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Modeling the Economic Impact of OCS Petroleum Development in Rural Alaska

Lee Huskey and Gunnar Knapp

Introduction

The location of Alaska Outer Continental Shelf (OCS) petroleum resources assures that the onshore activity associated with their development will occur near small, remote, rural communities. The problem of modeling the impact of OCS development on these communities is complicated by the non-marginal nature of the change which will occur. The pattern of change that occurs is likely to be dominated by the size of the exogenous change relative to the size of the community. When the OCS development is relatively large, as in most potential cases of OCS development in rural Alaska, the pattern of local economic response to exogenous forces may change as the structure of rural economic and demographic relationships change. This paper addresses the need to take account of the potential for structural change in modeling economic impact.

Economic impact as used in this paper, is the change from some projected future pattern of growth as a result of a specific project. The modeling problems addressed in this paper are concerned with the accuracy of a projection of the economic impact in the sense that we wish to limit the uncertainty involved in our projections. The accuracy of an impact projection depends on three separate sets of assumptions: 1) assumptions about base case growth or growth without the project; 2) assumptions about the pattern and scale of the specific project (the scenario); and 3) assumptions about the response of the local economy and labor force to the project. Modeling addresses this last set of assumptions, but the results of the modeling effort are significantly influenced by both base case and scenario assumptions.

The extent of our concern with accuracy in impact modeling, or more importantly, the resources we devote to improving the accuracy of a model depends on the uses and timing of the projections. Impact projections have two basic uses: decision making and planning. The first step in which projections are used in the process of OCS development is the decision to lease tracts. Projections of impacts are used at this stage in the process to weigh the benefits of development against the costs. What is needed at this stage is a feeling of the order of magnitude of the impacts, not an exact projection. Once the decision to lease is made, projections are needed to plan ways to mitigate the impacts. The need to invest in public or private infrastructure and services to meet the increased population requires a fairly certain estimate of the level of future population. Our concern with accuracy is greater in the planning stage.

The point in time the projection is made also influences our concern with accuracy. The farther out in time the OCS development is planned to occur, the less we should be concerned with the accuracy of our model. The farther out in time an event will occur, the more likely it is that important parameters will change, so spending a great deal of resources on modeling will not guarantee the accuracy of projections. The timing of the projection also influences the information we have about the magnitude and path of resource development.

Bender and Juers (1975) call uncertainty about the character of resource development one of the major planning problems faced by communities. The less we know about the dimensions of the development (i.e., how much oil, what the industry plans to do), the less concerned we should be with the accuracy of our models. If we don't know the parameters of petroleum development, even a perfect model will not guarantee the accuracy of a projection. In devoting resources to improving the accuracy

of our models, we should be most concerned with short-run planning applications. The remainder of this paper examines the particular problem of structural change, and the necessity of incorporating structural change in the projection of impacts.

Impact Projection in Rural Alaska

Traditional approaches to describing regional economic growth are not appropriate for forecasting the impact of OCS development in rural Alaska. The traditional approach of economic base theory makes two essential assumptions about regional growth which differ in subtle but important ways from the economic growth process in rural Alaska. These assumptions are that the growth of the economy results from growth in the basic sector and that population growth is determined by economic growth. The linkages between basic and support sector employment and population are not so direct in rural Alaska as usually assumed. Nonwork sources of income and the potential for exporting labor also influence the growth of the economy. These factors, along with the importance of subsistence, limit the need and the desire to migrate in response to a lack of employment.

The development of resources in enclaves, such as Prudhoe Bay, with few links to the local communities means that basic sector activity can occur with no economic impact on local communities. These differences must be incorporated in any modeling effort which describes rural Alaska.

A more important problem faced in modeling rural Alaska impact is how to incorporate structural change into the analysis (i.e., the change in the basic relationships in the economy). For example, in traditional types of explanations of economic growth, the multiplier describes the relationship between the basic and support sectors; a change in this multiplier is structural change.

