaska, and local governments reflected in their participation in the review processes and continuing litigation, indicate a "willingness to pay" and the existence of a positive level of external costs. These efforts understate the actual level of anticipated costs since the current focus is only the definition of property rights.

Once property rights are established, the willingness to pay criterion might have further use. For example, what might a rural community be willing to pay to avoid impacts of an OCS sale? While there are difficulties with this approach, inpart related to the distribution of income, the results should be of some use. Furthermore, it is worth noting that this estimate will understate the amount of compensation that would be required to offset the impact if consumption of

common property resources is affected adversely by the impact (Krutilla and Fisher, 1975).

Whether or not the application of the willingness to pay, and other techniques of environmental analysis, would significantly improve the quality of OCS decision making, or be worth the cost, is open to speculation. It would certainly be of interest to see some attempts at quantification, but it may be that the principal issue would turn out to be that of the distribution of benefits and costs in any event.

V. Summary and Conclusion

Projected OCS leasing activity will have a substantial impact on Alaska. Major increases in population, economic activity, and costs of government services can be anticipated through the turn of the century. More importantly, the timing and control of OCS activity will have significant consequences with respect to cumulative effects.

The accelerated leasing schedule, as reflected in this analysis will place real strain on the economic capacity of the state. It will also result in a net fiscal burden, as well as a sizable redistribution of private and public income. Costs of environmental and social externalities must also be anticipated, although it has not been possible to say much with respect to their magnitude.

At the same time the measurement of economic benefits of the program have been questioned. The potential for sizable error exists and the benefits measured are gross benefits, not net benefits. Thus, even if accurately calculated, they are overstated. Furthermore, it is not clear in what fashion the benefits reflect achievement of OCS program goals except from extremely short-sighted perspective. When juxtaposed against the potential costs to be born by the state, it is clear why the rapidity of OCS development is viewed with some apprehension in Alaska.

These concerns are important from a national, as well as state, perspective. It is clear that, at whatever pace, OCS development cannot significantly reduce U.S. dependence on world sources of petroleum and natural gas. This is certainly the case in the short run, and it is hard to see how accelerated depletion of domestic resources over the long run results in increased energy independence.

At the same time, efforts to accelerate OCS development can only be accomplished with higher real costs. This is so not only because of supply constraints, but because of delays imposed by affected states as they attempt to reconcile the disparity between the distribution of costs and benefits of the program.

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APPENDIX

CUMULATIVE ALASKA OCS SCENARIO

For purposes of evaluating potential long-run impacts of Alaska OCS activity a cumulative schedule was constructed for the years 1982-1990. The sales listed (see Table A.1) included those listed in the April 1981 schedule (Federal Register, Friday, April 17, 1981, p. 22470) except for the St. Matthew-Hall sale, which has been dropped. These include fifteen sales between May 1982 and October 1986. Three additional hypothetical sales have been included in 1988-1990. Most assumptions regarding employment and resource size are drawn from Economic and Policy Scenarios for Railbelt Electric Power Study (Working Paper #1 for Battelle Pacific Northwest Laboratories) by Ed Porter, Institute of Social and Economic Research, March 30, 1981, and studies referenced therein. A detailed listing of assumptions is available from the author.

Table A.1

Sale Name	Date	Estimated Recoverable Oil (Billion barrels of oil)
Norton	82	0.38
St. George	82	1.12
Beaufort Sea	83	1.30
North Aleutian Shelf	83	0.332
Navarin Basin	84	2.16
Beaufort Sea	84	1.30
Norton Sound	84	0.30
St. George	84	0.50
Chukchi Sea	85	1.90
Hope Basin	85	0.50
North Aleutina Shelf	85	0.332
Beaufort Sea	86	0.80
Norton Sound	86	0.0 (Exploration only)
Kodiak (So. Alaska)	86	0.332
St. George	86	0.0 (Exploration only)
Chukchi Sea	88	1.9
Navarin Basin	89	0.0 (Exploration only)
Chukchi Sea	90	1.9
		15.056

