479

LONG-RUN FISCAL PLANNING MODELS FOR REGIONAL ECONOMIES DEPENDENT UPON NONRENEWABLE RESOURCES

by

Scott Goldsmith
Assistant Professor of Economics
University of Alaska
Anchorage, Alaska

Institute of Social and Economic Research
Anchorage * Fairbanks * Juneau

Paper presented at

Western Regional Science Association Annual Meeting
Monterey, California

February 21, 1980

LONG-RUN FISCAL PLANNING MODELS FOR REGIONAL ECONOMIES DEPENDENT UPON NONRENEWABLE RESOURCES

Introduction

Regional economies which are largely dependent upon nonrenewable resources face the challenge of translating temporary economic growth associated with the exploitation of their resources into long-term economic development based upon a more diversified economic base. The rapid increase in the market price of natural resources such as petroleum has provided an opportunity for development heretofore not available to many of these economies. For these economies, strategies for effecting this transition range from the trust fund approach embodied in the Alberta Heritage Savings Trust Fund to the massive investment in industrialization approach undertaken by many of the OPEC nations. The particular set of policies adopted in any situation will depend upon both the long-run development objective of the region as well as the opportunities for growth and development embodied within the parameters of the economy.

This paper is a report on work in progress in Alaska attempting to establish a framework for analysis of the particular Alaskan version of this problem, to identify its constraints, and to trace out possible development strategies based upon alternative formulations of the regional objective function. The effort is policy-oriented and can largely be viewed as an attempt to operationalize growth models and optimal control models for use by those actually deciding policy questions relating to economic growth.

The Problem

About 80 percent of Alaska state government revenues derive from petroleum production on state owned lands at Prudhoe Bay and closely related activities (royalties, severance taxes, property tax, income tax). This level of revenues, although much in excess of current requirements of state government expenditures, is temporary in nature and will begin to decline when production from the field begins to fall off. A portion of state royalties (25 percent) is presently being set aside in a Permanent Fund in anticipation of the depletion of the resource and the accompanying decline in petroleum revenues. The remaining petroleum revenues are available for present consumption or for investment, presumably to engender economic development and, with it, a more diversified economy and tax base.

Two factors combine to make the choice of dealing with this substantial but temporary state government wealth extremely difficult to formulate. They are that industrial diversification possibilities are presently quite limited and that population is an endogenous variable in the problem.

The nonrenewable resource wealth provides the opportunity for almost unlimited capital investment to stimulate growth and development in an underdeveloped economy where capital scarcity is not a significant problem. Lack of development is more properly traced to the small size of the local market and the resultant high cost of doing business, the great distance from larger markets, and the inaccessibility of most natural resources. Consequently, although the means to construct a traditional development strategy exists, the application of that strategy appears inappropriate. Unfortunately, the presence of vast reserves of minerals such as coal and stocks of renewable resources such as timber creates the illusion of a "storehouse" requiring only capital infrastructure to unlock.

Second, the large size of petroleum revenues in relation to the economy of the state (Alaskan personal income in 1978 was about $4.5 billion and petroleum revenues projected for FY 1980 are about $2.3 billion) means that the disposition of these revenues will have a significant impact on the level of economic activity within the state and, because Alaska is an open economy, upon the population level. Population change affects the strategy choice problem in two important ways. First, it changes the set of possible options available for future development. For example, a larger population increases the potential for economies of agglomeration. On the other hand, it puts a strain on the essentially constant fiscal resources of the region as the demand for public services rises with population. Second, new migrants to the region may have welfare functions and rates of time preference different from those of the present residents. If the social welfare function is an aggregate of the functions of the individuals within the region, the specification of this aggregate function will be dependent upon population and endogenous to the problem.

