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IMPLICATIONS OF OIL SUPPLY  
UNCERTAINTY ON A SMALL OIL  
PRODUCING REGIONAL ECONOMY

PREPARED BY

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# IMPLICATIONS OF OIL SUPPLY UNCERTAINTY ON A SMALL OIL PRODUCING REGIONAL ECONOMY

## 1. INTRODUCTION

The state of Alaska has an economic and fiscal structure that is unique among the states. The petroleum industry, including exploration and development, production, transportation, and refining, accounts for nearly half of gross state product (the state equivalent of gross domestic product). About 35% of personal income is attributable to the production of petroleum either directly or indirectly from taxes and royalties paid to Alaskan state and local governments. State government derives about 85% of its general fund revenue from petroleum taxes and royalties. No other state economy is as depend upon a single industry and no other state government is as dependent on revenues from a single industry as is Alaska.

Complicating the management of an economy so dependent on a single industry is the tremendous wealth associated with the resource and the fact that petroleum is a depleting resource. In the early 1980s the market value of the inventory of Alaska oil reserves exceeded \$300 billion. It is estimated that during the decade of the 1980s, the state of Alaska with a population of 550 thousand (1990) collected \$32 billion in revenues from petroleum activity. This allowed the state to eliminate taxes on residents while at the same time greatly expanding the scope of government activities.

Since petroleum is a depleting resource the economy is subject to the cycles engendered by the expansion of economic activity during the development and early production phases of the petroleum resource and the contraction of economic activity during the later production phases. Because of the wealth associated with petroleum these cycles can potentially be extremely large.

In theory it is a simple matter to devise a rule that has the dual effects of neutralizing cycles in economic activity associated with the life cycle of petroleum exploitation and maximizing the benefits to residents from the expenditure of the petroleum wealth. Of the many complicating factors that make it difficult to devise and apply such a rule uncertainty in the size of the endowment is one of the most interesting. How much it is appropriate to spend today depends directly on the size of the endowment not yet collected.

This paper reviews a model for answering the public policy question of when to spend the endowment associated with petroleum wealth with special focus on how uncertainty complicates the debate. It also looks at the process of developing a plan for implementing the model within the context of the Alaska political and fiscal structure.

## 2. WHEN TO SPEND THE WINDFALL: THE SUSTAINABLE SPENDING MODEL

The public expenditure problem facing Alaska is one most states would envy. Alaska became a state in 1959 with an economy heavily dependent upon the federal government (fully half of all wage and salary jobs were federal civilian or military) and a very small tax base of marketable natural resource commodities. Early state budgets, relying on taxes on personal and corporate income from fishing, timber, and mining, had to be augmented with special federal transition grants to balance. Only the oil production in the Cook Inlet of Southcentral Alaska offered the promise of providing a significant and stable source of public funding to support statehood-building activities.

The state's prospects changed forever in 1968 with the discovery of the Prudhoe Bay oil field on state owned land on the North Slope. A lease sale held in 1969 produced a windfall of \$968 million for the state at a time when the annual budget for the state was less than \$200 million. Under the terms of the lease the state retained ownership to 1/8 of the estimated 9 billion barrels of recoverable oil in place as well as the right to tax production, income, and property associated with production and transportation. By one account state revenues from production were predicted to be \$200 million per year. Not one to engage in hyperbole, Alaska economist George Rogers flatly stated in reference to the impact of oil development on the state:

"But one certainty is that the state of Alaska will be rich."<sup>1</sup>

With the riches came the question that is still central to public policy in Alaska: When should the riches from oil be consumed to maximize benefits to the citizens of the state?

A simple answer to the question of when to spend the oil windfall is the annuity model. With this model the state would consume an equal amount each year that is equivalent to the annual earnings of the windfall invested to maximize its rate of return. This could also be called a sustainable spending model since the constant consumption level is sustainable indefinitely. This time pattern of consumption will maximize welfare if the time discount rate is zero and if the marginal welfare of consumption in each future year is the same.

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<sup>1</sup> George Rogers, "Change in Alaska" The 1960's and After," in Change in Alaska: People, Petroleum, and Politics, edited by George Rogers, University of Alaska Press, College, Alaska, 1970, page 11.

There is an argument in support of each of these simplifying assumptions. A time discount rate of zero means that future years are just as important as the present in the windfall allocation decision. From the point of view of a state government, a case could be made that the welfare of future generations of citizens is just as important as the welfare of the present generation. Adoption of this view results in a time discount rate of zero.

One way that the marginal welfare of consumption will be equal in each future year is if population is constant and no changes in wealth are anticipated.<sup>2</sup> With a constant population each resident can receive an equal share of consumption each year. If no future windfalls are expected, positive or negative, the benefit each resident receives from an additional unit of consumption each year would be the same as long as the marginal utility of consumption falls as consumption increases. In other words if the state expects to be neither richer or poorer in the future than it is in the present, consumption from the windfall should be allocated equally across all future years. If the state expects more wealth in the future, more consumption from the oil windfall should occur in the early years and vice versa.

Although simple and elegant, the annuity or sustainable spending model is fraught with complications which make it difficult for a state government to implement. The first problem is the determination of the time discount rate. Although a government may have a time discount rate of zero in theory, in practice the government is composed of individuals who discount the future for two reasons. The first reason is simply human nature and the fact that individuals are mortal. The second reason is that the probability is less than certain that an individual will still be a state resident in future years and able to partake in the public consumption associated with the windfall. To the extent that the collective discount rate is an aggregation of individual time discount rates, it will then be greater than zero. Of course there is nothing to prevent a collective decision from producing a positive time discount rate independent of these factors. The real difficulty here is that there is no simple answer to the question of how the time discount rate should be determined.

A second problem is determining what the welfare function actually looks like. A simple formulation would exclude the size of the population. In that case the benefit from a unit of consumption would not depend on the number of people served. This may seem inappropriate if the windfall funds public consumption

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<sup>2</sup>If the time discount rate is zero and the welfare measure grows with the population, the answer to the question of when to spend the windfall is a paradox. You should never consume the windfall since the population will increase to infinity as the number of years increases. Consumption in any year will fall to zero.

since the value of a public good increases with the number of people served. An equitable distribution of benefits, assuming a zero time discount rate, would be an equal share to each resident with larger amounts of aggregate consumption occurring in times of larger population.<sup>3</sup> But if the consumption is a pure public good, then the benefit to each resident is independent of the total population and population size becomes irrelevant. Per capita welfare becomes the appropriate measure. As with the time rate of discount, there is no simple answer in practice to the question of whether the size of the population counts in the welfare function since not all activities of state government involve the production of pure public goods.

If population size is in the welfare function then time inconsistency becomes a possibility for any time allocation of consumption. This can happen if the consumption of the windfall induces population to migrate into the state. Any plan for the distribution of consumption over time would be based upon a particular population level each future year. Actual consumption would alter the population in the future and result in a pattern of consumption over time that, ex post, was not the best since the population would be larger than had been anticipated when the plan was implemented.

The welfare function for consumption of the windfall is also influenced by the level of wealth anticipated in the future. If society is getting richer with the passage of time, the opportunities for consumption in the future will be greater than they are in the present. Under those circumstances it does not make sense to postpone consumption today as long as the marginal value of consumption is declining. On the other hand if society is getting poorer, it makes sense to postpone some consumption in the present because it will have greater value in the future. It is difficult to reach a consensus on the question of the future level of wealth relative to the present.

Next, the windfall may take on the characteristic of a public good resulting in over consumption in the near term and under consumption later on if individual consumption preferences differ. This can happen if there is a perceived risk among residents that the allocation of future consumption will not benefit them. In that case the resident would discount the expected value of consumption in the future relative to consumption in the present. The notion is that if I forego consumption that I could make today, the decision on future consumption may fall to someone else who chooses something other than what I would prefer. The

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<sup>3</sup> Special consideration might be given to older aged cohorts within the population at the time the windfall occurs if the rule is that each resident should get an equitable share of the windfall.

result can be a shift from higher valued consumption in the future toward lower valued consumption in the present.

A final problem is philosophical. It can, and has been, argued that the public sector has no business holding financial assets for the purpose of funding consumption over an extended period of time. This position could result from a certain type of welfare function where only the immediate residents matter, or a very high time discount rate, but it could also be the result of an interpretation of the appropriate role of government in the economy. Whether philosophical or not, this position resolves the problem of the timing of consumption by the choice of immediate consumption of the entire windfall.<sup>4</sup>

In spite of these complications and differences of opinion, there seems to be a general consensus among Alaskans, at least among those who are not philosophically opposed to the notion of the public sector holding assets, that a public windfall should not be immediately consumed but rather spent over time to try to maximize the benefits to residents.