Table A.2. Alaska Population Impacts: Impact Case Minus Base Case

	POPTST	MIGNET	NATINC
1980	0.	0.	0.
1981	0.	0.	0.
1982	0.	0.	0.
1983	0.546	0.547	0.
1984	1.716	1.148	0.022
1985	4.845	3.062	0.067
1986	8.777	3.75	0.188
1987	16.632	7.531	0.329
1988	26.569	9.332	0.618
1989	40.794	13.277	0.963
1990	59.476	17.25	1.454
1991	76.765	15.234	2.082
1992	88.892	9.555	2.598
1993	98.527	6.785	2.866
1994	105.375	3.84	3.019
1995	108.335	-0.086	3.051
1996	113.84	2.578	2.928
1997	120.73	3.969	2.926
1998	130.056	6.352	2.981
1999	136.236	3.055	3.135
2000	139.113	-0.27	3.152

Notes: POPST = State population.
MIGNET = Net migration.
NATINC = Natural increase in population.
All figures in thousands.

SOURCE: MAP model projections.

Table A.3. Total and Per Capita Real Personal Income Impacts: Impacts Case Minus Base Case

	PIRST	PIRPCST
1980	0.	0.
1981	0.	0.
1982	0.	0.
1983	13.812	16.41
1984	51.273	55.516
1985	157.547	150.215
1986	260.207	223.891
1987	543.891	573.402
1988	781.973	752.066
1989	1252.76	1201.62
1990	1794.23	1565.77
1991	2099.64	1484.14
1992	2191.09	1188.38
1993	2352.12	1088.37
1994	2429.24	963.34
1995	2259.63	554.332
1996	2429.93	549.
1997	2613.33	522.777
1998	2828.99	495.102
1999	2891.31	374.82
2000	2797.49	104.773

Notes: PIRST = State personal income (in millions of 1980 dollars).
PIRPCST = State per capita personal income (in 1980 dollars).

SOURCE: MAP model projections.

Table A.4. State Government Revenue and Expenditure Impacts: Impact Case Minus Base Case

	REVGFR	RP9SR	RFDSR	RNDSR	E99SR
1980	0.	0.	0.	0.	0.
1981	0.	0.	0.	0.	0.
1982	0.	0.	0.	0.	0.
1983	-0.685	-0.684	0.104	-0.108	2.229
1984	-4.42	-3.953	0.206	-0.673	6.918
1985	-14.234	-12.539	0.496	-2.191	19.25
1986	-7.914	-10.917	1.437	1.565	35.8
1987	24.867	10.782	3.43	10.657	71.512
1988	90.613	57.174	5.784	27.652	120.506
1989	192.73	135.635	8.375	48.718	194.075
1990	307.277	220.834	10.9	75.543	293.897
1991	445.977	317.86	12.862	115.253	392.028
1992	570.566	399.6	13.838	157.129	468.911
1993	642.844	437.23	14.144	191.471	536.105
1994	681.605	442.388	13.965	225.254	593.127
1995	715.102	452.847	13.252	248.999	630.205
1996	732.992	451.819	12.74	268.434	680.481
1997	760.703	455.959	12.38	292.365	740.286
1998	784.754	445.966	12.195	326.591	818.654
1999	804.348	428.859	11.777	363.714	883.98
2000	810.555	411.477	11.084	387.992	925.699

Notes: REVGFR = Total state government revenues.
RP9SR = Petroleum revenues.
RFDSR = Revenues from the federal government.
RNDSR = Other state government revenues.
E99SR = State government real expenditures.
All revenue figures are in millions of 1980 dollars.

SOURCE: MAP model projections.

Table A.5. General Fund and Per Capita General Fund Impacts: Impacts Case Minus Base Case

	FUNDRPC	FUNDR
1980	0.	0.
1981	0.	0.
1982	0.	0.
1983	-9.465	-3.762
1984	-37.422	-20.543
1985	-114.695	-70.289
1986	-200.543	-94.723
1987	-361.297	-80.41
1988	-567.902	-5.082
1989	-885.523	93.773
1990	-1316.89	163.43
1991	-1665.8	295.746
1992	-1841.03	496.93
1993	-1939.55	673.871
1994	-1970.05	824.734
1995	-1900.3	959.477
1996	-1853.12	1033.66
1997	-1804.14	1085.06
1998	-1786.71	1084.75
1999	-1709.67	1077.18
2000	-1565.1	1042.6

Notes: FUNDR = Real balance on general fund surplus (in millions of 1980 dollars.
FUNDRPC = Per capita real balance on general fund surplus (in 1980 dollars).

SOURCE: MAP model projections.