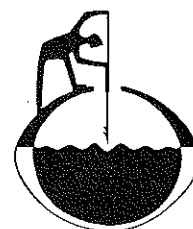


MAN IN THE ARCTIC PROGRAM
Working Paper

**The Growth Consequences of Alternative
Mineral Lands Leasing Policies**

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THE GROWTH CONSEQUENCES OF ALTERNATIVE MINERAL LANDS LEASING POLICIES

INTRODUCTION

There already exists an extensive economic literature on leasing strategies, but most treatments of "optimal" policies by natural resource economics have taken as their implicit or explicit policy objective either (1) the maximization of the present value of government direct revenues, or (2) efficient time allocation of the resource as measured by market prices and some computed shadow prices, or some combination of the two objectives.¹ Many government lessors, however, are concerned neither with the efficient time allocation of resources in the market sense nor with short-term maximization of government revenues. Many of the lessors are countries with development objectives that include as considerations employment, income, and cost of living of their citizens, with natural resource-determined government revenues and expenditures seen as means to achieve the development objectives. As the experience of Saudi Arabia shows, there are limits on the ability of simple economies to effectively absorb the massive revenues which accrue to resource owners in a world where natural resources have begun to command very high prices by historical standards. One option open to such a country is to reinvest in world markets those received funds which it could not conveniently invest internally. There are some external spending alternatives to reinvestment for sovereign countries, including the purchase of arms, which reduce the internal economic and social impact of "too much" government spending on domestic programs. However, another alternative is to adopt mineral leasing and production policies which delay both spending decisions and development impacts, and which generally smooth the expected growth path of the economy. An example may be drawn using the state of Alaska.

While not a sovereign nation, the state of Alaska already has control over the leasing of mineral rights on land (other than the Prudhoe Bay oil field) with oil and gas potential and oil industry interest. These state lands will produce oil and gas in commercial quantities and may add to an already swollen state treasury in the short run. Alaska is expected to run substantial fiscal surpluses in the mid-1980s, even without these additional leases. To spread the fiscal impact through time, the people of the state of Alaska have amended the state's constitution to force the state to save 25 percent of all future mineral lease rentals, royalties, royalty sale proceeds,

¹A partial list of works related to leasing strategy should include references [3], [5], [9], [13], [14], [18], [21], and [22].

federal mineral revenue sharing payments and bonuses (but not the proceeds from petroleum exploration, production taxes, or property taxes) in a revolving permanent investment fund (known as the Permanent Fund to Alaskans) whose principal can be used only for income-earning investments, and whose use for general operating expenditures or general capital expenditures of the state is specifically prohibited.² However, even given the existence of the permanent fund, the state may wish to manage its future leasing policies to postpone the receipt of new petroleum revenues available, while still permitting active leasing and petroleum development to achieve national supply goals.

There are two reasons why the state might wish to reduce front end revenues directly. Under the current law, 75 percent of bonus revenues, representing a substantial fraction of the future value of the nonrenewable oil resource, go into the general fund. There exist in Alaska political pressures to increase current state spending and to roll back state personal income taxes, negating any attempt to increase saving of these revenues for later use. Second, it appears difficult to increase Alaskan real income above the national average via spending policies without triggering a round of growth in population and government costs that Alaskans regard with ambivalence, and which would absorb much of the state's oil wealth. Results of earlier research on Alaska's economy and population suggest that net migration to Alaska is predicted very well by changes in available employment and by the difference in real income between Alaska and the southern forty-eight states, and that the income elasticity is quite high.³ In fact, it appears that the state cannot increase per capita incomes substantially without inducing in-migration which tends to absorb the increase.⁴

THE STRUCTURE OF ALASKA'S PETROLEUM REVENUES⁵

Alaska obtains her oil revenues from several different sources. The initial source of revenue is generally the lease sale. The formal requirement for competitive leases on state lands is that the royalty rate may not be less than 12.5 percent of the amount (in-kind royalty) or value of production. The method of bidding is either by public auction or sealed bids, and the high bidder is deemed to be the one offering the largest cash bonus, of which 20 percent is due with the bid. In the past, the average winning bid has ranged from \$1.54 per acre on Sale No. 3 in December,

²There are, however, no restrictions on the use of earned interest on the permanent fund.

³See [20].

⁴See [7], [11], and [12].

⁵The discussion in this section is based on the materials describing the current tax structure contained in [2] and the history of state leasing in [1].

1960, to \$2,181.66 per acre in Sale 23 (Prudhoe Bay) in September, 1969. High bids can and have been rejected. The only sales to use a royalty rate higher than 12.5 percent were Sales No. 28 and No. 29, the last two, which used 16.67 percent.⁶

The next sources of state funds are lease rentals and the oil and gas reserves tax. The annual lease rental is \$1 an acre, and the primary term of the lease is 10 years for competitive sales. The lease will be extended if drilling has commenced until the well is completed or production of oil and gas is continued in paying quantities. Leases proved capable of production may be shut in. The temporary Oil and Gas Reserves Ad Valorem Tax of 20 mills on the value of proven reserves was devised by the 1975 Legislature as a means to compensate for the delay in construction of Prudhoe Bay reserves for the trans-Alaska oil pipeline, which led to projected revenue shortfalls in FY 1976 and FY 1977. New discoveries are exempt for 5 years. Producing companies can use reserves taxes paid now as a credit for future severance taxes, and each company can reduce its severance taxes up to 50 percent in any one month by using a portion of the built-up "credit" equal to the amount of reserves taxes previously paid.⁷

Three more sources of direct petroleum revenue exist, if oil or gas is found and produced. Besides the state's one-eighth royalty share of production, net of settlement payments to the Alaska Native Fund,⁸ the producing company must pay a production tax of 4 percent on the value of gas at the wellhead, and the greater of a cents-per-barrel or a progressively structured ad valorem production tax on oil whose current effective rate averaged over all Alaskan production is between 7.5 and 8.0 percent. In addition, the producer must pay a property tax equal to 20 mills on the assessed value of exploration and production equipment and pipelines (except those pipelines operated for the retail distribution of gas and regulated by the Alaska Public Utilities Commission).⁹

Several methods for increasing Alaska's total revenue from oil and gas operations and improving the timing of state receipts have been under discussion in

⁶However, the state has bought back many of the leases in Sale 28 (Kachemak Bay), and is negotiating to buy back the rest. There were technical problems with the manner in which the sale was held, and environmental opposition to development of the leases.

⁷Department of Revenue estimates total receipts on the reserves tax will be \$283 million for FY 1977. They were \$223 million for FY 1976. Credits are expected to be exhausted by FY 1982.

⁸The Alaska Native Fund was established by the Alaska Native Claims Settlement Act as part of the agreement that settled aboriginal land claims in Alaska. In exchange for these claims, the Alaska Native peoples received both a land settlement and a cash settlement, the latter managed by the Federal government as the Alaska Native Fund. In addition to a specifically scheduled \$462 million paid by the Federal government, the fund includes an annual payment of 2 percent of the value of oil and gas production on state lands.

⁹The state also receives production taxes on Native lands and the private share of production on Federal onshore properties. In addition, the state shares mineral royalties paid to the Federal government from onshore Federal production. However, the state does not share in Federal OCS royalties, and might not share NPRA royalties. See [12] and [16].

Alaska's state government. These have included tightening up the structure of the corporate income tax to give Alaska a larger share of the net income of multi-state oil companies,¹⁰ increases in severance taxes on oil and gas, and readjustment of the procedures for assessing pipeline property at replacement cost rather than historical cost. In addition, the state has explored the possibility of increasing its oil and gas lease sales by using a strategy other than bonus bidding with a fixed royalty as part of this effort. The State Department of Natural Resources has recently completed a study which analyzes several alternative bidding strategies under different conditions of risk, field size, cost of exploration and development, and wellhead value of oil. The alternative strategies included: no bonus with royalty bidding, no bonus with sliding scale royalty bidding, no bonus with net income share bidding, and bonus bidding with a percentage of acreage withheld for later drainage sales. The study concluded that:

1. Geologic risk was the most significant variable affecting the profitability of exploration and production.
2. In very high risk areas, the state could expect to maximize its income by bonus bidding.
3. In low-risk areas, other methods resulted in greater total income.
4. The income from any of the leasing methods could be increased by withholding part of the acreage expected to be productive from the sale and selling it in a subsequent drainage sale.

This paper, however, looks beyond the question of total leasing income to consider the effects on Alaska's economic growth. Three leasing experiments are considered, and these are compared in their effect on Alaska's growth to a change in the severance tax rates on oil, a change in real oil prices, a more stringent saving policy in state government, and a change in the expected rate of return on saved funds. The three leasing methods to be considered are (1) bonus bidding with fixed 12.5 percent royalty, (2) royalty bidding with no bonus, and (3) bonus bidding with delayed sales to postpone field development on state lands.

LEASING SCENARIOS

In order to test the impact of the alternative leasing strategies on Alaskan economic growth, we first had to construct a plausible exploration and development scenario that would show what might be expected to happen in leasing oil on state

¹⁰The corporate tax rate on corporations doing business in Alaska is 9.4 percent. Due to the use of the federal tax base and the factors which apportion tax liabilities of interstate corporations under Article IV of the Multi-state Tax Compact, multi-state oil companies pay somewhat less than the effective rate for corporations doing business only in Alaska.

lands in the future. The state currently has under patent the mineral rights to a large area of land between the National Petroleum Reserve in Alaska and the National Arctic Wildlife Refuge south of Prudhoe Bay. In addition, the state may lease in the Beaufort Sea offshore of Prudhoe Bay in state waters. The development scenario concentrates on this area because (see map in Appendix B) of the high probability of further oil and gas finds in extensions of the Prudhoe main reservoir onshore, because of a likely early sale date and high geologic promise in the Beaufort Sea, and because both are readily accessible to the trans-Alaska Oil Pipeline.

Other related and unrelated exploration activity is occurring in Alaska at the same time as the assumed exploration program is being conducted on state lands in the vicinity of Prudhoe Bay. Semi-submersible drill rigs are operating in the northern Gulf of Alaska on OCS lands that were leased to the oil companies on April 13, 1976. So far, they have not been successful. In addition, intensive seismic crew activities have been taking place on Brooks Range foothill lands selected by Native regional corporations (south of state lands) under the Alaska Native Claims Settlement Act. Some of this land is also within feasible collection range of the trans-Alaska Pipeline, should oil be discovered in substantial quantities. Therefore, the basic scenario includes commercial finds in both Federally controlled Gulf of Alaska areas and on the Native lands south of Prudhoe Bay. The former sale area lands are assumed to hold recoverable resources equal to 0.5 to 2.8 billion barrels by the U.S. Geological Survey (USGS) (1.3 billion most likely) and as much as 7.2 billion for the entire northern gulf by the state.¹¹ The Native lands may be assumed to hold as much as 2 billion barrels on a volumetric basis, although no official estimate of reserves exists.¹² Average future production is anybody's guess, but I assume 1.2 million barrels per day at peak production for Federal lands and 200 thousand barrels per day at peak production for Native lands, both toward the end of the 1980s.

Now consider the state lands surrounding Prudhoe Bay. Oil resources for the entire offshore arctic area have been estimated by USGS at 2 to 19 billion barrels, and from 5 to 16 billion barrels onshore north of the Brooks Range.¹³ The Alaska Department of Natural Resources estimates total North Slope onshore reserves of oil at 15.5 billion barrels beyond the known reserves in the Prudhoe Bay field, and Beaufort recoverable resources are estimated at 2.7 billion barrels.¹⁴ While the numbers cited here are speculative, they provide a basis for estimating the total

¹¹See [10] and [15].

¹²Author's discussions with personnel of Alaska Department of Natural Resources, Division of Minerals and Energy Management and Planning Section.

¹³See [15].

¹⁴See [10].

expected reserves that might be discovered in an exploratory program.

