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SOME INCOME REDISTRIBUTION CONSEQUENCES OF FEDERAL WATER DEVELOPMENT POLICIES

by
Henry James Vaux, Jr.

A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
(Natural Resource Economics)
in The University of Michigan
1973

Doctoral Committee:

Associate Professor Gunter Schramm, Chairman
Professor Lyle Craine
Associate Professor William B. Neenan
Professor Joseph Sax

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ABSTRACT

SOME INCOME REDISTRIBUTION CONSEQUENCES OF
FEDERAL WATER DEVELOPMENT POLICIES

by

Henry James Vaux, Jr.

Chairman: Gunter Schramm

Welfare economists have traditionally deemphasized income distribution in both their theoretical and applied work. With exceptions, problems of income distribution have been dealt with through the use of simplifying assumptions. Benefit-cost analysis, the most common practical application of welfare economics, generally assumes that 1) the prevailing distribution of income is optimal or 2) income redistribution should be accomplished through a separate system of tax and transfer payments.

Some economists recognize that society has preferences about the extent to which tax and transfer payments are appropriate means to accomplish income redistribution. These economists have devised methods whereby the income redistribution consequences of public policies can be evaluated within the context of benefit-cost analysis. These methods have shortcomings. Many enable examination of redistribution *ex post*. Studies utilizing such methods are of limited value in providing guidance relevant to future distributional consequences of contemplated policies. Other methods rely

on arbitrarily developed social welfare functions. These are not useful to the decision-maker since social welfare functions are not available for use in evaluation of policy alternatives.

This study asserts that definitions of distributional neutrality are value judgments and economists cannot draw conclusions about the superiority of any one definition. Economists can contribute conclusions relative to appropriate measures of net gain or loss to be used under varying circumstances. Such measures are discussed and evaluated and problems in their interpretation are identified and analyzed. A method is developed for use in estimating future redistributional consequences of alternative public policies without resorting to a social welfare function.

The method is then applied to an actual policy problem involving a controversy over the allocation of scarce waters in western Nevada between the Pyramid Lake Paiute Indians and the Truckee Carson Irrigation District. Despite many studies and deliberations, the Secretary of Interior has been unable to resolve the conflict. The matter is currently the subject of litigation. It is argued that the Secretary might have formulated sound bases for decision if he had examined the income redistribution consequences of various policy options.

Survey research, dynamic programming and statistical techniques are utilized to develop estimates of existing distributions of income among families. The distributions indicate

that the farmers have significantly more income than the Indians, that there are fewer low-income farm families than Indian families and that there are more middle and high income farm families than Indian families. The existing distributions are utilized in developing estimates of redistributive consequences in the event of no change in water allocation policies over the next 20 years. The resulting distribution, discounted to present value, is used for comparison and evaluation of the redistributive effects of two policy options available to the Secretary.

The analysis demonstrates that under either policy alternative low income Indian families would tend to benefit disproportionately more than relatively high income Indian families. Similarly, under either policy alternative, relatively high income farm families would tend to bear a disproportionately high share of the costs compared to the relatively low income farm families. An analysis of the redistribution of income between the groups indicates that farm families would bear very small costs relative to the magnitude of the benefits which accrue to each Indian family. This result is shown to be partially attributable to the presence of more farmers than Indians. However, it is generally concluded that high income farmers would bear a relatively disproportionate share of the costs while low income Indians would receive a disproportionate share of the benefits under either of the assumed policy alternatives.

INTRODUCTION

> . . . ; that the Federal Government should improve or participate in the improvement of navigable waters or their tributaries, including tributaries thereof, for flood-control purposes if the benefits to whomsoever they may accrue are in excess of the estimated costs, and if the lives and social security of the people are otherwise adversely affected.[1]

The above quotation, taken from the Flood Control Act of 1936, was the genesis of the development of what is perhaps the most sophisticated methodology for the application of welfare economics to public policy. Over the last thirty-six years both academic and government economists have labored to develop and improve procedures to ascertain, in fact, whether the benefits accruing from individual water resource projects exceed the costs of these projects. Since 1936 almost all water development projects submitted to the Congress for authorization have had attached to them a benefit-cost ratio. With but a few exceptions, only those projects having benefit-cost ratios exceeding one have been authorized for construction. Benefit-cost analysis has been referred to in the literature as the principal exercise in applied welfare economics.[2]

For the most part, benefit-cost analysis has focused on the efficiency aspects of a given project. The analysis identifies the

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[1] Flood Control Act, 49 Stat. 1570 (1936), 33 U.S.C. sec. 701 (a) (1970).

[2] See for example: John V. Krutilla, "Welfare Aspects of Benefit-Cost Analysis," *Journal of Political Economy*, LXIX (June, 1961), pp. 226-235.

net national income benefits, that is the benefits from the project accruing to national income. The principal focus of benefit-cost analysis, then, has been on efficiency in resource use. In the economic sense, efficiency refers to the allocation of scarce resources among unlimited demands for them so as to maximize the returns to the nation obtainable from such allocation over time. In developing the benefit-cost methodologies economists have traditionally focused principally on the efficiency aspects of the project under consideration. In so doing they have often failed to recognize that efficiency is a relative concept. An efficient state is an optimal state only if there is agreement that the resulting distribution of income is in some sense optimal. Economists have traditionally been reluctant to talk of optimal states of distribution because of the intractable conceptual and empirical problems associated with characterizing such states. It is conventionally argued that economists have no special expertise in determining what is an equitable distribution of income or utility. How, for example, is the worth of an additional dollar in income to one or another persons to be ascertained? This is the fundamental problem of interpersonal utility comparisons. Most economists concede that this is an ethical problem whose solution must be left to the political process.

In the development of benefit-cost analysis it has thus been necessary to make two simplifying assumptions in order to surmount the difficulties of interpersonal utility comparisons. The first assumption is that the marginal utility of income is constant in the relevant range and the second is that the marginal utility of income is constant

among individuals.[3] This latter assumption implies that the subjective utility of the marginal dollar is identical for a Rockefeller and a welfare recipient. It follows that national income should be maximized irrespective of who receives it.

The assumption of constant marginal utilities of income among individuals not only handles the conceptual problems of interpersonal utility comparisons, it also appears justified by the language of the 1936 Flood Control Act. "To whomsoever they may accrue" seems to imply that the Congress in passing the Act felt either that water resource development programs were not an appropriate tool for redistributing income and therefore income redistribution effects should not be taken into account and/or that it believed implicitly that the marginal utility of income was constant among individuals. Although there is no explicit evidence relating to either of these implications in the legislative history of the Act, economists could defend their assumption of constant marginal utilities on the basis of the language contained in the 1936 Act.

Several recent developments indicate that both the Congress and Executive Branch are unprepared to accept the notion that the distribution of income is irrelevant in deciding whether to authorize and construct a water project. The 1965 Rivers and Harbors Omnibus Act authorized three projects which required additional cost sharing because of the special nature of some of the benefits.[4] The three

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[3] Otto Eckstein, *Water Resource Development* (Cambridge: Harvard University Press, 1958), pp. 70-72.

[4] Flood Control Act, 79 Stat. 1074 (1965).

projects in question were all flood control projects designed to protect, at least in part, previously undeveloped land. The projects were as follows: San Diego River (Mission Valley), California;[5] Tahquitz Creek, Whitewater River Basin, California;[6] and Gila River Basin, New River and Phoenix City Streams, Arizona.[7] These projects all had the common characteristic that significant benefits of a "windfall" nature would accrue to a few select land owners. The Chief of Engineers, the Secretary of the Army and the Bureau of the Budget all recommended that the local cooperating bodies be required to pay costs over and above those normally required in view of the land enhancement benefits. In the case of Mission Valley and Phoenix these recommendations were upheld by the Congress in the authorizing legislation. In the case of Tahquitz Creek, the Congress modified the cost sharing recommendations slightly in order to relieve a tribe of Indians from the additional costs that they would have had to bear. The action taken on these three projects by both the executive agencies and the Congress reveals that both the size of the benefits and the individuals to whom they accrued were very relevant factors in the decision making process.

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[5]U.S. Congress, House, *Report on San Diego River (Mission Valley), California*, H. Doc., 212, 89th Cong., 1st sess., 1965.

[6]U.S. Congress, House, *Report on Tahquitz Creek, Whitewater River Basin, California*, H. Doc. 223, 89th Cong., 1st sess., 1965.

[7]U.S. Congress, House, *Report on Gila River Basin, New River and Phoenix City Streams, Arizona*, H. Doc. 216, 89th Cong., 1st sess., 1965.

A second and potentially more pervasive development indicating that income distribution is emerging as a relevant factor in the decision making process with respect to water development is the publication by the Water Resources Council of the *Proposed Principles and Standards for Planning Water and Related Land Resources.*[8] The *Proposed Principles* . . . would require that water resource projects be evaluated on the basis of three criteria, enhancement of national economic development, enhancement of environmental quality and enhancement of regional development. Additionally, planning documents would be required to enumerate beneficial and adverse effects on social factors. Social factors are defined, in part, as including the ". . . effects which are contributions to the equitable distribution of real income and employment and to other social opportunities."[9] Although the document is not explicit about how such benefits are to be measured, the importance of the above statement is the recognition that the distribution of benefits among individuals is not a neutral factor but rather ought to be taken into account.

There are very real problems associated with the ways in which income distribution effects were taken into account in the three projects in the 1965 Rivers and Harbors Omnibus Act and in the proposal of the Water Resources Council. These will be discussed later. The point to be made by referring to them here is to indicate that there

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[8] U.S., Water Resources Council, Notice of Public Review and Hearing, "Proposed Principles and Standards for Planning Water and Related Land Resources," *Federal Register*, XXXVI, No. 245, Part II, Dec. 21, 1971, pp. 24144-24194.

[9] *Ibid.*, p. 24164.

is at least semi-official recognition of the fact that income distribution cannot be assumed to be optimal and, further, that water resource projects do have an impact on income distribution. In other words, the income distribution consequences of water projects should be considered explicitly in the decision making process.

The purpose of this study is to show that economists have in the past been remiss in their neglect of the income distribution consequences of water policies. The study will demonstrate that it is not always necessary to make the assumption that subjective marginal utilities of income across individuals are always constant. Furthermore, the study will demonstrate that in the making of public policy decisions, it is possible to ascertain the incidence of income changes associated with any decision to devote resources to the benefit of a given group of individuals rather than some alternative group.

The study will be carried out in two parts. The first part will focus on theoretical welfare economics and methodologies devised to apply welfare economics to the public decision making process. Chapter 1 consists of a summary review of the conventional conclusions of theoretical welfare economics and applied welfare economics relative to income distribution. Particular emphasis will be placed on the importance of assumptions about income distribution which underlie both theoretical and applied welfare economics. Chapter 2 is devoted to a critical survey of the economic literature dealing with the problem of accounting for income distribution effects of water policies and programs. Chapter 3 will propose a methodology whereby

public policy makers can explicitly take account of income distribution consequences. Additionally, this chapter will consider several criteria which might be used in evaluating income distribution consequences.

The second part of the study consists of an empirical application of the proposed methodology to an existing water policy dilemma. Chapter 4 will describe and characterize the policy dilemma posed by water allocation in the lower Truckee-Carson River basins in western Nevada. Chapter 5 will examine empirically the income distribution consequences of the Newlands Project, a relatively large Bureau of Reclamation irrigation project in the region. Finally, Chapter 6 will consider empirically the income distribution implications of various reallocation options open to the executive, legislative and judicial branches of the federal government. In summary, this study is designed to show both the theoretical and practical importance of taking income distribution into account in public decision making and secondly to demonstrate that it is possible to take such distributive consequences into account in the actual decision making process.

CHAPTER 1

WELFARE ECONOMICS AND INCOME DISTRIBUTION

The purpose of this chapter is to review briefly the views of economists on the role of income distribution within the total scheme of welfare economics. The first portion of the chapter will consider the conclusions of theoretical welfare economists relative to income distribution. Following this, the positions of applied welfare economists and the work that has flowed from their thinking relative to the role of income distribution will be examined. This chapter will show that the efforts of welfare economists have, for the most part, involved the development of untenable theoretical constructs or have consisted of the enumeration of varied arguments suggesting that income distribution is either not an appropriate subject for scrutiny by economists or, alternatively, cannot be scrutinized given the current state of economic thought and methodology.

Theoretical Welfare Economics and Income Distribution

Early theoretical welfare economics utilized the notion of Pareto optimality as its principal guideline.[1] This notion suggests that welfare is maximized when no one person can be made better

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[1]For a full discussion of the concept of Pareto optimality see: Francis M. Bator, "The Simple Analytics of Welfare Maximization," *The American Economic Review*, XLVII (March, 1957), pp. 22-59.

off without making some other person worse off. An ancillary principle holds that exchange or production of a specified nature is Pareto efficient if it makes somebody better off without making anyone worse off. The early tradition of welfare economics held, then, that once a Pareto optimal state had been attained the economist could provide no further guidance respecting potential increases in social welfare.

There are numerous difficulties with the notion of Pareto optimality and with the claim that the economist has no special expertise to prescribe changes once a Pareto optimal state has been reached. These have been well documented in the literature.[2] The principal difficulty, however, lies with the fact that there are an infinite number of Pareto optimal states if all of the conditions for perfect competition obtain. The Pareto optimal state which actually occurs is a function of resource endowments or the initial distribution of wealth. As a consequence, achievement of a Pareto optimal state can be regarded as a social welfare maximum if and only if the existing distribution of wealth is presumed to be optimal in some sense. Economists generally have always eschewed the idea that they had any special expertise which would enable them to prescribe or characterize the optimum distribution of wealth. Some have pressed the argument still further, concluding that the inability of economists to be scientific in their prescriptions relative to income distribution

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[2]See for example: O. A. Davis and A. B. Whinston, "Piecemeal Policy and the Theory of Second Best," *The Review of Economic Studies*, 99 (July, 1967), pp. 323-331; R. G. Lipsey and Kelvin Lancaster, "The General Theory of Second Best," *The Review of Economic Studies*, 25 (1956-57), pp. 11-32.

implies that they should say nothing about it and leave the value decisions to the political process.[3] This is a curious kind of an argument since the refusal to make a value judgment is in itself a value judgment both because it implies that economists should refrain from making value judgments and because it imparts normative significance to the prevailing distribution of income.[4]

A later formulation in theoretical welfare economics was the contribution of Abram Bergson.[5] Bergson postulated the existence of a social welfare function which depicted states of maximum social welfare. Social welfare was optimal when this function was maximized subject to constraints on resource availability, production and exchange possibilities. Use of the social welfare function theoretically enables the economist to identify which Pareto optimal state yields maximum social welfare. Once this has been identified all of the variables in the idealized competitive market system become determined for maximization of social welfare. Bator's use of the social welfare function, for example, enables him to identify explicitly the optimum endowments of resources or wealth.[6]

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[3]See: Arnold C. Harberger, "Three Basic Postulates for Applied Welfare Economics: An Interpretive Essay," *The Journal of Economic Literature*, IX (September, 1971), p. 796; John V. Krutilla and Otto Eckstein, *Multiple Purpose River Development* (Baltimore: Johns Hopkins Press, 1958), pp. 49-50.

[4]Franklin M. Fisher, "Income Distribution, Value Judgements and Welfare," *Quarterly Journal of Economics*, (August, 1956), p. 394.

[5]Abram Bergson, *Essays in Normative Economics* (Cambridge, Mass.: Harvard University Press, 1966), pp. 3-90.

[6]Bator, "Simple Analytics," p. 37.

In addition to Bator, numerous other economists have used the social welfare function as a device for depicting social welfare optima thus enabling them to develop completely determinate theoretical models.[7] The principal appeal of the social welfare function to economists is that it enables them to deal with the normative problem of optimal wealth distribution in a way which provides a single solution to many types of economic problems which are susceptible to theoretical specification. There are great difficulties, however, in attempting to transfer the social welfare function from the theoretical world to the real world. No such function can be empirically specified except by a philosopher king or a benevolent dictator. The social welfare function is particularly inapplicable in democratic societies.[8] Even if it were possible to specify such a function there would remain the problem of describing its changes over time.

As a result, the use of the social welfare function has been restricted to theoretical work and provides no guidance to the economic practitioner or decision maker. Rather, many economic formulations and indeed decisions are made under the tacit assumptions that income distribution is optimal and that any change in distribution will also be optimal. This, of course, is tantamount to saying that income distribution is not important or does not matter. A

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[7] See for example: Richard Musgrave, *The Theory of Public Finance* (New York, N.Y.: McGraw-Hill Company, 1959), pp. 80-86.

