SCOMM

#16:14

PLEASE NOTE: THE FOLLOWING PAGES WERE TREATED AS A UNIT IN THE ORIGINAL DOCUMENT.

Trustees for ALASKA

[illegible] Anchorage, Alaska 99501 (907) 276-4244
835 D Street

March 16, 1978

Honorable Bill Miles
House Special Committee
on the Sale of Royalty Oil & Gas
Pouch V
Juneau, Alaska 99811

Re: Royalty Oil Sale/ALPETCO Contract

Dear Bill:

As I mentioned, I have a few brief comments regarding the royalty oil sale which I hope will prove helpful to the Committee.

The contract generally is a major improvement over the earlier version and seems to be a serious attempt to make a conventional business deal. The critical problem, however, remains the financial viability of the proposal. I am not qualified to discuss the financial alternatives in depth and I presume most of the problems have been adequately analyzed by the state's economic consultants. I have enclosed, however, an analysis of some problems relating to oil-based petrochemicals which was done by Dr. Matthew Berman, a Rockefeller fellow associated with TfA. The terms of his fellowship preclude an advocacy approach and the enclosed discussion is an objective analysis of the issue. It should be treated as a formal submission of written testimony.

I do have some comments regarding economic viability, however. The Governor has announced that any decreases in oil price will be put to an initiative. Given an objective debate of the merits of such a subsidy, that approach may be workable. However, I foresee a strong possibility of ALPETCO paying for a massive publicity campaign (a la AOGA's tax ads) which, without adequate opposition, would almost certainly ensure approval of a subsidy.

Some serious thought needs to be given to a system of checks and balances, including not only the involvement of the administration and legislature, but also a requirement for equal media time for opponents of such a subsidy.

A rather serious problem is posed by section 2.3 of the contract. This section could allow an unlimited price subsidy at the sole discretion of the Commissioner of Natural Resources. Approval by the Royalty Board and the legislature of the mechanism outlined in that section may circumvent the established procedures for approval of sales. Since there is no requirement for fair market value, nor even a requirement that the oil be offered for sale (the language is "proposed to be offered for sale), it provides a massive loophole to future administrations which may wish to subsidize ALPETCO. Unless the Royalty Board and the legislature are involved at the "proposal to offer for sale" stage, this section may be used to avoid all input from them.

Turning to the terms of the contract itself there are several additional points which may cause some problems. The most obvious is the sale of as-yet-undiscovered oil. We have discussed this in the Energy Policy Committee and I won't belabor the point. The Committee was quite firm about not selling something we do not have and I think the arguments are still persuasive.

A second problem which was discussed in the hearings is the question of end-of-the-month billing. This delay in payments provides a subsidy to the buyer which can be substantial. Given a 9.25% interest rate (prime rate of 8% plus the 1.25% specified in the contract) and a price of $6.21 per barrel, the lost interest charges amount to approximately 3.4 million dollars per year.

I also have serious problems with the state appointing a state official to act as a coordinator for the purpose of facilitating the granting of permits. While I have not researched the legal implications of this apparent conflict of interest, it is a matter which should be looked into thoroughly by the Attorney General. It will almost certainly be an issue in any attempt to block the issuance of a state permit for the facility.

Another potential problem is the interpretation of the Force Majeure clause. The clause includes "any other event or condition otherwise not reasonably within the control of the party." A literal reading of this could include market conditions or other factors which are normally included as business risks. I don't believe that this is the intent of the state.

Some of these problems might be resolved by an appropriate colloquy between the parties. Others, however, will require amending the contract if they are to be resolved.

I appreciate this opportunity to comment on the proposed contracts.

Personal regards,

Bill

Wilson A. Rice
Executive Director

k
enc

Statement Of:

Matthew D. Berman, Research Associate
Trustees for Alaska
835 D Street, Suite 202
Anchorage, Alaska 99501

To:

Special Joint Royalty Oil and Gas
Committee
Tenth Alaska State Legislature

March 16, 1978

Trustees for ALASKA

~~1020 West 4th Ave.~~, Anchorage, Alaska 99501 (907) 276-4244
835 D Street

March 16, 1978

Honorable Bill Miles
House Special Committee
on the Sale of Royalty Oil & Gas
Pouch V
Juneau, Alaska 99811

Dear Representative Miles:

Thank you for the opportunity for me to comment on the proposed contract between the Commissioner of Natural Resources and the Alaska Petrochemical Company. As you are probably unaware of my background, I am sure it would be helpful if I supplied a few pertinent facts.

I have a Ph.D. degree in economics from Yale University and am currently on leave from the University of Texas at Austin, where I am an Assistant Professor at the Lyndon B. Johnson School of Public Affairs. I have been in Alaska since January, 1978, as a recipient of a post-doctoral fellowship from the Rockefeller Foundation's Program in Environmental Affairs to study problems with economic development and environmental preservation in the state. While carrying out my research for the fellowship, I am associated with Trustees for Alaska. However, the views expressed in this testimony are my own, and do not necessarily reflect the views of Trustees for Alaska or the Rockefeller Foundation.

Sincerely yours,

Matthew D. Berman

Matthew D. Berman

k

Summary

The costs and benefits of the proposed sale of royalty oil to the Alaska Petrochemical Company (ALPETCO) cannot be determined independently of other major decisions involving Alaskan oil and gas reserves. A number of factors suggest that a petrochemical complex using crude oil as a feedstock would be non-competitive with a similar facility processing North Slope natural gas liquids. A favorable decision on the ALPETCO contract, moreover, would limit the options available for the instate use of the state's royalty gas and gas liquids.

Two sets of questions which should be resolved before a rational decision can be made on the ALPETCO contract are:

(1) How will pending national energy legislation change the method by which well-head prices are determined for crude oil and natural gas produced from North Slope fields?

(2) What will be the design and cost of the ALCAN natural gas pipeline system, and how will that project be financed?

Thus it would be unwise for the Legislature to attempt to deal with the ALPETCO contract at this time unless it is done in conjunction with an overall state plan for the disposal North Slope oil and gas resources.

There are three critical choices facing the State of Alaska regarding the disposition of state oil and gas reserves. One choice concerns the issue of state financial participation in the ALCAN natural gas pipeline. This decision may ultimately hold the key to whether or not the pipeline is ever built. A second decision that must be made arises from the alternatives for instate use of the state's royalty share of natural gas and gas liquids taken from North Slope fileds. The third decision is approval or disapproval of the ALPETCO contract for disposition of the state's royalty share of North Slope oil.

All three of these decisions hold in the balance massive development projects. Each potential project involves commitments of billions of dollars worth of scarce capital funds, as well as nonrenewable natural resources. Each has the potential to employ thousands of construction workers, bringing serious disruptive consequences for labor markets in the state, burdens on local communities that must deal with an enormous increase in demands on municipal services, and many other spillover effects from rapid immigration.

All three of these projects involve a high degree of risk. There is a substantial probability of financial failure in each case, which, in the case of the gas pipeline at least, is the reason why financial participation has been requested from the state. If successful, all three of these projects are likely to bring substantial long-term benefits to the state. There are skilled, well-paid, year-round jobs that would be created, new tax revenues

would accrue to the state treasury, and the Alaskan economy would have a more diversified economic base.

If any one of these projects is constructed and then turns out to be financially unsuccessful, the state would be left with all the negative aspects of massive construction development -- unemployment, the social problems associated with economic depression, and the environmental degradation that invariably comes from boom-bust growth. These problems will place strong demands on the state for social services at the same time as the project's failure may be draining the state's treasury. The drain on the treasury does not need to come from an unprofitable direct investment that the state may have in the project. The state and local governments would lose income and property taxes, and probably incur massive legal costs.

The current business of the Committee is to consider the merits of one of these massive development projects: The proposed sale of up to 150,000 barrels per day of royalty oil to the Alaska Petrochemical Corporation (ALPETCO) in order to obtain a commitment from the firm to construct a refinery and petrochemical complex within the state of Alaska. A favorable decision should be made if it is determined that the total benefits to the residents of the state of Alaska outweigh the total social costs, including consideration of those costs and benefits which do not translate readily into a dollar yardstick. Certainly, it appears that it is the intent of the state legislature to use this criterion as the basis for its decision.

The purpose of this testimony is not to express an opinion one way or the other on the merits of the proposed ALPETCO contract. Surely, it is hoped that the legislature will make its decision on the basis of facts, not opinions. Rather, the purpose of this testimony is to express a serious doubt that the process by which the legislature is reviewing the proposal, including its scrutiny by the Royalty Oil and Gas Development Advisory Board and the House Special Committee on the Sale of Royalty Gas & Oil, will produce except by chance, a satisfactory outcome for the state. There seems to be substantial political pressure, apparently due to the fact that 1978 is an election year for the Administration and the House of Representatives, to expedite the legislative review in order to obtain a quick decision on the ALPETCO proposal.

In all this rush, it appears that a critical factor underlying the costs and benefits of the ALPETCO project seems to have been overlooked completely. No intelligent decision can be made on the proposed royalty oil contract in isoloation from the two decisions regarding the disposal of North Slope gas. The true value of the ALPETCO project is heavily dependent on the natural gas decision. Conversely, the options available for North Slope gas may be severely limited by approval of the ALPETCO proposal. The economic issues involved here are far more complex than the simple fact that the royalty oil and gas in question are both produced from the same fields.

What do royalty gas proposals have to do with ALPETCO? On January 23, 1978, Bonner and Moore Associates, Inc., submitted their study of options for instate utilization of the state of Alaska's royalty gas to the

Department of Revenue. Under contract to the Department, this firm was asked, among other things, to identify options for instate manufacture of natural gas which might be economically feasible. The most feasible alternative studied was an ethane cracking plant producing ethylene-based olefins (see page 4-2 of the Bonner and Moore study) using royalty gas liquids as a feedstock. Although there is a narrower range of final products in this gas liquids proposal than in the ALPETCO royalty oil bid, the same basic type of product would be manufactured.

If the state is considering sale of its royalty gas for instate processing, it is important to note that the two petrochemical projects -- the ALPETCO royalty oil proposal at hand and Bonner and Moore's most feasible alternative for instate manufacture of natural gas liquids -- would inevitably have to compete against each other in a number of ways. The projects will have to compete for capital funds and construction workers, as well as for customers. Would there be financing available for a billion dollar gas liquids plant if ALPETCO has to struggle to raise over a billion dollars for a project located in the same place selling to the same potential customers? Would labor be available to build both projects without long delays, massive immigration, cost overruns, or all three? Would there be a market for all the ethylene products produced from both plants?

Because of the competition that would exist for markets, capital and labor, it is quite likely that an action to award the state's royalty oil to

ALPETCO forecloses the option for the state to find an instate processor for the gas liquids. It certainly will have a profound effect on the feasibility of the alternative uses of royalty natural gas.

Given the strong probability that only one world-scale petrochemical plant can be constructed in the state of Alaska, one should, accordingly, take a close look at the factors which are likely to affect the desirability of a gas liquids proposal relative to the ALPETCO proposal. Since the two projects are basically similar in technology, construction, operation, environmental effects, etc. the most important question regarding the relative strengths of the two proposals is the risk of financial failure. As stated above, the failure of a major construction project once built will place severe demands on the state and local governments, even if the state has no financial interest at stake in the project itself.

What are some of the primary determinants of the relative financial riskiness to the projects and to the state of Alaska?