For the purpose of constructing the development scenario for this paper, the following conservative and "expected" pattern of events was assumed. Lease sales occur on Beaufort Sea offshore lands in 1978, and sales are held onshore in 1979 and 1980. An exploratory drilling program is initiated from the offshore islands in 1978 with one rig per lease area. Between 1978 and 1990, a total of forty-five holes are drilled as part of the exploration program: four successes, five confirmation wells, and thirty-six dry holes, for a success/failure ratio of 11.1 percent. The successes include a 600-million barrel field offshore, and a close-lying cluster of three onshore fields (one of 110 million barrels), and two of 50 million barrels each.¹⁵ A production program is begun for each field upon completion of the confirmation well, modeled on development programs at Prudhoe Bay, at Cook Inlet, and on estimates of development facilities thought to be required for "typical" oil fields in NPRA.¹⁶ Two gathering pipelines are constructed: 25 miles of 14-inch line to the offshore islands from the Prudhoe Bay facilities and 75 miles of 8-inch line to collect the three onshore fields. Peak oil field and pipeline construction activity occurs in 1983, with an annual average of about 3,750 jobs (and peak monthly employment about 50 percent greater). Between 1982 and 1990, a total of 144 production wells and 44 injection wells are drilled by two to seven drilling rigs and crews. Oil and gas industry employment on state, Native, and Federal lands peaks in 1986, with almost 7,000 persons employed in drilling, field and pipeline maintenance, production, and field services. Production begins in 1983, and peak production is achieved in 1988 at about 178 thousand daily barrels, with a gross dollar value of \$455 million in 1977 dollars.

For purposes of computing state revenues, the following assumptions are made:

- The 1977 netback wellhead price of oil on state lands is assumed to be \$7.00 per barrel (about \$13 delivered to West Coast refineries).
- Through inflation, this price increases at the rate of 5 percent per year through the year 2004 (for the purpose of estimating both bonus revenues and recurring revenues).
- Capital replacement costs also increase at 5 percent per annum, for purposes of computing property taxes.

In the base case, all current administrative rules and tax laws applying to severance of minerals and assessment of oil and gas exploration, producing, and pipeline

¹⁵The cluster of three fields is probably only marginally profitable, even within support distance of Prudhoe Bay. Resources Planning Associates and LaRue-Moore-Schafer found in their research for [17] that 500-million-barrel fields are marginal on the North Slope, if outside the range of existing camps, support facilities, and road nets. Some preliminary calculations by the author tend to confirm this.

¹⁶See [14].

properties are assumed to apply. For simplicity, an average effective severance tax rate is assumed at its current rate of about 7.5 percent, and lease rentals are ignored.¹⁷ Bonuses are computed at 10 percent of the present value of gross wellhead value, at a discount rate of 15 percent.¹⁸

On the average, if there are no significant differences between the size of actual discoveries and the expected discoveries upon which the oil companies are basing their bids, the scenario can treat the expected field size as the actual field size for purposes of comparing contributions of bonus and royalty bidding systems to the state treasury.

THE MAN-IN-THE-ARCTIC PROGRAM MODELS

The assumptions used in compiling the development scenario can be varied at will using a simple non-stochastic model of Alaskan petroleum development and revenues called SCENARIO¹⁹. The model takes assumptions concerning oil and gas employment, lease dates, peak production and production schedules, state and federal royalty, bonus, severance tax policies, and Native leasing policies, and compiles vectors of:

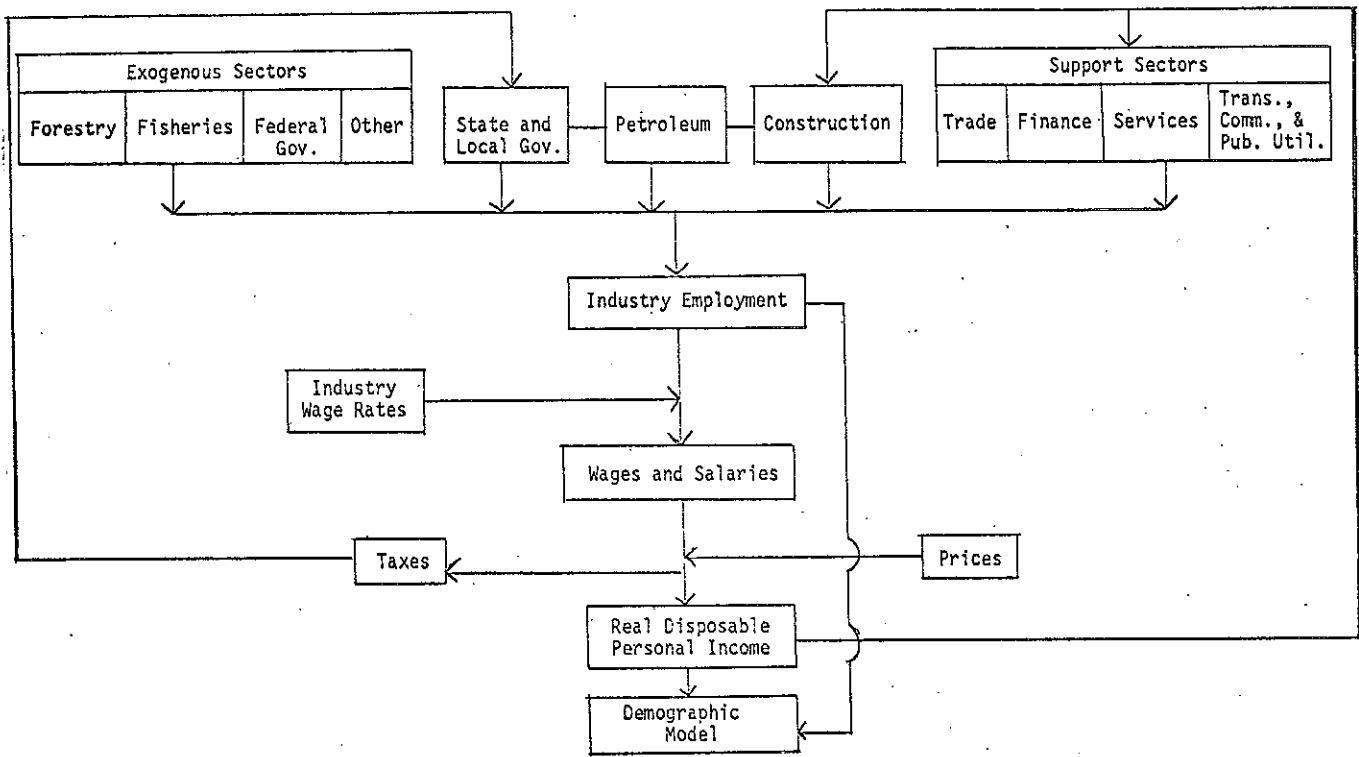
- Direct employment in mining and construction in Alaska.
- Lease sale revenues received by Federal and Alaska state governments and Native regional corporations.
- Recurrent royalty and direct tax revenues to Federal and state government.
- Royalties and Native claims payments mandated under the Alaska Native Claims Settlement Act.

These time series are introduced into a statewide econometric model called EXREVMOD, which was designed and built by ISER economists and David Kresge of the National Bureau of Economic Research. Simple diagrams of the model EXREVMOD are shown in Figures 1 and 2. Since the models are continually undergoing minor change, and since EXREVMOD has more than 400 equations, complete current documentation for EXREVMOD could not be supplied in this paper. However, a listing of the version of SCENARIO used in this study appears in

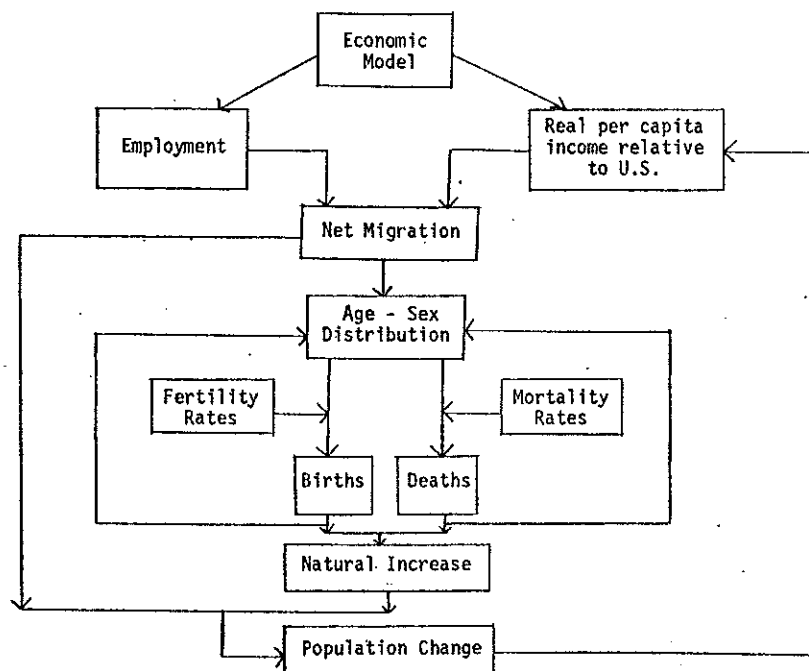
¹⁷Lease rentals are on an acreage basis and so are difficult to compute, and would not distort the relationship between cases. The lower bound severance value was used because it is probable that although some wells may be more productive and taxed at a higher rate, gas is not explicitly included in the scenario, and would be taxed at a lower rate than oil.

¹⁸This amounts to about 13.5 cents per barrel of recoverable oil, compared with 9.5 cents per recoverable barrel bid for Prudhoe Bay in the late 1960s, and 42 cents per expected barrel in the Gulf of Alaska federal sale last year.

¹⁹The model was originally developed by Barbara Seiver and the author at ISER in the summer of 1976 and is modified by the author for the present purpose.



STRUCTURE OF THE MAP POPULATION MODEL



Source: See [11].

Figure 1. Structure of the MAP Population Model

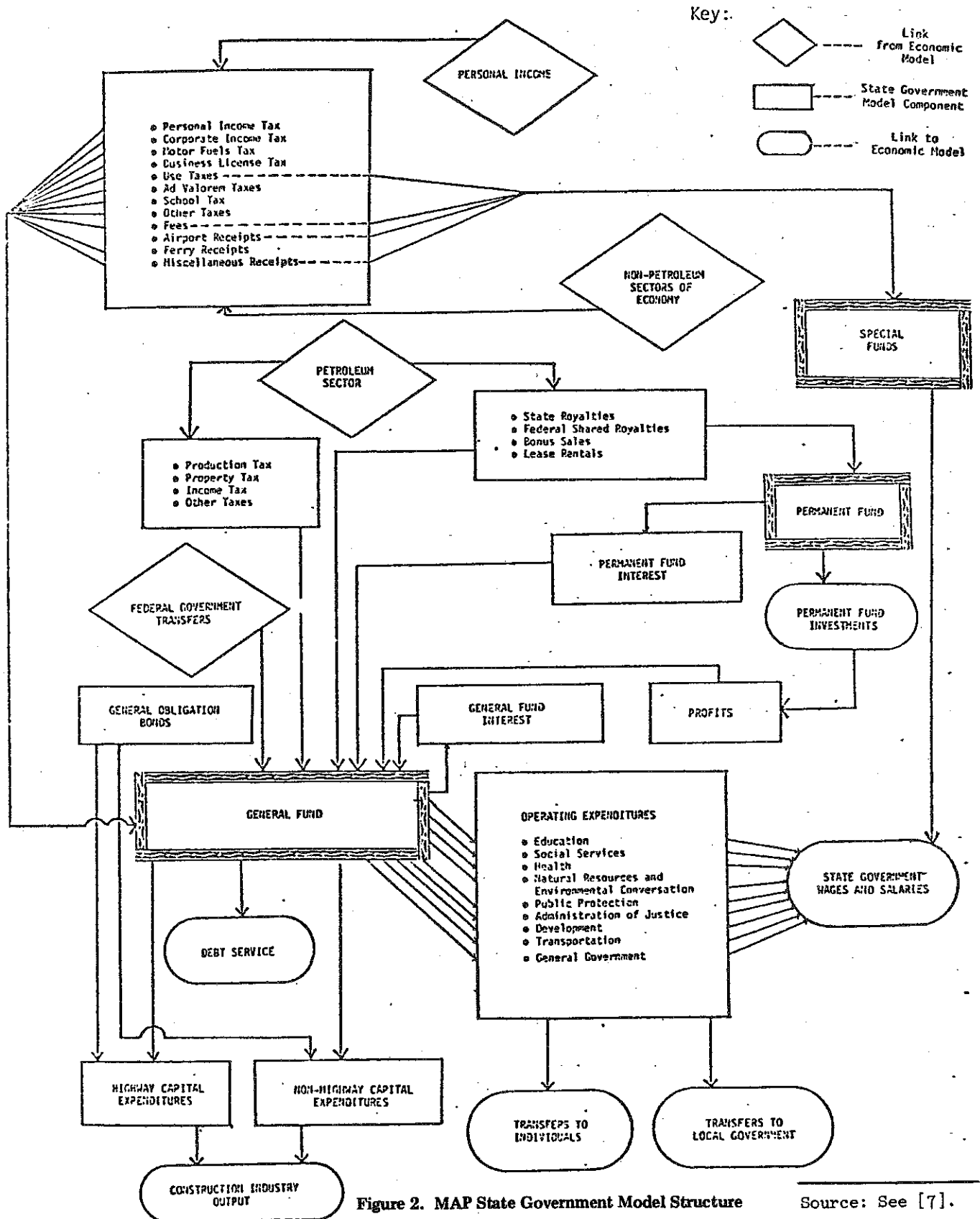


Figure 2. MAP State Government Model Structure

Source: See [7].