[8] See: Kenneth Arrow, *Social Choice and Individual Values* (New York: N.Y.: John Wiley and Sons, Inc., 1963).

consistent disregard for income distribution is also characteristic of applied welfare economics which is briefly reviewed in the following section.

Applied Welfare Economics and Income Distribution

If the idealized neoclassical world which is often the basis for economic models actually existed, there would, with one exception, be no need for applied welfare economics. If some institution could be devised which could specify an appropriate social welfare function, then the efficiency conditions for consumption and production would be determinate. The only possible problem that could arise in such a situation stems from the fact that the efficiency conditions might not be fulfilled due to an improper distribution of income. In such a world, applied welfare economics would consist only of specifying the social welfare function and making the appropriate transfers of income between groups in order to ensure that optimum economic welfare was attained. The job of the applied welfare economists would be simply to calculate the transfers necessary to achieve the "efficient" distribution of income implied by the social welfare function.

It hardly need be stated that no such idealized neoclassical world exists. It has been argued and demonstrated that the purely competitive model breaks down or fails in the real world in numerous instances.[9] The existence of such situations is presumed to be *a priori*

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[9]Richard A. Musgrave, *The Theory of Public Finance* (New York: McGraw-Hill Co., 1959), pp. 3-27; Francis M. Bator, "The Anatomy of a Market Failure," *Quarterly Journal of Economics*, (August, 1958), pp. 351-379; U.S., Congress, Joint Economic Committee, *The Analysis and*

justification for intervention of the government into the workings of the private economy. Theoretical guidelines to govern the nature of those interventions have been ably demonstrated elsewhere.[10] The case for governmental intervention is not of central importance here. What is of importance here is that such a case has been made as testified to by the fact that the expenditures of the national government alone account for approximately 20% of total gross national product.[11] What this means is that applied welfare economics has a far greater role to play than that described in the first paragraph of this section. This is so because government activities are intermingled with the activities of the free market. And yet the application of welfare economics to public policy issues has been relatively retarded. Almost solely through the tools of benefit-cost analysis has welfare economics been applied to public policy problems in any systematic way.

Benefit-cost analysis had its practical birth in the Flood Control Act of 1936.[12] Despite the efforts of many government and academic economists it was nearly 20 years before a formal mathematical statement of the welfare content of benefit-cost analysis was developed. This statement was published by Otto Eckstein and remains today the

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Evaluation of Public Expenditures: The PPB System, Vol. 1, "Pervasive External Costs and the Response of Society," by Allen V. Kneese and Ralph C. d'Arge, Joint Committee Print (Washington, D.C.; Government Printing Office, 1969), pp. 87-102.

[10]Bator, "The Anatomy of a Market Failure," pp. 351-371; R. G. Lipsey and Kelvin Lancaster, "The General Theory of Second Best," pp. 11-32.

[11]U.S., Council of Economic Advisors, *Annual Report of the Council of Economic Advisors, 1971* (Washington, D.C.: Government Printing Office, 1971), pp. 197, 275.

[12]Flood Control Act, 49 Stat. 1570 (1936), 33 U.S.C. sec. 701 (a), 1970.

basic theoretical statement of benefit-cost analysis.[13]

Eckstein makes and justifies crucial assumptions during the development of his statement. He assumes first that the marginal utility of income is constant in all ranges and, second, that the marginal utility of income is constant among all individuals. The clear implication of these assumptions is that income distribution does not matter. More graphically, an extra dollar of income produces an identical increase in social welfare irrespective of the incidence of that additional income if society values all marginal dollars identically irrespective of their incidence.

These same assumptions tend to pervade the literature dealing with the practical application of benefit-cost analysis to public investment programs although they are rarely made explicit. The "Green Book,"[14] the first formal practical guide for use of federal agencies in applying benefit-cost analysis, makes no mention of income distribution whatsoever. Similarly, Bureau of the Budget Circular A-47[15] fails to deal with income distribution at all. Senate Document No. 97,[16] the successor to Circular A-47, states that "well-being of all people shall be the overriding determinant in considering the best use of

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[13]Otto Eckstein, *Water Resource Development* (Cambridge: Harvard University Press, 1958), pp. 70-73.

[14]U.S., Inter-Agency Committee on Water Resources, Subcommittee on Evaluation Standards, *Proposed Practices for Economic Analysis of River Basin Projects* (Washington, D.C.: Government Printing Office, 1958), pp. 1-51.

[15]U.S., Bureau of the Budget, *Circular A-47*. December 31, 1952 (Mimeographed pamphlet issued by the Bureau of the Budget).

[16]U.S., Congress, Senate, *Policies, Standards, and Procedures in the Formulation, Evaluation, and Review of Plans for Use and Development of Water and Related Land Resources*, S. Doc. 97, 87th Cong., 2nd sess., 1962.

water and related land resources."[17] However, beyond certain requirements to take account of alleviation of unemployment and stabilization of production and income together with a general statement to the effect that ". . . care should be taken to avoid resource use and development for the benefit of the few or the disadvantage of the many,"[18] no statement is made relative to the need to consider explicitly the distribution of income. As a consequence, it is reasonable to argue that, for the most part, benefit-cost analysis has been conducted without regard to the distribution of income. With very few exceptions (those projects noted in the introduction being among them) applied benefit-cost analysis assumes that national efficiency benefits are synonymous with an increase in social welfare. Despite this obvious shortcoming it is not altogether clear that future application of benefit-cost analysis or other evaluative techniques will take account of distributional consequences in any systematic way.

Recent work by the Water Resources Council has recommended that the distribution of income be considered as a criteria in project planning and development.[19] A number of economists have argued that impacts of government investment on inter-personal income distribution should remain a secondary consideration in planning and investing in

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[17] *Ibid.*, p. 2.

[18] *Ibid.*, p. 2.

[19] U.S., Water Resource Council, *Principles for Planning Water and Land Resources*, Report to the Water Resources Council by the Special Task Force (Washington, D.C.: mimeographed pamphlet, 1970), pp. 3, 5-6, 9.

federal water projects. Jack Knetsch and a number of his colleagues state, for example, that:

> The basic economic rationale justifying public sector responsibility for natural resource development requires that the criterion of national income enhancement serve as the primary criterion for choice among investment alternatives. . . . There should be no allocation of national income costs to the attainment of other objects."[20]

Charles Cicchetti and several of his colleagues argue that:

> . . . the equity issue can and should be eliminated by requiring all identifiable beneficiaries of the project to pay their share of the project cost.[21]

This group explicitly identifies equity as being the same thing as income redistribution.[22] Cicchetti *et al.* discuss the need for encouraging both the efficient use of resources and the proper incidence of project costs.[23] It is clear from a reading of their critique that they believe water resource development investments are improper means through which to redistribute income. This, however, ignores the fact that water resource projects and other federal investments *do* redistribute income and it is unlikely that many of them could be designed to avoid such consequences. As a result it seems appropriate to

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[20] Jack L. Knetsch, Robert Haveman, Charles Howe, John V. Krutilla and Michael Brewer, *Federal Natural Resources Development: Basic Issues in Benefit and Cost Measurement* (Washington, D.C.: Natural Resources Policy Center, The George Washington University, 1969), p. 11.

[21] Charles Cicchetti, Robert K. Davis, Steve H. Hanke, Robert Haveman and Jack L. Knetsch, *Benefits or Costs? An Assessment of the Water Resources Council's Proposed Principles and Standards* (Baltimore, Md.: Department of Geography and Engineering, The Johns Hopkins University, 1972), p. 5.

[22] *Ibid.*, p. 5.

[23] *Ibid.*, p. 6.

illuminate in some systematic fashion the precise nature of that redistribution. If one does concede that water projects are an inappropriate means of redistributing income then it would appear all the more important to identify precisely the transfers which do occur as a result of the construction and operation of such projects.

Thus the efforts of the Water Resources Council to take more explicit account of the range of impacts (including income redistribution) stemming from water resource projects are being criticized by many economists on the traditional grounds that economics has nothing to say about income distribution. Many still hold the view that efficiency considerations must stand alone.

Conclusion

The conclusion of this chapter is that economists have been somewhat cavalier in their disregard for income redistribution consequences of economic activities and particularly so in their analyses of public investment activities. The theoretical derivation of benefit-cost analysis as typified by Eckstein's work assumes that income distribution does not matter. Indeed, Eckstein states that, "there is no logical way of incorporating distributive effects into benefit-cost analysis, which must confine itself to the one dimension benefit for the country as a whole."[24]

It is ironic, however, that economists have been so reluctant to become involved in the problems of income distribution and

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[24]Eckstein, *Water Resource Development*, p. 36.

redistribution. One of the most eminent welfare economists of modern times, J. de V. Graaf, is highly critical of the traditional formulations of welfare economics.[25] And yet he concludes one of his most noted works with the following statement:

> No doubt many professional economists are reluctant to abdicate what they may like to regard as their traditional prescriptive role and are uneasy at the prospect of becoming mere purveyors of information. If they are, it is up to them to show how welfare economics can be set upon a basis which is even reasonably satisfactory--or can be made to yield conclusions with which a significant number of men are likely to concur.[26]

Having failed to develop a reasonably satisfactory basis upon which welfare economics can be set and having failed to make welfare economics yield conclusions which are generally acceptable, it is perhaps time that economists devoted some attention to developing information which is relevant to welfare economics and particularly to the income distribution dimension of welfare economics. The difficulties of measuring and predicting personal income are, after all, manifest. So too are the problems of interpreting what those measures and predictions mean. This study, then, seeks to develop and interpret information relative to income distribution.

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[25] J. de V. Graaf, *Theoretical Welfare Economics* (Cambridge: The Cambridge University Press, 1967), pp. 55-92.

[26] *Ibid.*, p. 171.

CHAPTER 2

INCOME DISTRIBUTION AS AN INVESTMENT CRITERION

To imply that income distribution has been completely ignored by economists is incorrect. At highly aggregative levels, a number of studies of factor shares and rewards have been made.[1] Additionally, there have been a number of attempts to develop empirical estimates of income distribution for the nation as a whole as well as for certain regions of the nation.[2] Although there are a number of exceptions, these studies have, for the most part, been so aggregative as to provide little or no guidance as to the income distribution consequences of decisions to undertake individual projects or programs.

At less aggregative levels a small number of studies have been carried out. Empirical work on the distribution of benefits of certain programs administered by the Department of Agriculture have yielded results which indicate that some of those programs have income distribution consequences which favor the larger corporate farmer and

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[1] See for example: N. Kaldor, "Alternative Theories of Distribution," *Review of Economic Studies*, (1955-1956), pp. 83-100; Lee Soltow, ed., *Six Papers on the Size Distribution of Wealth and Income* (New York: National Bureau of Economic Research, Columbia University Press, 1969), pp. 1-264.

[2] U.S., Department of the Treasury, Internal Revenue Service, *Statistics of Income for 1968* (Washington, D.C.: Government Printing Office, 1968).

provide little assistance for the small farmer.[3] In addition to the agricultural area some work has been done on the distributive effects of federally funded water development projects. This work encompasses both theoretical and empirical considerations. The purpose of this chapter is to review critically the work which has been done on the income distribution consequences of public programs. However, the review will focus primarily on work involving federal water projects.

An early attempt to deal with the problems of income distribution relating to water development was that of Krutilla and Eckstein.[4] Although the authors assume throughout most of their study that resource endowments are optimal in an equity sense,[5] Krutilla and Eckstein do recognize that the redistributive consequences of water resource development cannot be ignored.[6] Accordingly, they devote two chapters of their study to an analysis of the distribution of costs and gains stemming from proposed water control structures and reservoirs in the Williamette Valley.[7] They examine the differences in costs under private and public development and

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[3]See for example: James T. Bonnen, "The Distribution of Benefits from Cotton Price Supports," in *Problems in Public Expenditure Analysis*, ed. by Samuel Chase (Washington, D.C.: Brookings Institution, 1968), pp. 223-248; David H. Boyne, "Changes in Income Distribution in Agriculture," *Journal of Farm Economics*, 47 (December, 1965), pp. 1213-1224.

[4]John V. Krutilla and Otto Eckstein, *Multiple Purpose River Development* (Baltimore: Johns Hopkins Press, 1958), pp. 3-301.

[5]*Ibid.*, p. 50.

[6]*Ibid.*, p. 20.

[7]*Ibid.*, pp. 199-264.

then analyze the distribution of costs among income classes by region. To assist in the estimation procedure they develop two different tax incidence models and examine the regional tax incidence predicted by each of the models. In analyzing gains or benefits they consider only first round effects while conceding that the effects of subsequent rounds may be important but are extremely difficult to estimate. They argue that their estimates, while admittedly crude, are valuable because they suggest the directions and magnitudes of income distribution changes.[8]

On the basis of their analyses, Krutilla and Eckstein conclude that under public development the residents of a region in which the federal government constructs hydroelectric power projects receive a net income gain while residents of other regions suffer some net income loss. They also point out that dynamic effects such as the attraction of new industry to the region as a result of federal provision of hydroelectric generating facilities would have favorable distributional consequences for that region. They do not, however, attempt the dynamic analysis necessary to establish the precise nature of these and similar consequences.[9] The authors conclude that with private development of hydroelectric facilities there is a slight regional income gain resulting primarily from the distribution of increased dividends from private power companies to the individual residents of the region.[10]

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[8] *Ibid.*, p. 263.

[9] *Ibid.*, p. 263.

[10] *Ibid.*, pp. 263-264.

Although the principal purpose of the Krutilla-Eckstein study was not to pioneer work on the income distribution aspects of water development, their undertakings in this area represented a beginning. The work can, of course, be criticized because of the crudeness of the empirical estimates. However, this seems relatively insignificant in view of the fact that this was the first attempt to examine the nature of income redistribution attributable to water projects and the data with which they were forced to work was not good. A major criticism of the study stems from its focus on broad regions and broad income classes. To be sure, aggregate descriptions of distributional effects are useful but they tend to mask important distributional effects at less aggregative levels. A policeman in Chicago, for example, may be bearing costs in order to provide income gains to executives or shareholders in a large electro-process industry in the Pacific-Northwest. The level of aggregation used by Krutilla and Eckstein does not enable the decision maker to ascertain explicitly who is paying the costs and receiving the benefits. The federal government quite possibly could develop a policy to transfer incomes from a relatively wealthy region to a relatively poor region. However, the program devised to carry out that policy might not be so attractive if it resulted in the transfer of income from poor individuals in the rich region to rich individuals in the poor region. The Krutilla-Eckstein methodology does not enable the program analyst to address this issue.

Another important and early effort to deal with income distribution as a criterion in the design of water resource systems was

undertaken by Stephen Marglin.[11] Marglin's efforts are devoted to developing conceptual methods for taking account of income redistribution effects. He suggests that national economic welfare is three dimensional in nature. He categorizes the dimensions as 1) the size of the economic pie, 2) the division of the pie among members of society and 3) the method of division.[12] He readily concedes that there is no single index which can be used as a measure of how well a given program or project succeeds in achieving these three goals. Marglin does not dwell on the third objective. He simply asserts that the traditional notion that incomes should be redistributed through transfer payments and taxes is probably not correct.[13] He states that it seems clear that people do possess explicit preferences about the fashion in which income is redistributed and these preferences seem to point toward techniques other than direct transfers and taxes for accomplishing redistribution.[14] He concludes, then, that water resource projects may not be a wholly inappropriate way of redistributing income.

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[11]Stephen Marglin, "Objectives of Water Resource Development: A General Statement," in *The Design of Water Resource Systems* by Arthur Maass, Maynard Hufschmidt, Robert Dorfman, Harold Thomas, Jr., Stephen A. Marglin and Gordon Maskew Fair (Cambridge, Mass.: Harvard University, 1962), pp. 17-87.

[12]*Ibid.*, p. 18.

[13]This assertion has been examined more systematically. See: Lucien Foldes, "Income Distribution in Money and Kind," *Economica*, XXXIV (February, 1967), pp. 30-41.

[14]Marglin, "Objectives of Water Resource Development," p. 67.