This in fact is what happened with the \$968 million windfall the state received in 1969. That windfall was spent over a period of about 4 years. This may seem like an extremely short time frame given the idea of sustainability, but in interpreting what many would label profligate behavior, two things should be kept in mind. First, some of the spending was really a form of investment in public infrastructure rather than consumption. The benefits from that investment would not occur immediately but rather over the lifetime of the capital facilities. Second, the state was expecting to begin collecting royalties and taxes worth hundreds of millions annually as soon as production from Prudhoe Bay began in the early 1970s. With the expectation of a continuing flow of windfalls, postponing the consumption of the first installment would not maximize the public welfare.

### **3. WHAT TO DO WHEN THE WINDFALL DRIBBLES IN**

The formulation of the problem becomes a little more complicated when the windfall does not come all at once, but rather dribbles in a little at a time. This is the situation the state of Alaska faced in the early 1970s and continues to face today. At that time the Prudhoe Bay reservoir contained 9 billion barrels of recoverable reserves which were to be produced over a period of 20+ years. The state would receive revenues from this the largest oil field in North America a little

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<sup>4</sup> This solution has the attractive property that it eliminates any population growth induced by the expectation of sharing in the windfall simply by virtue of residency in the state.

bit at a time according to the production profile determined by the oil producers. When production ended the revenues would cease. This was clearly a temporary bonanza to be treated as a windfall, albeit one that dribbled into the treasury a little at a time.

This case is easily converted to that of the simple case described in the previous section (the windfall is collected all at once) by calculating the present value of the dribbles. This is the present value of the future revenues the state expects to receive from the production of oil. The resultant present value of the future windfall is an asset on the books of the state financial accounts, and it can be treated in the same way as a windfall already received. A time pattern of consumption can be calculated based on earnings of this asset. As long as the windfall actually dribbles into the treasury as anticipated and the rate of return on financial assets is as predicted, the calculated constant annual consumption level will be indefinitely sustainable.

There are two practical complications introduced if the windfall dribbles in over time. The first relates to the recognition that the revenues in fact are a windfall and consequently not to be treated in the same way as regular revenues in fiscal deliberations. The correct distinction is between a revenue flow that can be expected to continue indefinitely, as for example a royalty on the sale of timber, or a tax on the production of a manufactured good, and a revenue flow that is known in advance to be temporary, like the production revenues from a depleting oil field.

The distinction is obviously not precise. A timber resource is renewable, but it can be depleted through poor management or environmental disaster. It may also, like the manufacturing facility, become economically obsolete and lose value. What is important is that there is foreknowledge that the depleting resource has only a finite life.

In practice most government budgeting is done on the basis of available revenues. Once an acceptable level of services has been settled upon revenues can be expected to change from year to year by about the same percentage as the cost of those services. Higher income, sales, and property taxes reflect inflation, population, and real per capita income growth. Those same factors explain much of the demand for increases in public services. As a consequence, it is appropriate that in most political jurisdictions revenues are spent in the same year as collected.

Government spending under the sustainable spending model does not follow this pattern of letting revenues determine spending. It requires a more active role in the budget making process in two respects. First, spending must be established independent of the level of current revenues. Second, the proportion

of current revenues spent in any year will not be a constant. A simple example can illustrate these points.

Assume an initial windfall of \$1 billion followed in subsequent years by windfalls dribbling in as shown in column 1 of Table 1 below. Further assume the time discount rate is zero and the social welfare function is independent of the population and changes in wealth from other sources. With no inflation and a rate of return on investments of 10 %, the present value of the total windfall is \$1.5 billion at the start of the first year. The annual sustainable level of consumption is \$150 million, an amount that can be spent each year without depleting the value of the asset.

A convenient way to implement this time pattern of consumption is for the government to establish an account both for managing the revenues as they are collected, for investing the balances in hand each year, and for funding consumption. The activities of such a fund are shown in columns 3, 4, and 5 of Table 1. Column 3 is the balance in the fund at the start of the year. Column 4 is the balance at the end of the year after the collection of the windfall revenues, the posting of annual fund earnings, and the withdrawal for consumption.

At the start of year one there is no balance in the financial asset while the value of the windfall is \$1.5 billion. However as the oil revenues are collected the value of the oil yet to be produced, Column 2, falls as the balance in the fund grows. Each year the combined value of the fund and the oil remaining in the ground is \$1.5 billion. At the end of the life of the oil field all the value has been converted into the fund which has a value of \$1.5 billion.

What complicates this plan is the fact that the source for the constant level of spending is changing over time. In Table 1, all oil revenues flow through the fund, and until the revenues cease the annual draw on the fund includes not only the earnings, but also a portion of its principal. The withdrawal rate as a percentage of the balance in the fund, is shown in Column 5 to increase and subsequently decline to the long run equilibrium of 10%. A varying percentage rule like this is difficult to understand within the context of normal state financial operations.

An alternative characterization of the process of conversion of the windfall is more complex. This case would be for the windfall revenues to be divided each year between direct consumption and saving in the fund. Consumption would then be financed partially by direct expenditure of windfall revenues and partially by fund earnings. Table 2, illustrates this case on the assumption that if sufficient, current revenues would fund consumption with any extra going into the fund. Any shortfall in revenues would be made up by drawing from the fund. In this case neither the

TABLE 1. SUSTAINABLE CONSUMPTION  
DRAWING ON A FUND

| YR | WINDFALL             |                   | FUND             |         | FUND<br>RATE<br>OF<br>WITH-<br>DRAWAL | SUSTAINABLE<br>CONSUMPTIO |
|----|----------------------|-------------------|------------------|---------|---------------------------------------|---------------------------|
|    | REVENUES<br>RECEIVED | WINDFALL<br>VALUE | BALANCE<br>START | END     |                                       |                           |
| 1  | \$1,000              | \$1,500           | \$0              | \$850   | ERR                                   | \$150                     |
| 2  | \$0                  | \$650             | \$850            | \$785   | 18%                                   | \$150                     |
| 3  | \$0                  | \$715             | \$785            | \$714   | 19%                                   | \$150                     |
| 4  | \$100                | \$788             | \$714            | \$735   | 21%                                   | \$150                     |
| 5  | \$150                | \$765             | \$735            | \$808   | 20%                                   | \$150                     |
| 6  | \$200                | \$691             | \$808            | \$939   | 19%                                   | \$150                     |
| 7  | \$200                | \$560             | \$939            | \$1,083 | 16%                                   | \$150                     |
| 8  | \$200                | \$416             | \$1,083          | \$1,242 | 14%                                   | \$150                     |
| 9  | \$150                | \$258             | \$1,242          | \$1,368 | 12%                                   | \$150                     |
| 10 | \$100                | \$134             | \$1,368          | \$1,452 | 11%                                   | \$150                     |
| 11 | \$52                 | \$47              | \$1,452          | \$1,500 | 10%                                   | \$150                     |
| 12 | \$0                  | \$0               | \$1,500          | \$1,500 | 10%                                   | \$150                     |
| 13 | \$0                  | \$0               | \$1,500          | \$1,500 | 10%                                   | \$150                     |
| 14 | \$0                  | \$0               | \$1,500          | \$1,500 | 10%                                   | \$150                     |
| 15 | \$0                  | \$0               | \$1,500          | \$1,500 | 10%                                   | \$150                     |
| 16 | \$0                  | \$0               | \$1,500          | \$1,500 | 10%                                   | \$150                     |
| 17 | \$0                  | \$0               | \$1,500          | \$1,500 | 10%                                   | \$150                     |
| 18 | \$0                  | \$0               | \$1,500          | \$1,500 | 10%                                   | \$150                     |
| 19 | \$0                  | \$0               | \$1,500          | \$1,500 | 10%                                   | \$150                     |
| 20 | \$0                  | \$0               | \$1,500          | \$1,500 | 10%                                   | \$150                     |