Appendix A. Partial documentation of EXREVMOD exists as a series of ISER publications and working papers.^{20,21}

SIMULATION EXPERIMENTS

A group of seven simulations was done with SCENARIO and EXREVMOD in an attempt to calculate the impact of different leasing policies on Alaska's economy.²² The base case was run using lease bonuses at 10 percent of the present value of expected gross revenues, and royalty rates at the legal minimum of 12.5 percent, with all current tax rates on oil and gas applying. SCENARIO was simulated, and the resultant data series were used to simulate EXREVMOD. This base case, against which other runs of the model were to be compared, was called the bonus bidding case.

The first alternate policy to be compared to the base case was a change in the leasing system. Instead of low royalties and high bonuses, this case set the bonus bid at zero, and a royalty rate was calculated which would yield to the state the same present value of state royalty revenues as the lease bonus of 10 percent on gross value, given the expected size field. The required royalty premium was 10 percent, making the total royalty 22.5 percent on gross value produced in each year. This case was called the royalty bidding case.

As will be shown below, there was a considerable difference between the two cases. However, it is difficult to judge the importance of this change in state policy in isolation, so it was compared to other possibilities affecting state revenues.

One policy which has been suggested recently is that the state ought to increase its "savings" rate on oil money by increasing the permanent fund contribution out of royalty and bonus revenues to 50 percent (up from the current 25 percent). This, it is argued, will shelter significantly more of the oil and gas income from political

²⁰See [6], [7], [11], [12], [19], [20].

²¹SCENARIO and EXREVMOD are stored on a software system called TROLL (Time-Shared Reactive On-Line Laboratory) developed by the National Bureau of Economic Research especially to facilitate quantitative work in economics, and well-adapted to econometric model building and simulation. ISER economists access the system from remote terminal on a time-share basis.

²²Base case assumptions concerning Alaska's economy are as follows:

1. Constrained by the availability of marine resources, real output in Alaska's fishing industry grows at one percent per year.
2. Forest products growth rate is 6 percent per year initially, declining to 2.5 percent per year and approaching maximum sustained yield by 1990.
3. There is only minor growth in nonpetroleum mining and agriculture, which are constrained by climate, lands, and transportation cost.
4. Other exogenous variables follow past trends in the future, except (as in petroleum) where otherwise specified.
5. The underlying rate of price inflation is 5 percent.

pressures to spend non-renewable resource income for ongoing programs, artificially lowering the costs of government services to the citizens of Alaska in the short run. It also has the effect of smoothing the growth path of the economy and reducing the rate of population growth induced by government spending on social programs. This is called the high savings case.

Another policy is suggested by the activities of the current session of the State Legislature, which has just raised the severance tax rate on oil to an effective rate of 11.5 percent of wellhead value. It is interesting to compare the impact on Alaska's economy of reallocating state receipts via a change in the leasing system, with the impact of an attempt to increase these receipts by a substantial increase in severance taxes. For what will be called the high tax case, the assumed effective average severance tax on oil is increased from 7.5 percent to 11.5 percent of wellhead value.

Alaska is a price-taker in the world and national oil markets. The best current guesses about the wellhead price of North Slope crude oil suggest that the equivalent of about \$7 per barrel (in 1977 dollars) will be the netback wellhead value. What would happen if the real wellhead value were to suddenly increase to \$9.00? Clearly, Alaska's treasury would be increased. However, whether a \$2.00 rise would be enough to bring significant additional exploration and production to Alaska is difficult to say, since the rates of exploration and production depend on the timely availability of state and federal land for lease and the quality of drillable prospects, as well as oil prices. For simplicity, only the impact on the base case state treasury was considered in this high price case, and no additional exploration was assumed.

The effective nominal rate of return on both the permanent fund balance and general fund balance is assumed to be a conservative 7 percent in the base case. However, since the question of bonus versus royalty leasing is at least partly a question of optimal time allocation of money, it is worthwhile to examine whether increasing rate of return on bonus funds has any effect on the decision on which leasing system to adopt. Rate of return might be expected to have an effect, since (1) bonus leasing loads much of the fiscal impact on the front end of the program of exploration and development, and (2) no royalty is forthcoming from oil for at least 5 years after the lease sale in many fields. In this high return case, the rate of return on state funds was changed from 7 percent to 8 percent.

The final case explored the possibility of retaining the lease bonus as the primary bidding variable, but delaying further lease sales on state lands to reduce growth in the short term, while increasing it over the longer term. For purposes of the delayed lease case, state leasing after Prudhoe Bay occurs 1 year later than in the base case.

RESULTS OF THE SIMULATION EXPERIMENTS

EXREVMOD gives more detailed and comprehensive results than those shown in this paper. However, an excellent indication can be given of the overall relative impact of each of the cases by considering:

- The effects on state revenues, expenditures, the general fund, and permanent fund balance as measures of the fiscal impact.
- Alaska total employment and population as measures of the total economic impact.
- Real disposable personal income per capita and real state government expenditures per capita as rough measures of the economic impacts on individuals.

The model computes each of these on an annual basis through the year 1990.

The Base Case

The results for the bonus bidding case appear in Table 1. As can be seen in the table, total state revenues rise from a total of about \$1.1 billion in 1977, of which \$451 million (41 percent) is recurrent oil revenue, to \$3.85 billion in 1990, of which \$2.1 billion (54.5 percent) is oil revenue. Part of the increase is due to an assumed underlying inflation rate of about 5 percent per annum. However, by 1990 the real increase is still almost 100 percent.

Expenditures increase from about \$968 million in 1977 to \$4.0 billion by 1990, implying a budget deficit. Whether or not total expenditures grow as rapidly as indicated will depend on increase in real demand for these expenditures, the size of the fiscal surplus in the early 1980s, and the rate of inflation. In the base case, the 1977 total expenditure figure more than quadruples to 416 percent of its 1977 value by 1990, and real expenditures more than double.

The general fund and permanent fund balances reflect the pattern of state government savings and dissaving. In 1977, the general fund and permanent fund balances both begin a rapid rise, as substantial fiscal surpluses ranging from 200 to 450 million dollars swell the state treasury in the early 1980's. The permanent fund begins growing at about \$100 million per year, and this rate accelerates in spite of the fact that all interest earned is automatically transferred to the general fund in this scenario. The permanent fund reflects only the 5 percent rate of inflation and increasing oil production through the year 1990. On the other hand, the general fund balance initially rises quite rapidly, reaches a peak in 1985, and declines rapidly thereafter because general fund expenditures begin to eclipse general fund revenues in 1985 (there is no overall budget deficit until 1987, however).

Table 1
Alaskan Growth Indicators
Base Case

	R99S	E99S	GFBAL	FFBAL
1977	1018.7	968.458	633.565	50.005
1978	1309.51	1081.53	828.911	156.798
1979	1596.12	1221.26	1149.31	290.691
1980	1908.35	1464.96	1518.37	453.251
1981	2146.92	1837.59	1743.46	632.3
1982	2355.3	2014.45	2009.92	818.963
1983	2659.51	2438.37	2153.8	1019.14
1984	2855.35	2696.96	2223.12	1234.32
1985	3001.21	2868.19	2258.91	1464.15
1986	3173.21	3079.52	2245.24	1710.9
1987	3347.23	3323.91	2154.64	1972.9
1988	3519.42	3593.93	1961.9	2248.28
1989	3493.16	3840.35	1691.61	2536.86
1990	3852.84	4029.01	1385.59	2839.3

	EM99	POP	DIRPA	E99SRPC
1977	181.804	387.361	2753.29	1089.41
1978	187.048	395.384	2826.56	1138.67
1979	196.949	409.677	2908.56	1193.99
1980	215.877	436.179	3037.83	1294.76
1981	244.449	455.145	3338.2	1497.52
1982	257.983	507.486	3185.85	1416.79
1983	276.524	539.941	3228.66	1551.35
1984	272.646	545.988	3165.81	1633.09
1985	273.571	555.863	3149.3	1641.39
1986	276.301	566.88	3144.52	1662.94
1987	283.417	582.531	3166.71	1680.77
1988	291.433	599.244	3188.94	1700.02
1989	297.388	613.439	3203.71	1707.84
1990	300.192	623.52	3203.34	1696.45

R99S = State Government Revenues (Millions of Dollars)
E99S = State Government Expenditures (Millions of Dollars)
GFBAL = State Government General Fund Balance (Millions of Dollars)
FFBAL = State Government Permanent Fund Balance (Millions of Dollars)
EM99 = Total Employment (Thousands of Wage Earners)
POP = Total Population (Thousands of Persons)
DIRPA = Real Disposable Personal Income Per Capita (1967 Dollars)
E99SRPC = Real State Government Expenditures Per Capita (1967 Dollars)

The economic and demographic effects of the base case are substantial. Total Alaska employment rises to just about 300 thousand workers in 1990. The growth rate turns out to be quite uneven. While the average rate is 3.9 percent, year-to-year changes range from +13.2 percent in 1980-81 to -1.4 percent in 1983-84. The population of the state also grows rapidly, from the 1977 level of 387.3 thousand to 623.5 thousand in 1990. The rapid average annual rate of increase is 3.7 percent, with a range of 11.5 percent (1981-82, characterized by heavy drilling and construction employment) to 1.1 percent (1983-84, after much of the construction but before much of the new North Slope fields begin production).

Finally, consider the effect on the average Alaskan, as revealed in the final two columns of Table 1. Alaskans' real per capita disposable incomes grow quite rapidly in the base case until 1981, then fall off until additional oil production starts up in 1985, and end somewhat below their peak. It is important to note that in real per capita terms, the base case does not result in clear increases in disposable personal incomes of Alaskans beyond the increase associated with spending Prudhoe Bay petroleum revenues. State services provided by government spending are another matter. These expenditures rise fairly steadily in real terms from the \$1,100 constant 1967 dollar figure for 1977, to about \$1,700 per capita in 1988-90, an increase of about 55 percent. If citizens of Alaska were indifferent between additions to disposable personal income and additional public services such as education, health, and transportation services provided by the state expenditures, they are considerably "better off" by 1990 as a group than today, even allowing for a population increase of 61 percent.

THE POLICY EXPERIMENTS

The other cases can be conveniently compared to the base case on a variable-by-variable basis or on a case-by-case basis. Each method has its advantages, but the one that will be used here is a variable-by-variable method, with a table summarizing the rankings of growth impacts for each variable at the end of the section.

Revenues

Compared to the base case, all of the other cases except the one-year delay in leasing result in higher revenues to the government by 1990. All the cases except royalty leasing, lease delay, and the high savings case also result in higher government revenues in the short run. The royalty leasing case initially results in lower total revenues, compared to the base case. For reasons identified below, by 1990 total revenues in the royalty leasing case are \$130 million greater per year and

growing faster. Royalty leasing also shows the largest average revenue growth rate of any case between 1978, the year the policy is implemented, and 1990 (Table 2).