Rural Alaska economies are in the transition stage between pure economies and market economies (Fisk, 1975). Table 1 shows that the subsistence economy is still relatively important in rural Alaska. This transitional nature and the small size of the cash economy insures that structural change would occur in response to OCS development.

There are three structural relationships which are especially important in determining the impact of energy development. These are the local economic response (multiplier), the rate of labor force participation, and the residency of energy workers. The primary determinant of changes in each of these is the size of the local economy. As the size of the local economy increases, we expect these relationships to change. We describe the process of structural change and evidence of the potential for change in each of these relationships below.

Table 1. Share of Food from Subsistence Economy

Region	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.

Local Economic Response

The response of the local support sector to exogenous increases in economic activity is a 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 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 as changes in the multiplier will reflect structural change.

Multipliers have shown considerable variation in rural Alaska. In typical impact studies, historical ratios are used to represent the local economic response to exogenous change. Table 2 illustrates the problems with this simple approach to estimating multipliers. 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 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.

A more appropriate description of the causes of support sector growth in rural Alaska assumes local 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 relationship 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 basic sector employment growth does not necessarily increase the size of the market.

Table 2. Support Sector Ratios
(1970-1978)

	SS1[1]/Basic[3]			SS2[2]/Basic[3]			SS1[1]/Population			SS2[1]/Population		
Census Division	High		Low	High		Low	High		Low	High		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
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
Wade Hampton	.113	(+)	.037	.696	(—)	.206	.015	(+)	.003	.051	(—)	.027
Kenai	.567	(+)	.287	.686	(+)	.457	.125	(+)	.040	.111	(+)	.060
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.

(—) Decline in ratio over the period.
(+) Increase in ratio over the period.

The size of the local support sector is limited by the size of the market with regional income and population determining the size of the market. As the region grows, we expect more goods to be produced and more services to be provided in the region. 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 will, in turn, absorb high transport costs. The scale of the economy influences the goods and services available in the region, and consequently, the extent of local sector

growth for each additional dollar of income.

Table 3 provides evidence of the potential for change in the structure of the local economic response as the market expands. To investigate the potential for this type of structural change in response to OCS activity, we examined the change in support sector employment as the size of local markets changed both over time and across regional economies (see Huskey, et al., 1982). The regressions shown in Table 3 were run for coastal economies in Alaska and for small rural counties in the rest of the United States. In both cases, employment grew faster than population, indicating a change in the relationship.

Table 3. Comparison of U.S. and Alaska Support Sector Growth Regression Coefficients

	U.S.		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.
[2]All variables are in natural logs.

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.

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, consequently, 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 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 increases.

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. The most important reason for this is the discouraged worker effect. 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. 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 small size of rural labor markets and the limited economic activity in rural Alaska suggests that the discouraged worker effect would be significant and Tables 4 and 5 indicate this. Table 4 shows the results of a state survey conducted in the Wade Hampton Census Division. This survey compared those saying they were unemployment 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 5 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.

The desired rates of participation can also be expected to change over time; as the economy grows, we would expect the structure of labor force participation to change. Kleinfield's descriptioin 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 (Kleinfield, 1981).

Growth of the local economy may actually increase the desired labor force participation. In rural Alaska the desired labor force participation rates are higher in the larger, more developed economies of the regional centers. This type of structural change must also be incorporated into the projections.

Table 4. 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

[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.

Table 5. Discouraged Worker - Wade Hampton

	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.

The change in desired labor force participation results from three general effects associated with the growth of the rural economies. These changes can all be explained in a model of labor supply which describes the trade off between market work, leisure, and nonmarket work (Huskey, et al., 1982). The three effects are an increase in real wages, changes in subsistence, and changes in the marginal utility of income.