With the third objective out of the way he concentrates on the first two and suggests three ways in which efficiency benefits and redistribution benefits might be combined. Marglin develops the notion that there is a trade-off between redistribution and efficiency. If this notion is accepted, the water planner might 1) attempt to maximize net efficiency benefits subject to some explicit income redistribution constraint, 2) combine redistribution with efficiency in an objective function which is to be maximized subject to some design constraint or 3) maximize redistribution benefits subject to some efficiency constraint.[15]

While Marglin's suggestions possess a certain theoretical neatness they have some severe shortcomings. First, it is reasonable to ask under what conditions efficiency and redistribution can be regarded as trade-offs. Efficient states are relative in nature, being themselves a function of the prevailing distribution of income. The notion that efficiency and redistribution should be treated as competitive goals involves difficult problems of application. When Marglin and others refer to an efficient state, they are imparting some normative significance to such a state. This is so because attainment of such an efficient state presumes that the initial distribution of income is optimal. However, if it is argued that some inefficient modifications of that efficient state should be made in the interests of obtaining a more equitable distribution of income, then by implication the initial assumption of optimal distribution is invalid. The difficulty arises in that it is often difficult as a practical matter to affect an optimal distribution of income because

[15] *Ibid.*, pp. 70-84.

society has preferences relative to the magnitudes and forms of redistribution.

On the other hand, in many instances it may be reasonable to accept the assumption of optimal income distribution on the grounds that such an assumption only results in minor distortion in the analysis.[16] Even if this is granted there remain serious questions as to the feasibility of applying Marglin's three suggestions. Explicit income constraints necessarily will be arbitrary and a large number of designs will have to be prepared to display for the decision maker the array of alternatives facing him. Only in this fashion will the decision maker be able to see how sensitive the design analysis is to income constraints. The combination of redistribution with efficiency as an objective is particularly difficult inasmuch as it requires an explicit weighting of the income of different groups or individuals. Where are these weights to come from? Again, they must be arbitrarily chosen and this puts both the project analyst and the decision maker in the position of positing social welfare functions.

Marglin's third suggestion, that of maximizing redistribution benefits subject to some constraint on efficiency benefits has the same operational shortcomings. Again, both analyst and decision maker are put in the position of selecting an explicit efficiency

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[16] It is sometimes argued that an increase in national output in modern societies is accompanied by a greater equality in the distribution of that output. Krutilla and Eckstein argue that this has been empirically demonstrated but their reference merely asserts that this is the case. See Krutilla and Eckstein, *Multiple Purpose River Development*, p. 77.

constraint. Such selection has normative overtones and here again a large number of designs will have to be prepared to test sensitivities.

Even if the logical shortcomings of Marglin's separation of objectives are ignored, his recommendations seem impractical to implement. If the President and the Congress are unwilling to establish explicit social welfare functions then policy analysts and decision makers must define the functions themselves. It is true that by using one of the three Marglin procedures, the analyst is forced to make explicit the redistributive consequences of his design. This is, of course, an improvement over present practices. However, difficulties still remain with regard to the ease with which transfers of income can be made and with the appropriateness of analysts or lower level decision makers developing social welfare functions.

Another major effort to account for the redistributive impacts of water resource projects is that of Freeman. Freeman's work is both theoretical[17] and empirical.[18] At the theoretical level, Freeman criticizes Marglin's approach as involving poorly defined subjective judgments about income weights and opportunity costs and argues that if subjective judgments are to be made they should be made explicitly within the context of a rigorously defined social welfare function. He then proposes a design criteria which is derived from a social

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[17] A. Myrick Freeman, "Income Distribution and Planning for Public Investment," *American Economic Review*, LVII (June, 1967), pp. 495-508.

[18] A. Myrick Freeman, "Six Federal Reclamation Projects and the Distribution of Income," *Water Resources Research*, 3 (Second Quarter, 1967), pp. 319-332.

welfare function and provides normative guidance for decisions relevant to both repayment policies and the scale of the project.[19] The model which Freeman develops is an attempt to follow up on Otto Eckstein's suggestion that economists ought to attempt to interpret the desires of policy makers and express them in a form which yields an objective function. Subsequently, according to Eckstein, they can develop decision models which will aid in maximizing the specified objectives.[20] After demonstrating that redistribution can be achieved either through varying repayment policies or varying the scale of the project, Freeman argues that an increasing marginal effective tax rate implies a downward sloping social marginal utility of income schedule as long as there are increasing costs to utilizing taxes and transfers for income redistribution purposes.[21] This is a realistic refinement of Marglin's suggestion that the methods of income redistribution have costs and benefits associated with them.

Freeman then posits a social welfare function of traditional form where total welfare is the sum of the welfare of each individual and each individual's contribution to total welfare is a function

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[19]Freeman, "Income Distribution and Planning," pp. 499-500.

[20]Otto Eckstein, "A Survey of the Theory of Public Expenditure Criteria," in *Public Finances: Needs, Sources and Utilization* (Princeton, N.J.: National Bureau of Economic Research, Princeton University Press, 1961), p. 455.

[21]Freeman, "Income Distribution and Planning," p. 501.

solely of his income.[22] The welfare function is assumed to have the following form:

$$1) \quad \frac{\partial W}{\partial Y_i} = Y_i^{-\alpha}$$

W = Social welfare
Y_i = Income of ith individual

This simply implies that the larger the value of income the more steeply inclined is the marginal welfare function.[23] Freeman then demonstrates mathematically the nature of welfare changes and claims his procedures are an improvement over Marglin's because they take account of the initial levels of income of the beneficiaries as well as the ultimate distribution of benefits among groups. Freeman assumes that project net incomes are distributed in proportion to the original incomes of the beneficiaries. Given this assumption he concludes that repayment relief is the best way to redistribute income but once the possibilities for repayment relief are exhausted the project designer must resort to a change in the scale of the project if income redistribution remains an objective.[24]

In another article Freeman attempts to demonstrate the empirical workability of his theoretical construct.[25] He considers six irrigation projects proposed for authorization by the Bureau of Reclamation. After correcting the benefit-cost ratios of the projects to take account of systematic errors in the Bureau's methodology, he finds that only one of the projects qualifies on an efficiency basis with

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[22] *Ibid.*, p. 500.

[23] *Ibid.*, p. 502.

[24] *Ibid.*, p. 505.

[25] Freeman, "Six Federal Reclamation Projects," pp. 319-332.

a B/C ratio exceeding one. He then adopts the welfare function developed previously and derives criteria for evaluating the projects based on income distribution resulting from the projects. These criteria enable him to develop welfare-weighted benefit-cost ratios. On the basis of these welfare-weighted ratios Freeman concludes that all of the projects redistribute income away from the relatively well-to-do toward relatively lower income groups. However, only one of the six projects has a welfare weighted ratio which exceeds one.

The principal difficulty with Freeman's work lies with his reliance on a social welfare function. The function which he posits is strictly arbitrary. It assumes that an individual's welfare depends solely on his own income. Work by Duesenberry and others suggests that this is a dubious assumption.[26] Freeman further assumes that all social marginal welfare functions are alike and downward sloping. Again, the notion that all individual welfare functions are identical can be challenged and there may well be grounds for challenging the assertion that such functions are always downward sloping. There is simply no persuasive empirical evidence pointing to an ever decreasing marginal utility of additional income. Freeman, himself, admits that the choice of a constant elasticity marginal utility function is made for the sake of convenience alone. Even if it were granted that decision makers could potentially gain access to social welfare functions these difficulties would have to be surmounted.

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[26]James S. Duesenberry, *Income, Saving and the Theory of Consumer Behavior* (Cambridge: Harvard University Press, 1949), pp. 1-124.

The major problem is that while both of Freeman's studies are interesting exercises in accounting for redistribution effects they are not likely to provide guidance to decision makers. It is abundantly clear that neither the Congress nor the President are prepared to promulgate explicit social welfare functions for evaluative purposes. Furthermore, there is no reason why the project planner for the Bureau of Reclamation, the Corps of Engineers or anyone else should be imbued with any special expertise in developing social welfare functions.

Freeman implies that his theoretical work is a major improvement over that of Marglin. This is dubious. Freeman does away with Marglin's "artificiality" by invoking a set of wholly untenable assumptions with respect to the nature and form of social welfare functions. Freeman's work might also be considered to be a contribution in that it serves to demonstrate how benefit-cost ratios might be calculated using social welfare functions. Inasmuch as social welfare functions are not likely to be available in any reliable form Freeman's exercise is of little more than theoretical interest. Despite the many shortcomings of Marglin's proposals, they are likely to have more relevance for planners than does Freeman's approach.

Another important work on the income distribution effects of water projects is that of Robert Haveman.[27] Through an examination of Congressional statements and an analysis of Congressional

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[27]Robert Haveman, *Water Resource Investment and the Public Interest* (Nashville: Vanderbilt University Press, 1965), pp. 1-199.

legislative behavior, Haveman finds that Congress behaves out of a variety of motivations in authorizing and funding water projects constructed by the Army Corps of Engineers. His analysis of appropriations between 1946 and 1962 for Corps projects in ten southern states demonstrates that efficiency, distribution of income and a desire to develop resource intensive regions all underlie Congressional behavior. Through further analysis Haveman concludes that while there was a net transfer of income to the ten southern states, that transfer was accomplished, in part, through the construction of inefficient water projects. Haveman concludes that these projects were neither efficient means of increasing national income or achieving desired states of income redistribution.[28]

In an epilogue to his study, Haveman conducts two empirical welfare experiments. These experiments are based on a recognized need for the policy maker to possess some means for making marginal utility comparisons among individuals.[29] Following Eckstein, Haveman proposes that a marginal utility of income function expressing the desires of Congress can be inferred by examining the structure of the Federal personal income tax. From this structure he devises a set of weights to be used in evaluating the welfare impact of increments of income on individuals of different income levels. Recognizing that it is not possible to identify individual beneficiaries of Corps projects, Haveman simplifies the analysis by modifying his raw weights in order

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[28] *Ibid.*, p. 120.

[29] *Ibid.*, p. 133.

to focus on income flows to groups rather than individuals. He assumes that the groups in question are primarily distinguishable by geographical location.[30] The weights are thus redefined to apply to groups identified by state residency and according to a weighted average of three potential distribution functions.[31] Haveman then assumes that these welfare weights can reasonably be interpreted as Congress' relative evaluation of the welfare impact of income flows out of and into each of the states. The two experiments in welfare evaluation are then performed and Haveman concludes that despite his earlier findings, redistribution of income through the construction of inefficient projects may well be both feasible and desirable.[32]

Haveman's study has both strengths and weaknesses. Its chief strengths are its empirical findings relative to the efficacy of stated Congressional intentions as actually embodied in Congressional actions. Haveman's empirical work on efficiency and income redistribution provides interesting and valuable insights into the actual *ex post* efficiency and distribution effects of the Corps' program in ten southern states. His experiments in welfare evaluation are sound to the extent that they take account of both benefits and costs within the framework of some explicitly stated social welfare function.

While analyses of the type conducted by Haveman are valuable and should be continued and extended, they do have serious shortcomings.

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[30] *Ibid.*, p. 138.

[31] *Ibid.*, p. 139.

[32] *Ibid.*, p. 151.

By focusing on the average incomes of state residents the study necessarily deals with income distribution at an extremely aggregative level. Haveman's analysis thus fails to deal with problems of income distribution within the broadly defined groups. For example, the Haveman type of analysis might lead to the conclusion that a Corps program was desirable because it redistributed income from California, which has a high average income, to Mississippi, which has a low average income. (This, of course, grants Haveman's assumptions about interpersonal utility comparisons.) However, such a conclusion could be very misleading if the transfer actually involved taxing poor Californians to provide subsidized flood control for wealthy Mississippi cotton growers. While Haveman seems aware of this problem he makes little effort to deal with it.

An additional difficulty with Haveman's work stems from the *ex post* nature of the analysis. The analysis shows how past decisions have worked out but does not provide any guidance as to how future decisions should be made. Certainly *ex post* analyses are badly needed. Particularly in the water resource development program area, where there has been a considerable amount of experience with cost and benefit esimation and projection techniques, it would be useful to know exactly how well those techniques have worked. This sort of feedback would permit systematic adjustments in benefit-cost procedures to reflect past successes and failures. Haveman does not deal with this problem inasmuch as his analysis assumes that benefits and costs actually projected by the Corps were fully accurate.

Haveman's experiment in welfare evaluation does hold some promise for *ex ante* analysis but unfortunately that too is frought with problems. Haveman resorts to the social welfare function device and claims that his methodology is superior to that proposed by Marglin since he derives his social welfare function from a Congressional decision which implies the weights to be attached to various levels of income. These weights were derived from federal tax legislation.

This methodology, while undoubtedly superior to the arbitrarily defined social welfare functions also has severe shortcomings. First, Haveman assumes that the Congress acts on the principle of equimarginal sacrifice. That this is not so should be apparent from the fact that all incomes above a certain level are not completely taxed away. Furthermore, the personal income tax is not solely a tool of income redistribution. Stabilization considerations enter into the formation of tax policy and this tends to make the tax unreliable as a pure guide to the redistributive desires of the Congress. Furthermore, it seems reasonable to assert that any implicit social welfare function which exists for the nation is dynamic in nature. It is constantly changing depending upon the issue under consideration and the political mood of the country. And yet, tax changes are enacted only every four years or so and consequently it can be argued that at any given time the structure of personal income taxes represents only a very rough approximation of redistribution desires. (This would be so even if taxes were changed solely in the interest

of redistribution and stabilization policy were affected in some other fashion.)

A final criticism of Haveman's approach stems from the indisputable fact that there are limitations imposed on taxation as a device for redistributing income. As both Marglin and Freeman point out, people do have preferences about how income ought to be transferred. As a general rule transfers that are obscured from public view tend to be preferred and given this general social preference for hidden subsidies it is difficult to argue that there is a clear and direct correspondence between tax rates and the social welfare function.

Burton Weisbrod has also contributed a study which examines the possibilities of taking into account the redistributive impacts of public policies.[33] Weisbrod's study is theoretical in nature although he does provide some suggestive empirical estimates in an effort to demonstrate the potential workability of his scheme. Weisbrod discusses the need for taking the redistributive effects of public programs into account and suggests two means through which this might be accomplished.[34] As a first approximation he recommends the development of "side displays" coupled with traditional benefit-cost analysis. The side displays would identify the incidence of

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[33]Burton A. Weisbrod, "Income Redistribution Effects and Benefit-Cost Analysis," in *Problems in Public Expenditure Analysis*, ed. by Samuel B. Chase, Jr. (Washington, D.C.: The Brookings Institution, 1968), pp. 177-209.

[34]*Ibid.*, pp. 178-184.

the benefits and have the merit that they are operationally workable. Weisbrod recognizes the problems inherent in selecting and subdividing beneficiary groups. He alludes to the fact that information costs are likely to be high and suggests that the number of groups and subdivisions ought to be a function of information costs. He proposes that appropriate groupings might be made among income classes, age classes, races and among geographical areas.[35]

It is difficult to fault this suggestion as far as it goes. Policy analysts would do well to illuminate explicitly the beneficiary groups of given public projects and programs. At a minimum, such a procedure would tend to avert the present practice of disguising the actual beneficiaries of many federal programs. There are, however, two problems with this approach. The first stems from Weisbrod's assumption that costs of programs are financed from general revenues and thus program costs can be neglected in the analysis. The weaknesses of this assumption are apparent when it is remembered that many programs are not financed from general revenues. The Federal highway program and certain portions of the federal water resources programs are examples. Furthermore, Weisbrod provides no estimates of the incidence of general revenues. Consequently, his side display method fails to take account of net redistribution effects and it is the net redistribution effects rather than the gross effects that the policy analyst is really interested in.

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[35] *Ibid.*, p. 185.

The second problem with the "side display" approach is that it fails to integrate the efficiency and distributive facets of welfare economics. It was demonstrated in Chapter 1 that distinctions between equity and efficiency in welfare economics would result in misleading conclusions. Weisbrod recognizes this problem but his display approach merely serves to advance and promote the artificial distinction.

Weisbrod's concern over the problems inherent in distinguishing between efficiency and equity effects lead to his second suggestion. He proposes a social welfare function, which, like Freeman's, assumes that an individual's welfare is solely a function of his own income. He then proposes that weights should be attached to each individual's income and suggests that the benefits of the project should equal the sum of the weighted changes in the incomes of the project beneficiaries. Weisbrod derives the weights by examining the benefit-cost ratios of projects listed by priority in which those projects were selected for construction. Where projects other than the one with the highest benefit-cost ratio were selected, Weisbrod argues that they were presumed to be at least as good or better than the project with the highest benefit-cost ratio. The residual quantity of benefit required to bring the ratio of the project in question up to the point where it exceeds the highest benefit-cost ratio available is ascribed to the distribution benefits and Weisbrod develops his income weights in this fashion.[36] Weisbrod recognizes that his procedure is frought with difficulties, among them the need for the

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[36] *Ibid.*, pp. 193-194.

number of projects and the number of beneficiaries to be equal (if they are not equal it is not possible to solve for the weights). Additionally, he recognizes the difficulties inherent in identifying project beneficiaries.