1) The gas liquids proposal involves a simpler process to produce a smaller range of products than the ALPETCO proposal. This simplifies both operating procedures and marketing tasks. According to Bonner and Moore (Royalty Gas Study, p. 7-4), "Most likely the use of NGL as a petrochemical feedstock would be preferential to the use of crude oil at an equivalent feedstock value."

2) Royalty oil has a secure, valuable market for export using existing transportation systems, while there are currently no transportation systems

available to export royalty gas or gas liquids. This means that the possibility that the state might at some future date have to sell royalty oil to ALPETCO for less than its full market value is a more serious financial risk than a possible "gas subsidy" to a gas liquids plant, since there is no export market for North Slope gas at the present time.

3) Even if the pipeline is built and can operate profitably, the total oil revenues which the state is risking with ALPETCO are likely to be far more than royalty gas revenues, due to the relatively higher cost of transportation of Alaskan gas to the market in the lower 48 states.

4) Bonner and Moore estimated that it would cost 40% more to construct a petrochemical plant in Alaska than along the U.S. Gulf coast. This means that a substantial operating cost savings must be realized in some aspect of the manufacturing process in order that the plant may prove financially feasible. For the ALPETCO project, the Bonner and Moore revised study of royalty oil alternatives points out clearly that the Alaskan cost factor, which they estimated at $1.80 per barrel of oil, could be counteracted by the fact that ALPETCO would receive an "entitlements" credit of roughly $2.30 per barrel of oil it processes under existing federal law.

It would be extremely risky, however, to base a judgment of feasibility of the petrochemical operation on obtaining the entitlements credit since

(a) The entitlements program is in doubt under pending energy legislation,

(b) The value of the entitlements credit is very likely to fall

to zero before the ALPETCO plant becomes operational, even if the law remains in effect,

(c) The entitlements credit may only be received if the refined oil products are sold in the U.S.A. A sale of a large proportion of petrochemical output to Japan, as is the apparent intention of ALPETCO, would mean a loss of most of the entitlements credit.

On the other hand, Bonner and Moore calculated that a natural gas liquids petrochemical plant would be economically feasible at a feedstock cost not exceeding $1.24 per MBTU in 1977 prices. It is likely that this break-even price for gas liquids will not be exceeded if either (1) financing is not obtained for the ALCAN line, or (2) the ALCAN pipeline is built and exceeds the current cost estimates of $10 billion. Thus, it is quite possible, in fact, one might say that it is quite likely that one or the other problem will develop with the ALCAN gas pipeline. It seems that the probability of financial success for a petrochemical plant in Alaska is greater if that plant is designed to use North Slope natural gas liquids rather than North Slope oil as a feedstock.

The factors discussed above seem to indicate that the ALPETCO proposal is considerably more risky, and therefore inferior, to a gas liquids alternative. However, one must bear in mind that the well-head value of North Slope gas liquids, upon which the comparative feasibility calculations are based, is extremely uncertain until the following issues are resolved:

1) A National Energy Plan establishes a mechanism for setting the well-head value of old gas under new contract;

2) Financing has been achieved for the ALCAN pipeline;

3) An agreement is reached with the Canadian Government to extract gas liquids from the pipeline in Alaska;

4) The final design for the pipeline has been set, so that ALCAN tariffs can be predicted with more confidence. Needless to say, the final design of the gas pipeline, and hence its cost, depends on whether and/or where the gas liquids will be extracted from the ALCAN gas stream, which, in turn, is dependent on a decision to process gas liquids in Alaska.

So what does this mean forthe ALPETCO contract? It means that the financial success of the project, and therefore the projected costs and benefits to the state, is closely dependent on upcoming decisions with respect to the National Energy Act, the ALCAN gas pipeline and the possible use of royalty gas liquids within Alaska for petrochemical manufacture. It would be imprudent to rush through the scrutiny of the sales contract with ALPETCO in isolation from other related decisions when the risk to the state is so great. The legislature might wish to heed the advice of Bonner and Moore (Royalty Gas Study, p. 7-4):

> "If the State were to award a royalty oil contract to a group proposing to build a fuels refinery, then royalty gas use could be considered independently. If the State were to award a royalty oil contract to a group proposing to build a petrochemical refinery, then it should be understood that NGL availability at the right price would likely require that the oil project be abandoned or converted to the use of NGL if that option were within the power of the State to grant."

It is imperative for the welfare of the citizens of this state that the legislature take the time to resolve its three major oil and gas disposal questions with a common plan. The hurried, peicemeal approach is an unwise method for deciding the fate of the state's precious nonrenewable resources.

PLEASE NOTE: THE PRECEDING PAGES WERE TREATED AS A UNIT IN THE ORIGINAL DOCUMENT.

THE RELATION OF NON-PETROLEUM REVENUES TO PERSONAL INCOME IN THE MAP MODEL SIMULATION OF ALPETCO IMPACT

By Milt Barker, Legislative Finance Division

The ISER report on the impact of the Alpetco project met with a flurry of criticism regarding one of its main conclusions--that the project would result in greater additional expenditures by the state than the increases in revenue the State would receive. While major portions of the increased revenues were exogenous inputs to the MAP model which was used for the simulations, e.g., Alpetco's estimates of corporate income tax liabilities, some of the revenue increases were derived by the model.

The model categorizes State revenues as petroleum-related, federal transfers, income from the permanent fund, and endogenous, meaning those related to general economic activity. All petroleum revenues are exogenous to the model; the latter categories are computed by the model.

In Table II.7 from the Alpetco report (appended) the ratio of endogenous revenues to personal income (RENSRAT) declines from 9.8% in fiscal year 1977 to 5.8% in FY 2000 in the base case simulation. The report states "the slight downward trend in this proportion over time is indicative of the fact that the structure of government revenues in Alaska does not respond proportionately to an increase in economic activity."

Table I (appended) displays historical figures for personal income, some major non-petroleum unrestricted revenues, and total non-petroleum unrestricted revenues excluding investment income. The latter category should approximate that of endogenous revenues used in the MAP model which appears to include special fund revenues as well as unrestricted.

Table 2 (appended) displays the revenue figures from Table I as percentages of personal income. For the period 1961 to 1978, the ratio for total revenues increased from 5.5% to 7.6%. There is a sub-period from 1965 to 1974 during which the ratio of total revenues to personal income steadily declined, but upon constuction of TAPS, the ratio jumped to a new high of 8.8% in 1977. Of course, the TAPS project being of unparalled magnitude relative to Alaska's economy may mean that that high may not be reached again.

However, examination in Table 2 of the main component of endogenous revenues, the personal income tax, reveals a more definite upward trend in its ratio to personal income. This is logical, given that individual incomes have been rising and that the personal income tax structure is progressive. Indeed, this fact of an upward trend is reflected in recent efforts to index income taxes to avoid an increasing percentage government take due to inflation.

It appears that personal income in proportion to endogenous State revenue in the base case simulation (Table II.7) in 1977, 9.8%, is correct, allowing for special funds. However, whether this ratio should decline over time as in the simulation is open for question.

There will be a one-time downtick in State endogenous revenues due to the repeal of most of the business license tax. The Department of Revenue estimates this will drop business license revenues from $21.3 million in FY 79 to $4.1 million in 1980.

Also, the upward trend in the ratio for personal income will certainly be held in check for the next few years by tax credits enacted into law in 1978. However, it should resume its climb thereafter barring indexation (not unlikely - SB 76 and HB 268 were introduced for this purpose in 1977) or further tax reduction measures. The movement of the personal income tax should be more determinate of the trend in endogenous revenue in the future since by FY 1978, it accounted for 48% of all endogenous revenue up from 28% in 1961.

Of course, what was of concern in the Alpetco report was not the way the model's assumptions worked themselves out in the base case, but their depiction of Alpetco's impact. In Table 3 (appended), the increases in personal and non-petroleum corporate income taxes generated by Alpetco are compared to increases in personal income stemming from the project. These figures are derived from Tables III.4 and III.6 in the Alpetco report (appended). Alpetco's estimated corporate income taxes are excluded from non-petroleum corporate income taxes.

From this last table, it appears that the increase in non-petroleum corporate income taxes relative to increases in personal income is at the level of recent historical averages, .7%, over most of the simulation while that for the personal income tax ranges well below the historical averages in Table 2. In the absence of legislation, the ratio for personal income taxes in Table 3 should increase over time due to the effect of a progressive tax structure on increasing incomes, both nominal and real.

However, the ratios in Table 3 are measures of the marginal responsiveness of taxes to increases in personal income and should be judged for reasonableness by looking, not at the average ratios in Table 2, but by some marginal measures that can be derived from Table 1. For example,

Fiscal Year	Change in Personal Income Tax as a % of Change in Personal Income	Change in Non-Petroleum Corporate Income Tax as a % of Change in Personal Income
1975	5.2%	1.8%
1976	6.7	.8
1977	20.2	1.3
1978	83.1	2.6

Certainly these marginal rates for the pipeline construction years are only relevant to the construction phase for Alpetco. Yet, the highest marginal rate of personal income tax to personal income increases during Alpetco construction is only 3%. Given the cavalier expenditure of funds for TAPS construction, a proper ratio for Alpetco would perhaps be less than those experienced during TAPS construction.

The model might be improved by making income taxes more responsive to inflation and changes in wage rates, as well as re-evaluating the direction and degree of a trend, if any, in the relation of endogenous revenues to personal income.

Table II.7.

INDICATORS OF STATE FISCAL POSITION
BASE CASE

	SIMP	RENSRAT	EXBITES	VIABL2
1977	246.672	0.098	0.222	0.748
1978	149.935	0.082	0.257	0.658
1979	435.177	0.078	0.257	0.636
1980	814.892	0.072	0.236	0.633
1981	824.85	0.066	0.219	0.61
1982	881.842	0.067	0.232	0.568
1983	903.154	0.072	0.263	0.539
1984	1390.42	0.07	0.255	0.549
1985	1545.1	0.068	0.247	0.551
1986	1591.33	0.067	0.246	0.545
1987	1416.	0.066	0.243	0.54
1988	1185.46	0.065	0.24	0.533
1989	948.255	0.064	0.237	0.526
1990	702.368	0.063	0.237	0.516
1991	469.357	0.062	0.234	0.509
1992	221.125	0.062	0.235	0.5
1993	-15.101	0.061	0.233	0.495
1994	-276.078	0.06	0.23	0.49
1995	-567.083	0.059	0.227	0.484
1996	-918.563	0.059	0.228	0.475
1997	-1304.77	0.058	0.227	0.47
1998	-1716.03	0.058	0.226	0.465
1999	-2158.43	0.058	0.225	0.462
2000	-2654.8	0.058	0.224	0.459

SIMP = general fund revenues minus general fund expenditures (million $)
RENSRAT = endogenous revenues as a percentage of personal income (percent)
EXBITES = state total expenditures as a percentage of personal income (percent)
VIABL2 = non-petroleum revenues (not including permanent fund earnings) as a percentage of general fund expenditures (percent)

TABLE I

NON-PETROLEUM UNRESTRICTED REVENUES
($ millions)