Surprisingly, the 1990 impact on state revenues is as large from royalty leasing as it is in another case receiving significant press in Alaska: doubling of contributions to the permanent fund. Another observation demonstrates the importance of the timing of oil receipts in this small economy. Even though the real rate of return on both the general fund balance and permanent fund balance (7 percent nominal rate, less 5 percent inflation, or 2 percent) is greater than the apparent real rate of return which could be earned on the oil by the state taking its lease money as a royalty (5 percent annual price increase, less 5 percent inflation), the state still achieves consistently higher revenue growth rates by using the royalty leasing system. Only 25 percent of bonus funds have the 7 percent rate of return. In the case of small, open economies like Alaska, much government spending immediately leaves the economy without generating additional tax revenues. The combination of low multiplier effects and the pressures on government to expand services regardless of return in tax revenues when funds are available means that in the base case, real total government revenues increase at an average annual rate of about 4.2 percent between 1978 and 1990. For the royalty bidding case, the corresponding average rate is 5.0 percent.

This need not be so, however. If the state were able to identify and spend bonus funds on Alaska import substitution investments which paid taxes back into the state treasury, or which generated high rates of revenue growth, the state might be able to get a rate of return on bonus funds above that on the average state program, and might be able to achieve higher growth rates with bonus bidding than with royalty bidding. In decisions involving the time allocation of funds and resource extraction rates, the decision to extract is based upon the expected reinvestment rate of return from alternative investment strategies; it is simply that the decision rule is more complicated when a whole economy represents one of the investment strategies. The existence of additional *dimensions* of "return," such as employment and per capita income, make the "rate of return" on government spending still more difficult to measure.²³

Government Expenditures

With the larger amounts of available revenue, as measured by increases in the general fund balance, and increases in demand for government services brought about by increases in population and per capita income, expenditures increase in

²³The Alaska Constitution discourages the establishment of earmarked funds. This means that the consistent strategy of investing bonus revenues in projects yielding high rates of return would have to be achieved through ordinary budget processes.

Table 2
State Government Revenues
Millions of Dollars

	WEA_SWEA7R.1	WEA_SWEA7R.3	WEA_SWEA7R.4	WEA_SWEA7R.5
1977	1018.7	1018.7	1018.97	1018.7
1978	1309.51	1227.18	1309.29	1421.07
1979	1596.12	1567.02	1595.16	1770.78
1980	1908.35	1893.18	1908.29	2136.71
1981	2146.92	2139.24	2149.18	2412.99
1982	2355.3	2348.21	2362.19	2645.02
1983	2659.51	2667.46	2672.93	2979.74
1984	2855.35	2884.42	2877.6	3207.16
1985	3001.21	3049.65	3035.62	3381.7
1986	3173.21	3248.06	3222.1	3584.07
1987	3347.23	3441.82	3412.59	3785.6
1988	3519.42	3626.88	3603.28	3982.03
1989	3693.16	3810.79	3797.76	4178.16
1990	3852.84	3980.2	3980.84	4358.33

	WEA_SWEA9R.6	WEA_SWEA7R.7	WEA1_SWEA7R.8
1977	1018.7	1025.58	1018.7
1978	1469.27	1317.89	1227.09
1979	1830.49	1607.96	1653.39
1980	2214.56	1925.37	1922.56
1981	2509.11	2170.28	2149.81
1982	2770.4	2384.02	2347.02
1983	3120.73	2694.3	2634.08
1984	3351.93	2895.23	2821.53
1985	3545.32	3045.41	2963.02
1986	3766.01	3221.42	3124.46
1987	3983.74	3398.97	3313.87
1988	4196.17	3573.93	3503.38
1989	4408.47	3749.24	3684.15
1990	4605.1	3909.32	3846.95

- WEA_SWEA7R.1 = Base Case (Bonus Leasing, 12.5% Royalty)
- WEA_SWEA7R.3 = Royalty Leasing Case (Bonus=0, 22.5% Royalty)
- WEA_SWEA7R.4 = High Saving Case (Permanent Fund Contribution=50% of Applicable Revenues)
- WEA_SWEA7R.5 = High Tax Case (Severance Tax on Oil=11.5%)
- WEA_SWEA9R.6 = High Price Case (Wellhead Value=\$9 in 1977 Dollars)
- WEA_SWEA7R.7 = High Return Case (Nominal Rate of Return on Fund Balances=7%)
- WEA1_SWEA7R.8 = Delayed Leasing Case (Bonus Leasing Schedule Delayed by 1 Year)

most cases between 1978 and 1990 relative to the base case. The highest total impact is in the high price case. Because the general fund balance is an important explanatory variable for government expenditures, and because of the large general fund balance achieved in the royalty leasing case by smoothing the receipt of revenues, the royalty leasing case ultimately results in higher government expenditures than the base case, with a somewhat smaller deficit (\$154.3 million in 1990, as opposed to \$176.2 million in the base case). Unfortunately for those who would like Alaska's government to show a surplus, the model indicates historical spending patterns will eventually lead to deficits in both cases and a running down of the general fund balance. The effect on expenditures is shown in Table 3.

General and Permanent Fund Balances

Given the fact that all the bonus revenue has about 5 years to generate income under the bonus system before any royalty income is forthcoming under the royalty leasing system, one would expect that this would be one area of comparison where the bonus bidding system would have a larger long-term impact than the royalty leasing system. Surprisingly, as Tables 4 and 5 show, by 1990 both the permanent fund and general fund balances in the royalty leasing case have passed those in the bonus leasing case, and the general fund is declining more slowly, in spite of higher expenditures than in the base case. The reason may again lie in the low rate of return to the Alaska treasury of traditional state spending programs on which the model is based and upon which, by assumption, the bulk of the bonus money is spent. The slower buildup of the general fund balance and lack of oil income when demand for government services begins to grow steadily in the late 1980s causes the more rapid decline of the balance in the base case.

Employment

A significant measure of the growth of an economy is the number of jobs available. Table 6 indicates a small variation between cases in the number of jobs available, with all cases except high savings and delayed leasing showing at least some increase over the base case by 1990. High taxation and high price cases show significant increases, the others only slight differences. The most important fact to notice in comparing the bonus and royalty cases is that there is no significant employment penalty associated with royalty bidding; indeed, if additional exploration and field development is induced as a result of the state's bearing part of the oil companies' geological risk, there would probably be a substantial employment bonus from royalty bidding.

Population

The effect on population in the model EXREVMOD follows from the effect on

Table 3

State Government Expenditures
Millions of Dollars

	WEA_SWEA7R.1	WEA_SWEA7R.3	WEA_SWEA7R.4	WEA_SWEA7R.5
1977	968.458	968.458	960.637	968.458
1978	1081.53	1070.41	1055.8	1100.15
1979	1221.26	1204.41	1165.28	1279.64
1980	1464.96	1448.78	1383.68	1561.4
1981	1837.59	1822.16	1724.24	1984.01
1982	2014.45	2000.83	1882.14	2197.86
1983	2438.37	2428.18	2276.22	2678.04
1984	2696.96	2694.84	2511.68	2989.48
1985	2868.19	2877.41	2668.32	3205.45
1986	3079.52	3104.47	2865.84	3464.94
1987	3323.91	3367.44	3097.07	3762.07
1988	3593.93	3657.84	3355.15	4090.49
1989	3840.35	3925.31	3594.35	4395.54
1990	4029.01	4134.46	3784.61	4635.77

	WEA_SWEA9R.6	WEA_SWEA7R.7	WEA1_SWEA7R.8
1977	968.458	972.328	968.458
1978	1103.51	1086.11	1070.4
1979	1288.71	1227.84	1218.72
1980	1576.14	1473.88	1465.56
1981	2008.03	1850.91	1838.56
1982	2233.96	2031.79	2013.23
1983	2730.52	2462.32	2431.29
1984	3055.88	2727.58	2682.83
1985	3286.25	2904.8	2847.41
1986	3562.1	3122.51	3050.4
1987	3877.66	3373.75	3291.36
1988	4227.35	3651.19	3543.22
1989	4555.34	3904.59	3814.27
1990	4818.32	4098.61	4009.31

WEA_SWEA7R.1 = Base Case (Bonus Leasing, 12.5% Royalty)
 WEA_SWEA7R.3 = Royalty Leasing Case (Bonus=0, 22.5% Royalty)
 WEA_SWEA7R.4 = High Saving Case (Permanent Fund Contribution=50% of Applicable Revenues)
 WEA_SWEA7R.5 = High Tax Case (Severance Tax on Oil=11.5%)
 WEA_SWEA9R.6 = High Price Case (Wellhead Value=\$9 in 1977 Dollars)
 WEA_SWEA7R.7 = High Return Case (Nominal Rate of Return on Fund Balances=7%)
 WEA1_SWEA7R.8 = Delayed Leasing Case (Bonus Leasing Schedule Delayed by 1 Year)

Table 4

State Government General Fund Balance
Millions of Dollars

	WEA_SWEA7R.1	WEA_SWEA7R.3	WEA_SWEA7R.4	WEA_SWEA7R.5
1977	633.565	633.565	607.111	633.563
1978	828.911	778.128	721.184	921.847
1979	1149.31	1091.85	962.324	1359.04
1980	1518.37	1463.75	1249.3	1861.11
1981	1743.46	1696.57	1409.71	2207.68
1982	2009.92	1969.59	1627.2	2582.81
1983	2153.8	2128.08	1744.59	2810.37
1984	2223.12	2220.4	1804.05	2942.82
1985	2258.91	2283.34	1841.79	3026.42
1986	2245.24	2302.17	1841.17	3043.56
1987	2154.64	2241.9	1777.71	2959.42
1988	1961.9	2070.53	1628.96	2739.92
1989	1691.61	1809.87	1417.24	2407.54
1990	1385.59	1501.82	1177.67	2009.27

	WEA_SWEA9R.6	WEA_SWEA7R.7	WEA1_SWEA7R.8
1977	633.563	646.96	633.563
1978	939.724	846.095	778.058
1979	1392.83	1171.77	1142.59
1980	1915.49	1548.99	1521.43
1981	2286.72	1784.25	1746.76
1982	2699.23	2062.24	2006.41
1983	2960.	2217.21	2134.82
1984	3113.71	2296.13	2188.39
1985	3218.83	2339.94	2211.38
1986	3254.77	2332.01	2184.23
1987	3183.26	2243.94	2096.11
1988	2967.67	2049.2	1918.9
1989	2629.05	1771.6	1665.7
1990	2214.61	1453.43	1373.6

WEA_SWEA7R.1 = Base Case (Bonus Leasing, 12.5% Royalty)

WEA_SWEA7R.3 = Royalty Leasing Case (Bonus=0, 22.5% Royalty)

WEA_SWEA7R.4 = High Saving Case (Permanent Fund Contribution=50% of Applicable Revenues)

WEA_SWEA7R.5 = High Tax Case (Severance Tax on Oil=11.5%)

WEA_SWEA9R.6 = High Price Case (Wellhead Value=\$9 in 1977 Dollars)

WEA_SWEA7R.7 = High Return Case (Nominal Rate of Return on Fund Balances=7%)

WEA1_SWEA7R.8 = Delayed Leasing Case (Bonus Leasing Schedule Delayed by 1 Year)

Table 5

State Government Permanent Fund Balance
Millions of Dollars

	WEA_SWEA7R.1	WEA_SWEA7R.3	WEA_SWEA7R.4	WEA_SWEA7R.5
1977	50.005	50.005	100.01	50.005
1978	156.798	136.366	313.597	156.799
1979	290.691	264.628	581.382	290.691
1980	453.251	425.333	906.502	453.251
1981	632.3	604.383	1264.6	632.301
1982	818.963	791.045	1637.93	818.963
1983	1019.14	994.856	2038.27	1019.14
1984	1234.32	1218.47	2468.65	1234.32
1985	1464.15	1460.76	2928.3	1464.15
1986	1710.9	1725.53	3421.8	1710.9
1987	1972.9	2009.15	3945.81	1972.9
1988	2248.28	2307.93	4496.56	2248.28
1989	2536.86	2621.07	5073.71	2536.86
1990	2839.3	2949.31	5678.6	2839.3

	WEA_SWEA9R.6	WEA_SWEA7R.7	WEA1_SWEA7R.8
1977	50.005	50.005	50.005
1978	183.763	156.799	136.366
1979	352.459	290.691	286.09
1980	557.692	453.251	452.702
1981	784.472	632.301	633.698
1982	1023.49	818.963	820.361
1983	1279.63	1019.14	1017.87
1984	1552.79	1234.32	1229.26
1985	1844.98	1464.15	1454.56
1986	2159.02	1710.9	1695.13
1987	2492.53	1972.9	1953.78
1988	2843.16	2248.28	2228.29
1989	3210.73	2536.86	2516.86
1990	3596.13	2839.3	2819.31