Increases in the real wage for market work results from an increase in average wage of those employed, a decline in the cost of living, or an increase in the probability of employment. Each of these will probably result in an increase in the real wage as the market increases. Increases in the real wage will most likely lead to a substitution of market work for nonmarket work and leisure. Changes in the cost, productivity of time, and the utility of subsistence will also change the desired participation in market work. As the population in a region grows, the costs of subsistence are likely to increase and the productivity decrease, which should increase the labor force participation. Finally, as an economy

grows, more goods and services will be made available, and costs will be reduced, which will increase the utility of a dollar of income. As the value of a dollar (in terms of what it can buy) increases, individuals will participate more in the market economy. In addition, the increased employment opportunities will allow that proportion of the population which would have migrated to find jobs to stay. The higher labor force participation rate of this group will increase the average rate.

Residency of Workers

The final relationship of importance to impact analysis is the proportion of the immigrant population which lives outside of an enclave in the community. Migrants in the community bring families and will increase the population effect of OCS development. This in turn will increase the secondary economic response to OCS development.

The residency share of migrants depends primarily on the policies of the oil companies. If they decide to base operations away from any community, the residency effect will be low. If oil companies pay trips to some base, such as Anchorage, the residency effect will also be low. Given an oil company policy, the residency will be higher the larger the economy. Although Alaska has only extreme examples, such as Prudhoe Bay, the attraction of larger communities has been shown in other research, and we would expect a similar pattern. The larger communities offer more amenities and housing for the migrants, so we would expect more people to migrate in response to OCS development.

Effects of Structural Change on Base Case and Impact Projections for Rural Alaska

In this section, we examine the effects of structural change on base case and OCS impact population projections for the Aleutian Islands. These provide an indication of the relative importance of structural change in different modeling circumstances.

The projections were done using a model developed by the Institute of Social and Economic Research as part of the Alaska OCS Socioeconomic Studies Program, in order to project the impacts of OCS development on small Alaskan communities or regions. The model is referred to as the Small Community Impact Model, or "SCIMP." A detailed description of the model is presented in Knapp (1982).

The SCIMP model is divided into four separate sectors—the baseline sector, the short-term impact sector, the long-term impact sector, and the secondary impact sector. In each of these sectors, the model projects separate the major demographic events—births, deaths, and migration—which determine population change. The sectors are linked through labor supply and demand considerations.

In the baseline sector, the model projects population and employment which would occur in the absence of industrial development. In the short-term impact sector, the model projects population and employment changes which would occur in response to short-term impacts. The impacts occur primarily as a result of employment of local labor by the impact industry, and importation of labor to fill jobs not filled by local labor. Short-term imported labor is implicitly assumed to leave after each year. In the long-run impact sector, a portion of the import labor is assumed to reside permanently in the community, resulting in a changing age structure of the impact population. The secondary impact sector projects seconday employment generated by employment in the short-term and long-run impact sectors, as well as migration to fill these jobs and jobs left vacant by local residents taking impact industry jobs. Finally, a summation sector calculates summary outputs of the model.

The primary determinant of population change in the SCIMP model is usually migration, which occurs in response to changes in employment opportunities. Employment is calculated as the sum of basic or exogneous employment and endogenous support sector and government sector employment. Government employment is a function of population. Support sector employment is calculated by multiplying basic sector employment by a simple multiplier.

To examine the effects of structural change on population projections of the model, we ran three different sets of projections for the Aleutian Islands, incorporating different assumptions about growth in the base case (without OCS) and the size of the employment impacts of OCS. For each of the three combinations of assumptions, we ran the model twice—once with "structural change" and once without "structural change." In the case without structural change, the support sector multiplier was assumed to remain constant at the current ratio of endogenous to exogenous employment, or .26. In the case with structural change, the multiplier was assumed to follow a logarithmic growth path as population grows, as defined by the current multipliers for the Aleutians and for Kenai. This growth path is given by the equation

Multiplier = -2.225 + .291 log (population).