Weisbrod's proposal has been cogently criticized by Robert Haveman and Ruth Mack and there is no need to repeat their criticisms here.[37] The principal shortcomings of the Weisbrod approach lie in its reliance on an explicitly posited social welfare function and the fact that his function is developed through an *ex post* analysis of how decision makers actually behaved in the past. Again, it must be argued that while knowledge of past behavior is useful it does not provide an *ex ante* guidance to analysts and decision makers relative to the income weights which should be assigned before decisions are made.

The final study to be reviewed is the recent work of William Neenan.[38] The essence of Neenan's approach is to assume that program decisions are made against a norm which requires the equating of marginal costs and marginal benefits of any given program. Neenan then asserts that any deviations from this equivalency has distributive impacts. These impacts, he argues, are not derived from any normative standards but are merely the *de facto* value judgments which are embedded

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[37] Samuel B. Chase, ed., *Problems in Public Expenditure Analysis* (Washington, D.C.: The Brookings Institution, 1968), pp. 209-222.

[38] William B. Neenan, "Distribution and Efficiency in Benefit-Cost Analysis," *The Canadian Journal of Economics*, 2 (May, 1971), pp. 216-224.

in public policy decisions. Neenan is careful not to attribute the residual difference between the marginal cost-marginal benefit equivalency to an explicit desire on the part of public policy makers to redistribute income. Rather, he argues that no matter what the motivation for approving a program which is not efficient, the inefficient aspects have distributional consequences.

Neenan then analyzes empirically the distributional consequences of a tuberculosis screening program in the State of Michigan and develops marginal redistribution weights. He examines groups in different geographic areas but notes that grouping by race, age or income classification might be more interesting or relevant.[39] Through this scheme, Neenan is able to discover the implicit dollar weights assigned to the dollar of cost and benefit associated with programs.

Neenan's main contribution is his explicit recognition that dollar costs and benefits carry implicit distributional weights in decision making wherever a decision is made to undertake a program at a level where marginal costs do not equal marginal benefits. An additional contribution is to be found in the unique method which he proposes for uncovering these weights. Neenan argues, correctly, that there is no justification for leaving the implicit welfare weights hidden and that there does indeed exist a methodology for uncovering those weights and utilizing them in the evaluation of programs.

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[39] *Ibid.*, p. 223.

There are several limitations of Neenan's approach. First, as with many of the other studies, it is basically an *ex post* analysis, useful during periodic and systematic evaluation of on-going programs. Neenan fails, however, to provide any specific guidance relative to the weights implicit in alternative courses of action *ex ante*. Neenan's empirical study can also be criticized for the apparently arbitrary choice of groupings. This criticism is somewhat muted by his own recognition that different types of groupings may be equally appropriate. A final criticism involves the residual approach to determining welfare weights. While Neenan takes care not to attribute the residual to explicit decisions relative to income redistribution, he is not so careful with his assumption that the program design will be guided by the marginal condition if other things are equal. Particularly, in the health care area where benefit-cost analysis (or even economic analysis of any sort) has not been traditional, it is difficult to see how administrators could possibly be aware or even interested in marginal conditions. This is especially so in view of the fact that the conventional "economics" applied by non-economists to medical care revolves around the notion that it is worth any price to save a life or reduce illness.[40]

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[40]For an example of this type of thinking see: Leslie Chambers, "Classification and Extent of Air Pollution Problems," *Air Pollution*, Vol. 1, ed. by Arthur Stern (New York: Academic Press, 1962), p. 21.

There are, of course, a number of other works dealing with the income redistribution aspects of public expenditures.[41] However, those discussed so far in this chapter present a representative sample of the range of approaches and problems associated with the various approaches. Two major problems seem manifest throughout most of the work. The first is the use of a social welfare function. As noted earlier social welfare functions are useful abstractions for theoretical work but the barriers to establishment of social welfare functions for use by policy makers are so large as to make any expectation that such a function will be available to decision makers unrealistic.

The second major problem stems from the fact that most of the suggested approaches and empirical analyses are *ex post* in nature. While *ex post* analyses have their uses, what is really needed are methods whereby income distribution weights can be accounted for during the decision making process. The next chapter considers a method whereby income redistribution resulting from federal investment decisions can be explicitly identified and utilized in the decision making process. Through the use of this methodology decision makers at all levels can take account of income redistribution consequences prior to the time a commitment is made to provide the benefits and incur the costs.

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[41] See for example: James L. Douglas, "A Case Study in Income Redistribution from Reservoir Construction," *Water Resources Research*, 4 (June, 1968), pp. 499-506; Burton A. Weisbrod and W. Lee Hansen, "An Income-Net Worth Approach to Measuring Economic Welfare," *American Economic Review*, 58 (December, 1968), pp. 1315-1329; Arthur Maass, "Benefit-Cost Analysis: Its Relevance to Public Investment Decisions," *Quarterly Journal of Economics*, LXXX (May, 1966), pp. 208-226; Robert Haveman, "Benefit-Cost Analysis: Its Relevance to Public Investment Decisions: Comment," *Quarterly Journal of Economics*, LXXXI (November, 1967), pp. 695-699; Arthur Maass, "Benefit-Cost Analysis: Its Relevance to Public Investment Decisions: Reply," *Quarterly Journal of Economics*, LXXXI (November, 1967), pp. 700-702.

CHAPTER 3

ACCOUNTING FOR INCOME DISTRIBUTION

The last chapter indicated that most work done on the income distribution and redistribution aspects of public expenditures contained at least one of two potentially serious shortcomings. One was the use of a social welfare function which, while perhaps a useful theoretical abstraction, is simply unavailable to decision-makers. A second stemmed from the fact that the analyses were *ex post* in nature. It was argued that while *ex post* analyses are useful some way must be found to take account of income distribution impacts before resources are committed to a given program or project. Only in this way can income distribution become an effective criterion for use in allocating scarce resources among competing programs and projects. The purpose of this chapter is to propose and describe a methodological procedure which is designed to overcome both shortcomings. If implemented, this procedure will enable decision-makers to examine redistributive effects *ex ante* and to consider explicitly some of the value judgments which are inherent in alternative resource allocation schemes.

The first section of the chapter will develop a procedure for analyzing *ex ante* the distributional impacts of public programs or projects. The second section will discuss alternative criteria which might be used to interpret and evaluate the distributional impacts. The third section will discuss potential problems which will have to

be faced in the application of the methodology and interpretive criteria. However, it will be argued in this section that the methods are implementable and represent a good first approximation for dealing with the income redistribution consequences of certain public activities.

Ex Ante Model

One published work which purports to take account of redistributive effects stemming from federal investment *ex ante* is that of Kalter and Stevens.[1] Kalter and Stevens develop two equations which are designed to account for the incidence of net benefits from federal investments to identifiable groups or individuals depending upon whether the redistributive effects are analyzed from a national or regional stance.[2] The authors argue that:

> Income distribution is changed by federal resource investments whenever the distribution of project *net* benefits is non proportional to the income distribution expected to occur without the project in question.[3]

Unfortunately the accompanying narrative and mathematical formulations contain a number of errors. These errors will be corrected here and the resulting formulation will subsequently be utilized to predict income redistribution impacts.

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[1]Robert J. Kalter and Thomas H. Stevens, "Resource Investment, Impact Distribution and Evaluation Concepts," *American Journal of Agricultural Economics*, 53 (May, 1971), pp. 206-215.

[2]*Ibid.*, p. 209.

[3]*Ibid.*, p. 207.

The exposition and critique of the Kalter-Stevens model can be facilitated by considering the following equations which represent simplifications of the equations actually developed by the authors. The equations will ordinarily be expressed in present value terms. The present value expressions have been omitted here in the interests of clarity. Consider first the basic identity:

1) $NB_j = GB_j - C_j$

where

NB_j = net benefits to class j.

GB_j = gross benefits to class j.

C_j = costs to class j.

Kalter and Stevens find it useful to break up the cost components as depicted in the following equation:

2) $C_j = (Z_j + R_j + O_j)$

where

Z_j = portion of tax payment by class j that is allocated to development of the project or program.

R_j = direct reimbursement or repayment by class j to the government.

O_j = operation and maintenance costs to class j.

They then introduce the concept of the "reimbursement adjustment." Here they argue that the difference between the actual repayment or reimbursement by class j and the reimbursement that class j would have paid had that reimbursement been proportionate to the tax structure represents a redistribution of income and must be accounted for. The following equation depicts the fashion in which they account for the reimbursement adjustment.

3) $NB_j = GB_j - [Z_j + (A_j - P_j) + O_j]$

where

A_j = the actual reimbursement or repayment by class j.

P_j = the reimbursement or repayment that would be made by class j had the repayment schedule been proportionate to the appropriate tax structure.

Several difficulties are immediately apparent. First, an error arises from the authors' assumption that annual operating and maintenance costs will either be paid for by the project beneficiaries in full or will be completely paid by the government but they conclude that the results of the analysis will not be affected by either assumption. It seems clear that net benefits to a given group will be smaller the greater the amount of operation and maintenance costs which are assigned to that group. It is also true that the proportion of operation and maintenance costs borne directly by project beneficiaries varies widely between projects. Consequently, there is no reason why operation and maintenance costs should be conceptually different from other types of costs. If they are borne directly by project beneficiaries they should be subjected to the same sorts of analyses as other types of reimbursable costs. Therefore, equation 3) must first be modified to take account of this fact. The O_j term is dropped out and reimbursable operation and maintenance costs are included in the A_j term while the non-reimbursable costs will be included in the Z_j term.

A second problem stems from a misspecification of the cost terms in equation 3). This equation suggests that the costs borne by an individual or class, j, amount to the additional tax cost attributed

to the project (assuming a flexible budget) plus the reimbursement cost minus the reimbursement or repayment that would have been made had the repayment schedule been proportional to the "appropriate" tax structure. This misspecifies the costs because individual or class j actually pays the tax costs allocable to the project and the reimbursement costs, if any. As a consequence equation 3) must be corrected as follows to take account of the two errors alluded to so far.

$$4) \quad NB_j = GB_j - [Z_j + A_j + (A_j - P_j)]$$

All terms are the same as previously defined except that A_j includes the reimbursable operation and maintenance costs and Z_j includes the non-reimbursable operation and maintenance costs.

The need for adding the additional A_j term can be demonstrated quite easily by reference to the following example. Consider a project which costs \$10,000 and yields \$11,000 in benefits. Suppose the project is constructed in a country which is inhabited by only three people (j = c,d,e). The allocation of gross benefits and the reimbursement scheme are entirely arbitrary but this makes no difference in the following analysis. If equation 3) from Kalter-Stevens is modified only to the extent of removing the O_j term the results depicted in Table 1 will obtain. If, on the other hand the modified equation 4) is utilized the results in Table 2 will obtain.

Table 1 indicates that if the original Kalter-Stevens formulation is used, the net benefits of the project will vary with the amount of reimbursement. This is implausible enough since the net benefits will always be \$1,000 but the Kalter-Stevens equation yields an even

Table 1

Distribution of Net Benefits Using Kalter-Stevens Equation
Hypothetical Project: Total Benefits = $11,000
Total Costs = $10,000

Marginal Tax Rates	Reimbursement Schedule*
c = 20% d = 30% e = 50%	c = $ 5,000 d = $ 3,000 e = $ 2,000 *Assuming all costs are fully reimbursable

Case 1: 100% Reimbursement

	NB_j	=	GB_j	-	$[Z_j$	+	A_j	-	$P_j]$
NB_c	= $ 1,000	=	$ 4,000	-	[0	+	$5,000	-	$2,000]
NB_d	= 2,000	=	2,000	-	[0	+	3,000	-	3,000]
NB_e	= 8,000	=	5,000	-	[0	+	2,000	-	5,000]

NB_j = $11,000

Case 2: 50% Reimbursement

	NB_j	=	GB_j	-	$[Z_j$	+	A_j	-	$P_j]$
NB_c	= $ 1,500	=	$ 4,000	-	[$1,000	+	$2,500	-	$1,000]
NB_d	= 500	=	2,000	-	[1,500	+	1,500	-	1,500]
NB_e	= 4,000	=	5,000	-	[2,500	+	1,000	-	2,500]

NB_j = $6,000

Case 3: No Reimbursement

	NB_j	=	GB_j	-	$[Z_j$	+	A_j	-	$P_j]$
NB_c	= $ 2,000	=	$ 4,000	-	[$2,000	+	0	-	0]
NB_d	= -1,000	=	2,000	-	[3,000	+	0	-	0]
NB_e	= 0	=	5,000	-	[5,000	+	0	-	0]

NB_j = $ 1,000

Table 2

Distribution of Net Benefits Using Corrected Equation
Hypothetical Project: Total Benefits = $11,000
Total Costs = $10,000

Marginal Tax Rates	Reimbursement Schedule*
c = 20% d = 30% e = 50%	c = $ 5,000 d = $ 3,000 e = $ 2,000 *Assuming all costs are fully reimbursable

Case 1: 100% Reimbursement

	NB_j	=	GB_j	-	[Z_j	+	A_j	+ (A_j	-	P_j)]
NB_c	$-4,000	=	$ 4,000	-	[0	+	$5,000	+ ($5,000	-	$2,000)]
NB_d	-1,000	=	2,000	-	[0	+	3,000	+ (3,000	-	3,000)]
NB_e	6,000	=	5,000	-	[0	+	2,000	+ (2,000	-	5,000)]
NB_j	$ 1,000									

Case 2: 50% Reimbursement

	NB_j	=	GB_j	-	[Z_j	+	A_j	+ (A_j	-	P_j)]
NB_c	$ 1,000	=	$ 4,000	-	[$1,000	+	$2,500	+ ($2,500	-	$1,000)]
NB_d	-1,000	=	2,000	-	[1,500	+	1,500	+ (1,500	-	1,500)]
NB_e	3,000	=	5,000	-	[2,500	+	1,000	+ (1,000	-	2,500)]
NB_j	$ 1,000									

Case 3: No Reimbursement

	NB_j	=	GB_j	-	[Z_j	+	A_j	+ (A_j	-	P_j)]
NB_c	$ 2,000	=	$ 4,000	-	[$2,000	+	0	+ (0	-	0)]
NB_d	-1,000	=	2,000	-	[3,000	+	0	+ (0	-	0)]
NB_e	0	=	5,000	-	[5,000	+	0	+ (0	-	0)]
NB_j	$ 1,000									

more implausible result in that it shows that the greater the total reimbursement required, the greater the net benefits. Consequently, the original Kalter Stevens equation (equation 3) must be rejected and reformulated to correct the conceptual errors.

Table 2 is based on the corrected Kalter-Stevens equation (equation 4) and demonstrates that the total amount of reimbursement affects the distribution of the net benefits among the three members of society but does not affect the net benefits. Thus it can be seen that the corrected equation is not only conceptually correct but produces plausible results under conditions of varying degrees of reimbursement.

A third problem in the Kalter-Stevens model is attributable to the failure to account explicitly for the income distributions which would prevail in the absence of the project in question. Kalter-Stevens assume that in the absence of the investment income distribution will remain constant. In order to make the model completely general, it is necessary to add an expression which will enable the analyst to net gross benefits and total costs against the benefits and costs which would be expected to prevail in the absence of the investment in question. Equation 5) accomplishes this by explicitly accounting for the income distribution expected to prevail in the absence of the project.

5) $NB_j = GB_j - [Z_j + A_j + (A_j - P_j)] - [GB_{j,w} - Z_{j,w} - C_{j,w}]$

where

NB_j = net benefits accruing to group j.

GB_j = gross benefits accruing to group j with the project or investment.

Z_j = portion of tax payment by group j that is allocated to development and operation of the project or program.

A_j = actual reimbursement or repayment by class j.

P_j = the reimbursement or repayment that would be made by group j had the repayment been proportional to the appropriate tax structure.

$GB_{j,w}$ = gross benefits accruing to group j without the project or program

$Z_{j,w}$ = portion of tax payment by group; that would accrue in the absence of the project or program.

$C_{j,w}$ = unspecified cost term accruing to group j without the project or program.

It is important to recognize that in many cases the "without investment" expression will be zero. Still there may be cases where additional benefits, taxes and/or costs will be incurred in the "without" case and these costs and benefits must be accounted for. Equation 5) is now a perfectly acceptable identity for use in accounting for income redistribution impacts provided one accepts the Kalter-Stevens criterion that income distributional neutrality can be defined with reference to the "appropriate" tax structure.