WEA_SWEA7R.1 = Base Case (Bonus Leasing, 12.5% Royalty)
 WEA_SWEA7R.3 = Royalty Leasing Case (Bonus=0, 22.5% Royalty)
 WEA_SWEA7R.4 = High Saving Case (Permanent Fund Contribution=50% of Applicable Revenues)
 WEA_SWEA7R.5 = High Tax Case (Severance Tax on Oil=11.5%)
 WEA_SWEA9R.6 = High Price Case (Wellhead Value=\$9 in 1977 Dollars)
 WEA_SWEA7R.7 = High Return Case (Nominal Rate of Return on Fund Balances=7%)
 WEA1_SWEA7R.8 = Delayed Leasing Case (Bonus Leasing Schedule Delayed by 1 Year)

Table 6
Total Employment
Thousands of Wage Earners

	WEA_SWEA7R.1	WEA_SWEA7R.3	WEA_SWEA7R.4	WEA_SWEA7R.5
1977	181.804	181.804	181.343	181.804
1978	187.048	186.421	185.613	188.097
1979	196.949	196.154	194.37	199.566
1980	215.877	215.145	212.329	219.994
1981	244.449	243.785	239.75	250.4
1982	257.983	257.416	252.703	265.156
1983	276.524	276.107	270.392	285.417
1984	272.646	272.525	265.998	282.945
1985	273.571	273.832	266.733	284.895
1986	276.301	277.039	269.356	288.588
1987	283.417	284.678	276.38	296.745
1988	291.433	293.219	284.348	305.856
1989	297.388	299.677	290.368	312.857
1990	300.192	302.929	293.47	316.422

	WEA_SWEA9R.6	WEA_SWEA7R.7	WEA1_SWEA7R.8
1977	181.804	182.032	181.804
1978	188.286	187.298	186.421
1979	199.974	197.258	196.77
1980	220.62	216.268	215.875
1981	251.367	244.996	244.475
1982	266.54	258.666	257.93
1983	287.333	277.417	276.262
1984	285.257	273.727	272.15
1985	287.574	274.803	272.874
1986	291.648	277.674	275.374
1987	300.218	284.937	282.421
1988	309.782	293.1	290.523
1989	317.252	299.182	296.632
1990	321.237	302.06	299.626

WEA_SWEA7R.1 = Base Case (Bonus Leasing, 12.5% Royalty)
 WEA_SWEA7R.3 = Royalty Leasing Case (Bonus=0, 22.5% Royalty)
 WEA_SWEA7R.4 = High Saving Case (Permanent Fund Contribution=50% of Applicable Revenues)
 WEA_SWEA7R.5 = High Tax Case (Severance Tax on Oil=11.5%)
 WEA_SWEA9R.6 = High Price Case (Wellhead Value=\$9 in 1977 Dollars)
 WEA_SWEA7R.7 = High Return Case (Nominal Rate of Return on Fund Balances=7%)
 WEA1_SWEA7R.8 = Delayed Leasing Case (Bonus Leasing Schedule Delayed by 1 Year)

employment and the effect on real incomes of Alaskans. The 1990 state population is significantly lower in the high savings case, significantly higher in the high tax and high price cases, and about the same for all others (Table 7). State spending contributes to direct employment and an increase in personal incomes, which in the Alaskan economy implies an induced increase in support sector employment. Increased real income per capita income (relative to lower forty-eight levels) and increased employment opportunities induce net in-migration, which adds to natural increase of the population. Since the level of state expenditures is consistently the highest in the high tax and high price cases, these cases naturally show the largest increases. The high savings case shows the lowest expenditures by state government in every year, and the lowest rate of employment growth, so population is also smallest. Expenditures and employment grow faster in the royalty bid case than in the base case. This seems to be the factor which leads to the slightly larger population in the royalty bidding case, compared to the base case.

Per Capita Disposable Income and State Real Spending Per Capita

While there are many variables which could be adopted to measure the impact of alternative public policies on individual Alaskans, there are two generated by EXREVMOD which provide some simple standards of comparison of cases. While real per capita disposable income and real per capita state spending may not indicate whether Alaskans are actually "better off" with one policy than another, these variables at least indicate how individual income and the general level of state services may be affected. Table 8 shows the projected level of real per capita disposable income for each case through the year 1990. The most noticeable feature of the table is the insignificant differences between the cases. Between 1978, the first year of leasing, and 1990, the average annual growth rate in real disposable personal income is 1.1 percent in all cases. Two factors cause this similarity. The higher spending cases are characterized by larger population influx, which offsets the larger impact on individual incomes in these cases. Secondly, the additional jobs created by state spending tend to occur in trade and services industries, where real wages are below the statewide average. Expansion of these sectors acts as a drag on the rate of increase in real incomes.

The differences in state real per capita expenditures appear in Table 9. While EXREVMOD gives no indication of what difference the level of per capita spending makes in the level of services received by the state's citizens, it is a useful indicator of where the possibilities of improved services are greater. Between 1978 and 1990, the rate of increase in real per capita spending is highest in the high price and high savings cases, even though population is also largest in these cases. Real per capita expenditures in the high price case grow at an annual rate of 4.3 percent, compared

Table 7
Total Population
Thousands of Persons

	WEA_SWEA7R.1	WEA_SWEA7R.3	WEA_SWEA7R.4	WEA_SWEA7R.5
1977	387.361	387.361	386.909	387.361
1978	395.384	394.61	393.646	396.68
1979	409.677	408.588	406.286	413.089
1980	436.179	435.051	431.196	441.851
1981	455.145	454.017	448.272	463.644
1982	507.486	506.422	499.385	518.162
1983	539.941	539.026	530.239	553.517
1984	545.988	545.426	535.069	562.186
1985	555.863	555.801	544.103	574.333
1986	566.88	567.485	554.41	587.589
1987	582.531	583.915	569.413	605.599
1988	599.244	601.466	585.584	624.755
1989	613.439	616.523	599.43	641.349
1990	623.52	627.437	609.506	653.488

	WEA_SWEA9R.6	WEA_SWEA7R.7	WEA1_SWEA7R.8
1977	387.361	387.563	387.361
1978	396.914	395.655	394.609
1979	413.624	410.062	409.349
1980	442.72	436.711	436.055
1981	465.017	455.921	455.07
1982	520.159	508.489	507.328
1983	556.326	541.277	539.528
1984	565.685	547.646	545.263
1985	578.522	557.816	554.835
1986	592.511	569.127	565.492
1987	611.319	585.085	580.958
1988	631.344	602.112	597.68
1989	648.848	616.601	611.99
1990	661.864	626.911	622.256

WEA_SWEA7R.1 = Base Case (Bonus Leasing, 12.5% Royalty).
 WEA_SWEA7R.3 = Royalty Leasing Case (Bonus=0, 22.5% Royalty)
 WEA_SWEA7R.4 = High Saving Case (Permanent Fund Contribution=50% of Applicable Revenues)
 WEA_SWEA7R.5 = High Tax Case (Severance Tax on Oil=11.5%)
 WEA_SWEA9R.6 = High Price Case (Wellhead Value=\$9 in 1977 Dollars)
 WEA_SWEA7R.7 = High Return Case (Nominal Rate of Return on Fund Balances=7%)
 WEA1_SWEA7R.8 = Delayed Leasing Case (Bonus Leasing Schedule Delayed by 1 Year)

Table 8

Real Disposable Personal Income Per Capita
1967 Dollars

	WEA_SWEA7R.1	WEA_SWEA7R.3	WEA_SWEA7R.4	WEA_SWEA7R.5
1977	2753.29	2753.29	2749.8	2753.29
1978	2824.56	2822.93	2818.07	2832.6
1979	2908.56	2905.04	2895.85	2921.58
1980	3037.83	3035.93	3024.78	3053.41
1981	3338.2	3337.95	3327.74	3352.5
1982	3185.85	3185.91	3174.92	3202.12
1983	3228.66	3229.53	3218.69	3245.29
1984	3165.81	3167.74	3155.39	3185.08
1985	3149.3	3152.51	3140.72	3168.09
1986	3144.52	3149.15	3138.13	3162.18
1987	3166.71	3172.55	3162.87	3182.49
1988	3188.94	3195.65	3187.57	3202.88
1989	3203.71	3211.	3204.59	3216.18
1990	3203.34	3210.93	3206.75	3214.01

	WEA_SWEA9R.6	WEA_SWEA7R.7	WEA1_SWEA7R.8
1977	2753.29	2755.17	2753.29
1978	2833.68	2828.22	2822.93
1979	2923.54	2910.18	2908.53
1980	3055.71	3039.36	3038.68
1981	3354.84	3339.57	3339.07
1982	3205.59	3187.52	3186.18
1983	3249.44	3230.54	3228.19
1984	3189.98	3168.15	3164.52
1985	3173.32	3151.74	3147.47
1986	3167.6	3146.95	3142.15
1987	3187.87	3169.	3164.67
1988	3208.21	3191.06	3187.81
1989	3221.56	3205.62	3203.54
1990	3219.38	3204.93	3204.07

WEA_SWEA7R.1 = Base Case (Bonus Leasing, 12.5% Royalty)
 WEA_SWEA7R.3 = Royalty Leasing Case (Bonus=0, 22.5% Royalty)
 WEA_SWEA7R.4 = High Saving Case (Permanent Fund Contribution=50% of Applicable Revenues)
 WEA_SWEA7R.5 = High Tax Case (Severance Tax on Oil=11.5%)
 WEA_SWEA9R.6 = High Price Case (Wellhead Value=\$9 in 1977 Dollars)
 WEA_SWEA7R.7 = High Return Case (Nominal Rate of Return on Fund Balances=7%)
 WEA1_SWEA7R.8 = Delayed Leasing Case (Bonus Leasing Schedule Delayed by 1 Year)

Table 9

Real State Government Expenditures Per Capita
1967 Dollars

	WEA_SWEA7R.1	WEA_SWEA7R.3	WEA_SWEA7R.4	WEA_SWEA7R.5
1977	1089.41	1089.41	1081.88	1069.41
1978	1138.67	1129.18	1116.49	1154.48
1979	1193.99	1180.65	1148.77	1240.73
1980	1294.76	1283.77	1237.06	1362.28
1981	1497.52	1488.63	1426.69	1587.2
1982	1416.79	1410.17	1345.21	1513.94
1983	1551.35	1547.5	1474.69	1662.05
1984	1633.09	1633.49	1551.94	1758.06
1985	1641.39	1646.85	1560.01	1775.4
1986	1662.94	1674.63	1582.36	1805.12
1987	1680.77	1698.74	1602.14	1829.87
1988	1700.02	1723.85	1624.09	1855.89
1989	1707.84	1736.89	1635.8	1869.67
1990	1696.45	1729.98	1630.18	1862.42

	WEA_SWEA9R.6	WEA_SWEA7R.7	WEA1_SWEA7R.8
1977	1089.41	1093.19	1089.41
1978	1157.33	1142.71	1129.16
1979	1247.91	1199.29	1192.46
1980	1372.44	1301.06	1295.66
1981	1601.68	1505.81	1498.55
1982	1532.9	1426.17	1416.38
1983	1686.06	1562.73	1548.04
1984	1785.99	1646.64	1626.7
1985	1806.97	1656.52	1632.52
1986	1840.33	1679.5	1651.26
1987	1868.44	1698.52	1668.81
1988	1897.97	1718.88	1689.9
1989	1915.25	1727.51	1700.26
1990	1911.26	1716.42	1691.58

WEA_SWEA7R.1 = Base Case (Bonus Leasing, 12.5% Royalty)

WEA_SWEA7R.3 = Royalty Leasing Case (Bonus=0, 22.5% Royalty)

WEA_SWEA7R.4 = High Saving Case (Permanent Fund Contribution=50% of Applicable Revenues)

WEA_SWEA7R.5 = High Tax Case (Severance Tax on Oil=11.5%)

WEA_SWEA9R.6 = High Price Case (Wellhead Value=\$9 in 1977 Dollars)

WEA_SWEA7R.7 = High Return Case (Nominal Rate of Return on Fund Balances=7%)

WEA1_SWEA7R.8 = Delayed Leasing Case (Bonus Leasing Schedule Delayed by 1 Year)

to 3.6 percent in the royalty leasing case and 3.4 percent in the bonus case. It is also worth noting that both 1990 real per capita spending and its 1978-1990 rate of growth (3.2 percent) are lowest in the high savings case. This may imply that in this case, the attempt to hold down the rate of growth by saving large amounts of the oil income does not necessarily improve the "well-being" of the "average" Alaskan in 1990 as measured by state spending on public services. Whether it improves the well-being of the current Alaskan who must help decide upon the policy is an issue on which the model is silent. Whatever the relationship of state spending to individual well-being, the impact is slightly larger for royalty than bonus leasing, and it is growing faster in 1990.