Thus, a very simple model of structural change was used, based on very limited cross-sectional evidence. However, the results serve to illustrate the possible relative importance of structural change under different modeling circumstances.

Different base case growth paths were projected based on differing assumptions about the growth of an onshore bottomfish processing industry in the Aleutians. OCS impacts were for a typical Bering Sea OCS sale, with the greatest impacts occurring during the construction period from 1986-1990. Under the "low impact population" assumption, only a small share of OCS workers become local residents, while under the "high impact population," over half of OCS workers become local residents.

The three sets of model projections are presented in Tables 6-8. In Table 6, a low growth base case and low impact population are assumed. In this case, there is relatively little effect upon the models projections when structural change is allowed for. Base case population projections differ by only one in the maximum impact year of 1989, while the total projected impact increases by only 32, or five percent.*

In Table 7, a low growth base case and a high impact population are assumed. Here the effects of allowing for structural change are much more significant. Although there is little change in the base case projections, when structural change is allowed for, the 1989 impact population increases by 494, or 20 percent.

In Table 8, a high growth base case and a high impact population are assumed. Here, allowing for structural change results in much higher projections of the base case population, especially in the final years of the projection. In addition, projected peak year (1989) impact population increases by 789, or 31 percent.

These three examples illustrate a simple but important point concerning the significance of population-related structural change when modeling small communities. If little change is expected in the base case and if the impacts are expected to be small, then structural change is unlikely to occur to any great degree, and models which do not account for structural change are likely to provide reasonable projections.

However, the more that growth can be expected to occur, either in the base case or due to an impact industry such as OCS, the greater the potential importance of structural change. In effect, the greater the impact projected by a model, the greater the chance that the impact will be underestimated unless the model also takes account of structural change which the impact might bring about.

**The SCIMP model slightly understates the total impact in the structural change case, because the multiplier is calculated using total (resident and impact) population, leading to an overestimate of structural change in the base case.*

Table 6. Effects of Structural Change on Base Case and Impact Population Projections: Low Growth Base Case and Low Impact Population

Year	Base Case Population Projections	
	Without Structural Change	With Structural Change
1980	5125.	5125.
1981	5213.	5213.
1982	5304.	5304.
1983	5481.	5481.
1984	5620.	5620.
1985	5735.	5735.
1986	5804.	5805.
1987	5845.	5846.
1988	5857.	5858.
1989	5949.	5950.
1990	6040.	6041.
1991	6131.	6133.
1992	6222.	6224.
1993	6312.	6314.
1994	6402.	6404.
1995	6491.	6494.
1996	6579.	6587.
1997	6667.	6707.
1998	6814.	7005.
1999	7024.	7286.
2000	7271.	7602.

Year	Impact Population Projections	
	Without Structural Change	With Structural Change
1980	0.	0.
1981	0.	0.
1982	2.	2.
1983	4.	4.
1984	8.	8.
1985	21.	21.
1986	173.	179.
1987	395.	409.
1988	491.	514.
1989	592.	624.
1990	420.	452.
1991	33.	50.
1992	22.	24.
1993	23.	24.
1994	23.	25.
1995	24.	26.
1996	24.	26.
1997	25.	27.
1998	26.	27.
1999	26.	28.
2000	26.	28.

Table 7. Effects of Structural Change on Base Case and Impact Population Projections: Low Growth Base Case and High Impact Population

Year	Base Case Population Projections	
	Without Structural Change	With Structural Change
1980	5125.	5125.
1981	5213.	5213.
1982	5304.	5304.
1983	5481.	5481.
1984	5620.	5620.
1985	5735.	5735.
1986	5804.	5805.
1987	5845.	5846.
1988	5857.	5846.
1989	5949.	5859.
1990	6040.	5951.
1991	6131.	6135.
1992	6222.	6226.
1993	6312.	6316.
1994	6402.	6407.
1995	6491.	6496.
1996	6579.	6637.
1997	6667.	6846.
1998	6814.	7102.
1999	7024.	7395.
2000	7271.	7720.