Fiscal Year	Personal Income (1)	Personal Income Tax (2)	Non-Petroleum Corporate Income Tax (3)	Business license Tax (2)	Selected Sales & Gross Receipts Taxes (4)	Licenses, Fees and Permits (2)	Total Non-Petroleum Unrestricted Revenue Excluding Investment Income (2,3)
1961	657	10	1	1	8	3	36
1962	651	12	2	1	11	4	42
1963	693	13	2	2	11	5	43
1964	745	14	2	2	11	4	51
1965	842	16	2	3	11	5	64
1966	886	19	4	3	13	6	62
1967	972	23	3	3	13	6	63
1968	1066	23	4	4	15	7	68
1969	1163	25	4	4	17	7	75
1970	1350	32	5	5	19	8	89
1971	1470	36	6	6	20	9	95
1972	1618	39	6	6	21	9	104
1973	1840	43	6	7	23	10	115
1974	2165	49	7	8	25	11	132
1975	2900	87	20	11	31	14	204
1976	3774	146	27	19	41	16	287
1977	4091	210	31	23	40	16	362
1978	4014*	146	29	22	44	19	305

Sources:
(1) U.S. Dept. of Commerce, Bureau of Economic Analysis (fiscal year basis)
(2) Alaska Dept. of Revenue, "Revenue Sources"
(3) Alaska Dept. of Revenue, unpublished data
(4) Includes fuel, alcoholic beverage, tobacco products, insurance premiums and electric and telephone utilities taxes

*Based on Commerce & Economic Development estimate for 4th quarter 1978

TABLE 2

NON-PETROLEUM UNRESTRICTED REVENUES AS A % OF PERSONAL INCOME

Fiscal Year	Personal Income Tax	Non-Petroleum Corporate Income Tax	Business License Tax	Selected Sales & Gross Receipts Taxes	Licenses, Fees, and Permits	Total Non-Petroleum Unrestricted Revenue Excluding Investment Income
1961	1.5%	.2%	.2%	1.2%	.5%	5.5%
1962	1.8	.3	.2	1.7	.6	6.5
1963	1.9	.3	.3	1.6	.7	6.2
1964	1.9	.3	.3	1.5	.5	6.8
1965	1.9	.2	.4	1.3	.6	7.6
1966	2.1	.5	.3	1.5	.7	7.0
1967	2.4	.3	.3	1.3	.6	6.5
1968	2.2	.4	.4	1.4	.7	6.4
1969	2.1	.3	.3	1.5	.6	6.4
1970	2.4	.4	.4	1.4	.6	6.6
1971	2.4	.4	.4	1.4	.6	6.5
1972	2.4	.4	.4	1.3	.6	6.4
1973	2.3	.3	.4	1.3	.5	6.3
1974	2.3	.3	.4	1.2	.5	6.2
1975	3.0	.7	.4	1.1	.5	7.0
1976	3.9	.7	.5	1.1	.4	7.6
1977	5.1	.8	.6	1.0	.4	8.8
1978	3.6	.7	.5	1.1	.5	7.6

TABLE 3

ALPETCO IMPACT
RESPONSIVENESS OF INCOME TAXES TO INCREASES IN PERSONAL INCOME

Fiscal Year	Increase in Personal Income Tax as a % of Increase in Personal Income	Increase in Non-Petroleum Corporate Income Tax as a % of Increase in Personal Income
1979	1.1%	-
1980	1.4	.1%
1981	1.4	.2
1982	1.9	.4
1983	2.1	.5
1984	3.0	.7 (or 1.0%)*
1985	2.5	.8
1986	2.2	.7
1987	2.0	.6
1988	2.0	.6
1989	2.0	.6
1990	1.8	.6
1991	1.8	.6
1992	1.6	.6
1993	1.7	.6
1994	1.7	.6
1995	1.8	.6
1996	2.0	.8
1997	1.9	.7
1998	1.9	.7
1999	1.8	.7
2000	1.8	.7

*Depends on whether a negative tax liability for Alpetco for this year as shown in the simulation is deducted from state tax receipts.

Table III.4.

IMPACT OF ALPETCO ON INCOME AND PRICES

	PI	PINRPC	RPI	PRAT
1977	0.	0.	0.	0.
1978	0.	0.	0.	0.
1979	71.844	39.084	0.538	0.003
1980	247.141	110.383	1.834	0.009
1981	757.109	272.281	5.013	0.022
1982	1020.05	290.375	6.691	0.028
1983	1167.77	308.207	7.823	0.032
1984	697.16	83.859	5.796	0.022
1985	512.164	19.605	4.205	0.015
1986	448.848	-7.918	3.594	0.013
1987	440.695	-20.168	3.404	0.011
1988	456.371	-26.223	3.38	0.011
1989	486.73	-29.762	3.428	0.01
1990	522.66	-31.324	3.51	0.01
1991	566.383	-32.109	3.616	0.01
1992	612.32	-31.937	3.734	0.01
1993	666.082	-31.652	3.966	0.01
1994	726.457	-31.758	3.998	0.009
1995	799.941	-31.805	4.143	0.009
1996	739.168	-45.789	3.66	0.008
1997	737.668	-51.824	3.509	0.007
1998	762.18	-53.855	3.476	0.007
1999	803.055	-54.277	3.499	0.006
2000	830.598	-55.316	3.453	0.006

PI = personal income (million $)
PINRPC = real per capita personal income (deflated by RPI)
RPI = relative price index for Alaska (1967US = 100)
PRAT = ratio of RPI to U.S. CPI

Note: All variables measured as the difference from the base case.

Table III.6.

IMPACT OF ALPETCO ON INDIVIDUAL COMPONENTS
OF STATE ENDOGENOUS REVENUES

	RENS	RT98	RTCSX	RTCTS	RTBSX	RTBS	RTIS
1977	0.	0.	0.	0.	0.	0.	0.
1978	0.	0.	0.	0.	0.	0.	0.
1979	0.961	0.961	0.	0.	0.	0.006	0.769
1980	7.904	6.936	0.4	0.757	1.4	1.697	3.549
1981	22.307	18.945	0.6	1.894	2.3	3.339	10.927
1982	45.899	35.537	0.5	4.641	2.4	5.619	19.802
1983	58.785	44.643	0.5	6.362	2.6	7.015	24.33
1984	58.116	41.681	-2.	4.826	3.9	8.785	21.317
1985	39.724	30.044	0.	4.039	5.8	8.41	13.31
1986	55.935	48.855	24.	26.929	6.5	8.345	10.244
1987	69.812	63.617	40.4	42.965	6.8	8.379	9.258
1988	76.745	70.648	47.2	49.754	7.2	8.743	9.177
1989	83.509	77.164	52.7	55.391	7.6	9.195	9.529
1990	90.456	83.648	57.8	60.745	7.9	9.618	10.09
1991	98.101	90.737	63.2	66.435	8.3	10.154	10.782
1992	106.314	98.275	68.8	72.404	8.7	10.732	11.563
1993	115.378	106.62	75.	78.984	9.2	11.406	12.436
1994	123.253	113.651	79.7	84.151	9.6	12.025	13.42
1995	134.21	123.649	87.	91.979	10.1	12.769	14.557
1996	144.523	132.796	94.4	100.062	10.6	13.589	14.623
1997	150.057	139.266	102.3	107.511	11.1	13.777	13.75
1998	159.44	148.66	111.	116.31	11.7	14.378	13.753
1999	170.755	159.564	120.4	125.989	12.3	15.062	14.197
2000	182.79	170.923	129.9	135.935	12.9	15.828	14.682

RENS = total endogenous revenues (million $)
RT98 = taxes net of petroleum production (million $)
RTCSX = Alpetco corporate income taxes (million $)
RTCTS = total corporate income taxes (million $)
RTBSX = Alpetco business license taxes (million $)
RTBS = total business license taxes (million $)
RTIS = personal income taxes (million $)

Note: All variables measured as the difference from the base case.

Alaska Economic Multiplier Experiments With the MAP Model

PREFACE

The attached memorandum illustrates how the basic income multiplier in the MAP models can vary over a range from about 1.5 to 2 depending on a variety of factors including the type of change being introduced into the economy, the sector in which the change originates, and the state of the economy at the time the change is introduced. These numbers fall within the range of income multiplier figures generally developed for regional economies.[1]

It may be useful to supplement the memorandum with two additional clarifying points. These are, first, a taxonomy of different types of multipliers commonly referred to by economists and economic modelers and, second, a very brief description of the difference between short run and long run in regional economic analysis.

1. Precise definitions of multipliers exist in the econometric literature, but the terminology is not entirely consistent. Goldberger has suggested the most widely recognized terms.[2] If dY_t is change in total income at t and dG_t is the exogenous change at t, then at least four multiplier concepts can be distinguished if the change in the exogenous variable is sustained for one period only.

$\frac{dY_t}{dG_t}$ impact multiplier

---

[1] For example, Gary Klockenteger, "Impact Model of Sub-Regional Alaskan Employment," Economic Analysis, Vol. 1, #10, 5/26/72.

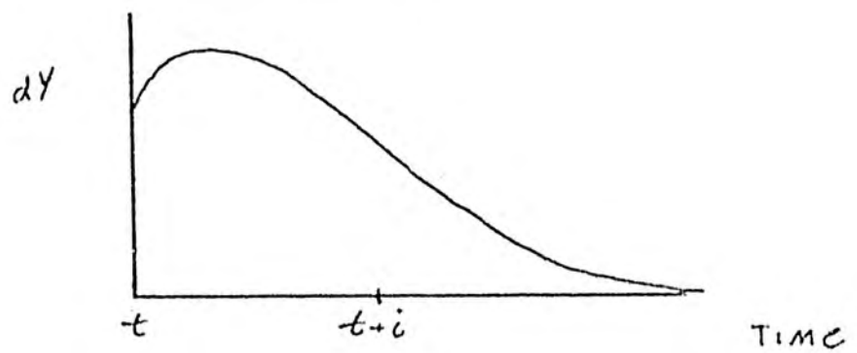
[2] See Glickman, Econometric Analysis of Regional Systems; Pindyck and Rubinfeld, Econometric Models and Economic Forecasts; and Theil, Principles of Econometrics.

$\frac{dY_{t+i}}{dG_t}$ dynamic multiplier

$\sum_{j=t}^{k} \frac{dY_j}{dG_t}$ interim multiplier

$\sum_{j=t}^{\infty} \frac{dY_j}{dG_t}$ total long-run multiplier

Generally, a response in Y over time to an exogenous change not sustained would look as shown below:



The impact and dynamic multipliers are measures of dY at a point in time. The interim and long-run total multipliers are summations of dY_t over different time periods beginning when the exogenous change was introduced.

In many applications, the exogenous change is sustained for all succeeding periods. Such a permanent change could be defined in the same framework as the multipliers above, but in fact terms for such changes are not generally indicated in the literature. If dG_{st} is designated as an exogenous change which is sustained, then the following results are obvious:

$$\frac{dY_t}{dG_t} = \frac{dY_t}{dG_{st}}$$

$$\frac{dY_{t+i}}{dG_t} < \frac{dY_{t+i}}{dG_{st}}$$

$$\sum_{j=t}^{\infty} \frac{dY_j}{dG_t} < \sum_{j=t}^{\infty} \frac{dY_j}{dG_{st}} = \infty$$

2. In a short-run analysis of impact on a regional economy, the following assumptions are generally made or are implicit:

a. resources of the region are fixed (labor, capital, materials)
b. prices and wages constant
c. government spending, exports, and investment exogenous
d. consumption and imports a function of income

The basic equation for income determination in the region is

$$Y = C + I + G + (X-M) \tag{1}$$

and the short-run multiplier for a change in any exogenous factor (I, G, or X) is

$$\frac{dY}{dI} = \frac{1}{1-s} \tag{2}$$

where s is the marginal propensity to consume locally.