Summary of Effects

This section has been concerned with the relative effects of policies and, apart from passing remarks about well-being of individuals, makes no judgment about better or preferred policies, which are the province of the individual reader. A few summary statements about the rank order of impacts might help clarify the choices, however. The price of oil, over which the state has no control, seems to have the most impact on Alaska's economy and population, within the limits of the experiments discussed in the paper. The state does have control over severance tax rates and, assuming the same level of exploration and production would occur, proposed tax changes have a fairly dramatic long-term impact on Alaska's treasury, employment, and population, if not per capita income. Royalty leasing turns out to have a larger impact than bonus leasing, delayed leasing, small changes in the rate of return on saved funds, or doubling the savings rate on oil income. Of all the sample policies shown in this paper as a means to smooth out the rate of state government spending and Alaskan economic growth rates, royalty leasing turns out to be among the most effective in increasing long-term growth. The ranking of effects appears in Table 10.

CONCLUSION

One interesting conclusion regarding the Alaska experiments in this paper is that given current state spending options, Alaska would be well advised to consider royalty leasing. Not only does it increase the total long-run income received by the state, but it can increase the long-run growth rate by putting off receipt of income which earns low returns. At a low enough social discount rate, this higher growth rate becomes an important consideration. While postponing leases was shown in this paper to be effective in stretching out the receipt of revenues, total state revenues do not grow as fast as in the royalty leasing case. Overall economic growth

Table 10
The Ranking of Economic Growth Impacts by Case and Variable

<u>Variable</u>	Case and Ranking ^a						
	<u>Bonus Bidding</u>	<u>Royalty Bidding</u>	<u>High Saving</u>	<u>High Tax</u>	<u>High Price</u>	<u>High Return</u>	<u>Delayed Lease</u>
R99S	7	1	5	4	2/3	6	2/3
E99S	7	3	6	2	1	4	5
GFBAL ^b	6	3	7	2	1	5	4
PFBAL	4/7	1	4/7	4/7	3	4/7	2
EM99	6	3	7	2	1	4/5	4/5
POP	5/6	3/4	7	2	1	3/4	5/6
DIRPA	1/7	1/7	1/7	1/7	1/7	1/7	1/7
E99SRPC	6	3	7	2	1	4	5

^aRanking determined by the average growth rate of the variable over the period 1977-1990. Real rates are used for dollar variables. Rankings separated by a slash (/) represent ties between cases.

^bThe bonus bidding, high savings, high rate of return, and delayed lease cases show small declines in the General Fund balance.

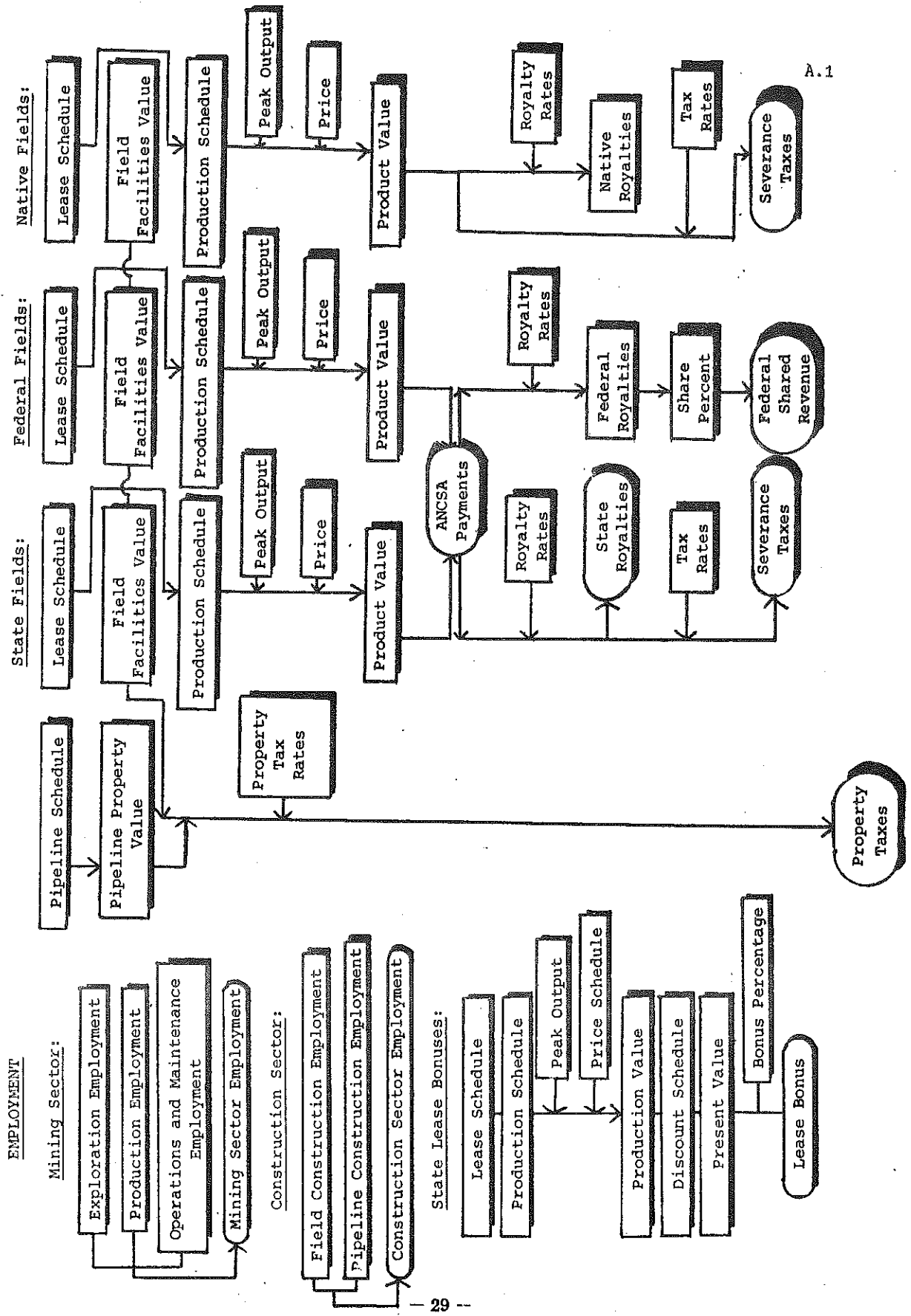
rates were also lower. While the mixed practice of leasing only very high-risk areas with bonus bidding and all other areas with royalty bidding was not analyzed in this paper, one could infer that it would do more for state growth than straight bonus bidding because of its smoothing effect on total receipts. The mixed strategy of combining royalty bidding and withholding acreage may also have a larger impact than royalty bidding alone, but that strategy is also beyond the scope of this paper.

Alaska can be usefully viewed as a less developed country (LDC) with an open border. The combination of a relatively small, simple economy and the open border implies that, in general, much of state expenditure goes directly out of the state and that attempts to increase per capita incomes of its citizens result in net in-migration

and a dissipation of the gain. In such circumstances, the small "country" with a simple economy needs to examine very carefully the probable investment opportunities for its received cash income and the probable returns on internal and external investments.

It is not simply a matter of comparing some expected rate of real price increase with some expected real rate of return in the world money markets. Most of the benefits of mineral extraction to the people of LDC's may well come as future employment opportunities in service and consumer goods industries financed by government internal spending on services and capital projects. For countries with a limited number of high-return internal investment opportunities, the low reinvestment rate of return may make delayed or smoothed-out receipt of natural resource revenues a very attractive proposition. For many of these countries and certainly for the state of Alaska, the opportunity cost of today's mineral revenue receipts is not just the rate of price increase of minerals in the ground. Such an analysis is merely the starting point. Overall, what is being compared is always two alternative development strategies with all their various dimensions.

Figure A1. Scenario Model



ECONX Component

DEFINITION

ECONXR1-R7 Exogenous construction employment for each of 7 economic regions of Alaska (not shown).

$$\text{ECONXRr} == \text{TAPS1Rr} + \sum_{\text{Ann}=\text{A01-A13}} (\text{ECONXAnn} * \text{CNAAnnRr})$$

ECONXR5X is also added for R5 only. Region 5 is Anchorage; 1 = Northwest; 2 = Southwest; 3 = Southeast; 4 = Southcentral, except Anchorage; 6 = Interior Alaska, except Fairbanks; 7 = Fairbanks.

ECONX Exogenous construction employment for the state, input into EXREVMOD.

EXOGENOUS

ECONXA01-A13 Construction employment for as many as 13 areas.

TAPS1R1-R7 Construction employment for trans-Alaska Pipeline based on historical data and estimates supplied by Alyeska. Zero in R1-3.

ECONXR5X Management personnel based in Anchorage related to construction employment. Non-zero starting in 1978.

PARAMETER

CNA01R1-
CNA13R7 Regional allocation (percentage) of exogenous construction employment for each area.

EMP9 ComponentDEFINITION

EMP9R1A-R7A Field development component of mining employment for each region except R5 which is management employees in Anchorage for both field development and pipeline operation.

$$\text{EMP9RrA} == \sum (\text{EMP9Fnn} * \text{P9FnnRr})$$

$$\text{Fnn} = \text{F01-F30}$$

$$\text{except EMP9R5A} == \text{P9R5} * \text{EMP9A98} - \text{EMP9A98}(-1)$$

$$+ \text{EMP9R5A}(-1)$$

EMP9R1B-R7B Pipeline component of mining employment for each region.

$$\text{EMP9RrB} == \sum (\text{EMP9Pnn} * \text{P9PnnRr})$$

$$\text{Pnn} = \text{P01-P10}$$

$$\text{except EMP9R5B} == \emptyset$$

EMP9A98 Subtotal - field development and pipeline mining employment for all regions except R5. Mining (management) employment in R5 is a function of the change in the level of this variable, i.e. employment in the field.

EMP9R1-7 Total mining employment for each of the 7 regions.

$$\text{EMP9Rr} == \text{EMP9RrA} + \text{EMP9RrB} + \text{EMP9RrX}$$

EMP9 Total mining employment for the state, exogenous input into EXREVMOD.

EMP9 Component (Cont.)

EXOGENOUS

EMP9F01-F30 Mining employment for as many as 30 fields.

EMP9P01-P10 Mining employment for as many as 10 pipelines.

EMP9RrX Non-petroleum mining employment in each region.
Now using 1974 mining employment.

PARAMETER

P9F01R1-P9F30R7 Regional allocation (percentage) of field development
mining employment for each field.

P9P01R1-P9P10R7 Regional allocation (percentage) of pipeline mining
employment for each pipeline.

P9R5 Percentage of change in mining employment subtotal
used to calculate change in management overhead
in R5.

RPBS Component

DEFINITION

SCHEDA Combination of Bonus Production Schedule 1 and
Discount Multipliers Schedule 2, for field
operation for 20 years.

$$\text{SCHEDA} == \sum_{\text{nn}=01-20} (\text{RPBSB1nn} * \text{RPBSD2nn})$$

SCHEDB Combination of Bonus Production Schedule 2 and Dis-
count Multipliers Schedule 2, for field operation
for 20 years.

$$\text{SCHEDB} == \sum_{\text{nn}=01-20} (\text{RPBSB2nn} * \text{RPBSD2nn})$$

* SCHEDC, SCHEDD, SCHEDE

Value of leases this year determined by projected
production, for a 20 year period, of fields that
are leased this year:

RPBSFED - Federal leasing for as many as 15 fields over
the period the model is run.

$$\begin{aligned} \text{RPBSFED} == & \text{RPBSPCT} * \text{BPRICE2} * 365 * \\ & (\sum (\text{PEAKFnn} * \text{SCHEDA} * \text{LEASEFnn}) \\ & \text{Fnn}=\text{F01-F04}, \text{F06-F13} \\ & + \sum (\text{PEAKFnn} * \text{SCHEDB} * \text{LEASEFnn})) / 1000 \\ & \text{Fnn}=\text{F05}, \text{F14-F15} \end{aligned}$$

RPBSST - State leasing for as many as 10 fields over
the period the model is run.

$$\begin{aligned} \text{RPBSST} == & \text{RPBSPCT} * \text{BPRICE2} * 365 * \\ & (\sum (\text{PEAKSnn} * \text{SCHEDB} * \text{LEASESnn}) \\ & \text{Snn}=\text{S01-S08} \\ & + \sum (\text{PEAKSnn} * \text{SCHEDA} * \text{LEASESnn})) / 1000 \\ & \text{Snn}=\text{S09-S10} \end{aligned}$$

*SCHEDC, SCHEDD, SCHEDE all follow the same format as SCHEDB and use
Discount Multipliers Schedule 2 (15 percent), but are associated with
different Bonus Production Schedules.