TABLE 2. SUSTAINABLE CONSUMPTION  
USING REVENUES BEFORE DRAWING ON A FUND

| YR | WINDFALL             |                   | FUND             |         | REVENUE<br>USE<br>RATE | FUND<br>RATE<br>OF<br>WITH-<br>DRAWAL | SUSTAINABLE<br>CONSUMPTIO |
|----|----------------------|-------------------|------------------|---------|------------------------|---------------------------------------|---------------------------|
|    | REVENUES<br>RECEIVED | WINDFALL<br>VALUE | BALANCE<br>START | END     |                        |                                       |                           |
| 1  | \$1,000              | \$1,500           | \$0              | \$850   | 15%                    | ERR                                   | \$150                     |
| 2  | \$0                  | \$650             | \$850            | \$785   | 100%                   | 18%                                   | \$150                     |
| 3  | \$0                  | \$715             | \$785            | \$714   | 100%                   | 19%                                   | \$150                     |
| 4  | \$100                | \$788             | \$714            | \$735   | 100%                   | 7%                                    | \$150                     |
| 5  | \$150                | \$765             | \$735            | \$808   | 100%                   | 0%                                    | \$150                     |
| 6  | \$200                | \$691             | \$808            | \$939   | 75%                    | 0%                                    | \$150                     |
| 7  | \$200                | \$560             | \$939            | \$1,083 | 75%                    | 0%                                    | \$150                     |
| 8  | \$200                | \$416             | \$1,083          | \$1,242 | 75%                    | 0%                                    | \$150                     |
| 9  | \$150                | \$258             | \$1,242          | \$1,368 | 100%                   | 0%                                    | \$150                     |
| 10 | \$100                | \$134             | \$1,368          | \$1,452 | 100%                   | 4%                                    | \$150                     |
| 11 | \$52                 | \$47              | \$1,452          | \$1,500 | 100%                   | 7%                                    | \$150                     |
| 12 |                      | \$0               | \$1,500          | \$1,500 | 100%                   | 10%                                   | \$150                     |
| 13 |                      | \$0               | \$1,500          | \$1,500 | 100%                   | 10%                                   | \$150                     |
| 14 |                      | \$0               | \$1,500          | \$1,500 | 100%                   | 10%                                   | \$150                     |
| 15 |                      | \$0               | \$1,500          | \$1,500 | 100%                   | 10%                                   | \$150                     |
| 16 |                      | \$0               | \$1,500          | \$1,500 | 100%                   | 10%                                   | \$150                     |
| 17 |                      | \$0               | \$1,500          | \$1,500 | 100%                   | 10%                                   | \$150                     |
| 18 |                      | \$0               | \$1,500          | \$1,500 | 100%                   | 10%                                   | \$150                     |
| 19 |                      | \$0               | \$1,500          | \$1,500 | 100%                   | 10%                                   | \$150                     |
| 20 |                      | \$0               | \$1,500          | \$1,500 | 100%                   | 10%                                   | \$150                     |

portion of revenues going directly to spending, Column 5, nor the portion of earnings going to spending, Column 6, is a constant.

Because of these complicating factors in determining the sustainable time allocation of consumption two other alternatives are sometimes suggested. The first is to consume the windfalls as they are collected. This takes the consumption decision away from the government and puts it at the discretion of the producers, nature, and world markets. Such a decision is unlikely to maximize the public welfare, although some might argue that this is appropriate based on the idea that the government role should be entirely passive.

The second is more sophisticated, but also likely to be inferior because it penalizes residents in the early years. With this plan, patterned after the idea of an endowment, all windfalls are deposited into the fund, but only the earnings of the present balance of the fund go to consumption each year.<sup>5</sup> Figure 1. contrasts annual consumption for both of these cases with the sustainable consumption case.

The presence of a fund to manage financial assets raises additional issues. The government must now take on a management function and concern itself with questions of appropriate risk and return, investment instruments, etc. An important political question is the extent to which the monetary return on fund investments should be sacrificed in exchange for other social objectives or other "non-monetary" returns such as job creation. The distinction between investment and consumption can easily become blurred as special interest groups attempt to disguise the later as the former.

Figure 2. describes in a general way the experience of Alaska since the Prudhoe Bay windfall was identified. The revenues from production have dribbled into the state treasury first in increasing and more recently in decreasing amounts. A fund has been established, the Alaska Permanent Fund, to hold petroleum wealth converted to cash and to serve as the investment vehicle to generate earnings to sustain the higher level of spending. State spending increased rapidly to a high plateau which it has subsequently maintained. A portion of petroleum revenues are deposited into the Permanent Fund while the bulk are spent directly. The portion of revenues deposited has varied over the years. A portion of the earnings of the Permanent Fund is consumed each year in the form of the Permanent Fund Dividend, an equal cash distribution to each resident.

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<sup>5</sup> A formal proposal along these lines has been put forward as the "Cremo" Plan.

Figure 1

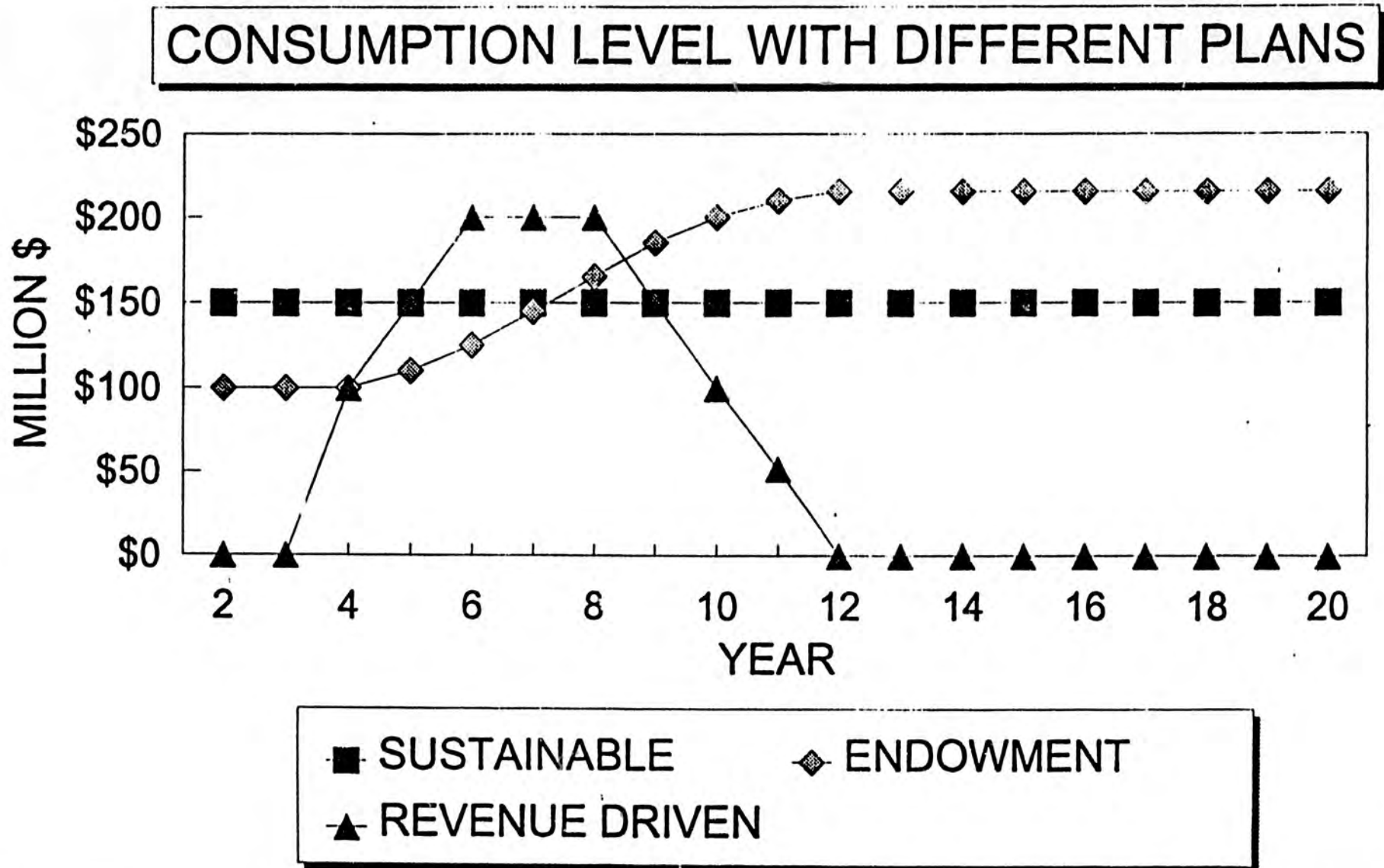
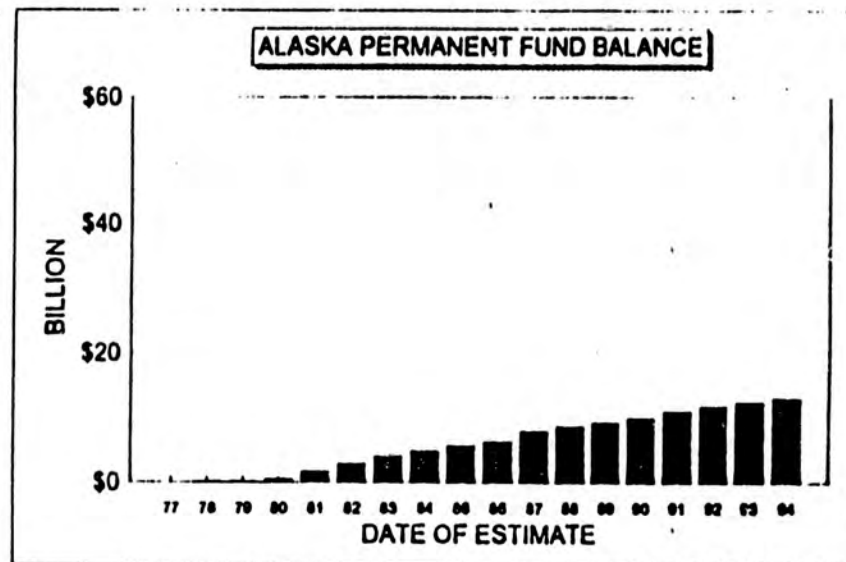
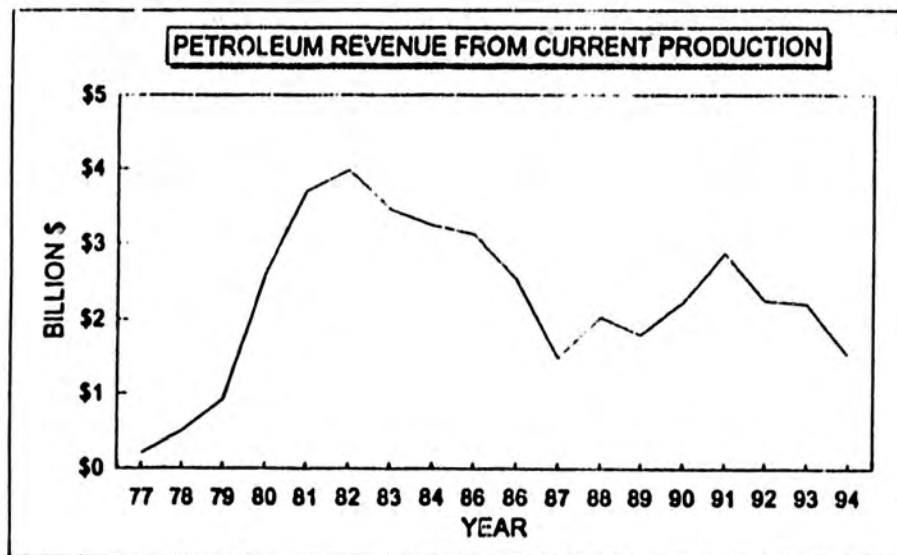