This relationship holds only if there is excess capacity, because if a positive exogenous change occurs at full capacity utilization, then prices must rise, resources must increase through in-migration, or both. These responses are not allowed by the model assumptions.[3]

---

[3]Taken from Hugh Nourse, Regional Economics, chapter 7.

In a long-run analysis, none of the assumptions made for the short run would hold. Specifically, one would expect in the case of an expanding economy that,

a. Resources of the region would increase because of technological change as well as factor movements and growth.

b. Prices would respond to supply and demand conditions.

c. Investments and government spending would be a positive function of regional income just as consumption is in the short run.

d. Imports would be a declining proportion of income over time because of import substitution.

Relaxing these assumptions has a significant effect on calculation of $\frac{dY}{dI}$. The model is now as follows:

$$Y = C + I + G + (X-M) \tag{3}$$

$$C_\ell = C + cY$$
$$G_\ell = G + gY$$
$$I_\ell = I + iY$$
$$M_\ell = m_\ell Y$$
$$X_\ell = \bar{X}$$

and the long-run change in income in response to exogenous change would be as follows:

$$\frac{dY_\ell}{dX_\ell} = \frac{1}{(1-c-i-g+m_\ell)} \tag{4}$$

where c, i, g are the marginal propensities to consume, invest, and increase government expenditures out of income, and m_ℓ is the relationship between

changes in income and changes in imports. In the short run, i=g=o and m_s substitutes for m_ℓ.

$$\frac{dY}{dX} = \frac{1}{(1-c+m_s)} \tag{5}$$

The difference in the effects calculated using (4) or (5) can be seen with a simple example. Let

$$c = .7$$
$$g = .2$$
$$i = .07$$
$$m_s = .3$$
$$m_\ell = .25$$

Then $$\frac{dY_s}{dX} = 1.67$$

$$\frac{dY_\ell}{dX_\ell} = 3.57$$

Scott Goldsmith
University of Alaska

MEMORANDUM

FROM: David Kresge

DATE: April 10, 1978

SUBJECT: Economic Impacts and Multipliers in the MAP Model

SUMMARY

- The value of the basic income multiplier in the MAP models is approximately 1.6.
- The income multiplier in the MAP models varies (typically over a range from about 1.5 to 2.0) depending on the type of change being made, the sector in which it originates, the state of the economy. the time the change is made, and a variety of other factors.
- When there are simultaneous changes in several policy variables or outside forces, the overall impact can be much larger (or smaller) than indicated by the simple multipler.
- Ratios of total change to initial change in employment or income provide useful summary measures of economic impacts. There are few instances in which these ratios could be used to derive multipliers that would produce valid predictions of policy impacts.

MULTIPLIER EXPERIMENTS

The MAP models are designed to provide a reasonably detailed and yet comprehensive picture of the Alaska economy. One of the principal functions of the MAP models is to provide estimates of the impacts caused by changes in outside factors and to determine the effectiveness of alternative state economic policies. As a summary measure of the impacts of changes in exogenous factors or policy instruments it is often useful to calculate a so-called "income multiplier", which is defined as the change in total real income in the economy divided by the change in real income in the sector where the impact originates. The effective income multiplier due to an increase in petroleum sector employment, for example, would be calculated as the change in Alaska real personal income divided by the change in real wages in the petroleum industry. The term "real" indicates that the income changes have been adjusted to take into account any induced changes in the cost of living in Alaska.

Several experiments have been run to provide estimates of the income multipliers in the MAP models. In the first experiment, which is reported in the first line of Table 1, federal government employment in Alaska in increased by one thousand persons. This causes an increase in total employment of 1,450 and raises real disposable personal income by a little over $10 million (in constant 1967 prices). The increased pace of economic activity pushes up wage rates by 0.3%, a change which is very nearly matched by the increase in the cost of living. As shown in the last column of the table, the implied income multiplier is 1.6. This figure is probably the single best estimate of the "basic" income multiplier in the MAP model. It is also most comparable to the multiplier discussed in economics textbooks and the multiplier reported for other economic models.

The second experiment reported in Table 1 considers an increase of one thousand in petroleum sector employment. Since the petroleum sector pays very high wages, this would, of course, be expected to have a larger impact on the economy than the equivalent increase in federal government employment. In addition to producing a larger initial increase in real earnings, this experiment causes the income multiplier to rise to 2.1. When petroleum sector employment expands in Alaska, this tends to push up both wage rates and the cost of living, but the wage rates tend to increase faster than the cost of living. This increase in real wage rates adds an element to the multiplier process that was not present in the case of an increase of federal government employment. Thus, in comparing the impacts of equivalent changes in employment, a change which originates in the petroleum sector causes total Alaska employment to rise by 2,550 rather than 1,450, and increases real income by $32 million rather than $10 million.

Table 1 also reports, as a second summary impact measure, the ratio of the total change in employment to the change in employment in the initiating sector. This ratio is 1.4 when federal government employment increases, and 2.6 when petroleum employment increases. Most of the difference between the two experiments is due to the fact that wages are so much higher in the petroleum sector, but it also reflects the increase in the income multiplier caused by the boom-induced increase in real wage rates associated with petroleum sector expansion.

The experiments reported in Table 1 assume that the state's fiscal policies are not adjusted in response to changes in economic activity in Alaska. This is the standard approach used in multiplier analysis and there is a very good reason

TABLE 1

MAP MODEL ESTIMATES OF 1980 IMPACT MULTIPLIERS:
RESPONSE TO EMPLOYMENT CHANGES (WITH NO FISCAL RESPONSE)

EXPERIMENT	Changes from base case				Percent change from base case		SUMMARY IMPACT MEASURES	
	Initial change in employment (thousands)	Total change in employment (thousands)	Initial change in real wage earnings (millions of 1967 $)	Total change in real disposable personal income (millions of 1967 $)	Average wage rates	Alaska cost of living	Ratio of total to initial employment change	Real income multiplier
Increase of 1000 in federal government employment	1.00	1.45	6.33	10.11	0.3	0.3	1.4	1.6
Increase of 1000 in petroleum sector employment	1.00	2.55	15.12	32.26	1.4	0.5	2.6	2.1

for it. If fiscal policy were allowed to change, then the resulting impacts would confound the effects of a change in an exogenous factor with a change in a policy variable. While the MAP models have no difficulty in dealing with such simultaneous changes, the usefulness of the multiplier concept tends to break down when more than one factor is changed at the same time. The effects of such simultaneous changes, as estimated by the MAP models, will be discussed later but first it is useful to consider the impacts of changes in fiscal policy when other factors are held constant.

The first experiment in Table 2 considers the impact of an increase of $10 million in state government wages and salaries. In real terms, this amounts to an increase of a little over $3 million (in 1967 prices) and produces an increase in real personal income of $5.6 million. The implied income multiplier is 1.8. In the second experiment, state government expenditures are increased by $20 million but less than half of this money goes into wages and salaries while much of it goes to purchase commodities from outside the state. Therefore, the aggregate economic impact is less than in the previous experiment. Nonetheless, the income multiplier is about the same as before, in fact, slightly higher if it is calculated as the change in real income divided by the change in real wages paid to state employees. On the other hand, the multiplier is only 0.7 if it is calculated as the change in real personal income divided by the change in real state spending.

The final experiments, as reported in Table 3, consider the effects of exogenous employment increases which are accompanied by fiscal policies which increase state expenditures in response to the expansion in economic activity and population. The fiscal response in the experiments is, however quite modest and the increase in real state spending does not nearly keep pace with the increase in population. For example, in the experiment where petroleum sector employment is increased by a thousand, total employment goes up by 1.4%, personal income increases by nearly 3% (in current prices), but state expenditures increase by only 0.7%.

When fiscal policy is allowed to respond to changing economic conditions, the effects of exogenous changes in employment levels are, as would be expected, larger than when fiscal policy was held fixed. Thus, the summary impact measures shown in Table 3, are larger than the comparable measures in Table 1. It should be noted that the entry in the last column of Table 3 is no longer called a real income multiplier.

TABLE 2

MAP MODEL ESTIMATES OF 1980 IMPACT MULTIPLIERS:
RESPONSE TO CHANGES IN FISCAL POLICY

EXPERIMENT	Changes from base case				Percent change from base case		SUMMARY IMPACT MEASURES	
	Initial change in employment (thousands)	Total change in employment (thousands)	Initial change in real wage earnings (millions of 1967 $)	Total change in real disposable personal income (millions of 1967 $)	Average wage rates	Alaska cost of living	Ratio of total to initial employment change	Real income multiplier
Increase of $10 million in state government wages and salaries	0.33	0.64	3.03	5.57	0.2	0.1	2.0	1.8
Increase of $20 million in state government expenditures	0.24	0.48	2.22	4.27	0.2	0.1	2.0	1.9 (0.7)

TABLE 3

MAP MODEL ESTIMATES OF 1980 IMPACTS OF EMPLOYMENT CHANGES WHEN ACCOMPANIED BY MODEST RESPONSE IN STATE EXPENDITURES

EXPERIMENT	Changes from base case				Percent change from base case		SUMMARY IMPACT MEASURES	
	Initial change in employment (thousands)	Total change in employment (thousands)	Initial change in real wage earnings (millions of 1967 $)	Total change in real disposable personal income (millions of 1967 $)	Average wage rates	Alaska cost of living	Ratio of total to initial employment change	Ratio of total to initial change in real income
Increase of 1000 in federal government employment	1.00	1.67	6.37	12.17	0.4	0.4	1.7	1.9
Increase of 1000 in petroleum sector employment	1.00	2.98	15.12	35.93	1.6	0.6	3.0	2.4

Although the ratio of total to initial change in real income in this experiment still provides a useful summary measure of economic impact, it differs so significantly from the usual multiplier concept that it would be grossly misleading to refer to it as a "multiplier". Unlike the usual multiplier, which is typically assumed to remain fairly constant, the ratios shown in the last two columns of Table 3 can be changed drastically by altering the state's fiscal response pattern. For example, the total employment change can be two, three, five, or even ten times as large as the initial employment change if state fiscal policy is made sufficiently responsive to changes in state population.

A final point that needs to be made concerns the use of multipliers for predictive purposes. If the multiplier can be treated as a constant, then it is possible to calculate the total impact of a policy change simply from knowing the value of the multiplier and the size of the initial employment or income effect. The problem with applying this approach to Alaska is that is is difficult, if not impossible, to justify the assumption of a constant multiplier. To use the multiplier for predictive purposes, the following conditions, among others, would have to be satisfied:

- The multiplier would have to remain constant over time.

- The multiplier would have to be the same for all types of policy changes or combinations of policies. It would also have to be the same for all changes in outside forces.

- The multiplier would have to be the same regardless of whether the initial impact is located in the petroleum sector, state government, federal government, or any other sector of the economy.

- The multiplier could not depend on the state of the economy at the time when the policy change is implemented.

It seems clear that the Alaska economy satisfies few, if any, of the above requirements. The results of the experiments reported here confirm empirically and statistically that the Alaska multipliers vary substantially, depending on the types of changes being made and the context in which they are implemented. Other work wit the MAP models shows that many policies produce impacts which tend to accumulate over time so that the

"multiplier" increases as these effects build up. Thus, it is particularly inappropriate to use the multiplier approach to analyze the impact of a policy specifically designed to alter the growth path of the Alaska economy.