Year	Impact Population Projections	
	Without Structural Change	With Structural Change
1980	0.	0.
1981	0.	0.
1982	5.	5.
1983	14.	14.
1984	122.	122.
1985	469.	468.
1986	1039.	1103.
1987	1720.	1915.
1988	2062.	2406.
1989	2524.	3018.
1990	1906.	2393.
1991	683.	928.
1992	651.	794.
1993	645.	769.
1994	645.	769.
1995	645.	774.
1996	646.	776.
1997	647.	776.
1998	645.	777.
1999	638.	777.
2000	629.	777.

Table 8. Effects of Structural Change on Base Case and Impact Population Projections: High Growth Base Case and High Impact Population

Year	Base Case Population Projections	
	Without Structural Change	With Structural Change
1980	5125.	5125.
1981	5215.	5215.
1982	5371.	5371.
1983	5649.	5649.
1984	5920.	5920.
1985	6277.	6345.
1986	6844.	7014.
1987	7584.	7932.
1988	8476.	9099.
1989	9656.	10642.
1990	11041.	12524.
1991	12634.	14670.
1992	14445.	17058.
1993	16484.	19901.
1994	18762.	23246.
1995	21292.	27134.
1996	24085.	31611.
1997	27154.	36735.
1998	30512.	42575.
1999	34172.	49183.
2000	38146.	56620

Year	Impact Population Projections	
	Without Structural Change	With Structural Change
1980	0.	0.
1981	0.	0.
1982	6.	6.
1983	15.	16.
1984	118.	119.
1985	459.	457.
1986	1024.	1126.
1987	1708.	1991.
1988	2067.	2570.
1989	2529.	3313.
1990	1896.	2698.
1991	615.	1046.
1992	503.	804.
1993	412.	672.
1994	298.	536.
1995	167.	371.
1996	165.	249.
1997	165.	251.
1998	165.	258.
1999	165.	265.
2000	166.	271.

Conclusions

The change in the structure of important economic relationships in response to OCS development must be incorporated into impact models used in rural Alaska. In this paper we have shown that the potential for structural change exists in rural Alaska among three important relations: the local economic response, the labor force participation, and the residency of immigrants. Each of these relations both affects and is affected by the growth of the economy. When OCS activity represents a non-marginal change to the economy, structural change will occur.

We have also shown, using the SCIMP model, the difference in the projected impact which results from incorporating structural change. The incorporation of structural change in an economic impact model makes the impact more sensitive to the base case assumptions. If a particular economic relation depends on the size of the local economy, the size of impact will depend on the level of base case activity. This means that improving a model's ability to incorporate structural change also entails increased effort at improving the base case.

Incorporating structural change into an impact model is not a simple task. To date, the growth in rural Alaska has not been of the type which would indicate a likely pattern of structural change. Research must focus on cross-sectional analysis of small economies both inside and outside of Alaska.

The incorporation of structural change in an impact model requires a great research effort. Fortunately, the task can be simplified in some cases. First, when the community is not projected to grow much or OCS activity is relatively small, the potential for structural change is limited. The relative size of OCS activity reflects the decision of the oil industry on the isolation of the industrial activity. If OCS activity occurs in an isolated enclave, the relative effect of development will be small, independent of actual size of the activity. This makes the industry's approach to development an important research question.

Secondly, the approach to incorporating structural change should reflect both the use and timing of the projection. When accuracy is not the prime consideration, sensitivity analysis using different sets of reasonable parameters may be enough to provide the necessary information. In this case, the important question for research is: what are the limits of potential change? When our information about the pattern of resource development is specific and accuracy is more important, more research effort is required. The research questions in this case are: what pattern the structural change will follow, and what are the determinants of the change? Structural change is not linear and the turning points are important.

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