A fourth difficulty with the Kalter-Stevens contribution stems from their failure to elaborate more fully on one of the assumptions. The necessity of accounting for the Z_j term only arises when the federal budget is completely flexible. The Kalter-Stevens article

implies that the decision to undertake a given investment is an all or nothing decision. That is, if the federal government decides not to invest in the project in question, total federal expenditures will reflect that decision and be reduced by exactly that amount. However, it is well known that the decision to invest or not to invest in a federal project has little or no effect on the federal budget for given expenditure categories in any one budget year. Given the fact that there are usually many more projects available than can be funded from the limited budget it seems unrealistic to assume that a decision to invest or not to invest in any one project will affect the expenditure total of that budget. The Office of Management and Budget provides each agency head with a "mark" or ceiling to be used in budgetary planning for each fiscal year. The existence of marks or ceilings implies a very rigid budget constraint. Therefore, it is appropriate to argue that a budget constraint does exist and the taxes which people pay are not at all affected by decisions to undertake a particular federal investment. If investment in one project is rejected then the funds will be put into an alternative project and there will be no tax impact. Kalter and Stevens recognize this point but they relegate it to a footnote implying that it is something of a special case.[4] It would have been more accurate to point out that taxes are not affected by the decision to a given project except at higher decision making levels where the ultimate totals for the budgets or agencies are decided.

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[4] *Ibid.*, p. 207n.

As a consequence, equation 5) will, in most cases, be modified as follows. Both the Z_j and the $Z_{j,w}$ terms will be equal to zero. If it is found that the $C_{j,w}$ and the $GB_{j,w}$ terms are also zero equation 5) can be simplified as follows:

6) $NB_j = GB_j - [A_j + (A_j - P_j)]$

It should be understood that the normative reimbursement adjustment $(A_j - P_j)$ is appropriate only in those cases in which the reimbursement is charged as a flat cost against all participants rather than as a variable charge per unit of output. In the first case the marginal cost per unit of output is zero whereas in the second the reimbursement by the user depends entirely on the quantity which he consumes.

A final difficulty, and perhaps the principal shortcoming, in the Kalter-Stevens contribution is their failure to be explicit about the normative nature of any definition of distributional neutrality. The authors posited the definition cited earlier in this section as the definition of distributional neutrality. However, they failed to point out that the definition of distributional neutrality is itself a value judgment. There are a number of definitions of distributional neutrality which might be utilized. In view of the normative nature of these definitions it would appear useful to develop a number of such definitions and then to examine redistributive consequences in light of these alternative definitions of neutrality. Interpreting redistributive data against a variety of criteria for distributional neutrality appears to be warranted not only in view of the normative nature of those criteria but also because the criteria do have positive implications. The next section will discuss a number of criteria for distributional neutrality and suggest how each may be useful in interpreting and evaluating information on income distribution.

Distributional Neutrality

The benefits of any public undertaking may be classified into two categories. First, there are direct money benefits which generally consist of cash transfers such as crop subsidy payments or wages for construction workers who would have otherwise been unemployed but find employment on federally funded projects. Second, federal investments provide benefits in the form of income-in-kind. Some examples would be protection from floods, provision of recreation facilities and provision of irrigation water to farmers in arid regions. It appears useful to keep this distinction in mind when considering appropriate definitions of distributional neutrality.

Consider first a program or project which provides all benefits in the form of income-in-kind and/or monetary rewards. It is important to bear in mind that the value of either type of benefit can be determined only through knowledge of the consumer's willingness to pay for the good or service in question. It is well known that this willingness to pay sometimes exceeds the payments which are made. This is the concept of consumer's surplus.[5] An individual, for example, might be willing to pay $500 for some commodity but is actually only paying $200 because of supply conditions. His willingness to pay, then, is not the observed $200 but rather $500.

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[5]For discussion of the basic concept of consumer surplus see: J. R. Hicks, *Value and Capital* (Oxford: Clarendon Press, 1950), pp. 26-41; Milton Friedman, "The Marshallian Demand Curve," *Journal of Political Economy*, LVII (December, 1949), pp. 463-495.

The potential importance of this concept for use in defining distributional neutrality can be seen by referring to figure A.

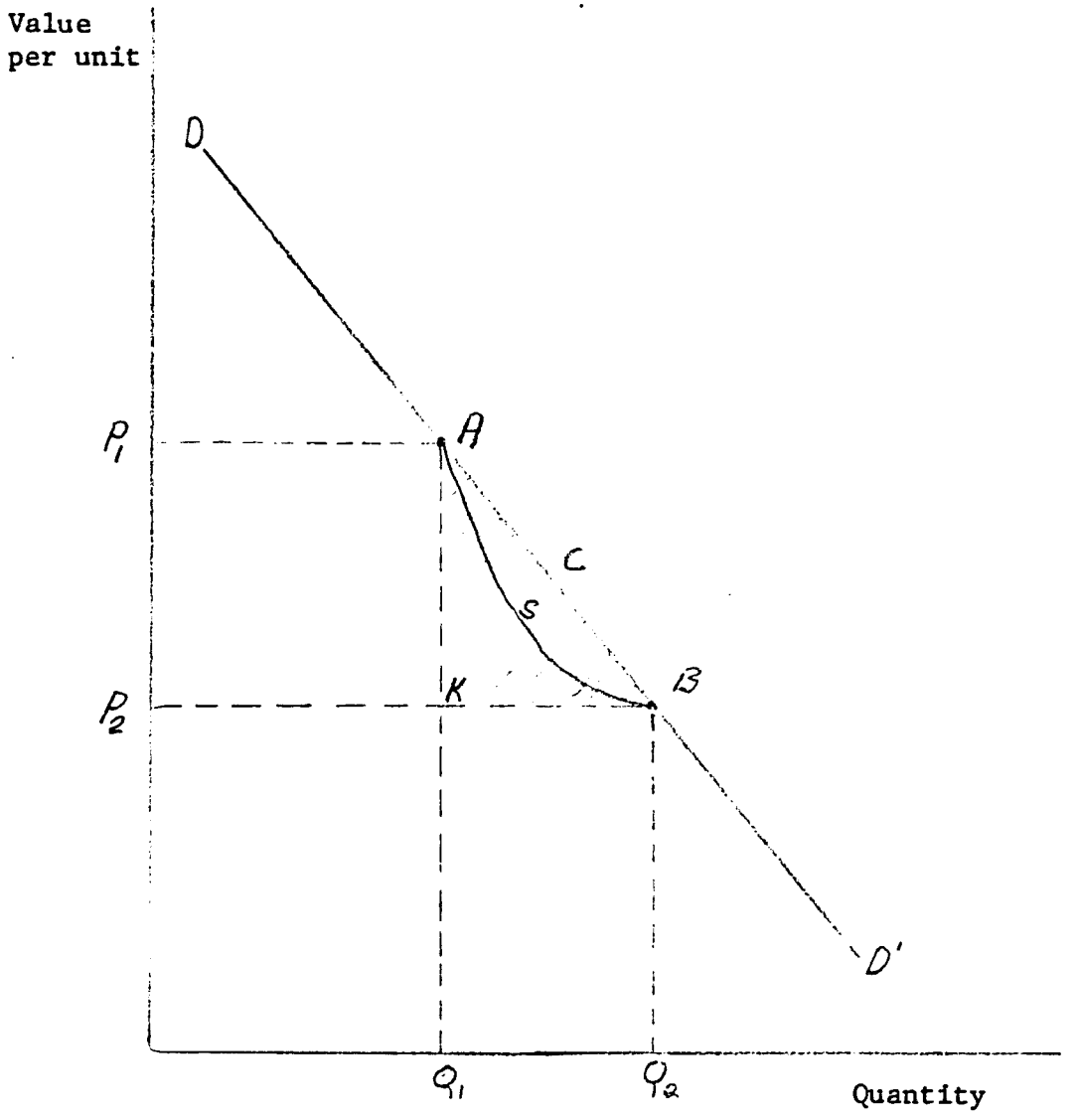


Figure A

This figure depicts two demand curves. Curve DACBD' is the demand curve for income class j for some service which could be provided in-kind by a federal project. Curve DASBD' is the demand curve for income class i for the same service. Now suppose that without the

project both income classes demand Q_1 units of the service and pay a price of P_1 (assuming supply conditions without the investment). Further, suppose that with the investment both income classes demand Q_2 units of the service and pay a price of P_2. (It should be noted that the assumption that both income groups would be observed to demand exactly the same amounts at different prices with and without the investment is, of course, rather arbitrary and unlikely. However, the assumption was introduced in order to emphasize the point to be made here.)

Given the assumption, one might be tempted to conclude that the consumer surplus for quantity Q_1Q_2 for both groups is identical. However, this may not be the case at all. The consumer surplus for the marginal quantity Q_1Q_2 for income class j is ACBK while the consumer surplus for class i is ASBK. Due to the difference in shape of the demand curves for the service in question, the willingness to pay of income class j exceeds that of income class i.

The discussion of Figure A serves to demonstrate that care must be taken in calculating the consumer surplus. Just because the change between the "without investment" consumption and the "with investment" consumption is the same for both classes i and j does not mean that their willingness to pay for this additional amount is identical because it is possible that the shapes of the demand curves will differ. Outdoor recreation and environmental quality improvements are examples of cases in which rather substantial differences in "willingness to pay" schedules are likely to exist.

The consumer surplus notion is conceptually superior for developing definitions of distributional neutrality where the project results in provision of either or both monetary income and income in

kind. Unfortunately, while this notion is conceptually superior, it is impossible to implement empirically because of the difficulties attendant to estimating the elasticities of demand curves. If and when these difficulties are overcome the definition of distributional neutrality should be based on the notion of consumer surplus for all projects yielding income-in-kind.

For projects yielding these two types of benefits two different definitions of income distributional neutrality could be posited. One would be the definition that the total consumer surplus for each group should be equal whereas the other would be that the consumer surplus for each group should be proportional to the income of each group in the "without" case. The latter definition must be further subdivided by specifying whether the "without investment" income is to be before or after tax income.

A second type of definition of distributional neutrality can be based on actual money rewards. Definitions founded on this basis are appropriate where the project yields net benefits in the form of money income. Distributional neutrality might be assumed to exist where net money rewards are equal to before tax income or after tax income. The former definition presumes, of course, that a part of the net benefit will be taxed away. Consequently, it will be necessary to take account of the amount of income to be taxed away in determining which distribution ends up giving everyone an equal money reward.

Similarly, distributional neutrality might be defined as money rewards being distributed in proportion to the "without investment"

income. Here again it is necessary to specify whether that income is before or after taxes and an adjustment will have to be made to take account of the portion of net benefits which are given up in taxes.

Rarely do projects yield net benefits solely in the form of money income or solely in the form of income-in-kind. However, in all probability most water projects yield a greater proportion of their benefits in kind than in the form of monetary income. Given the impossibility of utilizing the consumer surplus measure empirically and given that monetary measures would tend to understate project net benefits substantially, some compromise criterion must be sought.

The third criterion to be discussed is something of a compromise measure. This criterion suggests that income distribution is neutral if project net benefits are distributed in proportion to the without project income. An alternative criterion would call for redistribution to be neutral if it is equal among all income classes regardless of the size of incomes possessed by those classes. In utilizing either of these definitions it is important to specify whether the "without investment" distribution is before or after taxes. Kalter and Stevens failed to do this thus leaving some ambiguity to their definition of tax neutrality. If any of the benefits expected to accrue from the project are to be in the form of monetary income then it is essential to specify whether pre- or post-tax income is the measure against which we evaluate neutrality. As a consequence, the already modified Kalter-Stevens equation requires further changes to take account of the possibility that monetary rewards may

be taxed. Equation 7) contains that modification.

$$7)\quad NB_j = GB_{jh} + [GB_{jm} - A_{jm}]\,[1-t_j] - [Z_j + A_{jh} + [A_{jh} - P_{jh})] - [GB_{j,w} - Z_{j,w} - C_{j,w}]$$

where

NB_j = net benefits to income class j.

GB_{jh} = gross benefits "in-kind" to income class j.

GB_{jm} = gross monetary benefits to income class j.

A_{jm} = direct reimbursement by income class j for monetary benefits.

t_j = effective marginal tax rate of income class j.

Z_j = proportion of taxes paid by income class j to finance the project.

A_{jh} = direct reimbursement by income class j for benefits "in-kind."

P_{jh} = the reimbursement or repayment that would have been made for benefits "in-kind" by income class j had the repayment schedule been proportionate to the appropriate tax structure

$GB_{j,w}$ = gross benefits received by income class j without the project.

$Z_{j,w}$ = portion of tax payment by income class j that would accrue in the absence of the project.

$C_{j,w}$ = unspecified cost term accruing to income class j without the project.

Finally, mention should be made of one other potential definition of distributional neutrality. This definition would hold that the *potential* gain to every group be equal or proportional to some pre or post tax "without" investment distribution. This definition is appropriate

in cases where the good supplied is a pure public good.[6] It may be argued that everyone can choose to use the good for free. For distributional purposes it makes no difference whether or not they actually do use it. What is of importance is that a group of individuals has been provided with the opportunity to use it and this opportunity should be accounted for in distribution measurement and interpretation. However, such an interpretation might be subjected to severe criticism since consumption of many public goods (i.e. National Parks, remote areas) are often times dependent upon substantial private expenditures before they can actually be consumed even though the public services themselves are provided free of charge to all.

The problems associated with empirical implementation of this criterion are, of course, severe. Since the exclusion principle fails to operate it is usually not possible to ascertain what people would be willing to pay to consume a pure public good.

Conclusion

It has been argued in this chapter that definitions of "distributional neutrality" are themselves value judgments. Economists have generally agreed that if increments or decrements of income were proportionately distributed then distribution would be "neutral." This position is rejected. Rather it is argued that the measurement

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[6]For a discussion of pure public goods see: Richard A. Musgrave, *The Theory of Public Finance*, pp. 43-44.

of income distribution and redistribution is really the only non-value laden activity in which economists can partake.

This chapter developed techniques for predicting and measuring income distribution and redistribution and also suggested and evaluated several normative criteria for analyzing such redistributions. Use of the methodology will enable the public and the decision-maker to see what are the income distribution value connotations of various decisions. Table 3 summarizes the various measures of gain or loss as well as the various definitions of distributional neutrality. The subsequent chapters will describe and analyze an actual policy and program dilemma. It will be argued that despite the expenditure of significant sums of money and thousands of hours of time, the failure to consider the equity implications of the ultimate decision in a dispassionate fashion has contributed to the difficulties in resolving the problem. Two methods for developing reference income distributions will be discussed and utilized. The models developed in this chapter will be applied and some conclusions will be drawn with regard to the equity dimension of the problem in question.

Table 3

Summary of Alternative Measures and Definitions of Distributional Neutral

Alternative Definitions of Neutrality*	Potential Measures of Net Gain (or Loss)			
	Consumer Surplus	Net Monetary Gain or Loss	Net Benefits	Pure Public Good Benefits
1. Benefits Proportional to "without" investment income.	Implies declining marginal utility of income.	Implies declining marginal utility of monetary income. Neglects income-in-kind and consumer surplus.	Implies declining marginal utility of income assuming consumer surplus proportional for all income classes.	Not applicable
2. Absolute equal benefits	Implies constant marginal utility of income.	Implies constant marginal utility of monetary income. Neglects income-in-kind and consumer surplus.	Implies constant marginal utility of income assuming consumer surplus equal for all income classes.	Not applicable
3. Proportional potential benefits.	Not applicable	Not applicable	Not applicable	Implies declining marginal utility of income
4. Absolute potential benefits.	Not applicable	Not applicable	Not applicable	Implies constant marginal utility of income

*If the definition is applied to the "before tax" distribution the definition will have additional and uncounted normative significance due to the tax structure. Such will not be the case if the "after tax" distribution is utilized.

CHAPTER 4

WATER ALLOCATION IN THE LOWER TRUCKEE-CARSON RIVER BASINS: A POLICY DILEMMA

Physical Setting

Both the Truckee and Carson Rivers have their origins high on the east side of the Sierra Nevada Mountains about 250 miles east of San Francisco. As depicted in Figure 1, the Truckee River rises in the basin surrounding Lake Tahoe, flows out of that lake and down the steep east side escarpment of the Sierra Nevada and flows in an easterly and northeasterly direction through the city of Reno and ultimately terminates in Pyramid Lake some 50 miles northeast of that city. Pyramid Lake is commonly regarded as an "evaporating pan" as it has no outlet and waters reaching Pyramid Lake are ultimately lost through the processes of evaporation and transpiration.[1]

The Carson River occupies the watershed immediately south of the Truckee River. Like the Truckee, it flows down the east side of the Sierras and turns northeasterly where it flows for a distance of about 60 miles through agricultural lands and arid desert. The Carson River ultimately disappears in the Carson Sink which is lake-like during wet periods and marshy or nearly dry during drought periods.