October 20, 1978

THE EVALUATION OF ECONOMETRIC MODELS AND MODEL CHANGES

Scott Goldsmith

This paper reviews and discusses the generally accepted criteria for the evaluation of econometric models and shows how one might use them in the context of a potential model change.

I. The Starting Point: Initial Model Design

The starting point for every model to be used in economic analysis is economic theory. The theory tells the researcher what the general form of the relationships between the various economic variables should be. Without a specific theory, the researcher does not know what his data equations, and model are telling him.

Consider the following equation:

$$Q = f(P,X)$$

where Q = quantity of a good
P = price of that good
X = a list of other related variables

Is this a demand equation or a supply equation? It could be either in this form. A theory is necessary to choose the list of variables, X, to determine whether it is a supply or demand equation.

For the policy analysis purposes for which most econometric models are designed, a complex model is often preferred to a simpler but naive model. This complexity allows the model to be used to do a great variety of analyses. However, as soon as the researcher starts to make his model complex, he begins to encounter problems which require that he balance off different objectives. Most of this paper will discuss these tradeoffs, but a simple example will indicate the principle involved.

Consider two models: one, the DRI model of the U.S. economy or some equivalently large and complex econometric model and, the other, the following "simple" model.

$$GNP = a + bt + cT$$

where GNP = U.S. gross national product
t = time
T = income tax rate

Which model is preferred? Both are designed to calculate U.S. GNP and can accomplish policy analysis in which the effect on GNP of changing the income tax rate is determined. To make the question interesting, assume that the simple model predicts GNP better than the complex model over some period of time. This could actually be the case.

The complex model allows the researcher to analyze a large variety of tax changes and to look at the impact of the tax change on a large number of variables not present in the simple model. In addition, the complex model is based on economic theory rather than making GNP a function of time, which may improve its capability of projecting changes in the relationship of GNP to time. The choice then is between accuracy in one task on the one hand, and flexibility in use on the other. The answer depends on expected uses of the model which determines which criteria is more important, as well as the researcher's budget.

II. Data

After having developed a framework for the model based upon economic theory and the use to which it will be put, the researcher attempts to collect the data necessary to develop the parameters which define the model relationships. At this point, many models fail because data in

the real world never conforms to the expectations of the theoretical economist. Unlike the physical sciences where the researcher creates his own data through experimentation, the economist must generally rely on data collected by someone else for some other purpose. For this, however, he considers himself lucky, because for many of the variables in his theoretical model, there is no data at all.

Just because data is available on a variable is no guarantee that it is usable. In Alaska, in particular, all data should be presumed guilty of substantial "noise" (variation of reported values from the true values) until proved otherwise. The difficult problem is to determine under what conditions data with noise in it should be used anyway, and under what conditions the variable should be omitted from the analysis altogether because, on balance, it will increase the noise of the whole model. There are few easy choices in econometric model building.

Occasionally, one can clean up a data series or artificially create a data series using partial data like census information. This is a valuable technique for allowing more complex models to be built, but the same caveat about noise and noise creation is applicable here.

III. Criteria for Model Evaluation

III.A. Statistical tests

A standard set of statistical tests is available to determine, in a statistical sense, whether an individual equation in a model should be judged to be reasonable. R^2 increases as the variation of the dependent variable is better "explained" by the independent variables. The t value of individual coefficients is larger if that particular variable significantly "explains" any of the variation of the dependent variable. The list goes on. Other things being equal, high R^2 and t values are preferred. Unfortunately, these tests cannot tell the

researcher whether or not the structure of the equation corresponds to theory, however, or that it will predict and otherwise perform well. It just tells one how the equation "fits" the data. "Explain" used above really means "fit," and it should be noted that time series data, the kind more often used by economists, generally "fits" well.

If several equations in a model have been estimated simultaneously using a more exotic technique such as two-stage least squares, the same tests generally apply and the same degree of confidence should be engendered in the researcher by good statistical test results or good "fit."

Even confining the choice of equation to statistical criteria does not obviate the need for the researcher to use his judgment. One form of the equation may yield a high R^2 while the alternative, very significant t statistics. The choice will partially depend on the use of the equation. For forecasting purposes, R^2 is important; while for hypothesis testing or measurement of elasticities, large t statistics are preferable.

III.b. Formal simulation tests

For a single equation model, one can calculate the R^2, t, and the error of forecast as indications of the goodness of fit of an equation and its ability to recreate, through historical simulation, the actual historic values. A historical simulation involves running the simulation model over the historic period to see how well it "tracks" the variables it is predicting.

With a multiequation model, the situation is different if there is any interaction among the variables (and it would be a dull model if there were none), because in such a case, the statistics of all the individual equations may indicate a good "fit" and yet upon running a simulation, the model could get way "off track." This is because the interactions of the model mean that the simulation value for a particular variable now could be determined by several equations interacting simultaneously.

Table 1. MAPE COMPARISON

	MAP 65-76	Phil I	Phil III	Phil IV	Northeast Corridor	Buffalo	Los Angeles	Mississippi
gross output	.78	4.32	.97	.98	2.05	1.87	2.08	.94
total employment	1.96	1.56	1.21	.66	1.40	3.39	.88	.41
personal income	3.72	6.69	1.50	1.55	3.13	8.42	1.45	.70
population	3.15	1.02	1.49	1.27	.78	2.50	NA	NA

Source: Norman Glickman, "Son of 'The Specification of Regional Econometric Models'." Papers of the Regional Science Association, Volume 32, p. 165.

In such cases, high R^2 values are of little comfort. Several measures have been developed to measure how well a model of many variables is able to replicate the historic period by taking various aggregations of the individual differences between actual and estimated variable values. Among these measures is the mean absolute percent error or MAPE. This measure calculates for each variable the mean of the absolute percent differences between the actual and predicted values. One can thus evaluate the MAPE for a single variable (as opposed to equation) or for all variables together.

Unfortunately, there is no specific guideline to tell the researcher when a satisfactory MAPE value has been obtained either for a single variable or for the complete model. One can only compare MAPE values between model runs and between models. MAPE values for important variables of the MAP model are shown in Table 1 and can be put in perspective by comparing them to other representative regional econometric models.

The difficulty with a complex model, because of equation interactions, is that the variables are not independent of one another. Thus, the attempt to improve the MAPE statistic for one variable through a model change will normally change the MAPE statistics for several other variables. One must be resigned to the fact that it is not possible to simultaneously improve (reduce) all MAPE statistics, so the final form of the model chosen should be the one that "tracks" for the most important variables.

If the MAPE statistics are generally bad, it means that the model is not simulating well; and in order to improve on its simulating capabilities, it will probably be necessary to sacrifice some of the equations with good statistics ("fit" well according to R^2, etc.) in favor of equations that have less desirable R^2 but which nonetheless improve the ability of the model to simulate. It is the rare model builder who has not been forced into this tradeoff and, other things being equal, it is the more

simple-minded model in terms of structural interrelationships which will have the better MAPE statistics.

III.c. Theoretical reasonableness

A model may consist of equations which all have desirable statistical properties and yield low MAPE values for all variables when run over the historic period. In spite of this, it may yield "unreasonable" results when employed to do a future projection. The test of reasonableness is not quantifiable but rests upon the economic theory which was the starting point for model construction.

For example, if a regional econometric model is constructed on the basis of a neoclassical theory of factor movements, it is to be expected that over time the factor returns in the region would move toward national averages. Thus, if the model simulated wage rates growing away from parity with national averages, this would be a signal to the researcher that the model was not operating consistently with the theory, and adjustments should be made.

Alternatively, simulation results may not be what one expects, or "counterintuitive," in spite of seeming consistency with the theory. Such a result, of course, requires close investigation of the equations determining the result. If intuition is to be the final arbiter, then, of course, there is no reason to build a model at all. It is a strength of a complex model that it is able to keep track of relationships which an individual, relying on intuition and a limited memory bank, could easily overlook or lose track of.

Several types of tests of model theoretical reasonableness are common. The model should be able to pick up turning points in the time path of an important variable or significant changes in the growth rate. For the Alaskan economy, the Alyeska years would be such a case. The model should give dynamic responses to large changes in exogenous

variables and policy stimuli that are consistent with theory and recent experience. Ratios between important model variables will be (theoretically) constrained to remain within particular ranges. Monitoring these ratios is an additional check on reasonableness. For example, the ratio of employment to population could not be reasonably expected to approach zero or one.

III.d. Sensitivity tests

A well-designed model should be insensitive to a variety of changes. These include the time period during which a simulation is initiated, small changes in the values of individual coefficients, and small changes in the time paths of exogenous variables. As with theoretical reasonableness, there are no established standards of sensitivity by which the researcher can judge his results.

III.e. Stability

In a simple linear model, one can test for stability by solving the characteristic equations for the roots. Stability means simply that over time the variables in the model will come to rest at an equilibrium position if they are moved off an equilibrium position by an exogenous shock. In an unstable model, the variables will forever move away from an equilibrium if once disturbed.

Large complex models are more likely to be unstable because of the interaction of the equations in the determination of values for the variables. Unfortunately, for large models which are usually nonlinear, one cannot simply solve the characteristic equations. Stability can only be determined by "putting the model through its paces" in a series of simulations covering as long a period of time as feasible and covering as much variation in the exogenous variable values as plausible. In this way, one develops a "sense" of the model's stability properties.

A little bit of instability is not necessarily a bad property for a model to have. The real world, after all, is not always stable and does not always conform to the comparative static framework of the neoclassical economist. Exogenous changes to the system do not occur sequentially nor are factors, technology, tastes, etc., constant over time.

IV. Model Updates and Changes

Model updating is carried out any time that new data points or new variables become available or when economic theory and model results suggest that the present formulation of the relationship between the variables is unreasonable. As with model development, there are several criteria for judging the value of a potential model change. One weighs the criteria on the basis of what the model will be used for. The choice will probably result in a tradeoff among the criteria. This is the sense in which econometric modeling is an art.

In a model that is being used primarily for policy analysis rather than prediction, the t statistics are more important than R^2 and theoretical reasonableness is more important than low MAPE values. In predictive models, the opposite would probably hold true.

* * * * *

Several important observations derive from this discussion:

1. The more complex a model is in terms of variable interrelationships, the more likely it is that low R^2 will be encountered with some equations, MAPE values may be poor, and instability becomes a potential problem. Generally, the richness of model detail outweighs these concerns.

2. In a complex model, an individual equation must be analyzed in the context of the whole model rather than "out of context."

3. Because of multiple criteria for determining model reasonableness, each modeler assigns his own weights to the individual criteria in model construction. Thus, each model bears the imprint of the designer.

4. Choosing a structural form for an equation or deciding whether to include or exclude a specific variable in a particular equation is never a straightforward matter.

5. There is no perfect model which absolutely satisfies all criteria. All can be criticized and improved upon. But because no model completely satisfies all criteria does not imply the models are not useful.

Scott Goldsmith
University of Alaska
October 20, 1978

Comments on
Relation of Nonpetroleum Revenues to Personal Income
In the MAP Model Simulation of Alpetco Impact

1. I am tickled that someone has actually taken the time to get past the first page of the Alpetco study and to look at the analysis.