RPBS Component (Cont.)

RPBSNAT

- Native leasing for as many as 10 fields over the period the model is run.

$$\text{RPBSNAT} == \text{RPBSPCT} * \text{BPRICE2} * 365 * \\ (\sum (\text{PEAKNnn} * \text{SCHEDB} * \text{LEASENnn}) \\ \text{Nnn=N01-N08})$$

$$+ \sum (\text{PEAKNnn} * \text{SCHEDA} * \text{LEASENnn}) / 1000 \\ \text{Nnn=N09-N10}$$

RPBS

Adjusted petroleum bonus revenues; total reduced by Native claim payments; exogenous input into EXREVMOD.

$$\text{RPBS} == \text{RPBSST} - \text{DNCSPB}$$
EXOGENOUS

BPRICE2

Price of oil/barrel for bonus revenue calculations

PEAKann

Peak field production in 10^3 bbls/day.
See description under "RPBS Component."

Lease year, set to 1 in year in which field is to be leased and 0 otherwise:

LEASEF01-F15

- Lease years for up to 15 federal fields.

LEASES01-S11

- Lease years for up to 10 state fields.

LEASEN01-N10

- Lease years for up to 10 Native fields.

PARAMETERS

RPBSB101 - 20

Bonus Production Schedule 1

RPBSB201 - 20

Bonus Production Schedule 2

RPBS Component (Cont.)

RPBSB <u>301</u> - <u>20</u>	Bonus Production Schedule 3
RPBSB <u>401</u> - <u>20</u>	Bonus Production Schedule 4
RPBSB <u>501</u> - <u>20</u>	Bonus Production Schedule 5
RPBSD <u>201</u> - <u>20</u>	Discount Multipliers Schedule 2
RPBSPCT	Percentage of projected field revenues that are paid as lease bonus.

RP8S Component

DEFINITION

RP8SFTOT Total revenues from federally owned fields for as many as 15 fields.

$$RP8SFTOT == BPRICE * 365 * \sum_{Fnn=F01-F15} (PEAKFnn * PCTFnn) / 1000$$

RP8SFROY Federal royalties

$$RP8SFROY == RP8SFTOT * FEDROY$$

RP8SFST Federal royalties returned to state through revenue sharing.

$$RP8SFST == RP8SFROY * REVSHR$$

RP8SSTTA Total revenues from state-owned fields covered under ANCSA for as many as 11 fields.

$$RP8SSTTA == BPRICE * 365 * (\sum_{Snn=S01-S11} (PEAKSnn * PCTSnn) + RP8SPRUD) / 1000$$

RP8SSADJ Adjusted revenues from state-owned fields covered under ANCSA total reduced by Native claims payments.

$$RP8SSADJ == RP8SSTTA - DNCSP8$$

RP8SCOOK Revenue from Cook Inlet (State owned). Not covered by ANCSA and oil price controlled.

$$RP8SCOOK == BPRICE * 3 * 365 * PRODCOOK / 1000$$

RP8SSTOT Total taxable revenue from state-owned fields.

$$RP8SSTOT == RP8SSADJ + RP8SCOOK$$

RP8SSROY State royalties.

$$RP8SSROY == RP8SSTOT * STROY$$

RP8SSTAX State production taxes.

$$RP8SSTAX == RP8SSTOT * STTAX$$

RP8SNTOT Total revenues from Native-owned fields for as many as 10 fields.

$$RP8SNTOT == BPRICE * 365 * \sum_{Nnn=N01-N10} (PEAKNnn * PCTNnn) / 1000$$

RP8S Component (Cont.)

RP8SNROY Native royalties.

$$RP8SNROY == RP8SNTOT * NATROY$$

RP8SNTAX Native taxes - transferred to state.

$$RP8SNTAX == RP8SNTOT * NATTAX$$

RP8SPTAX State tax on pipeline property for as many as 10 pipelines.

$$RP8SPTAX == LINETAX * \sum_{Pnn} Pnn$$

Pnn=P01-P10

RP8S Total state recurrent revenues, exogenous input into REGMOD or STMOD.

$$RP8S == RP8SFST + RP8SSROY + RP8STAX + RP8SNTAX + RP8SPTAX + RP8SRTAX$$

EXOGENOUS

BPRICE Price of oil/barrel for current revenue calculations.

BPRICE3 Price of oil/barrel for Cook Inlet revenue calculations.

Peak field production in 10^3 bbls/day (also used to calculate bonus revenues):

PEAKF01-F15 - for as many as 15 federally-owned fields.

PEAKS01-S11 - for as many as 11 state-owned fields.

PEAKN01-N10 - for as many as 10 Native-owned fields.

Petroleum production schedules as a percentage of peak production:

PCTF10-F15 - for as many as 15 federally-owned fields.

RP8S Component (Cont.)

- PCTS01-S10 - for as many as 11 state-owned fields.
- PCTN01-N10 - for as many as 10 Native-owned fields.

Royalty tax rates:

- FEDROY - for federally-owned field production.
- STROY - for state-owned field production.
- NATROY - for Native-owned field production, presently same as state rate.

Production tax rates:

- STTAX - for state-owned field production.
- NATTAX - for Native-owned field production, presently same as state rates.
- REVSHR Percentage of federal royalties returned to state through revenue sharing.
- RP8SPRUD Production of Prudhoe Bay (state-owned) in 10^3 bbls/day.
- PRODCOOK Field production from Cook Inlet (state-owned) in 10^3 bbls/day.
- LINETAX State property tax rate on pipeline property.
- P01-P10 Cumulative value of pipeline property for as many as 10 pipelines.
- RP8SRTAX Reserves tax and tax credit.

DNCS Component

ANCSA specified that variable payments be made each year to the Native Corporations of 2 percent of the total of bonus petroleum revenues and the value of oil produced in that year. The cumulative payment to the Native Corporations shall not exceed \$500 million. For purposes of our model, we have assumed that in the year when payments reach \$500 million, the payments will be deducted from current oil production first, up to a maximum of 2 percent.

At the present time, the DNCS component of the model covers only the variable payments from the state to the Native corporations for the purpose of calculating RP8S and RPBS, but presumably this could be expanded to incorporate other payments to the Native Corporations and regionalization of DNCS. It also makes the approximation that the variable payments will total \$500 million.

DEFINITION

- DNCSP8A 2 percent of the value of oil produced, all of which will be paid to the Native Corporations until the cumulative payments to the Native Corporations is equal to \$500 million.
 $DNCSP8A == RP8SSTOT * .02$
- DNCSP8 Actual payment to Native Corporations from current petroleum revenue.
 $DNCSP8 == DNCSP8A$ if $DNCSP8A + DNCSTOT(-1) < 500$
or $500 - DNCSTOT(-1)$ if $DNCSTOT(-1) < 500$
or 0
- DNCSPBA 2 percent of state petroleum bonus revenues. The amount paid to the Native Corporations depends upon the level of DNCSP8 and DNCSTOT(-1).
 $DNCSPBA == RPBSST * .02$
- DNCSPB Actual payment to Native Corporations from petroleum bonus revenue.
 $DNCSPB == 0$ if $DNCSPBA = 0$
or $DNCSPBA$ if $DNCSPBA + DNCSP8 + DNCSTOT(-1) < 500$
or $500 - DNCSTOT(-1) - DNCSP8$ if $DNCSP8 + DNCSTOT(-1) < 500$
or 0
- DNCSA Total state variable payment to the Native Corporations.
 $DNCSA == DNCSP8 + DNCSPB$
- DNCSTOT Total to date of cumulative variable payments to the Native Corporations.
 $DNCSTOT == DNCSA = DNCSTOT(-1)$

EQUATIONS

- 1: ECONXR1 == TAP5IR1+ECONXA01*CNAA01R1+ECONXA02*CNAA02R1+ECONXA03*CNAA03R1+ECONXA04*CNAA04R1+ECONXA05*CNAA05R1+ECONXA06*CNAA06R1+ECONXA07*CNAA07R1+ECONXA08*CNAA08R1+ECONXA09*CNAA09R1+ECONXA10*CNAA10R1+ECONXA11*CNAA11R1+ECONXA12*CNAA12R1+ECONXA13*CNAA13R1
- 2: ECONXR2 == TAP5IR2+ECONXA01*CNAA01R2+ECONXA02*CNAA02R2+ECONXA03*CNAA03R2+ECONXA04*CNAA04R2+ECONXA05*CNAA05R2+ECONXA06*CNAA06R2+ECONXA07*CNAA07R2+ECONXA08*CNAA08R2+ECONXA09*CNAA09R2+ECONXA10*CNAA10R2+ECONXA11*CNAA11R2+ECONXA12*CNAA12R2+ECONXA13*CNAA13R2
- 3: ECONXR3 == TAP5IR3+ECONXA01*CNAA01R3+ECONXA02*CNAA02R3+ECONXA03*CNAA03R3+ECONXA04*CNAA04R3+ECONXA05*CNAA05R3+ECONXA06*CNAA06R3+ECONXA07*CNAA07R3+ECONXA08*CNAA08R3+ECONXA09*CNAA09R3+ECONXA10*CNAA10R3+ECONXA11*CNAA11R3+ECONXA12*CNAA12R3+ECONXA13*CNAA13R3
- 4: ECONXR4 == TAP5IR4+ECONXA01*CNAA01R4+ECONXA02*CNAA02R4+ECONXA03*CNAA03R4+ECONXA04*CNAA04R4+ECONXA05*CNAA05R4+ECONXA06*CNAA06R4+ECONXA07*CNAA07R4+ECONXA08*CNAA08R4+ECONXA09*CNAA09R4+ECONXA10*CNAA10R4+ECONXA11*CNAA11R4+ECONXA12*CNAA12R4+ECONXA13*CNAA13R4
- 5: ECONXR5 == TAP5IR5+ECONXA01*CNAA01R5+ECONXA02*CNAA02R5+ECONXA03*CNAA03R5+ECONXA04*CNAA04R5+ECONXA05*CNAA05R5+ECONXA06*CNAA06R5+ECONXA07*CNAA07R5+ECONXA08*CNAA08R5+ECONXA09*CNAA09R5+ECONXA10*CNAA10R5+ECONXA11*CNAA11R5+ECONXA12*CNAA12R5+ECONXA13*CNAA13R5+ECONXR5X
- 6: ECONXR6 == TAP5IR6+ECONXA01*CNAA01R6+ECONXA02*CNAA02R6+ECONXA03*CNAA03R6+ECONXA04*CNAA04R6+ECONXA05*CNAA05R6+ECONXA06*CNAA06R6+ECONXA07*CNAA07R6+ECONXA08*CNAA08R6+ECONXA09*CNAA09R6+ECONXA10*CNAA10R6+ECONXA11*CNAA11R6+ECONXA12*CNAA12R6+ECONXA13*CNAA13R6
- 7: ECONXR7 == TAP5IR7+ECONXA01*CNAA01R7+ECONXA02*CNAA02R7+ECONXA03*CNAA03R7+ECONXA04*CNAA04R7+ECONXA05*CNAA05R7+ECONXA06*CNAA06R7+ECONXA07*CNAA07R7+ECONXA08*CNAA08R7+ECONXA09*CNAA09R7+ECONXA10*CNAA10R7+ECONXA11*CNAA11R7+ECONXA12*CNAA12R7+ECONXA13*CNAA13R7
- 8: ECONX == ECONXR1+ECONXR2+ECONXR3+ECONXR4+ECONXR5+ECONXR6+ECONXR7
- 9: EMP9R1A == EMP9F01*P9F01R1+EMP9F02*P9F02R1+EMP9F03*P9F03R1+EMP9F04*P9F04R1+EMP9F05*P9F05R1+EMP9F06*P9F06R1+EMP9F07*P9F07R1+EMP9F08*P9F08R1+EMP9F09*P9F09R1+EMP9F10*P9F10R1+EMP9F11*P9F11R1+EMP9F12*P9F12R1+EMP9F13*P9F13R1+EMP9F14*P9F14R1+EMP9F15*P9F15R1+EMP9F16*P9F16R1+EMP9F17*P9F17R1+EMP9F18*P9F18R1+EMP9F19*P9F19R1+EMP9F20*P9F20R1+EMP9F21*P9F21R1+EMP9F22*P9F22R1+EMP9F23*P9F23R1+EMP9F24*P9F24R1+EMP9F25*P9F25R1+EMP9F26*P9F26R1+EMP9F27*P9F27R1+EMP9F28*P9F28R1+EMP9F29*P9F29R1+EMP9F30*P9F30R1
- 10: EMP9R2A == EMP9F01*P9F01R2+EMP9F02*P9F02R2+EMP9F03*P9F03R2+EMP9F04*P9F04R2+EMP9F05*P9F05R2+EMP9F06*P9F06R2+EMP9F07*P9F07R2+EMP9F08*P9F08R2+EMP9F09*P9F09R2+EMP9F10*P9F10R2+EMP9F11*P9F11R2+EMP9F12*P9F12R2+EMP9F13*P9F13R2+EMP9F14*P9F14R2+EMP9F15*P9F15R2+EMP9F16*P9F16R2+EMP9F17*P9F17R2+EMP9F18*P9F18R2+EMP9F19*P9F19R2+EMP9F20*P9F20R2+EMP9F21*P9F21R2+EMP9F22*P9F22R2+EMP9F23*P9F23R2+EMP9F24*P9F24R2+EMP9F25*P9F25R2+EMP9F26*P9F26R2+EMP9F27*P9F27R2+EMP9F28*P9F28R2+EMP9F29*P9F29R2+EMP9F30*P9F30R2
- 11: EMP9R3A == EMP9F01*P9F01R3+EMP9F02*P9F02R3+EMP9F03*P9F03R3+EMP9F04*P9F04R3+EMP9F05*P9F05R3+EMP9F06*P9F06R3+EMP9F07*P9F07R3+EMP9F08*P9F08R3+EMP9F09*P9F09R3+EMP9F10*P9F10R3+EMP9F11*P9F11R3+EMP9F12*P9F12R3+EMP9F13*P9F13R3+EMP9F14*P9F14R3+EMP9F15*P9F15R3+EMP9F16*P9F16R3+EMP9F17*P9F17R3+EMP9F18*P9F18R3+EMP9F19*P9F19R3+EMP9F20*P9F20R3+EMP9F21*P9F21R3+EMP9F22*P9F22R3+EMP9F23*P9F23R3+EMP9F24*P9F24R3+EMP9F25*P9F25R3+EMP9F26*P9F26R3+EMP9F27*P9F27R3+EMP9F28*P9F28R3+EMP9F29*P9F29R3+EMP9F30*P9F30R3