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[1]Wilsey and Ham, *Water Resources and Land Use of the Pyramid Lake Indian Reservation* (San Mateo, Calif.: Wilsey and Ham, 1970), p. 11.

The Carson Sink is geologically different from Pyramid Lake in that water flowing into the Sink disappears through evaporation and percolation through the soil. Pyramid Lake is generally thought to be watertight by geologists and thus percolation is not a factor there.

Both rivers have striking geographical similarities in that they arise high in the Sierras at elevations of nearly 10,000 feet and plunge quickly downward to elevations of approximately 4,000 feet. Over their courses, both rivers traverse biomes extending from the high alpine type to the semi-arid desert types found in the areas around Pyramid Lake and the Carson Sink. Rainfall in the lower reaches is sparse, averaging approximately 6.5 inches per year at Pyramid Lake[2] and 5.2 inches per year in the Carson Sink area.[3] Consequently, both rivers are dependent for the bulk of their flows on the winter snowpack and spring storms which occur in the Sierras. This means that the magnitude of flows in the river system varies significantly from season to season as well as from year to year.

The mean annual flow of the Truckee River is 499,100 acre feet[4] per year while the mean annual flow of the Carson River is 215,960 acre feet per year. These figures are somewhat deceptive, however. Annual flows in the Truckee River, as measured at Vista,

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[2] *Ibid.*, p. 31.

[3] Clyde, Criddle and Woodward, Inc., *Report on Water Use Improvement Study of Truckee-Carson River Basin*, Report prepared for Bureau of Reclamation, Department of Interior (Salt Lake City, Utah: Clyde, Criddle and Woodward, Inc., 1971), p. D-4.

[4] *Ibid.*, p. A-3.

Nevada, have ranged from 1,328,340 acre feet in 1952 to 125,280 acre feet in 1931.[5] Similarly, for the Carson River, annual flows, as measured at Fort Churchill, Nevada, have ranged from 590,640 acre feet in 1952 to 45,200 acre feet in 1961.[6] It is clear, then, that the flows of both rivers have varied by an order of magnitude over the period of record.

Another striking indication of variability can be seen by examining the monthly flows. Such an examination indicates that the flows vary rather sharply throughout the year. On the Truckee River the maximum mean flow in the period of record occurs in May and is equal to 92,290 acre feet, while the minimum mean flow occurs in August and is equal to 15,780 acre feet.[7] On the Carson River the maximum mean flow has also occurred in May and is equal to 64,720 acre feet, while the minimum mean flow occurs in September and is equal to 15,780 acre feet.[8] These figures indicate quite clearly that the dependable water supply in the river basin system is not only absolutely scarce, but is also subject to a significant amount of variation and attendant uncertainty.

Both rivers have a unique similarity in that they do not ultimately find their way to the sea but, rather, evaporate or disappear underground in locations which are far inland. Pyramid Lake itself

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[5] *Ibid.*, p. A-3.

[6] *Ibid.*, p. A-4.

[7] *Ibid.*, p. A-3.

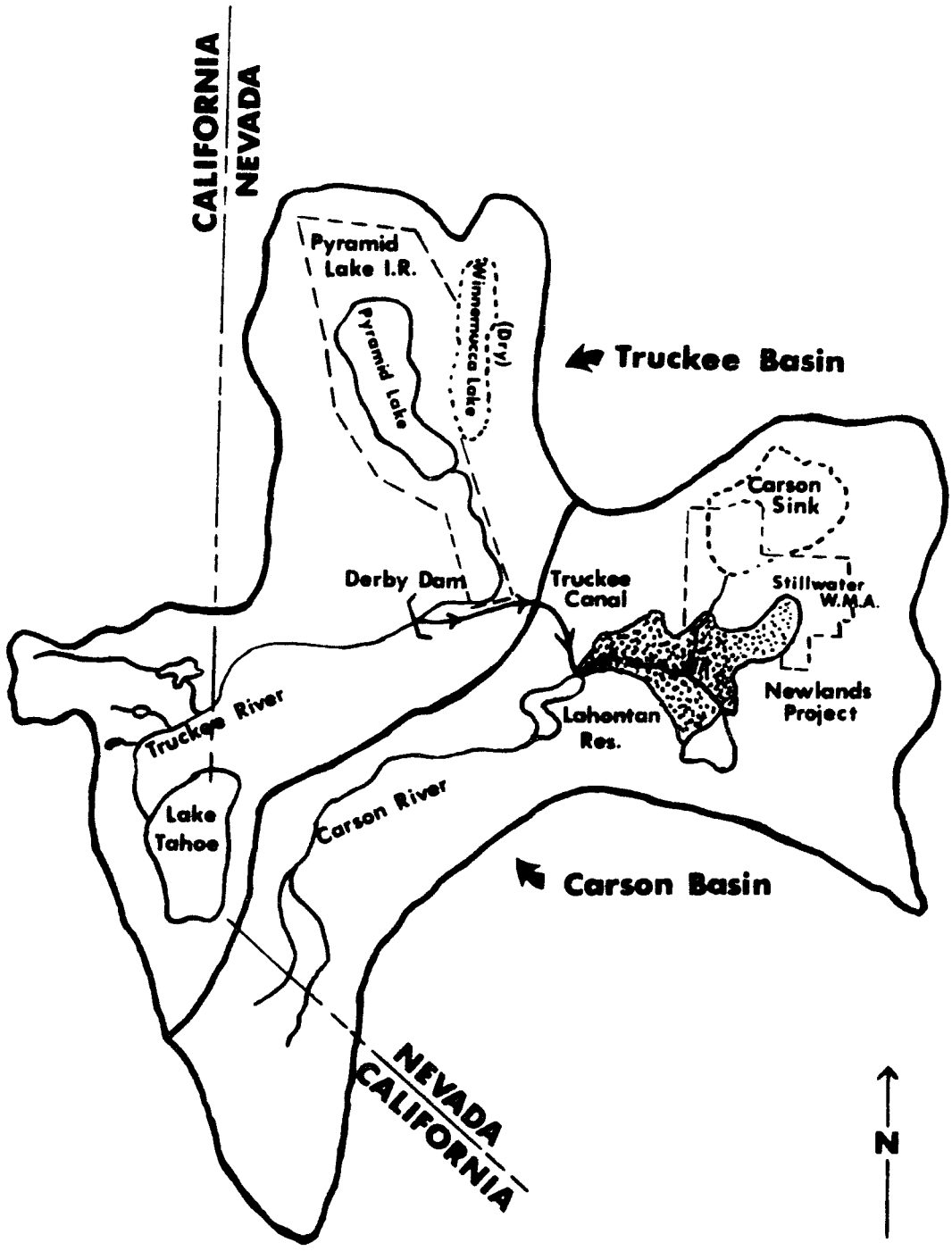
[8] *Ibid.*, p. A-4.

is one of the few relics of the Great Lahontan Sea, a large inland sea which covered about one-third of the Great Basin during the geological time period beginning with the glacial retreat of the last Ice Age. The sea has long since disappeared, leaving in its wake a few remnants such as Pyramid Lake.

The level of Pyramid Lake fluctuates with variations in the inflow of the Truckee River and, to a lesser extent, with variations in the rates of evaporation and transpiration which are dependent upon local climatic conditions. Almost immediately adjacent to Pyramid Lake is Lake Winnemucca (see Figure 1) which historically served as a reservoir for the overflow of Pyramid Lake. The only sources of water for Lake Winnemucca are the overflow from Pyramid Lake and the incidental run-off from the surrounding watershed. The latter is relatively insignificant and, as a result, Lake Winnemucca has been completely dry in recent times due to the declining levels of Pyramid Lake. The existence of Lake Winnemucca means that there is an absolute upper limit to the level of Pyramid Lake at an approximate mean elevation of 3,885 feet, but no absolute lower level.[9] Theoretically, if water were completely cut off from Pyramid Lake it would eventually dry up although this would take centuries. As the level of the lake falls, its surface area decreases thereby decreasing the absolute quantities of water lost by evaporation and thus further prolonging the life of the body of water.

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[9]Pyramid Lake Task Force, *Final Report of the Pyramid Lake Task Force*, Reno, Nevada, 1971, p. A-3 (Mimeographed).



TRUCKEE-CARSON RIVER BASINS

FIGURE 1

The lower basins of the Truckee and Carson Rivers present a picture of a semi-arid area with extremely limited dependable water supplies. Inasmuch as available groundwater in this region is not of sufficiently high quality to be useful, virtually all water supplies must be obtained from the Truckee and Carson Rivers and their tributaries. Since the flows of these rivers vary sharply over the year and from year to year there is great uncertainty associated with predicting quantities of dependable supplies. Against this picture of a relatively scarce resource the following section examines, in historical context, the history of demand for water in the lower Truckee-Carson River basins.

The Early History of the Lower Basins and Pyramid Lake

Pyramid Lake was discovered by Captain John Fremont in 1844 as he explored the Great Basin and the far west. Fremont named the lake for a large pyramid along the eastern shore, similar in appearance to the pyramid at Cheops. In modern times this geological feature has become known as Fremont's Pyramid. At the time he discovered the lake, Fremont found a tribe of Northern Paiute Indians inhabiting the lands surrounding the lake. The Indians subsisted almost entirely on fish from the lake, the principal species of which were the Lahontan cut-throat trout and a sucker-type fish called the Cui-ui. Both species were absolutely unique to Pyramid Lake. Fremont concluded that the fish in the lake formed the main source of support for the Indians and that they apparently held the fishery in their exclusive

possession.[10] Reports of the Commissioner of Indian Affairs in later years confirmed Fremont's initial conclusion.[11]

The shore of Pyramid Lake and the surrounding territory are thought to have been the home of the Pyramid Lake Paiutes since prehistorical times. In 1859, the lands which currently form the Pyramid Lake Indian Reservation (see Figure 2) were withdrawn for reservation purposes by the Commissioner of the General Land Office.[12] The reservation includes 475,000 acres. Pyramid Lake, the principal feature of the reservation, accounts for 20% of the total reservation area.[13] An official survey was made of the reservation in 1865 and this survey was apparently carefully drawn so as to include the entirity of the lake. On March 12, 1875, President U. S. Grant issued an Executive Order which formally proclaimed the withdrawn lands to be the Pyramid Lake Indian Reservation.[14] It is interesting to note that this reservation was created by Executive Order rather than by treaty.

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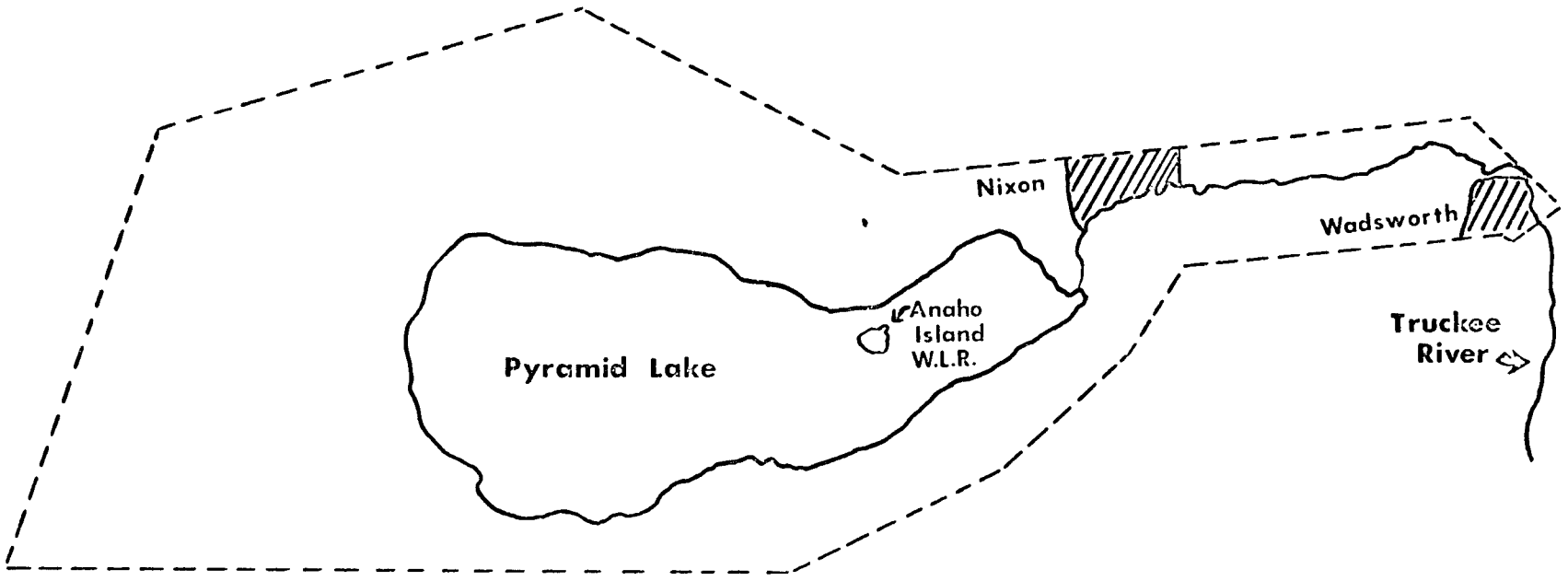
[10]Wilsey and Ham, *Water Resources and Lake Use of the Pyramid Lake Indian Reservation*, p. 13.

[11]U. S. Department of Interior, Bureau of Indian Affairs, *Annual Report of Commissioner of Indian Affairs, 1871* (Washington, D.C.: Department of Interior, 1871), p. 89.

[12]U. S., Congress, Joint Economic Committee, *Toward Economic Development for Native American Communities*, Vol. 2, "Federal Encroachment on Indian Water Rights and the Impairment of Reservation Development," by William H. Veeder, Joint Committee Print (Washington, D.C.: Government Printing Office, 1969), pp. 498-499.

[13]Wilsey and Ham, *Water Resources and Land Use of the Pyramid Lake Indian Reservation*, p. 11.

[14]*Ibid.*, p. 13.



PYRAMID LAKE INDIAN RESERVATION

FIGURE 2

The treaty was the commonest method of creating Indian reservations throughout the West.

Early reports of the Bureau of Indian Affairs indicated that the Pyramid Lake Indians used a small portion of their lands for agricultural purposes and for the feeding of livestock.[15] Some of the lands were apparently irrigated and there was a large ditch constructed for that purpose. However, it was clear that the lake itself was the keystone to the Indians' existence. Fish from the lake provided the primary component of the Indian diet and, as transportation improved, sales of fish to west coast markets provided sources of revenue.[16] According to the Commissioner of Indian Affairs, the sale of fish continued to be an important industry for the Indians as late as the turn of the century. At the turn of the century, the Indians had approximately 250 acres under cultivation.[17] The reports of the Bureau of Indian Affairs give the impression of an Indian economy which was relatively stable and supported the Indians in a reasonably satisfactory fashion through the early years of the 20th century. However, all of this was soon to change.

The Modern History of the Lower Basins and Pyramid Lake

Between 1859 and 1910 there was a significant amount of irrigation development along the Truckee River, particularly in the

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[15] *Ibid.*, p. 13.

[16] *Ibid.*, pp. 13-14.

[17] *Ibid.*, p. 15.

Reno-Sparks area. The diversions for this irrigation did not have a significant effect on Pyramid Lake because large portions of the diversions were returned to the stream after use and flowed into Pyramid Lake.[18] Thus, irrigation as historically practiced in the Truckee River basin apparently had no adverse effects on the Indians.

In 1902, Congress enacted the Reclamation Act, the objective of which was to promote settlement of the arid and semi-aris lands of the west with family-sized farms.[19] Senator Francis Newlands of Nevada was a strong supporter of the Act and thus it was not surprising that one of the first projects to be constructed under the provisions of the Act was on the lower Carson River. Expectedly, the undertaking was called the Newlands Project.

Although settlers had previously irrigated in the Carson Valley, the variability of the stream flow led to demands for a dam to store water during the wet season for later use during the dry season when crops could be grown only with irrigation. Additionally, Senator Newlands had visions of reclaiming nearly one-third of a million acres of Nevada desert for farming. The Newlands Project, as ultimately conceived and constructed, consisted of Lahontan Dam and Reservoir on the Carson River to provide regulation of the stream flows over the year and Derby Dam and the Truckee Canal on the Truckee River. Derby Dam and the Truckee Canal were constructed because the

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[18] U. S., Congress, Joint Economic Committee, *Toward Economic Development for Native American Communities*, p. 500.

[19] Newlands Act of 1902, 32 Stat. 388 (1902), 43 U.S.C., Sec. 371 (1970).