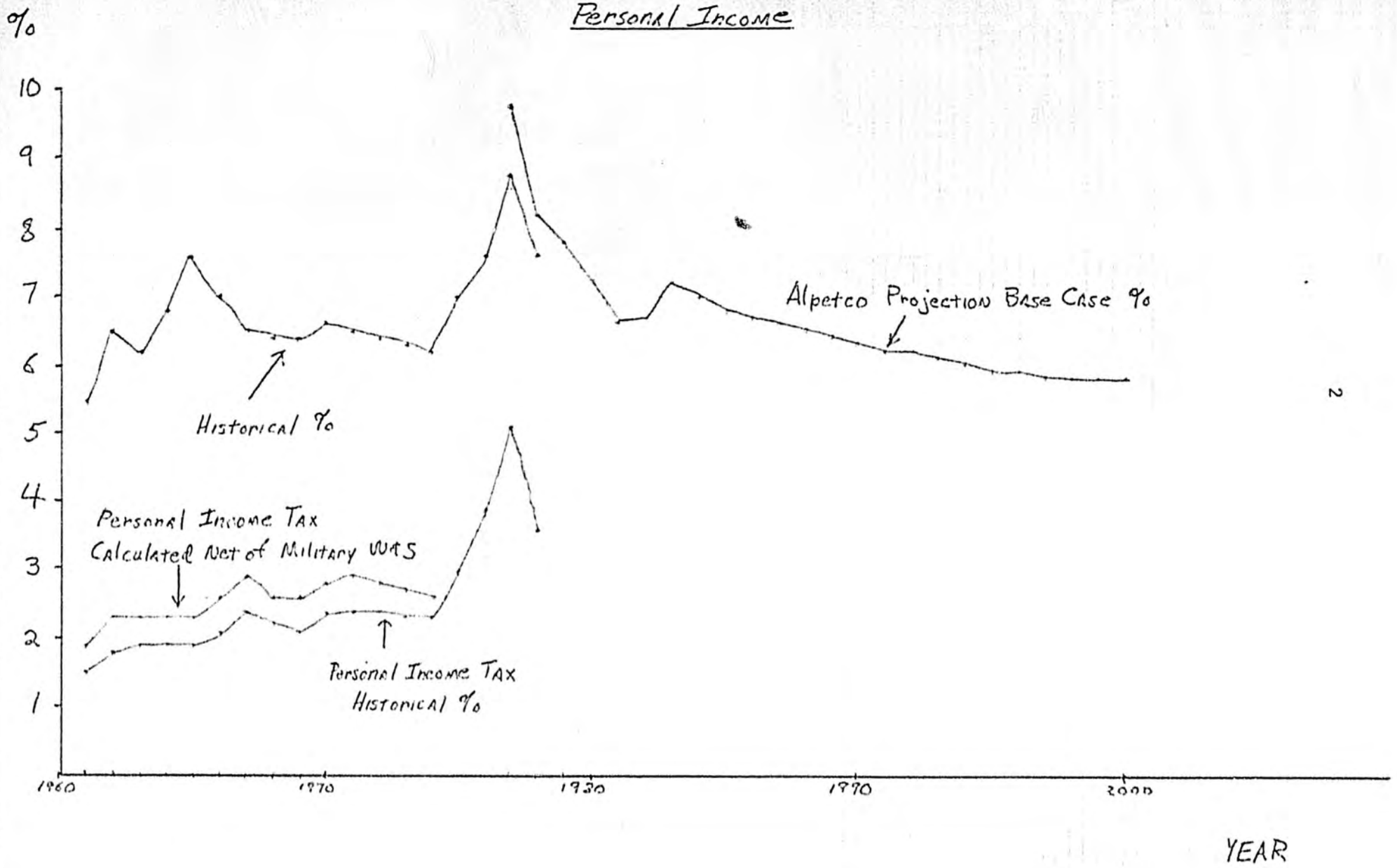
2. I agree that more responsive models of personal and corporate income taxes would be preferable. The basic problem is data. At present, the only data available on the state personal income tax is total collections, gross and net. Data on such basics as number of taxpayers and amount of tax paid from out-of-state addresses is not available. Brad Tuck and others will attest to the fact that economists have been asking Department of Revenue to pull information off the personal and corporate income tax returns for at least ten years, and no progress has been made. (This data would have much broader application than better estimation of tax models and would be extremely valuable.) In the absence of this data, one must try to construct Alaskan series from the information collected off federal returns. The basic difficulties with the approach are that the historical series have unexplainable large variation over time and provide information only on returns filed from Alaska and not for all income earned in Alaska.

3. In spite of these problems, I do not agree that one should revert to the analysis of aggregate past trends in the determination of endogenous revenues. A more systematic approach such as is developed in the MAP model is appropriate.

4. Looking at the past pattern of endogenous revenues in relation to personal income in Alaska in Table 2 of Barker, I do not observe a definitive, long-term trend emerging from the data. The points, if plotted on a graph, would be as shown in Figure 1.

Figure 1.

Endogenous Revenues
As Percentage of
Personal Income



5. Turning next to the base case projections in the Alpetco analysis, several points should be mentioned.

a. The major portion of the percentage decline in endogenous revenues compared to personal income occurs in the years immediately following Alyeska when the percentage declines from 9.8 (1977) to 6.6 (1981). This series is also included in Figure 1 for comparison purposes.

b. The differences between the historical figures and projection figures in the overlapping years indicate that the projection series contains some revenue items not in the historic series. In fact, the model value for endogenous revenues of $385 million in 1977 is quite close to the $362 million indicated by Barker. The personal income projection of the model for that year was somewhat low, and this tends to inflate the difference in the series.

c. The income elasticity of endogenous revenues is the weighted average of the elasticities of all taxes and revenues. Some such as the school tax and alcohol tax have clearly been income inelastic historically, thus requiring an elastic response in the larger taxes if an overall elasticity of one is to be observed.

d. Some upward movement in the ratio of personal income tax to personal income can be observed from the historic data. (See Figure 1.) Some of this would be the result of the declining importance over time of military wages which are not taxable. (See Figure 1.) Long-run projections of the national economy do not project a continuing increase in the percentage of personal income going into the federal income tax primarily

because of periodic changes in the tax laws to reduce the impact on the average effective rate of inflation and real income increases interacting with the progressive schedule. (It is important to avoid a fallacy of composition here. The effective rate for an individual may increase over time, and yet the effective rate for the population remains unchanged.) In addition, there may be a reason to expect the effective rate in Alaska to fall slightly in the projection period as the structure of employment shifts relatively away from high wage occupations in the petroleum and construction industries.

6. There is obviously an element of arbitrariness involved in presuming to project revenues over a 25-year period. The approach in the MAP model is to model the existing structure as much as possible and where possible make structural shifts in the future consistent with such shifts in the past. For example, historically the standard deduction has increased over time. This increasing trend is included in the projections. This appears to me to be a neutral approach and furthermore justified on the basis of the experience of the last legislature (federal and state) during which both the personal income tax and the business license tax were reduced. Since the state personal income tax essentially "piggybacks" the federal tax, this year Alaskans have been able to take advantage of not only a federal cut which affects state tax rates but also direct state-initiated cuts.

7. With respect to the impact on endogenous state revenues of the Alpetco project, several points should be noted.

a. The ratio of personal income tax to personal income would not be expected to increase in the Alpetco years to the same extent as in the Alyeska years, because the average wage of impact employment in the Alpetco case would be considerably below the Alyeska case.

b. The income tax model should be more responsive to short-run changes in per capita income. To this end, a different version of the state personal income tax model is being incorporated into the model which will better be able to distinguish between an increase in personal income resulting from an employment increase and one resulting from a wage increase. In general, the latter would have a more strongly positive impact on tax revenues. (See Scott Goldsmith, "A State Personal Income Tax Simulation Model," MAP working paper.)

c. In this context, it is useful to distinguish a marginal change measured as the impact within a year from the marginal change measured as the year-to-year change. I have a difficult time interpreting the latter when it is the change in personal income tax as a percentage of the change in personal income and a value in excess of 14.5 percent, the maximum marginal tax rate, is calculated.

October 20, 1978

TYPES OF MODELS AND ANALYSIS OF IMPACT

Scott Goldsmith
University of Alaska

Much of the work performed by regional economists involves tracing the economic impacts of specific exogenous actions through the regional economy. The impacts of tax structure changes, of the location of new industry, or of increases in export markets are common examples of this type of study.

Three types of models are available to assist the researcher in this work--economic base models, input-output models, and econometric models. Each is best suited for particular problems and situations. The economic base model is the easiest of the three to construct and use, requiring in its simplest formulation only that the basic and nonbasic sectors of the economy be identified by one of several established techniques. The ratio of nonbasic to basic activity becomes the estimate of activity which would be generated by an increase in basic activity. The simplicity of the model means that it can be widely used but also presents problems which severely limit its usefulness as the change being analyzed increases in size and/or occurs within a time dimension. The use of a single unit of measure of economic activity such as employment is misleading, since different industries can have very different levels of average wages with very different effects. The identification of basic and nonbasic sectors is a problem. Finally, the model assumes a constant basic/nonbasic ratio which is clearly not realistic over time.

The input-output model provides much more detail on the interrelationships within a regional economy and can trace the impact of a change in much greater detail than an economic base model. Differential impacts from changes in different sectors of the economy can be traced.

Data requirements are the largest problem in model implementation, although techniques have been developed to make input-output models transferable from region to region. The basic conceptual problem with these models is the assumption of constant coefficients which rules out economies of scale, other types of agglomeration economies such as urbanization, and technological change. This is not a problem in the short run but does introduce bias in any long-run analysis.

Econometric models of regions are not confined to the theories of regional growth implicit in either the economic base or input-output type models but are more flexible in terms of being able to apply other components of regional economic theory to the analysis of impact. Many adopt concepts from the economic base models, but a variety of factors can be handled within the econometric framework which are important in regional economic analysis, but which are not capable of being handled in the other model types.

Some of these capabilities include the ability to handle a changing ratio of basic to nonbasic employment, to incorporate a fiscal sector into the model of the economy, to include relative regional prices in the model, to differentiate the impacts of employment and wages, and to handle the determination of personal income and population based on activity within the region.

Econometric models have data requirements falling somewhere between those of economic base studies and input-output analyses. A basic problem from which they suffer is the availability of sufficiently long, stable, and accurate time series data to enable the researcher to adequately specify his relationships.