Figure 2



The combined value of oil remaining in the ground and the Permanent Fund have formed the bulk of state assets. Recent year asset valuations for the primary financial assets of the state show that their combined value has varied between \$25 billion and \$44 billion. (Table 3.) The value of oil reserves, simply measured at current reserve and price levels, and the Permanent Fund in each year are shown in Figure 3.

The financial assets of the state include several other accounts which in theory do not complicate the analysis but in practice make it more difficult to calculate the value of state assets from which the sustainable consumption level can be derived.

One complication arises because not all petroleum revenue is collected at the time of production. Disputes between the government and the oil companies over the wellhead value of the oil produced, the base for production taxes and the payment of royalties, have resulted in a large backlog of potential cash settlements. At present the state is claiming approximately \$6 billion from production in prior years. Past experience suggests the state may ultimately collect half of that amount, or \$3 billion. \$3 billion then becomes the estimate of the present value of the windfall associated with these future collections and this amount can be added to the other financial assets of the state for the purpose of calculating sustainable consumption.

The cash reserves of the state are held in several accounts, the largest of which are the General Fund, the Constitutional Budget Reserve, and the Earnings Reserve of the Permanent Fund. This proliferation of accounts creates confusion in the mind of the public as to the total value of state assets since the state does not produce a consolidated statement of state assets for the purpose of estimating sustainable consumption. For example the Earnings Reserve of the Permanent Fund, which has a balance in excess of \$1 billion, is included in the Permanent Fund balance as reported by the Permanent Fund Annual Report, at the same time that it is included in informal legislative reports of funds available for appropriations.

#### **4. UNCERTAINTY IN THE SIZE OF THE WINDFALL**

The assumption up to this point has been that the value of the oil windfall is known with certainty. The fact that it can only be estimated further complicates the choice of the time allocation of consumption. Figure 4. shows predictions of the petroleum revenues the state expected to collect in 1994 at various points of time since the state began formally predicting revenues in 1978 and compares those projections to the current estimate of about \$1.5 billion. It shows that the

TABLE 3. STATE OF ALASKA ASSETS  
(MILLION 1992 \$)

|      | GENERAL<br>FUND | CONST<br>BUDGET<br>RESERVE | PF<br>EARNINGS<br>RESERVE | PERM<br>FUND | SETTLE-<br>MENTS | OIL<br>RESERVES: | SUM ALL<br>ASSETS |
|------|-----------------|----------------------------|---------------------------|--------------|------------------|------------------|-------------------|
| 1988 | \$287           | \$0                        | \$573                     | \$9,859      | \$3,783          | \$24,762         | \$39,264          |
| 1989 | \$287           | \$0                        | \$688                     | \$10,547     | \$3,898          | \$19,833         | \$35,251          |
| 1990 | \$557           | \$0                        | \$668                     | \$11,019     | \$4,007          | \$26,156         | \$42,405          |
| 1991 | \$788           | \$0                        | \$630                     | \$11,445     | \$3,780          | \$33,810         | \$50,453          |
| 1992 | \$1,000         | \$650                      | \$650                     | \$11,700     | \$3,500          | \$23,800         | \$41,300          |
| 1993 | \$1,311         | \$680                      | \$922                     | \$12,039     | \$2,913          | \$22,718         | \$40,583          |
| 1994 | \$189           | \$1,555                    | \$94                      | \$12,254     | \$2,828          | \$14,987         | \$31,907          |

TABLE 4. SUSTAINABLE CONSUMPTION  
GRADUAL RETURN TO EQUILIBRIUM  
(ALPHA = 25%)

| YR | WINDFALL<br>REVENUES<br>RECEIVED | WINDFALL<br>VALUE | FUND<br>BALANCE<br>START | END   | FUND<br>RATE<br>OF<br>WITH-<br>DRAWAL | SUSTAINABLE<br>CONSUMPTIO |
|----|----------------------------------|-------------------|--------------------------|-------|---------------------------------------|---------------------------|
| 1  | \$1,000                          | \$1,500           | \$0                      | \$850 | ERR                                   | \$150                     |
| 2  | \$0                              | \$650             | \$850                    | \$785 | 18%                                   | \$150                     |
| 3  | \$0                              | \$715             | \$785                    | \$714 | 19%                                   | \$150                     |
| 4  | \$100                            | \$788             | \$714                    | \$585 | 42%                                   | \$300                     |
| 5  | \$150                            | \$765             | \$585                    | \$535 | 44%                                   | \$259                     |
| 6  | \$200                            | \$691             | \$535                    | \$563 | 42%                                   | \$225                     |
| 7  | \$200                            | \$560             | \$563                    | \$623 | 35%                                   | \$197                     |
| 8  | \$200                            | \$416             | \$623                    | \$712 | 28%                                   | \$173                     |
| 9  | \$150                            | \$258             | \$712                    | \$779 | 22%                                   | \$154                     |
| 10 | \$100                            | \$134             | \$779                    | \$818 | 18%                                   | \$139                     |
| 11 | \$52                             | \$47              | \$818                    | \$828 | 15%                                   | \$126                     |
| 12 | \$0                              | \$0               | \$828                    | \$794 | 14%                                   | \$115                     |
| 13 | \$0                              | \$0               | \$794                    | \$768 | 13%                                   | \$106                     |
| 14 | \$0                              | \$0               | \$768                    | \$746 | 13%                                   | \$99                      |
| 15 | \$0                              | \$0               | \$746                    | \$728 | 12%                                   | \$93                      |
| 16 | \$0                              | \$0               | \$728                    | \$713 | 12%                                   | \$88                      |
| 17 | \$0                              | \$0               | \$713                    | \$700 | 12%                                   | \$84                      |
| 18 | \$0                              | \$0               | \$700                    | \$690 | 11%                                   | \$80                      |
| 19 | \$0                              | \$0               | \$690                    | \$682 | 11%                                   | \$77                      |
| 20 | \$0                              | \$0               | \$682                    | \$675 | 11%                                   | \$75                      |