Reclamation Service realized that the flows of the Carson River were not sufficient to meet the "needs" of the irrigation project and would therefore have to be supplemented. Supplementary flows were thus obtained from the Truckee River through construction of Derby Dam which diverted water into the Truckee Canal and thence into the Carson Basin for use in the Newlands Project. The Newlands Project became one of the first projects in the United States involving a transbasin diversion.

Derby Dam was completed in 1905 and the Truckee Diversion Canal was completed in 1906, signaling the final completion of the project. From the outset it was apparent that serious mistakes had been made in the conception of the Newlands Project. The Reclamation Service had failed to make any soil surveys and as farmers began to move into the project area it became clear that much of the area was unsuitable for farming because of the high alkali content of the soil. As a result, the Newlands Project fell far short of its projected 287,000 acres. Although there is some dispute over the exact acreage there is general agreement that the project has never irrigated more than 60,000 acres.[20]

In 1926, the Bureau of Reclamation (the former Reclamation Service) entered into a contract with the Truckee-Carson Irrigation District (TCID). Under the terms of this contract the District was

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[20]"Action Program for Resource Development Truckee and Carson River Basins California-Nevada," U. S. Department of the Interior. Prepared by a Task Force of Department of Interior Agencies, in accordance with instructions issued by the Secretary of the Interior, Washington, D.C., 1964, p. 7.

to assume responsibility for operating and maintaining the Newlands Project. Additionally, provision was made to relieve the District of certain repayment obligations, thus providing a subsidy over and above the interest subsidy to the project.[21] The Truckee-Carson Irrigation District has retained responsibility for the management and operation of the project to the present day.

As the Newlands Project developed other settlement was taking place in the lower basins region and additional claims were being made upon the scarce waters. The claims were often conflicting and in water-short years not all of them could be satisfied. Violence was threatened on several occasions. In 1925, the United States initiated action to adjudicate the rights of the water users on both the Carson and Truckee Rivers. The federal government possessed standing to initiate such action by virtue of the fact that both the Truckee and the Carson were interstate streams and also because it held water rights in trust for both the irrigators and the Pyramid Lake Indians.

In the case of the Carson River the result was a temporary decree entered on in 1950.[22] However, today, some 47 years after the action was initiated, no final judgment has been entered. The presumption is that the waters of the Carson River are to be

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[21]Contract between the United States of America and the Truckee-Carson Irrigation District providing for the transfer of the management of irrigation works to the District and for the repayment of construction costs: December 18, 1926.

[22]United States v. Alpine Land and Reservoir Company, U.S. District Court, D. Nev., No. D-183.

allocated in accordance with the temporary *Alpine Decree*, although it has been demonstrated that the decree is not being enforced.[23]

On the Truckee River, a temporary restraining order was made in 1926 and a final decree was entered in September, 1944.[24] This decree, *The Orr Water Ditch Decree*, confirmed that the Pyramid Lake Indians held a senior right, dated 1859, entitled them to approximately 30,000 acre feet of water per year to irrigate some 5,875 acres of reservation land.[25] Additionally, the decree confirmed the right of the Newlands Project to divert from the Truckee River water in an amount not to exceed 1,500 cubic feet per second for use in irrigating some 232,800 acres. The application of water was not to exceed 3.5 acre feet per acre per year for bottom lands and 4.5 acre feet per acre per year for beach lands after allowing for transportation loss. This right has a priority of July 2, 1902.[26] No explicit mention was made of rights to maintain Pyramid Lake *per se*. Rather, the tribe had affirmed rights only for land which it could irrigate. Implicit in the decree was the view that water used for fish and wildlife or recreation purposes was not important or even beneficial.

The diversion of water from the Truckee River to the Newlands Project had a rather sharp effect on the condition of Pyramid Lake.

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[23]Pyramid Lake Task Force, *Final Report*, pp. 34-35.

[24]United States v. Orr Water Ditch Company (Nevada Equity No. A-3, U. S. District Court, D. Nev., 1944).

[25]*Ibid.*, p. 10.

[26]*Ibid.*, pp. 10-11.

The level of the lake has declined some 80 feet since the diversions began and the size of the lake has shrunk by some 34,000 acres[27] (see Figure 3). This is attributable to the fact that rates of evaporation and transpirtation have exceeded rates of inflow to the lake. This decline has had several undesirable effects. The lowering of the surface of the lake was accompanied by siltation at the mouth of the Truckee River. As a result, the cutthroat trout were no longer able to spawn and ceased to exist in 1939.[28] Although a stocking program is currently in operation, the increasing salinity of lake waters accompanying the decline make it questionable whether the cutthroat and its companion, the Cui-ui, will be able to survive.

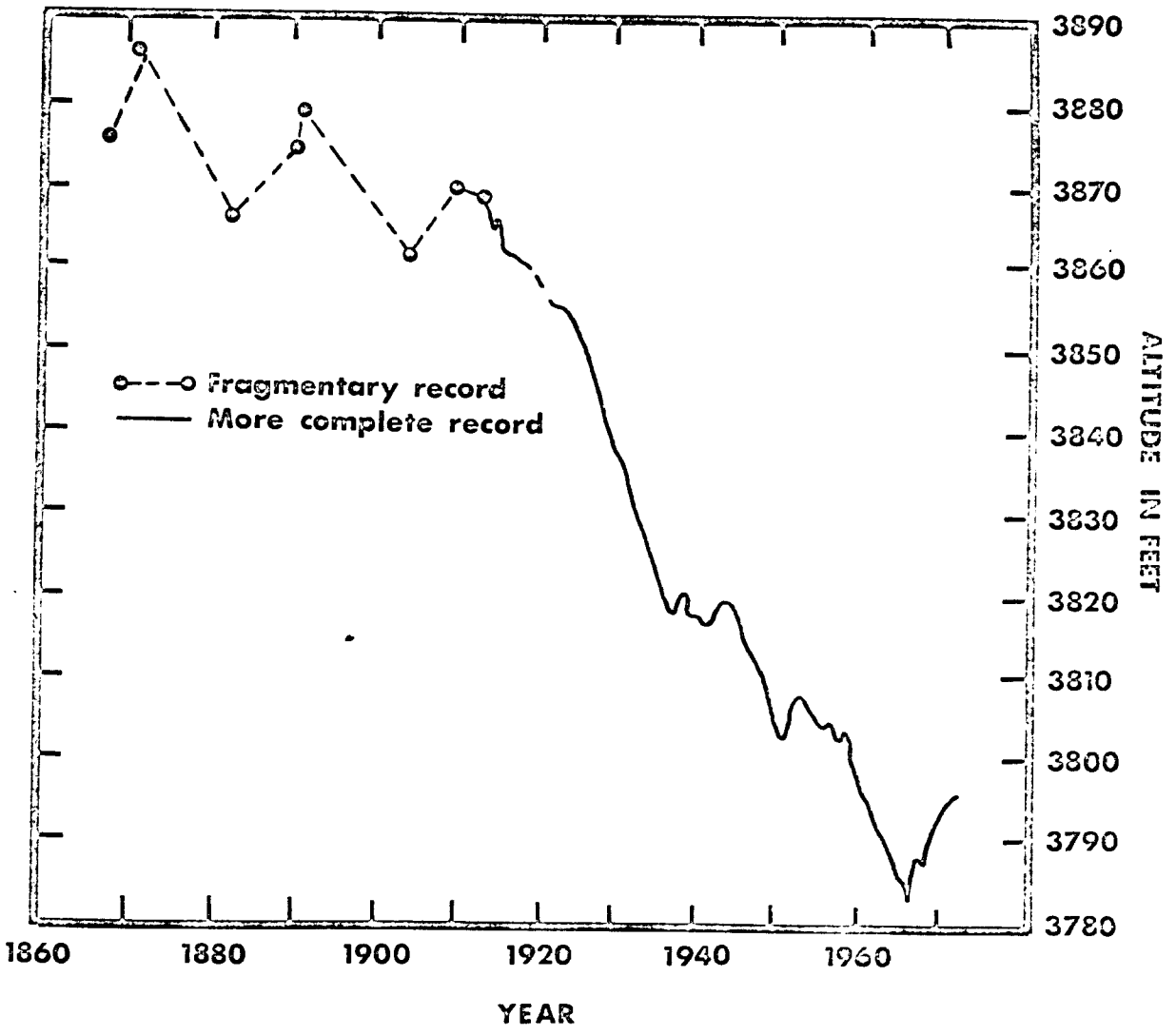
Additionally, as the economy has grown and the pattern of demands has changed, Pyramid Lake has become a significant recreational resource.[29] The lake is largely undeveloped at the present time both because the Indians do not possess the capital to undertake development and because private developers are unwilling to venture capital to develop facilities at the lake without some assurance that the level of the lake will remain relatively stable.

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[27]Wilsey and Ham, *Water Resources and Land Use of the Pyramid Lake Indian Reservation*, pp. 31-32.

[28]"Action Program for Resource Development Truckee and Carson River Basins California-Nevada," U. S. Department of the Interior, pp. 26-27.

[29]See: Bureau of Outdoor Recreation, *Pyramid Lake Recreation Study* (Washington, D. C.: Government Printing Office, 1968), p. 14.



WATER-SURFACE FLUCTUATIONS OF PYRAMID LAKE

FIGURE 3

Adapted from: U.S.G.S.
Hydrologic Investigations
Atlas HA-379

The Allocation Controversy Renewed

In the last 15 years two events have served to rekindle a controversy over water allocation in the Truckee-Carson River system. The first event was congressional action authorizing construction of the Washoe Project within the river system. The second was the development of a draft California-Nevada Interstate Compact. This Compact, if approved, would provide fundamental guidelines and institutional mechanisms for allocation of interstate waters between California and Nevada. Both the Washoe Project and the Interstate Compact have potentially significant implications for water allocation within the Truckee-Carson River system.

The Washoe Project

The major components of the Washoe Project are depicted in Figure 4. The Project consists of works in both the upper Truckee and upper Carson Basins.[30] In the Truckee Basin both Prosser Creek Reservoir and Stampede Reservoir have been constructed. Prosser Creek Reservoir is primarily a flood control facility designed to help protect Reno from heavy spring flood flows. It also serves as a regulating reservoir to assure a perennial flow in the upper Truckee River. Stampede Reservoir is also a flood control project, but, in addition, has approximately 7,000 acre feet of storage allocated to municipal and industrial water supply uses in the Reno-Sparks area.

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[30] U. S., Congress, House, *Report on Washoe Project, Nevada-California*, H. Doc. 181, 84th Cong., 1st Sess., 1955.

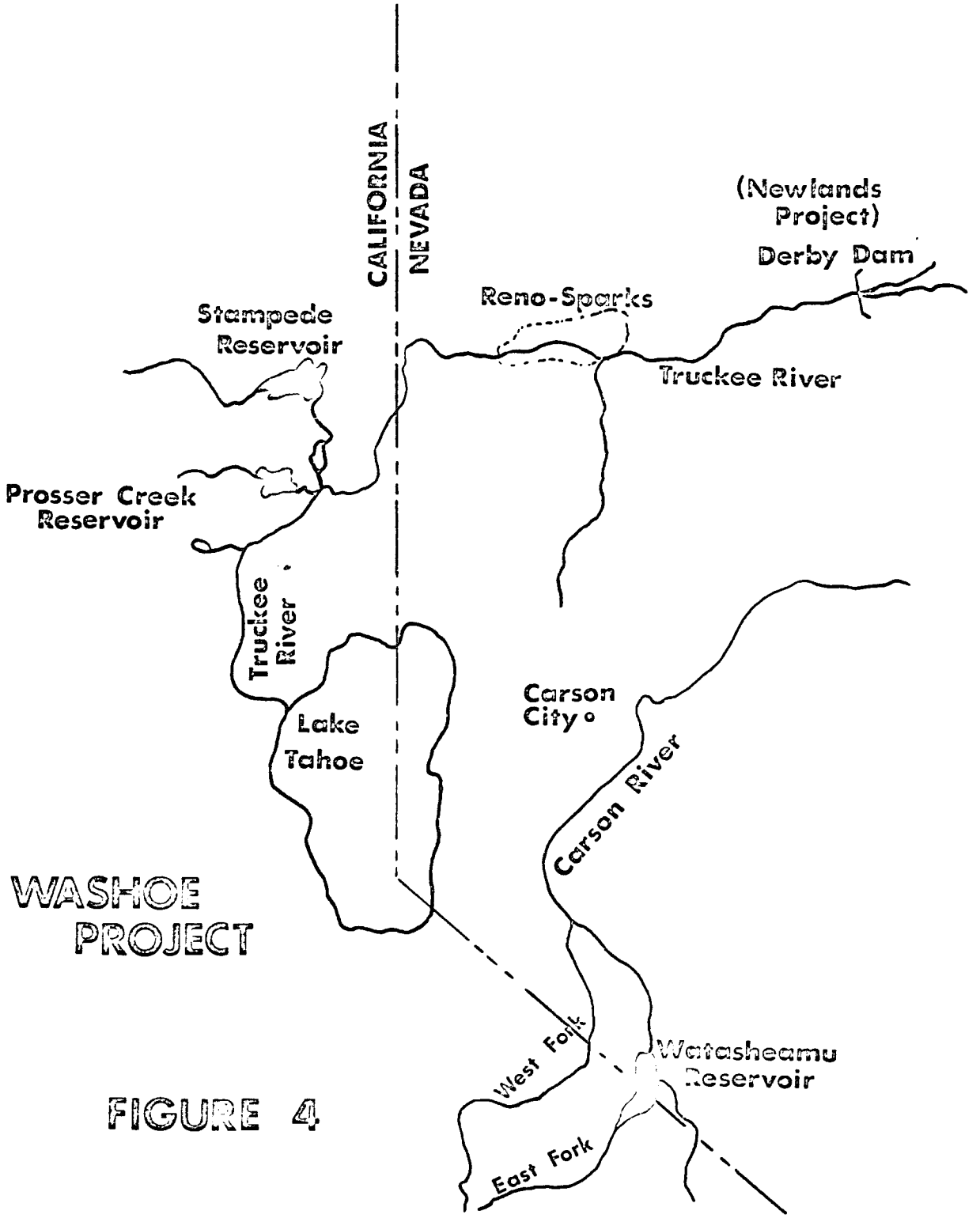

CALIFORNIA
NEVADA
(Newlands Project)
Derby Dam
Reno-Sparks
Stampede Reservoir
Truckee River
Prosser Creek Reservoir
Truckee River
Lake Tahoe
Carson City
Carson River
WASHOE PROJECT
West Fork
Watasheamu Reservoir
East Fork

FIGURE 4

The Watasheamu Dam and Reservoir and associated facilities on the upper Carson River would provide supplementary irrigation water for some 43,380 acres of land which are presently irrigated. It would also generate hydroelectric power and could be used for flood control storage for greater than average floods. Watasheamu Dam has not been constructed and there are no plans for construction in the foreseeable future.

In the course of planning for the Washoe Project, engineers recognized that a different water management scheme would have to be developed if all water commitments in the two basins were to be met. Accordingly, there was developed a rather complex scheme for reallocation of waters within and between the two basins. The construction of works on the Carson River would reduce the amount of water available from that river for the Newlands Project. To partially compensate for this loss the Bureau of Reclamation suggested that additional diversions be made from the Truckee River into the Truckee Canal for ultimate use on the Newlands Project.[31]

It should be noted that releases to the Newlands Project are utilized for purposes other than irrigation. Over the years irrigation tailwaters have made possible the development of two wildlife management areas in the lower Carson Valley. These are the Fernley Wildlife Management Area and the Stillwater Wildlife Management Area. The areas are managed by the Bureau of Sport Fisheries and Wildlife in the Department of the Interior. Although operation of the areas has been

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[31]U. S., Congress, Joint Economic Committee, *Toward Economic Development for Native American Communities*, pp. 502-506.

administratively approved by the federal government, the State of Nevada and the TCID,[32] there are no adjudicated water rights for such operations, and the existence of the areas depends upon the availability of irrigation tailwaters. The use of water in the wildlife management areas is justified on the grounds that it is "beneficial" use. Similarly, the use of tailwaters to irrigate a community pasture, the Carson pasture, is also justified on the basis of "beneficial" use although there is no adjudicated water right for that pasture. If irrigation water deliveries to the Newlands Project were curtailed, the wildlife areas (and the community pasture) would be affected, although it is a matter of some controversy as to whether the effect would be positive or negative.