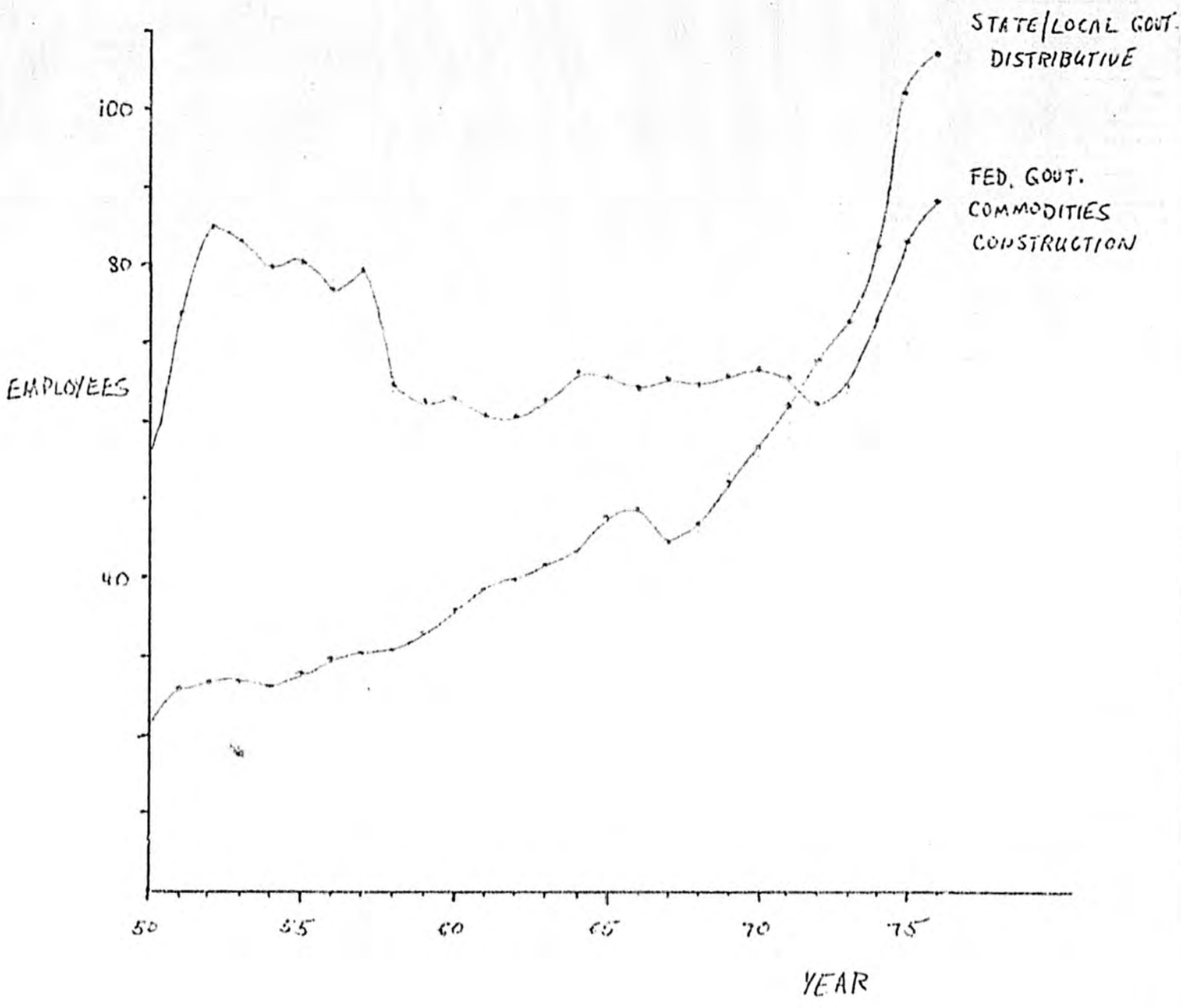
What sort of a model is best suited for identifying economic impacts in the Alaskan economy? For several of the reasons just mentioned, econometric models seem to have the most flexibility and the ability to

incorporate the widest range of factors when large multi-year impacts are being measured. In addition, one of the most important aspects of the Alaskan economy, the fact that it is underdeveloped but rapidly growing, cannot be reflected properly by the other model types. Inability to handle this basic feature greatly distorts long-run impact analyses done by these models.

To indicate the Alaskan dimension of this characteristic of an underdeveloped but growing economy, Figure 1 shows the growth since 1950 of the basic and support sectors in Alaska measured by employment. One may disagree over the proper classification of an industry as basic or nonbasic, but the overall pattern is unmistakable. The relationship between the basic and support sector employment has clearly changed dramatically over the years. Whereas in 1950 there were 39 employees in the distributive industries and state and local government for every 100 in the basic sector, in 1976 there were 121. The change over the period amounted to 267 distributive and state and local employees for every 100 in the basic sectors. This marginal ratio of 2.67 is quite different from the average ratio in 1950 of .39. Thus, any long-run analysis in 1950 applying the average nonbasic/basic ratio of that year to the economy and projecting into the future would vastly underestimate actual growth. In the same manner, it would underestimate the level of impacts in a growing economy.

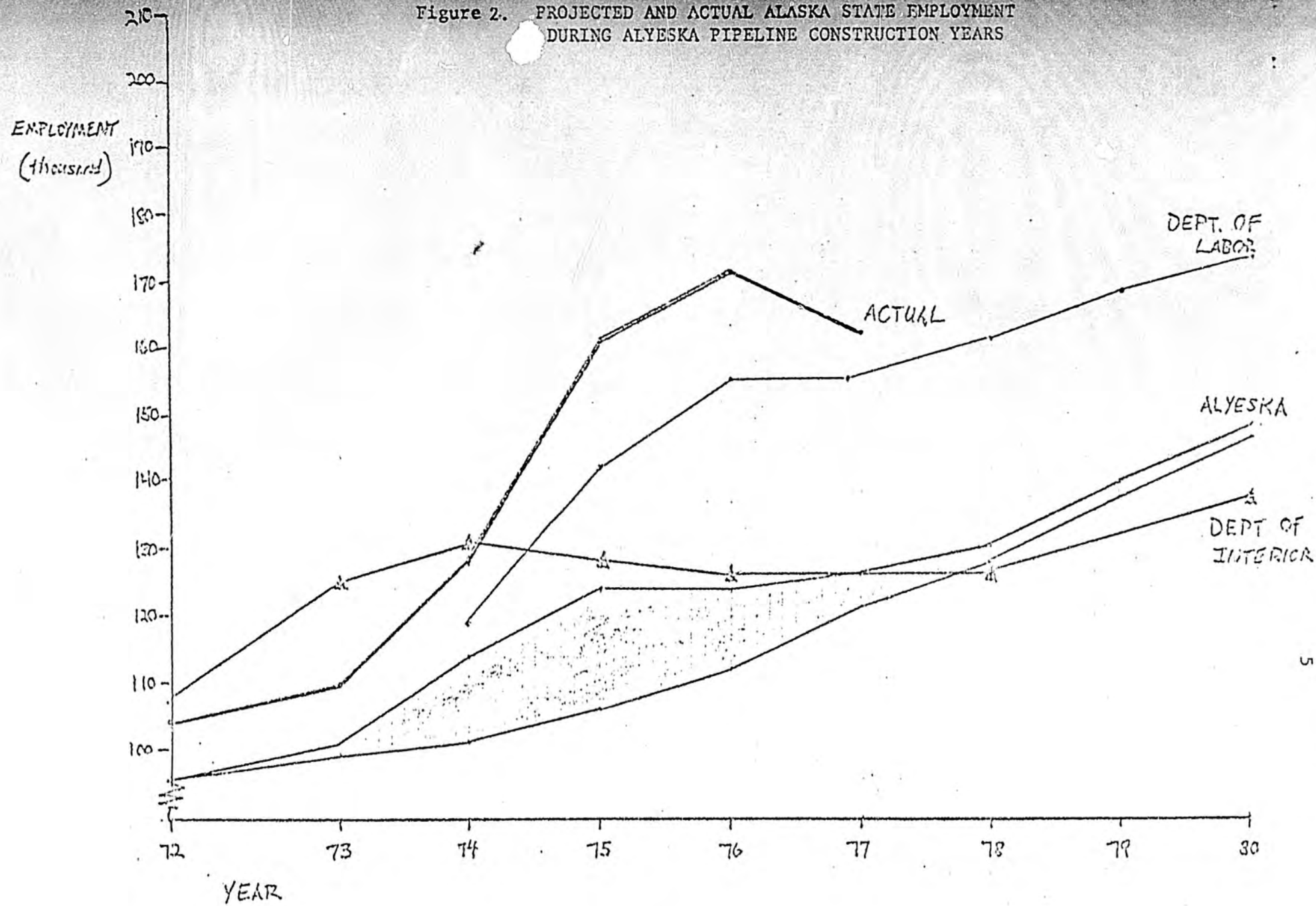
This mistake was definitely a factor in the underestimation of impacts for all a priori analyses of the Alyeska pipeline. As shown in Figure 2, all analyses done before the project completion underestimated the short- and long-run impact of the project substantially, partially because economic base models were employed which did not properly take account of the fact that growth changed the economy qualitatively as well as just increased its size. The actual impact could be called "blip-ratchet," whereas the economic base model describes the "blip" impact as shown stylistically in Figure 3.

Figure 1



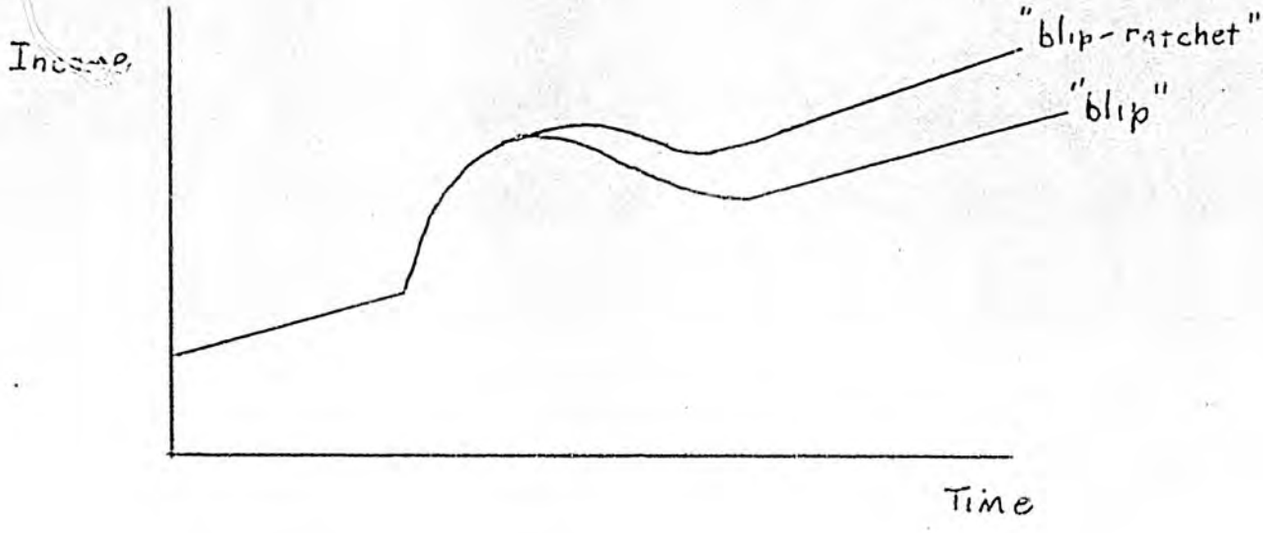
Adopted from Scott Goldsmith and Lee Huskey, "Structural Change in the Alaskan Economy: The Alyeska Experience," paper presented at the 29th Alaska Science Conference, August 15, 1978, Table 1.

Figure 2. PROJECTED AND ACTUAL ALASKA STATE EMPLOYMENT DURING ALYESKA PIPELINE CONSTRUCTION YEARS



Source: Scott Goldsmith and Lee Huskey, "Structural Change in the Alaskan Economy: The Alyeska Experience," paper presented at the 29th Alaska Science Conference, August 15, 1978.

Figure 3.



The difference in the level of economic activity after A between the "blip" and "blip-ratchet" cases is the impact attributable to structural change in the economy. This is essentially a change in the ratio of support to basic industry. Because of a variety of factors including economies of scale from increased market size, other agglomeration economies, reduced transport costs, changed expectations of growth, availability of capital, etc., there has been a "deepening" of the support sector--import substitution--rather than just an increase in its level, indicated by the shaded area.