Figure 3

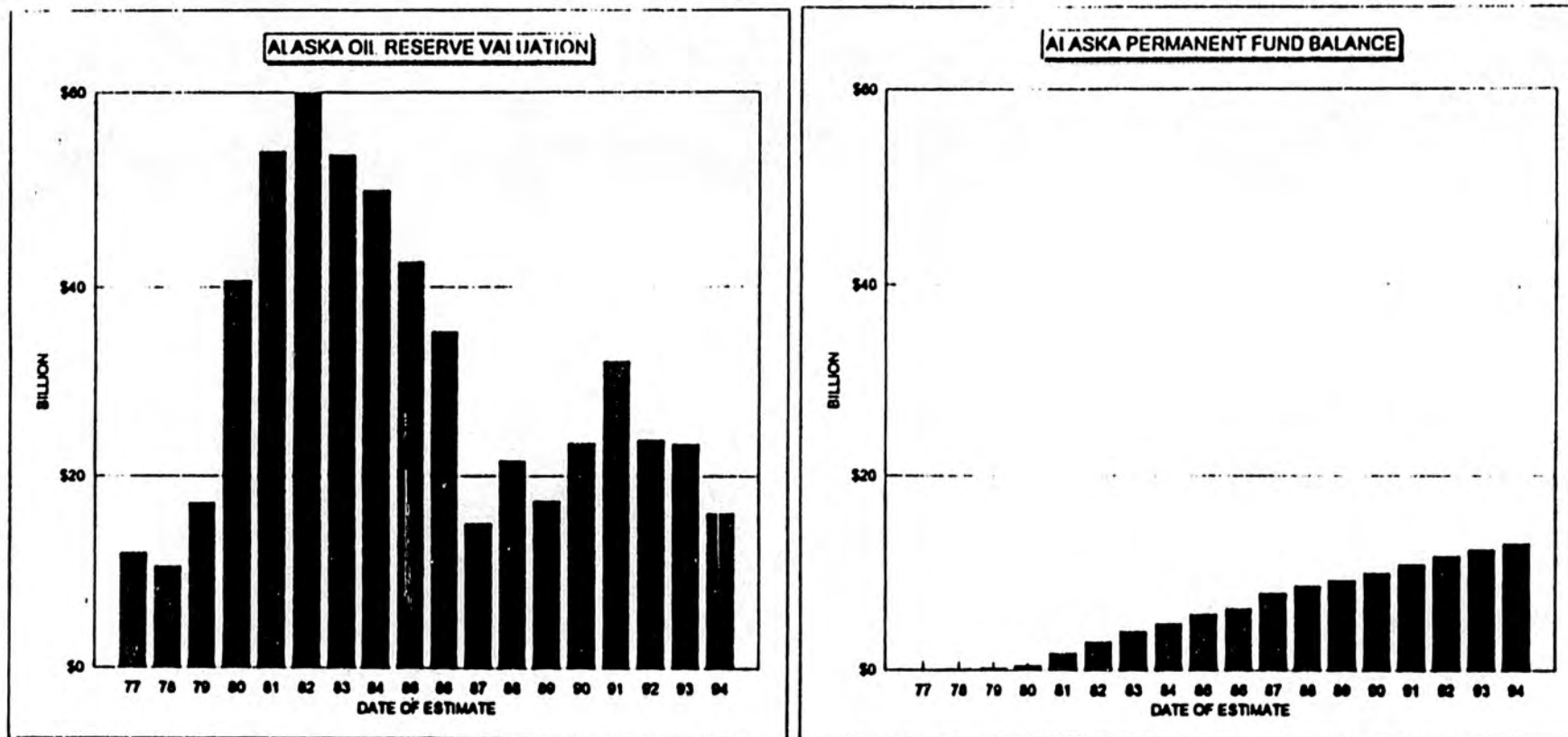
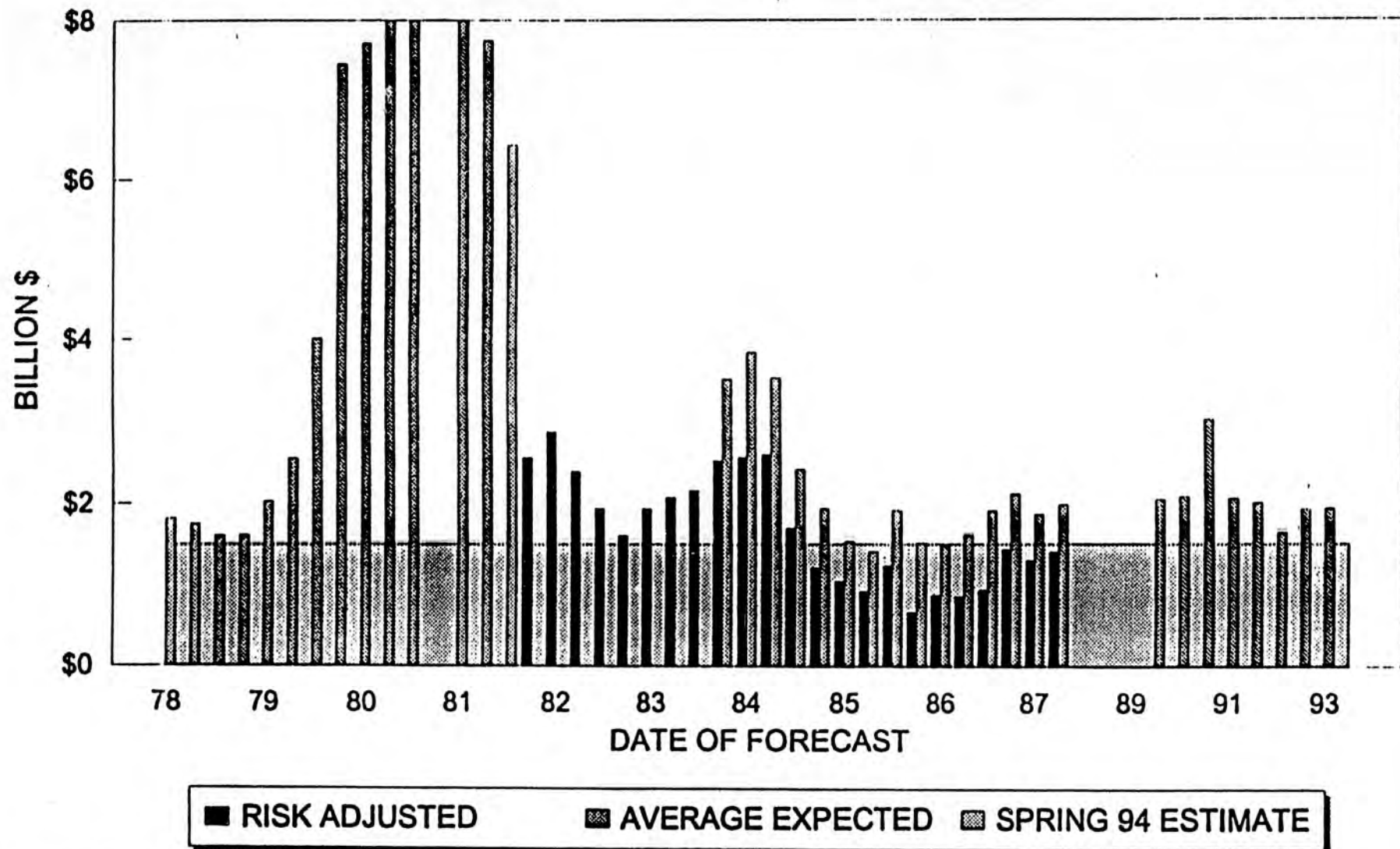


Figure 4

# FORECASTS OF 1994 OIL REVENUES

## COMPARISON WITH CURRENTLY ANTICIPATED COLLECTIONS



ALASKA DEPT OF REVENUE FORECASTS

1994 revenues were vastly overestimated in the early years and that in general they have been overestimated<sup>6</sup>.