Because of these complications which restricted development options and migration impose upon the problem of selecting a strategy for dealing with the nonrenewable resource revenues, translating a theoretical model into an operational tool becomes exceedingly difficult.[1]

The Nature of the Theoretical Model

The general problem can be simply stated. The region has a welfare function which it attempts to maximize. Most generally, the arguments are consumption, public and private, both in the present and all future periods. Alternative specifications might include employment or income or other variables reflecting aspects of the growth or development of the economy. The welfare function is maximized by the choice of levels and types of government spending in each period out of the revenues made available by the selling off of the nonrenewable resource. A large number of choices are available, each with different growth consequences in terms of employment, population, income, revenue generating capacity, and demand for government services. Revenues can be directly distributed either to individuals who would allocate their share to consumption and private saving or to businesses who would either invest or distribute the proceeds to stockholders. Alternatively, revenues can be spent by the government for current expenses, regular social capital goods, social overhead capital (in an attempt to make private development prospects more economically attractive), or direct government involvement in private sector industry. Revenues can be invested in securities or lent at market or below market rates in private sector business activities within the region or outside the region. Finally, the rate of extraction of the resource can be varied to bring the rate of return on holding the resource stock into equality with that of other investments.

The allocation rule that emerges from this framework is straightforward. In each period, funds should be allocated within the regional economy and outside the region, between savings and spending, and among types of saving and spending in such a way that the present value of the discounted stream of future benefits from the last dollar allocated in each use is equal.[2] Although easy to state, the optimal conditions for maximizing benefits from resource revenue use are extremely difficult to operationalize.

A Simple Operational Model

A simple simulation model for the Alaskan economy has been constructed which attempts to capture its essential characteristics and can be used to address some of the questions surrounding the problem of allocating nonrenewable resource revenues.[3] It was designed as a compact version of a detailed econometric model of Alaska.[4] This model highlights the importance of the long-run relationship between the demand for government expenditures and the supply of government revenues, both of which are a function of the level of economic activity in the region. Economic activity is, in turn, a function of exogenous growth in the basic sector and growth in the level of government spending.

This model has been used to address two questions of importance for state fiscal planning. First, how rapidly can state government expenditures per capita grow subject to the constraint that the state treasury always maintains a positive balance? Second, what types of government investments in or stimulation of the private sector will enhance the ability of the government to finance expenditures on a recurring basis? In this model, the welfare function is an extreme case. It consists of only public sector consumption, and future public consumption levels are undiscounted to the present with the result that they carry the same weight as present consumption in the welfare function.

Because of the high present degree of dependence of the state government on petroleum revenues and the dearth of alternatives available for diversification of the tax base, the maximum annual growth rate of real per capita state expenditures is a modest 1.2 percent. Essentially, expenditure growth must be slow and resource revenue accumulation large in order to allow time for recurrent revenues to grow to a size where they pay for all state expenditures just when nonrenewable resource revenues have all been spent. The day when recurrent revenues provide full support for expenditures does not come until the middle of the next century--about 70 years from now--and in the interim, a tremendous state government surplus (reaching 16 times the size of the current budget) would have to be built up and nurtured. Few of us would be likely to have the patience to resist the temptation to chip away at such a large surplus of nearly $20 billion.[5]

The model's answer to the second question is also perplexing because of the huge tax base which the petroleum industry provides relative to other potential industries which the state may foster. In the long run, the stimulation of industry by government will increase the size of the tax base. However, in the short run, the increase in the demand for government by the new migrants who fill the newly-created jobs draws down the fiscal surplus. Future earnings generated by the surplus are thus lower. To the extent that the latter effect predominates, there is virtually no industry investment which will increase the ability of the government to pay for increased levels of expenditures. Because of the huge tax base which the petroleum industry provides, particularly in relation to its population, and the high present level of per capita state spending, by this criterion of "ability to pay" virtually no industrial development should be fostered by state government.

Analysis of these results indicates several important points:

1. The maximum feasible growth rate is relatively insensitive to assumptions concerning total petroleum revenues received by the state, rate of return on invested government surpluses, and the response parameters of the model such as the rate of growth of recurrent revenues, the rate of growth of basic sector employment, the response of migration to employment opportunities, etc.

2. The higher the maximum per capita government expenditures growth rate (a function of petroleum revenues), the further into the future will be pushed the day when recurrent revenues grow to a size where they can fund all state expenditures and, thus, the longer the surplus management planning horizon.

3. Because the future is not discounted and the uncertainty of future events is not taken into account, it is necessary to estimate petroleum revenues, the structure of the economy, and other events and relationships for a period of about 70 years. These future speculations carry equal weight with more current and certain events.