This import substitution can be interpreted in two ways with respect to the analysis of impact of specific exogenous changes. On the one hand, the import substitution would presumably have occurred anyway at some future time, assuming continued growth of the economy, and the exogenous change merely altered the timing of the import substitution. This reasoning would argue that the import substitution that results after the exogenous change should not be counted as part of the impact

of the exogenous change but rather independently as part of the normal growth process. The alternative interpretation is that the import substitution was in fact the result of the exogenous change and should be counted among the project impacts.

The distinction is critical when one is doing a benefit-cost analysis of a project from a public perspective. The benefits and costs associated with the import substitution component of impact will generally not cancel one another out. Thus, their treatment could be critical in determining the outcome of the analysis. It seems clear that the import substitution effects of exogenous changes are correctly classified as impacts, and as such, it seems reasonable to weigh these impacts like all others as part of any benefit-cost analysis.

Alpetco Petrochemical Proposal: Impact Analysis

Supplement

The results of the Alpetco impact analysis depend significantly on the assumptions made in the base case and Alpetco scenarios. In both the base case and the Alpetco scenario, important assumptions concerning the relationships between variables and the direct effect of Alpetco were made. One benefit of using the MAP model in analyzing the Alpetco impact is that it allows relatively easy testing of the sensitivity of the results to changes in these assumptions. Since the publication of the Alpetco Impact report, suggestions of further sensitivity tests have been made. This supplement will present comparative results of four of these tests. The results will be compared in terms of the impacts on population, employment, real per capita state expenditures, and the general fund current account. These results are presented in Tables S.1 through S.4.

The importance of the effect of induced state expenditures on the impact generated by Alpetco suggests that the rule used to determine the level of state expenditures be examined. The first three sensitivity tests in this supplement examine the effect of changing the state spending rule. In the original Alpetco and base case scenarios, state spending was assumed to increase with prices, population, and personal income. Increases in response to changes in personal income expand the level of state services (measured by real per capita expenditures), while changes in response to increases in prices and population maintain the same level

of services. To test the sensitivity of the Alpetco impact to changes in the level of state expenditures induced by it, we examined the case (ALS9) when expenditures increased over the base case levels only because of changes in prices and population. The second sensitivity test (ALS10) examined the effect of a differential response of state expenditures during the construction period and the operations period of the Alpetco project. State expenditures were assumed to remain at their base case levels until after the end of construction in 1984, when they increased with population and prices. In the third sensitivity analysis (ALS13), the increase in total state expenditures was assumed to be constrained to equal the increase in general fund revenues (lagged one year) which result from the growth of the economy because of the Alpetco project. The comparison of these results should provide an idea of the effect of state government expenditures on the Alpetco impact.

The final sensitivity test analyzes the case where a substantially higher level of corporate income taxes is generated by Alpetco than assumed in the basic simulations (ALS20). This test was based upon an Alpetco criticism of the calculation of corporate income tax in the basic analysis.

Constant Real Per Capita Expenditures (ALS9)

When state expenditures are held constant in real per capita terms at the level of the base case, the relative effects differ between the construction and operations periods. The population and employment

impacts are lower than in the regular Alpetco case during construction, but higher by the end of the period. By the end of construction in 1983, the employment impact is 2,700 less when state spending is constrained; this reduces the employment impact by 12 percent. The population impact is also reduced during the construction period; the population impact is 10 percent less in 1983. By 2000, the employment and population impacts are greater than in the regular Alpetco case. The employment impact is 30 percent greater and the population impact is 17 percent greater than in the regular Alpetco case. This results because the real per capita level of expenditures falls below the base case level in the regular Alpetco case after construction (beginning in 1986), which dampens the state expenditure effect of the increased population; this does not happen in this case as total expenditures increase with population. This is reflected in comparing the impacts on the current account of the general fund which is negative but smaller during construction, but is greater by 2000 than in the regular Alpetco case. The current account balance is $149.5 million less than in the regular Alpetco case by 2000.

No Expenditure Response Until After Construction (ALS10)

This case is similar to the previous one, except that state expenditures are unchanged from the base case during construction. State government services only increase in response to changes in long-run or permanent employment and population change induced by the Alpetco project. Eliminating the construction phase response reduces the population

impact by the end of construction in 1983 by 32 percent. The employment impact is reduced by 37 percent by the end of construction. Even though state expenditures do not increase over base case levels during construction, the impact of Alpetco on the current account of the general fund becomes negative in 1984 and every year thereafter. The negative impact is much less than in the base case in early years.

Expenditure Increases Equal Revenue Increases (ALS13)

Introducing this rule for expenditures has the same type of effect on population and employment as the other cases. The population impact is less during construction and most of the years of operation, but greater by 2000. In 1983, the population impact is 22 percent less than in the regular Alpetco case. The employment impact follows the same pattern, being 25 percent lower than the regular Alpetco case in 1983. In 1990, employment slightly exceeds that of the basic Alpetco case.

This counter-intuitive pattern of response of employment and population in the long run is attributable to the fact that state expenditure growth in the base case is slightly depressed in later years because real personal income growth is moderating. The net fiscal impact is nonzero in this case because there is a lagged response of expenditures to changes in revenues. It is positive in those years when revenues from Alpetco are increasing and negative when they are declining.

The impact on real per capita state expenditures in this case is negative. The impact is significant during the construction years and

declines abruptly after completion. In 1990, it represents a reduction of less than 1 percent from the base case.

Higher Corporate Income Tax Revenues (ALS20)

The final sensitivity analysis (ALS20) conducted is based upon a criticism by Alpetco concerning the estimated real state corporate income tax generated by Alpetco. They felt that an adjustment to real corporate income taxes from the project should be made which accounted for the fact that depreciation and interest expense occur at a fixed rate, which does not change with inflation. This affects only state revenues; expenditures, employment, and population are the same as in the regular Alpetco case. Because expenditures have remained constant while revenues have increased, the current account of the general fund can be expected to be affected positively. In fact, the negative impact on general fund current account is less after 1986 when production begins than in the regular Alpetco case, and by 2000 the impact on the general fund current account is positive; it is $23.5 million greater than in the base case.

Table S.1.

Alpetco Population Impact Under Alternative Assumptions

(thousands)

	AL2_ER	ALS9_ER	ALS10_ER	ALS13_ER	ALS20_ER
1979	1.944	2.015	1.944	1.944	1.944
1980	7.015	7.517	6.129	6.295	7.015
1981	20.21	21.461	17.279	18.042	20.21
1982	29.968	28.024	21.794	23.924	29.968
1983	36.749	33.237	25.061	28.633	36.749
1984	31.333	23.726	20.825	21.584	31.333
1985	26.562	22.451	20.278	20.13	26.562
1986	24.896	23.078	21.047	19.571	24.896
1987	24.509	23.888	21.955	20.596	24.509
1988	24.585	24.675	22.827	21.707	24.585
1989	24.889	25.504	23.732	22.625	24.889
1990	25.234	26.319	24.628	23.382	25.234
1995	27.781	30.979	29.572	27.103	27.781
2000	24.966	29.261	28.203	26.055	24.966

AL2_ER = basic Alpetco assumptions
ALS9_ER = base case real per capita expenditures
ALS10_ER = no expenditure response until after construction
ALS13_ER = expenditure increases equal revenue increases
ALS20_ER = higher corporate income tax revenues

Table S.2.

Alpetco Employment Impact Under Alternative Assumptions

(thousands)

	AL2_ER	ALS9_ER	ALS10_ER	ALS13_ER	ALS20_ER
1979	1.494	1.525	1.494	1.494	1.494
1980	5.083	5.442	4.404	4.531	5.083
1981	14.287	15.18	12.119	12.687	14.287
1982	19.514	17.884	13.549	15.102	19.514
1983	22.253	19.584	14.13	16.656	22.253
1984	15.422	9.848	8.918	9.045	15.422
1985	10.587	8.236	7.969	7.305	10.587
1986	8.721	8.315	8.007	6.503	8.721
1987	8.095	8.587	8.292	7.055	8.095
1988	7.946	8.869	8.578	7.665	7.946
1989	8.036	9.206	8.914	8.109	8.036
1990	8.196	9.557	9.269	8.438	8.196
1995	9.694	11.78	11.482	10.095	9.694
2000	7.506	9.785	9.609	8.687	7.506

AL2_ER = basic Alpetco assumptions
ALS9_ER = base case real per capita expenditures
ALS10_ER = no expenditure response until after construction
ALS13_ER = expenditure increases equal revenue increases
ALS20_ER = higher corporate income tax revenues

Table S.3.

Alpetco Impact on State Current Account
Under Alternative Assumptions

(million $)

	AL2_ER	ALS9_ER	ALS10_ER	ALS13_ER	ALS20_ER
1979	1,906	-5,498	1,906	1,905	1,906
1980	-6,576	-16,677	10,888	6,925	-6,576
1981	-27,338	-52,944	30,386	13,261	-27,338
1982	-112,469	-65,626	54,944	6,318	-112,469
1983	-164,99	-93,941	66,169	-12,122	-164,99
1984	-221,881	-57,167	-28,555	-34,377	-221,961
1985	-142,006	-78,553	-42,474	-34,948	-142,012
1986	-89,527	-67,803	-28,419	7,385	-81,913
1987	-64,957	-62,493	-20,161	6,293	-52,7
1988	-58,613	-66,845	-21,416	-1,739	-43,198
1989	-57,366	-73,454	-24,694	-4,917	-38,532
1990	-58,898	-82,898	-30,548	-7,207	-36,265
1995	-76,37	-145,81	-71,138	-11,057	-31,672
2000	-48,13	-197,716	-92,358	-12,44	23,5

AL2_ER = basic Alpetco assumptions
ALS9_ER = base case real per capita expenditures
ALS10_ER = no expenditure response until after construction
ALS13_ER = expenditure increases equal revenue increases
ALS20_ER = higher corporate income tax revenues

Table S.4.

Alpetco Impact on Real Per Capita State Expenditures
Under Alternative Assumptions

(1967 U.S. $)

	AL2_ER	ALS9_ER[1]	ALS10_ER	ALS13_ER	ALS20_ER
1979	-7.12	-0.108	-7.12	-7.119	-7.12
1980	-8.01	-0.39	-20.793	-16.943	-8.01
1981	-18.109	-1.049	-54.531	-41.41	-18.109
1982	24.777	-1.328	-68.411	-35.007	24.777
1983	35.012	-1.61	-82.235	-35.073	35.012
1984	93.279	-1.031	-0.915	2.543	83.279
1985	24.563	-0.973	-0.885	-10.406	24.563
1986	-1.62	-0.992	-0.91	-23.731	-1.62
1987	-12.433	-1.025	-0.942	-18.203	-12.433
1988	-16.939	-1.058	-0.979	-13.352	-16.939
1989	-18.929	-1.089	-1.018	-11.717	-18.929
1990	-20.27	-1.126	-1.056	-11.643	-20.27
1995	-21.775	-1.291	-1.232	-14.508	-21.775
2000	-25.058	-1.162	-1.116	-10.542	-25.058

[1]Difference from base caused by the definition of current expenditures. This is not a significant difference from the base case.

AL2_ER = basic Alpetco assumptions
ALS9_ER = base case real per capita expenditures
ALS10_ER = no expenditure response until after construction
ALS13_ER = expenditure increases equal revenue increases
ALS20_ER = higher corporate income tax revenues

SIMPLIFIED FLOW DIAGRAM OF MAP ECONOMETRIC MODEL