The variation in revenue projections is due to uncertainty in predicting both the remaining reserves and the price of Alaska oil. Estimates of total recoverable reserves have trended upward over time. The initial estimates for the Prudhoe Bay field done in the 1970s were about 9 billion barrels of recoverable oil. Technological advances, cost reductions, and price changes have over the years increased that figure. Today it stands at about 12 billion ultimately recoverable reserves. The ultimate recoverable reserve estimates have also increased over time with the discovery and development of other fields on the North Slope. Although the relationship is inexact, the historical pattern suggests that about 1 barrel of new reserves is added to the inventory of producible oil for every 2 barrels produced. The increase over time in the estimate of ultimately recoverable oil is consistent with the industry practice of not announcing reserve additions until they are relatively certain. This introduces a natural downward bias in the official government statistics which rely on publicly available information from the industry.

In estimating the size of the windfall, it is possible to predict ultimately recoverable reserves based on the experience of the industry to date in the state. Ultimately recoverable reserves for this purpose would obviously differ from the official estimates of the industry and the state because they would have a different purpose. The official state remaining recoverable reserves estimates shown in Figure 5. can be used together with actual production to develop a historical based estimate of likely reserves taking into account new additions to reserves.

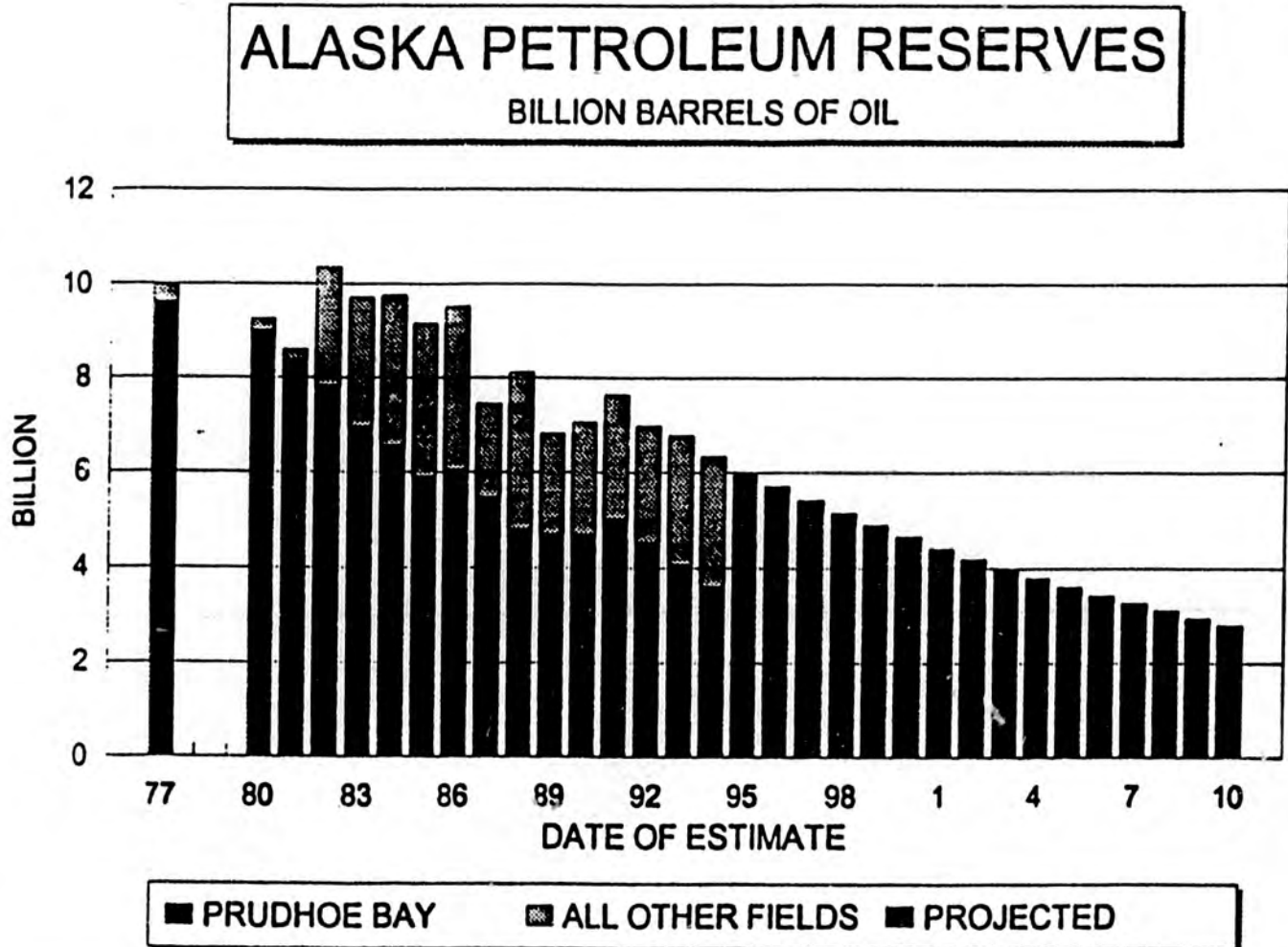
Predictions of price have neither consistently overestimated nor underestimated the price but predictions have fluctuated dramatically with actual and expected market conditions. In the early 1980s the market price was \$35 and expected to grow 1% to 2% faster than inflation for decades. In the mid 1990s the market price is \$15 and projected to grow no faster than the rate of inflation. Since projections of price tend to be heavily influenced by current market conditions, the swings in predicted future price are magnified and this causes the value of oil reserves to fluctuate dramatically as demonstrated in Figure 3.

Predicting the price should recognize that its movements are largely cyclical within a stable range. Estimates of the value of oil reserves could then be made based on the price at different points within that range rather than centered around the most recently observed price which could be anywhere within the range. Although this would result in a broad range of price estimates, they would change

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<sup>6</sup>1994 revenues are somewhat lower than prior years due to the recent drop in the price of oil.

Figure 5



slowly over time and the valuation of oil reserves would also change slowly over time.

When the size of the windfall changes, the size of the annual consumption level changes by the same percentage in the sustainable consumption model. So if the estimation of the value of oil in the ground were to increase by a factor of 4 as happened in late 1979 when the market price jumped from \$12 to \$35 per barrel, the calculated annual consumption amount would also increase by a factor of 4.

There was a dramatic increase in Alaska state spending during this time, but the increase in consumption, after netting out investment spending, was not as large as the price jump. The most obvious explanation of this would be that there is a lag effect operating on changes in the level of consumption in response to changes in assets. If so this inertia can reduce some of the fluctuations in consumption due to uncertainty in the estimate of assets.

## **5. RETURNING TO EQUILIBRIUM: THE TRANSITION TO SUSTAINABILITY**

Unanticipated changes in the value of assets, inappropriate policies, and many other factors can knock the state off a sustainable consumption program. If consumption falls below the sustainable level an upward adjustment to the sustainable consumption path can be immediate. If consumption is above the sustainable level the state may choose to return to the sustainable path gradually rather than abruptly. In any case there is a tradeoff between a more rapid movement to a sustainable path and a more gradual movement to a somewhat lower sustainable path.

Complicating the choice of how fast to adjust to the sustainable consumption level is the uncertainty over what that level actually is. The long run sustainable consumption level is a moving target and if it turns out to be higher than currently predicted, a sharp reduction in consumption today may subsequently prove to have been unnecessary. Of course if the sustainable consumption level turns out to be lower than anticipated, then postponing the reduction in consumption means greater reductions in the future.

As shown in the earlier graphs, the range of uncertainty can be quite large and projections of future revenues can change radically in a short period of time. This is primarily the result of changing price predictions but also due to changes in estimates of recoverable reserves.

Over time the uncertainty associated with predicting both price and reserves should fall both because we can use more actual experience over time in making

our predictions and because the value of the reserve declines in importance in the determination of the sustainable consumption level. Nevertheless some method of dealing with the uncertainty of trying to hit a moving target, the long run sustainable consumption level, needs to be identified. A logical policy would be to use an "adaptive expectations" formulation to move incrementally towards the long run sustainable consumption level.

Under such a rule current consumption,  $C_t$ , would be reduced from the prior year by a percentage (Alpha) of the difference between actual consumption in the previous year,  $C_{t-1}$ , and expected long run sustainable consumption based on current assets,  $C^*$ , according to the following formula:

$$\text{Change in Consumption} = -\text{Alpha} * (C_{t-1} - C^*).$$

Equivalently consumption in year  $t$ ,  $C_t$ , would be:

$$C_t = C_{t-1} - \text{Alpha} * (C_{t-1} - C^*).$$

Implementation of this rule requires the continuous calculation of the expected long run sustainable consumption level,  $C^*$ , and its comparison with actual consumption. The adjustment parameter, Alpha, should be low if the cost of adjustment is high relative to the loss in long run sustainable consumption from a slow adjustment, and if the level of uncertainty is high. The parameter should be high if the cost of adjustment is low, the difference between actual and long run sustainable consumption is high, and the level of uncertainty is low.