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26: EMP9R3 == EMP9R3A+EMP9R3B+EMP9R3X
27: EMP9R4 == EMP9R4A+EMP9R4B+EMP9R4X
28: EMP9R6 == EMP9R6A+EMP9R6B+EMP9R6X
29: EMP9R7 == EMP9R7A+EMP9R7B+EMP9R7X
30: EMP9R5 == EMP9R5A+EMP9R5B+EMP9R5X
31: EMP9 == EMP9R1+EMP9R2+EMP9R3+EMP9R4+EMP9R5+EMP9R6+EMP9R7
32: RP8SFTOT == BPRICE*365*(PEAKF01*PCTF01+PEAKF02*PCTF02+PEAKF03*PCTF03+PEAKF04*PCTF04+PEAKF05*PCTF05+
PEAKF06*PCTF06+PEAKF07*PCTF07+PEAKF08*PCTF08+PEAKF09*PCTF09+PEAKF10*PCTF10+PEAKF11*PCTF11+PEAKF12*
PCTF12+PEAKF13*PCTF13+PEAKF14*PCTF14+PEAKF15*PCTF15)/1000
33: RP8SFROY == RP8SFTOT*FEDROY
34: RP8SFST == RP8SFROY*KREVSHR
35: RP8SSTTA == BPRICE*365*(PEAKS01*PCTS01+PEAKS02*PCTS02+PEAKS03*PCTS03+PEAKS04*PCTS04+PEAKS05*PCTS05+
PEAKS06*PCTS06+PEAKS07*PCTS07+PEAKS08*PCTS08+PEAKS09*PCTS09+PEAKS10*PCTS10+PEAKS11*PCTS11+RP8SPRUD)/
1000
36: DNCSP8A == RP8SSTTA*0.02
37: DNCSP8 == IF DNCSP8A+DNCSTOT(-1) LT 500 THEN DNCSP8A ELSE (IF DNCSTOT(-1) LT 500 THEN 500-DNCSTOT(-1)
ELSE 0)
38: RP8SSADJ == RP8SSTTA-DNCSP8
39: RP8SCOOK == BPRICE*365*FRDDCOOK/1000
40: RP8SSTOT == RP8SSADJ+RP8SCOOK
41: RP8SSROY == (RP8SSTOT-RP8SPRUD)*0.98*BPRICE*365/1000-RP8SCOOK)*STROY+0.125*(RP8SPRUD*0.98*BPRICE*365/
1000+RP8SCOOK)
42: RP8SSTAX == RP8SSTOT*STTAX
43: RP8SNTOT == BPRICE*365*(PEAKN01*PCTN01+PEAKN02*PCTN02+PEAKN03*PCTN03+PEAKN04*PCTN04+PEAKN05*PCTN05+
PEAKN06*PCTN06+PEAKN07*PCTN07+PEAKN08*PCTN08+PEAKN09*PCTN09+PEAKN10*PCTN10)/1000
44: RP8SNROY == RP8SNTOT*SNATROY
45: RP8SNTAX == RP8SNTOT*SNATTAX
46: RP8SFPTAX == LINETAX*(P01+P02+P03+P04+P05+P06+P07+P08+P09+P10+P11)
47: RP8S == RP8SSROY+RP8SSTAX+RP8SFST+RP8SNTAX+RP8SFPTAX+RP8SRTAX

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48: SCHEDA == RPESB101*RPESD201+RPESB102*RPESD202+RPESB103*RPESD203+RPESB104*RPESD204+RPESB105*RPESD205+
RPESB106*RPESD206+RPESB107*RPESD207+RPESB108*RPESD208+RPESB109*RPESD209+RPESB110*RPESD210+RPESB111*
RPESD211+RPESB112*RPESD212+RPESB113*RPESD213+RPESB114*RPESD214+RPESB115*RPESD215+RPESB116*RPESD216+
RPESB117*RPESD217+RPESB118*RPESD218+RPESB119*RPESD219+RPESB120*RPESD220

49: SCHEDB == RPESB201*RPESD201+RPESB202*RPESD202+RPESB203*RPESD203+RPESB204*RPESD204+RPESB205*RPESD205+
RPESB206*RPESD206+RPESB207*RPESD207+RPESB208*RPESD208+RPESB209*RPESD209+RPESB210*RPESD210+RPESB211*
RPESD211+RPESB212*RPESD212+RPESB213*RPESD213+RPESB214*RPESD214+RPESB215*RPESD215+RPESB216*RPESD216+
RPESB217*RPESD217+RPESB218*RPESD218+RPESB219*RPESD219+RPESB220*RPESD220

50: SCHEDC == RPESB301*RPESD201+RPESB302*RPESD202+RPESB303*RPESD203+RPESB304*RPESD204+RPESB305*RPESD205+
RPESB306*RPESD206+RPESB307*RPESD207+RPESB308*RPESD208+RPESB309*RPESD209+RPESB310*RPESD210+RPESB311*
RPESD211+RPESB312*RPESD212+RPESB313*RPESD213+RPESB314*RPESD214+RPESB315*RPESD215+RPESB316*RPESD216+
RPESB317*RPESD217+RPESB318*RPESD218+RPESB319*RPESD219+RPESB320*RPESD220

51: SCHEDD == RPESB401*RPESD201+RPESB402*RPESD202+RPESB403*RPESD203+RPESB404*RPESD204+RPESB405*RPESD205+
RPESB406*RPESD206+RPESB407*RPESD207+RPESB408*RPESD208+RPESB409*RPESD209+RPESB410*RPESD210+RPESB411*
RPESD211+RPESB412*RPESD212+RPESB413*RPESD213+RPESB414*RPESD214+RPESB415*RPESD215+RPESB416*RPESD216+
RPESB417*RPESD217+RPESB418*RPESD218+RPESB419*RPESD219+RPESB420*RPESD220

52: SCHEDE == RPESB501*RPESD201+RPESB502*RPESD202+RPESB503*RPESD203+RPESB504*RPESD204+RPESB505*RPESD205+
RPESB506*RPESD206+RPESB507*RPESD207+RPESB508*RPESD208+RPESB509*RPESD209+RPESB510*RPESD210+RPESB511*
RPESD211+RPESB512*RPESD212+RPESB513*RPESD213+RPESB514*RPESD214+RPESB515*RPESD215+RPESB516*RPESD216+
RPESB517*RPESD217+RPESB518*RPESD218+RPESB519*RPESD219+RPESB520*RPESD220

53: RPESFED == RPESFCT*PRICE2*365*(PEAKF01*SCHEDA*LEASEF01+PEAKF02*SCHEDA*LEASEF02+PEAKF03*SCHEDA*
LEASEF03+PEAKF04*SCHEDA*LEASEF04+PEAKF05*SCHEDB*LEASEF05+PEAKF06*SCHEDA*LEASEF06+PEAKF07*SCHEDA*
LEASEF07+PEAKF08*SCHEDA*LEASEF08+PEAKF09*SCHEDA*LEASEF09+PEAKF10*SCHEDA*LEASEF10+PEAKF11*SCHEDA*
LEASEF11+PEAKF12*SCHEDB*LEASEF12+PEAKF13*SCHEDA*LEASEF13+PEAKF14*SCHEDB*LEASEF14+PEAKF15*SCHEDB*
LEASEF15)/1000

54: RPBSST == RPBSFCT*PRICE2*365*(PEAKS01*SCHEDB*LEASES01+PEAKS02*SCHEDB*LEASES02+PEAKS03*SCHEDB*
LEASES03+PEAKS04*SCHEDB*LEASES04+PEAKS05*SCHEDB*LEASES05+PEAKS06*SCHEDB*LEASES06+PEAKS07*SCHEDB*
LEASES07+PEAKS08*SCHEDC*LEASES08+PEAKS09*SCHEDD*LEASES09+PEAKS10*SCHEDB*LEASES10+PEAKS11*SCHEDB*
LEASES11)/1000

55: RPBSNAT == RPBSFCT*PRICE2*365*(PEAKN01*SCHEDB*LEASEN01+PEAKN02*SCHEDB*LEASEN02+PEAKN03*SCHEDB*
LEASEN03+PEAKN04*SCHEDB*LEASEN04+PEAKN05*SCHEDB*LEASEN05+PEAKN06*SCHEDB*LEASEN06+PEAKN07*SCHEDB*
LEASEN07+PEAKN08*SCHEDB*LEASEN08+PEAKN09*SCHEDA*LEASEN09+PEAKN10*SCHEDA*LEASEN10)/1000

56: DNCSPBA == RPBSST*0.02

57: DNCSPB == IF DNCSPBA EQ 0 THEN 0 ELSE (IF DNCSPBA+DNCSTOT(-1) LT 500 THEN DNCSPBA ELSE (IF
DNCSTOT(-1)+DNCSPB LT 500 THEN 500-DNCSTOT(-1)-DNCSPB ELSE 0))

58: DNCSEA == DNCSPB+DNCSPB

59: DNCSTOT = DNCSEA+DNCSTOT(-1)

60: RPTS == RPBSST-DNCSPB

61: RPTS == RPBSST+RPTS+RPBSST

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