The value of using this simple model to formulate the question of resource revenue disposition lies in the fact that it is an extreme case. The welfare function implicit in this analysis is that of a government which is concerned only with future public expenditure levels and which weighs the consumption of present and future generations of citizens equally. This is consistent with the interpretation of the natural resource as belonging to all generations of citizens, future as well as present.

More Complex Models

Work is presently underway to enrich the capabilities of this simple model in several areas under the general framework of an optimal control formulation.[6] In such a framework, a set of policy instruments--in this case, the levels of various types of expenditures from available petroleum revenues--is set in a manner which maximizes a welfare function of policy targets (and possibly instruments). The optimization occurs subject to the structure of the simulation model and any constraints on targets and instruments which may be built into the optimization function.[7] The advantages of this formulation are the flexibility and generality possible with respect to the specification of the welfare function and the ability to integrate a discount rate into the analysis.

A simple case was analyzed using this model in which the welfare function again includes only government expenditures which have a marginal value almost equal to their average,[8] in which consumption next year is discounted from the present only 3 percent, and in which the planning horizon is twenty years. A single instrument variable is the amount saved annually (equivalently the amount spent on government expenditures). Under these assumptions, the optimal rate of state expenditures is significantly different from the previous case. The optimal government spending strategy is a rapid growth in the level of state expenditures in the initial years with a subsequent constant level of per capita expenditures until the end of the planning horizon in the year 2000. Real per capita expenditures increase by about 50 percent over the initial six-year period.

An obvious problem with this solution is that without a terminal condition on the welfare function in 2001, expenditures must either be reduced by over 70 percent or the state must begin running a huge deficit in that year. By extending the planning horizon, growth in expenditures in early years is moderated; but even so, the difference in the optimal instrument level (growth rate of state expenditures) in the initial year between this case (16 percent) and that derived from the earlier case (1.2 percent) indicates the extreme sensitivity of the results to changing the welfare function and the rate of time discounting.

Conclusion

As has been pointed out elsewhere,[9] the specification of the welfare function and the discount rate applied to benefits determine the time pattern of the optimizing instruments in this analysis. The work done in the Alaskan case has so far concentrated on the alternative of a single-minded government with an expected infinite life. Modest changes in the welfare function result in drastic changes in optimizing behavior. If private sector consumption is also included in the welfare function, it is likely that the discount rate used to discount future benefits would be much higher, resulting in a further shift in spending toward the present as individuals would migrate into the state to take advantage of the temporary opportunities associated with the disposition of petroleum revenues and subsequently leave the state after those opportunities had passed. Work continues on the development of optimal investment and expenditure strategies assuming these and further extensions of the specification of the welfare function.

Notes

1. Analogous to the statewide problem is one posed for the Alaska Natives who, as a group, share in the nonrenewable resource wealth. The complication of migration is not so important for them, but that of development options creates more restrictions.

2. The model is developed in Scott Goldsmith, "Fiscal Planning and the Long-Run Growth Pattern of Resource Based Open Economies," paper presented at Western Economic Association Annual Meeting, Kona, Hawaii, June 1978.

3. This model is described in detail in Scott Goldsmith, BAM3: A Fiscal Planning Model for Alaska, prepared for the State of Alaska, Office of the Governor, Division of Budget and Management, June 1979.

4. This model is described in Dave Kresge and Dan Seiver, "Planning for a Resource Rich Region: The Case of Alaska," American Economic Association Papers and Proceedings, Vol. 68, No. 2, May 1978.

5. Since the completion of this analysis, the level of projected future petroleum revenues to the state has approximately doubled. This allows the growth rate to increase somewhat but pushes further into the future the day when recurrent revenues can pick up the tab for state spending.

6. For a recent application of optimal control theory to a state econometric model, see Wilford L. L'Esperance, "An Optimal Control of a State Econometric Model," Growth and Change, Vol. 10, No. 2, April 1979, pp. 30-39.

7. The particular computer program utilized for these experiments is the TROLL optimal control program.

8. Specifically, welfare is the level of real per capita appropriations in thousands of dollars minus 1 percent of the square of per capita appropriations.

9. B. L. Scarfe and T. L. Powrie, "The Optimal Savings Question: An Alberta Perspective," paper presented at the Conference on the Alberta Heritage Savings Trust Fund at University of Alberta, October 1979.