Figure 6. shows the proportion of the difference between initial actual and a constant long run sustainable consumption level closed after each year for several different values for the parameter Alpha. However the long run sustainable consumption level is not constant even in the absence of uncertainty.

Table 4. illustrates this adjustment rule where spending has deviated by 100% from the sustainable consumption level in period 4. An Alpha of 25% returns consumption close to a sustainable level about half as large as before the deviation. Figure 7. shows this case.

A practical difficulty with this strategy of gradually moving into equilibrium is that even with knowledge of the sustainable consumption level and Alpha, during the transition when consumption is falling, a portion of consumption is paid from draws on the balance in the assets account. This means that the asset balance is falling as the falling sustainable level of consumption is approached. Table 4. shows what the draw on assets should be each year as well as what the asset balance is each year, but there is no fixed relationship between the two policy variables--consumption and draw on asset balances.

Figure 6

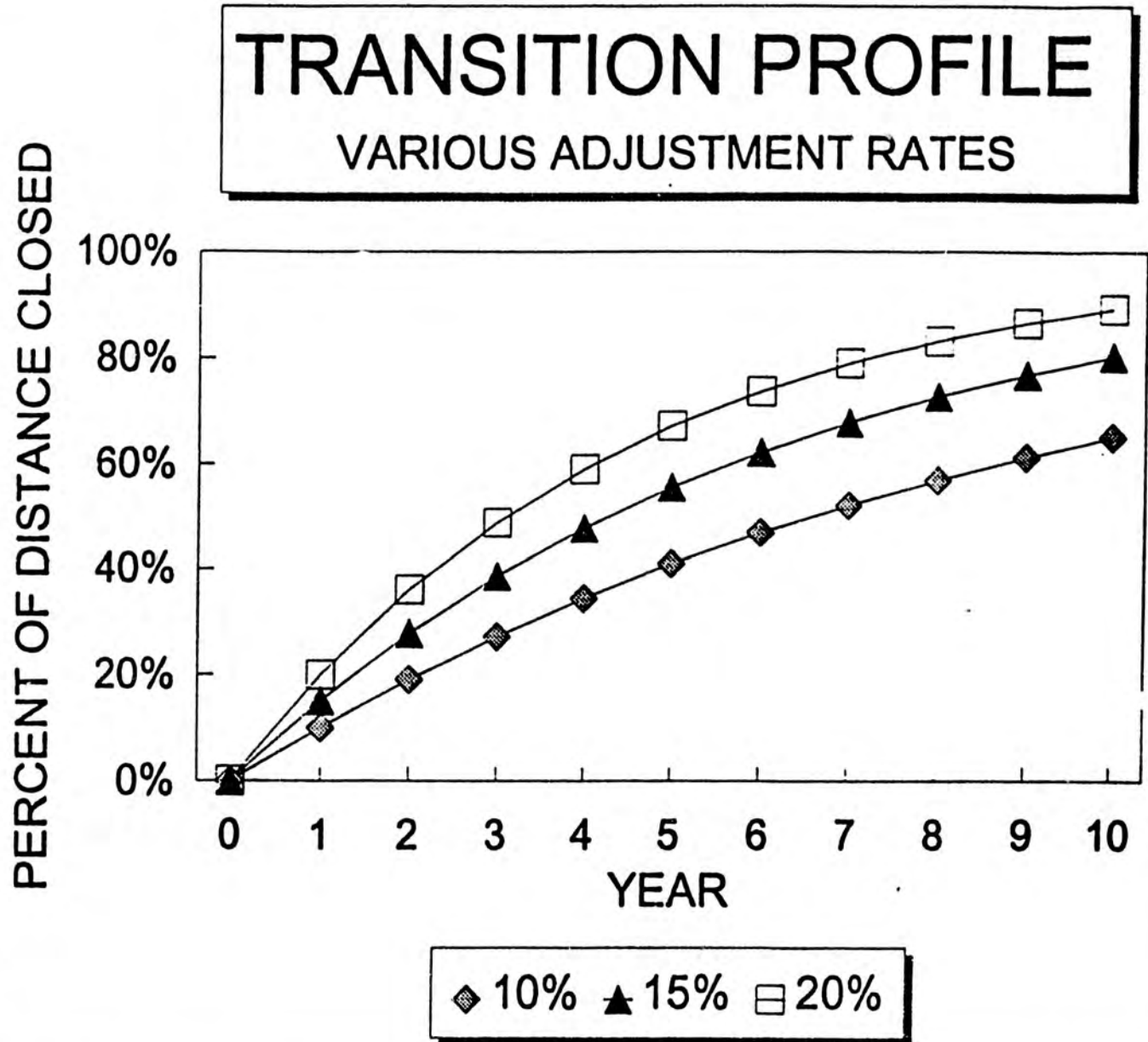
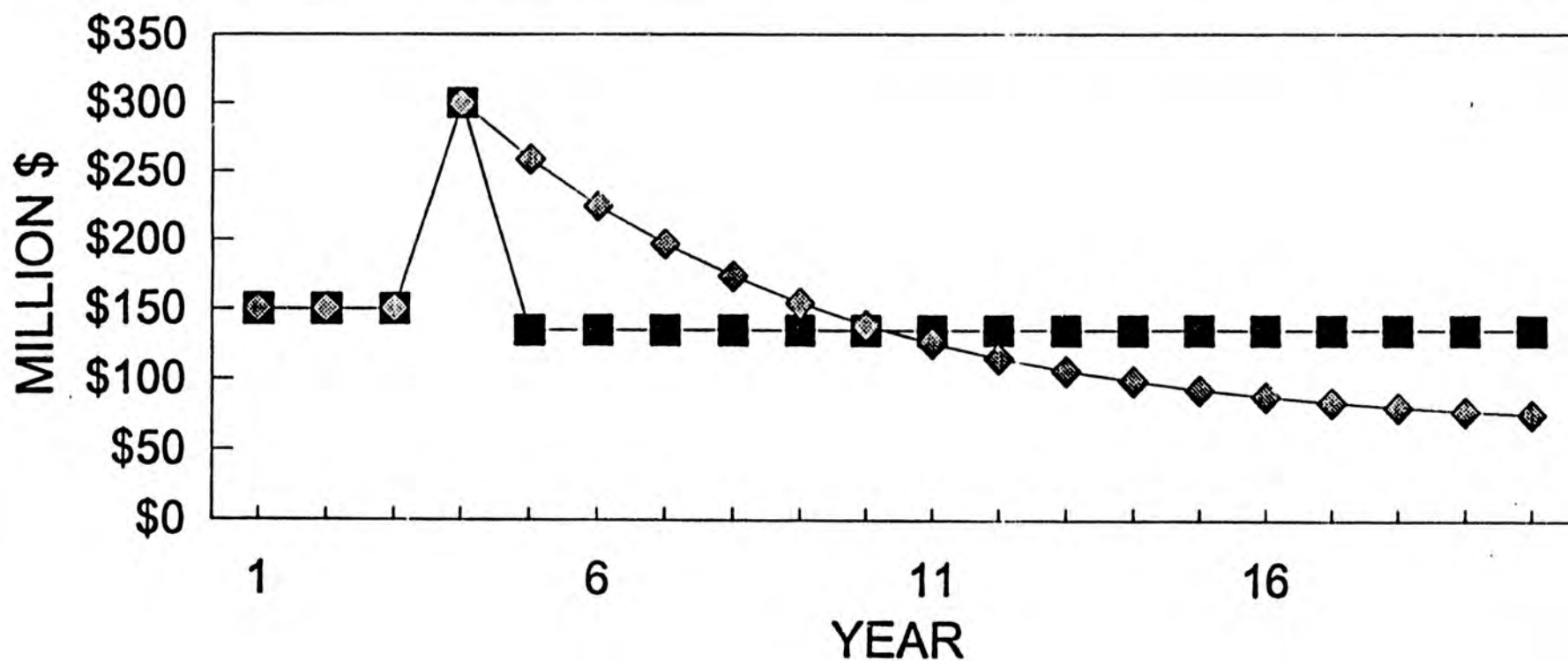


Figure 7

## SUSTAINABLE CONSUMPTION LEVEL INSTANT VS. GRADUAL TRANSITION



■ INSTANT

◆ 25% OF VARIANCE

With multiple accounts it is more difficult to sort through the financial picture to extract the essence of what is happening to asset values and sustainable consumption over time. Table 5. shows an abbreviated consolidated income statement for Alaska including the most important financial accounts. Most attention concentrates on the state General Fund as the source of funding for most state government operations. In 1994 expenditures exceeded revenues by about \$1.4 billion. Some of those revenues representing a draw on oil reserves are not sustainable. However the oil reserve was partially replenished by additions to reserves. Some of the shortfall in the General Fund was made up by revenues exceeding expenditures in the Permanent Fund. In addition considerable transfers among funds further blurred the distinction between what was a revenue and what was a draw on assets.

Alaska is in the situation of spending above the sustainable level. Income generating assets have a value of \$34 billion, which can generate between \$1 billion and \$1.7 billion in earnings each year at a real rate of return of between 3% and 5%. Other sources of state revenue currently add \$400 million for a total sustainable revenue flow of from \$1.4 and \$2.1 billion. In contrast annual expenditures are more than \$3 billion (including the Permanent Fund Dividend). If a personal income tax were reintroduced at an annual level of collections of \$300 million, the state could sustain a \$2.4 billion budget if earning assets generated a real return of 5%. Sustainable spending could be reached if there were an immediate drop in spending of \$600 million. Table 6. shows this calculation.

Implementation of a policy of this type may be further complicated if the fiscal structure is not flexible in the sense of revenue sources being available when needed to fund the targeted level of spending. The fiscal structure in Alaska may allow for that flexibility but it is not assured. The three major components of fiscal policy related to asset management are the Permanent Fund, the Constitutional Budget Reserve, and oil revenues. Use of the principal of the Permanent Fund is constitutionally prohibited. The purpose of the Constitutional Budget Reserve is to cover budgetary shortfalls when petroleum revenues alone are insufficient. If this fund is large enough and is maintained long enough it can serve that purpose until the earnings of the Permanent Fund alone are sufficient to fund spending. However there is no guarantee that the Constitutional Budget Reserve will be large enough to continue to serve that purpose. If it were to become prematurely depleted the transition would need to be partially funded by the Permanent Fund balance. This would require a constitutional amendment.

TABLE 5. STATE OF ALASKA CONSOLIDATED BALANCE SHEET FOR FISCAL YEAR 1994  
(MILLION \$)

|                                | GENERAL<br>FUND | CONST<br>BUDGET<br>RESERVE | PF<br>EARNINGS<br>RESERVE | PERM<br>FUND | SETTLE-<br>MENTS | OIL<br>RESERVES: | SUM ALL<br>ASSETS |
|--------------------------------|-----------------|----------------------------|---------------------------|--------------|------------------|------------------|-------------------|
| BALANCE 6/30/93                | \$1,350         | \$700                      | \$950                     | \$12,400     | \$3,000          | \$23,400         | \$41,800          |
| RESOURCES PROVIDED-FY94        |                 |                            |                           |              |                  |                  |                   |
| Revenues-Non Oil               | \$400           |                            |                           |              |                  |                  | \$400             |
| Investment Earnings            | \$50            | \$50                       |                           | \$1,050      | \$200            |                  | \$1,350           |
| RESOURCES USED                 | (\$3,200)       |                            |                           | (\$550)      |                  |                  | (\$3,750)         |
| CURRENT ACCOUNT SHORTFALL      |                 |                            |                           |              |                  |                  |                   |
| ASSETS TRANSFERRED INTO GF     |                 |                            |                           |              |                  |                  |                   |
| From Oil                       | \$1,350         |                            |                           |              |                  | (\$1,350)        | \$0               |
| From Settlements               | \$200           |                            |                           |              | (\$200)          |                  | \$0               |
| From ER                        | \$950           |                            | (\$950)                   |              |                  |                  | \$0               |
| TRANSFERS OUT OF GF            |                 |                            |                           |              |                  |                  |                   |
| To CBR                         | (\$900)         | \$900                      |                           |              |                  |                  | \$0               |
| TRANSFERS IN/OUT PF            |                 |                            |                           |              |                  |                  |                   |
| In from Oil                    |                 |                            |                           | \$200        |                  | (\$200)          | \$0               |
| Out to ER                      |                 |                            | \$100                     | (\$100)      |                  |                  | \$0               |
| NET CHANGE                     | (\$1,150)       | \$950                      | (\$850)                   | \$600        | \$0              | (\$1,550)        | (\$2,000)         |
| BALANCE BEFORE CHANGE          | \$200           | \$1,650                    | \$100                     | \$13,000     | \$3,000          | \$21,850         | \$39,800          |
| IN VALUE OF INVENTORY          |                 |                            |                           |              |                  |                  |                   |
| Additions to Inventory         |                 |                            |                           |              |                  | \$1,050          | \$1,050           |
| Inventory Valuation Adjustment |                 |                            |                           |              |                  | (\$7,000)        | (\$7,000)         |
| BALANCE 6/30/94                | \$200           | \$1,650                    | \$100                     | \$13,000     | \$3,000          | \$15,900         | \$33,850          |

Notes

Permanent fund figures from PFCorp Monthly Report Oct 1993  
Settlements balance for 6/30/93 based on OMB presentation to Commonwealth North  
October 1993 (\$4.3 billion), with adjustment by author to reflect fact  
that only a portion (50%) of disputed revenues are actually received,  
and subsequent disclosure in Feb. 94 that \$6 billion remains outstanding.  
Constitutional Budget Reserve and Earnings Reserve balances for 6/30/93 based on  
OMB presentation to Commonwealth North, October 1993  
General Fund Balance includes Statutory Budget Reserve, Railbelt Energy Fund,  
and Investment Loss Trust  
OMB presentation to Commonwealth North, October 1993  
Value of Oil Reserves based on reserves and current revenues per barrel produced  
Additions to Inventory based on 10 year historical average change in reserves  
Inventory Valuation Adjustment based on change in DOR fall oil price forecast  
Estimates for FY94 assume  
DOR Fall 93 projection adjusted by Revenews estimate for Feb. 94  
Deposit of \$924 million into Constitutional Budget Reserve occurs  
Budget for FY94 is \$3.2 billion

| Assumptions | Pop | Inflation |
|-------------|-----|-----------|
| 1988        | 531 | 1         |
| 1989        | 534 | 1.03      |
| 1990        | 554 | 1.06      |
| 1991        | 570 | 1.05      |
| 1992        | 586 | 1.03      |
| 1993        | 600 | 1.03      |
| 1994        | 612 | 1.03      |

**TABLE 6.    TRANSITION CALCULATION**  
**ALASKA 1994**  
**(BILLION \$)**

|                                               |         |
|-----------------------------------------------|---------|
| STATE ASSETS                                  | \$34    |
| REAL RATE OF RETURN ON ASSETS                 | 5%      |
| SUSTAINABLE INCOME FROM ASSETS                | \$1.700 |
| OTHER RECURRING REVENUES                      | \$0.400 |
| TOTAL RECURRING REVENUES FROM CURRENT SOURCES | \$2.100 |
| POTENTIAL REVENUES FROM PERSONAL INCOME TAX   | \$0.300 |
| TOTAL RECURRING REVENUES INCLUDING INCOME TAX | \$2.400 |
| STATE SPENDING                                | \$3.000 |
| ACTUAL MINUS SUSTAINABLE SPENDING             |         |
| WITHOUT INCOME TAX                            | \$0.900 |
| WITH INCOME TAX                               | \$0.600 |

## **7. IMPLICATIONS FOR FISCAL POLICY FOR THE NEXT CENTURY**

As oil in the ground is converted into financial and other assets the nature of the state fiscal structure and uncertainty evolves. Petroleum revenues decline and an increasing share of revenues come from other sources such as financial investments. Evidence of this structural change is the fact that in 1994 Alaska petroleum revenues will be \$1.5 billion while investment earnings will be over \$1 billion.

In this environment portfolio management becomes centrally important to the fiscal strength of the state. The difference between a 3% and 5% real return on the \$13 billion Permanent Fund is \$260 million, about the amount which a state personal income tax would generate. Since higher returns are always associated with greater variability in earnings, care much be given to cushioning state finances from those fluctuations as well as maximizing the return on investment.

A simple way to do this would be to draw off the fund earnings each year based on the expected long run average return on investment independent of the actual return in the most recent year. This rate can be reasonably estimated based on the historical experience of investments with characteristics similar to those in the portfolio. The flow of consumption would be stabilized and adjustments to the draw rate could be made incrementally based on actual performance.

Finally in this environment sustainability obviously depends on maintenance of the value of the corpus of the fund. This is accomplished by investing only in income earning assets and drawing no more than the real earnings of the fund for current consumption.