Both the Pyramid Lake Indians and the Truckee-Carson Irrigation District objected to the revised water allocation scheme. The TCID based its objection on the argument that it could not be deprived of any portion of its legally decreed water allotment. The objections of the Indians were somewhat more involved. Although the *Orr Water Ditch Decree* provided water to the tribe solely for the purpose of irrigation, the Indians argued that they possessed rights to maintain the level of the Pyramid Lake to preserve the fishery which has been their historical source of livelihood. Additionally, they argued that maintenance of a relatively stable water level represented beneficial use inasmuch as the lake was a significant recreation resource.

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[32]Agreement between the Truckee-Carson Irrigation District, the Board of Fish and Game Commissioners of Nevada, and the U. S. Fish and Wildlife Service, dated November 26, 1948.

In propounding their argument for maintenance of the water level to preserve fisheries, the Indians referred to the *Winters Doctrine* enunciated by the Supreme Court in 1908. The *Winters Doctrine* dealt with the issue of Indian water rights on semi-arid Indian reservations and can be summarized briefly as follows. The original case involved a question of whether non-Indian upstream water users could divert water, thus depriving downstream Indians of their basic source of livelihood. Without water the Indians had no means of survival on the reservation. In considering the case the Supreme Court examined the treaty creating the reservation in question in order to ascertain the rights of the Indians. The court concluded that the absence of an explicit providion reserving water for the Indians could be interpreted in two different ways. It could be argued that the Indians had deliberately abandoned any water rights upon the signing of the treaty or, alternatively, that they recognized the need for water and therefore reserved implicitly the use of that water for themselves.[34] The Court decided in favor of the Indians.

> The Indians had command of the lands and the waters--command of all their beneficial use, whether kept for hunting and grazing, roving herds of stock, or turned to agriculture and the arts of civilization. Did they give up all this? Did they reduce the area of their occupation and give up waters which made it valuable or adequate? . . . By a rule of interpretation of agreements and treaties with the Indians, ambiguities occurring will be resolved from the standpoint of the Indians. And the rule should certainly be applied to determine between two inferences, one of which would support

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[33] Winters vs. United States, 207 U. S. 564 (1908).

[34] *Ibid.*, p. 346.

> the purpose of the agreement and the other impair or defeat it. On account of their relations to the Government, it cannot be supposed that the Indians were alert to exclude by formal words every inference which might militate against or defeat the declared purpose of themselves and the Government, even if it could be supposed that they had the intelligence to foresee the "double sense" which sometimes might be urged against them.[35]

In another case, the Supreme Court stated that:

> . . . whenever the needs and requirements of the complainant for the use of the waters of Birch Creek for irrigation or other useful purposes upon the reservation exceed the amount of water reserved by decree for that purpose, the complainant may apply to the court for a modification of the decree.[36]

Thus, it was argued that what was impliedly reserved to the Indians was not only the amount of water required at the time the reservation was established but also the amount of water which they might need in the future to accomplish the purposes for which the reservation was set aside.

In summary, then, the argument of the Pyramid Lake Indians had two major thrusts. First, by virtue of the *Winters Doctrine* and other Court cases,[37] they possessed the right to a quantity of water from the Truckee River necessary to preserve (or reestablish, in this case) the fishery upon which they had historically depended. At the time the Washoe Project was authorized they were not receiving this quantity of water. Second, the tribe argued that construction of the

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[35] *Ibid.*, p. 346.

[36] Conrad Investment Company v. United States, 161 F. 829 (9th Cir. 1908), p. 835.

[37] See: United States v. Ahtanum Irrigation District, 236 F. 2d 321 (9th Cir. 1956); United States v. Winans, 198 U. S. 371 (1905) and Arizona v. California, United States Intervener, 373 U. S. 546, 600 (1962).

Washoe Project would further deplete flows of the Truckee River into Pyramid Lake and, consequently, further encroach on their *Winters Doctrine* rights.[38]

The Indians also argued that the fact that no *Winters Doctrine* rights were recognized in the *Orr Water Ditch Decree* was not of consequence. It was their view that the Secretary of the Interior, as the trustee of the tribe, had the authority to acknowledge administratively the existence of the *Winters Doctrine* rights and take all steps to see that water guaranteed the tribe by virtue of that doctrine be delivered to Pyramid Lake.[39]

Specifically, the tribe has contended that the average current flow to the lake at this time is roughly 238,000 acre feet per year. If this rate of flow prevails, the lake's level will continue to drop at a rate of approximately one foot per year and it will be destroyed utterly as a recreation and fishery resource.[40] In order to create a relatively stable lake an annual inflow of 385,000 acre feet per year would be required.[41] This means that approximately 150,000 acre feet of additional water would have to be diverted to the lake over and above what it is now getting. The Indians have contended further that the diversion of Truckee River water to the Newlands Project is wasteful. They believe the Secretary of Interior, as trustee of the

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[38]Pyramid Lake Paiute Tribe v. United States, No. 927, 39 L.W. 3201.

[39]Pyramid Lake Paiute Tribe v. Walter J. Hickel and John N. Mitchell, "Memorandum of Points and Authorities in Opposition to Motions to Dismiss," U. S. District Court, D. C., No. 2506-70.

[40]Lowell Smith and Pamela Deuel, "The California-Nevada Interstate Water Compact: A Great Betrayal," *Cry California*, 7 (Winter, 1971-72), p. 33.

[41]See: Pyramid Lake Task Force, *Final Report*, p. A-23.

tribe, should reallocate water away from Newlands in the amount of 150,000 acre feet annually and take all action to prevent further encroachment upon its *Winters Doctrine* rights.

The Secretary of Interior was thus placed in a dilemma. On the one hand, the Truckee Carson Irrigation District and other powerful irrigation interests within the two basins were asserting that they were entitled to their decreed rights. They were supported by the Bureau of Reclamation in this assertion. On the other hand, the Pyramid Lake Indians were asserting that the *Winters Doctrine* and related decisions bound the Secretary to allocate administratively sufficient waters to the lake to ensure relatively stable levels. Further, the Indians argued that the *Orr Water Ditch Decree* was explicit in stating that the justification for water entitlement was beneficial use and that the Newlands Project involved flagrant waste of significant quantities of water. In short, they argued that the Secretary had abrogated his trust responsibility to the Indians and should take immediate steps to fulfill that responsibility. Since there was not sufficient water in the river system to accommodate the conflicting claims, the Secretary was confronted with a problem of developing an administrative allocation of the scarce water. This dilemma and the accompanying controversy were heightened by negotiations attendant to the development of an interstate compact which purported to allocate the waters of the Truckee and Carson Rivers between the states of California and Nevada.

The California-Nevada Interstate Compact

Since 1955, California and Nevada have been engaged in negotiations to develop a means to equitably divide the waters of the three interstate streams common to both states. These streams are the Truckee River, the Carson River and the Walker River. The latter river lies immediately south of the Carson River and is not of concern in this study. The nature of Interstate Compacts is such that they must be approved by the legislatures of both states as well as the Congress. After more than 15 years of negotiation, a draft Compact was approved by both state legislatures.[42] Draft legislation was introduced in the House[43] but companion legislation has not been introduced in the Senate.

The Compact as currently drafted provides for creation of a Compact Commission to administer the provisions of the Compact. It also provides, with some degree of specificity, for the allocation of waters in the interstate streams between the two states. The draft Compact fails to recognize any Indian water rights in the Truckee-Carson system except those irrigation rights affirmed by the *Orr Water Ditch Decree* for the Pyramid Lake Indians. The draft Compact fails to make any mention of any *Winters Doctrine* rights. Thus, Congressional approval of the Compact as currently drafted could be interpreted as an implicit denial of the existence of *Winters Doctrine* water rights for the Pyramid Lake Indians.

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[42]Water, California Annotated Statutes, Part 8, California-Nevada Interstate Compact, Sec. 5975; Nev. Rev. Stat. 538.600.

[43]H.R. 6078, 91st Cong., 1st Sess. (1972).

The Compact, then, has become an important element in the continuing controversy over water allocation in the Truckee-Carson system. If ultimately adopted in its present form, the Compact will provide guidelines as well as the institutional machinery for allocation of the scarce waters of the basins involved. The Pyramid Lake Indians have opposed the Compact in all of its various forms principally on the grounds that it fails to recognize the existence of *Winters Doctrine* rights. One early draft of the Compact in fact contained language which was interpreted as denying the Indians even the possibility of adjudicating *Winters Doctrine* rights. The Bureau of Indian Affairs and the California State Legislature refused to ratify this version. The current version gives all waters in the Truckee River not explicitly allocated to California or the federal government to the state of Nevada. Thus, the tribe is at pains to make clear that the Compact provides for the seizure of waters which properly belong to the Indians. Furthermore, they argue that the Secretary of the Interior should recommend Congressional opposition to the current draft since it gives waters to the state of Nevada which properly should be under the control of the federal government acting as trustee for the tribe.

The draft Compact, then, appears to reenforce the policy dilemma which was raised by the Washoe Project. This is so because the draft Compact allocates the waters of the Truckee-Carson system in a fashion that will enable completion of the Washoe Project through the seizure of waters which the Indians claim as theirs. Thus, the Secretary is under the same sort of pressures with respect to his

position on the Compact as he is with respect to the Washoe Project. Essentially the same arguments surround the question of Compact approval as surround the issue over construction of the Washoe Project. This is not surprising in view of the fact that approval of the Compact in effect clears the way for completion of the Washoe Project.

The Task Force Studies

In an effort to resolve the controversy, the Secretary of the Interior has appointed two Task Forces at different times during the past ten years to study ways in which the conflict might be resolved. The first Task Force was composed solely of representatives of the various Department of Interior agencies having an interest in the Truckee-Carson water allocation problem.[44] This Task Force attempted to develop a plan which would permit early completion of the Washoe Project.

The report of this Task Force, entitled "Action Program for Resource Development Truckee and Carson River Basins California-Nevada," contained some ten recommendations. Two stand out. First, the Task Force assumed that the Secretary of the Interior could not guarantee water to any group unless that group held an adjudicated water right.[45]

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[44]Members of the Task Force included representatives of the Bureau of Reclamation, the Bureau of Indian Affairs, the Bureau of Sport Fisheries and Wildlife, the Geological Survey and the Office of the Solicitor. The Chairman of the Task Force was the Director of the Resources Program staff.

[45]"Action Program for Resource Development Truckee and Carson River Basins California-Nevada," U. S. Department of Interior, p. 2.

This meant that no water could be guaranteed to Pyramid Lake aside from the amount already adjudicated for irrigation purposes. The Task Force recommended, however, that Pyramid Lake be allotted as much water as possible without jeopardizing adjudicated rights.[46] Second, the Task Force recommended that the Newlands Project receive an allotment of 406,000 acre feet annually which annual allotment may be reduced.[47] These recommendations were unsatisfactory to both the Indians and the TCID. As a consequence, the only concrete action to emerge from the work of the Task Force was the formation of a committee to prepare operating procedures and criterion on an annual basis. Such procedures have been prepared, adopted by the Secretary and published in the *Federal Register* since 1967.[48]

It has been the case that the water available to Pyramid Lake has increased since the operating procedures and criteria were introduced. However, the increase is attributed to several exceptionally wet years and the Indians have remained dissatisfied with the procedures since they are left with a residual quantity of water which is subject to sharp variations. The TCID also objected to the initial recommendation, arguing that their adjudicated allotment of 406,000 acre feet should not be reduced in any circumstances except when supplies were so short as to require reduction to meet rights senior to theirs.

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[46] *Ibid.*, pp. 25-26.

[47] *Ibid.*, pp. 9-10.

[48] See for example: U. S. Department of Interior, Office of the Secretary, "Operating Criteria and Procedures; Truckee and Carson Rivers," *Federal Register*, XXXV, No. 59, March 26, 1970, 5131.

The objections of the TCID were overcome, however, when the Secretary agreed in writing not to reduce the 406,000 acre foot allotment.[49] Additionally, the Bureau of Reclamation played a crucial role in determining the procedures and criteria and represented the TCID effectively. The Pyramid Lake Indians had no such representation. This was due, in part, to the fact that the Bureau of Indian Affairs had withdrawn support for the Task Force recommendations in 1966 and was not in a position to effectively counter the Bureau of Reclamation.

The second Task Force was somewhat more broad-based and was founded in an effort to aid in the development of an acceptable interstate Compact. This Task Force, the Pyramid Lake Task Force, was created by the Secretary of the Interior and the governors of California and Nevada in an effort to aid in the development of an acceptable compact.[50] It consisted of members from the federal government and appointees from the states of California and Nevada. This Task Force defined its objectives as follows:

> To investigate the water availability and needs of the Tahoe, Truckee and Carson Basins and to recommend ways and means to use and distribute such waters in such a manner as will as closely as possibly provide sufficient water to preserve Pyramid Lake and to satisfy the beneficial needs of other users.[51]

The Task Force conducted its work by appointing study groups to examine seven areas which had not been studied previously or for

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[49]See exchange of correspondence between the Department of Interior and the Truckee-Carson Irrigation District relating to the "Nine-Point Package Agreement," dated July 13, 1967 and August 10, 1967.

[50]Pyramid Lake Task Force, *Final Report*, pp. v-xi.

[51]*Ibid.*, p. 9.

which previous work had been inconclusive. The areas were: (1) weather modification, (2) ground water availability, (3) water importation, (4) engineering and mechanical solutions, (5) water rights and their enforcement, (6) economic studies, and (7) water salvage studies. For the most part, the results of these studies were either inconclusive or the recommendations were deemed "infeasible" by the Task Force.

Two significant findings did emerge, hoever. The Task Force found that the two decrees governing the allocation of water rights within the system were not being adequately enforced.[52] Thus, lands without adjudicated rights were being irrigated and other lands for which adjudicated rights existed were taking more water than they were legally entited to. The Task Force recommended that the decrees be enforced.

The second significant finding came from the work of the engineering consulting firm of Clyde, Criddle and Woodward, Inc., which was engaged by the study group on water salvage. The consulting firm concluded that the 406,000 acre feet allocated to the Newlands Project was excessive.[53] It suggested that nearly 100,000 acre feet could be saved if certain portions of the project were modernized and management practices improved. With respect to management the consultants noted that modern metering equipment had not been installed and as a result accurate records of water deliveries were not being kept. Further, the consultants noted that in some cases farmers were

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[52] *Ibid.*, pp. 15-16.

[53] *Ibid.*, p. A-21.

opening and closing their own gates and in these instances management of the project devolved into the hands of the farmers rather than TCID management.[54] Consequently, the Task Force recommended that certain physical improvements designed to modernize portions of the project be undertaken at a cost of approximately $1.5 million dollars. They further recommended that this cost be borne by the federal government. The Task Force concluded that water savings realized from this modernization should be subtracted from the 406,000 acre feet figure which the TCID now claims as its entitlement.[55]

Discussion

In this situation the Secretary of the Interior was forced to attempt to mediate the competing claims of two groups for scarce water. He is presumably the trustee of the Indians in all respects and he holds the water rights for the irrigators in trust. To date, his actions have favored the irrigators due most probably to the fact that they were represented by the relatively strong Bureau of Reclamation. In this situation the Bureau of Indian Affairs has not been a particularly strong advocate of the Indians' position although there are signs that this posture is changing.[56] The failure of the

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[54]Clyde, Criddle and Woodward, Inc., *Report on Water Use Improvement Study of Truckee-Carson River Basin* (1971), pp. 57-61.

[55]Pyramid Lake Task Force, *Final Report*, p. 35.

[56]See: "Comments Concerning Truckee-Carson Operating Criteria." A memorandum to members of the Interior Committee on Operating Criteria and Procedures, Truckee and Carson River Basins, signed by George Hedden, Assistant Area Director, Bureau of Indian Affairs, dated November 16, 1971.

Secretary to find a satisfactory compromise to this conflict apparently means that the power to resolve it will be taken over by the courts.[57]

Part of the Secretary's difficulties have stemmed from the failure of his bureaus and task forces to view the problem of water allocation as an economic problem. To be sure, the Pyramid Lake Task Force did undertake an economic study. But this study was wholly unsatisfactory in that it failed to deal with the hard issues of willingness to pay for irrigation water, recreation opportunities at Pyramid Lake and Lahontan Reservoir as well as the hunting permitted at the wildlife management areas. The Task Force did examine the possibility of purchasing water rights to aid Pyramid Lake but concluded that this was not feasible because it was "too expensive" and might destroy already developed local economies.[58] The Task Force neglected to establish any criteria on which to base their judgment of "too expensive." Nor was there any demonstration or support for the assertion that local economies would be destroyed. Indeed, even if the assertion could be documented it might be argued that destruction of local econmies is an inevitable outcome of the market process when demands change. To argue that local economies should not be destroyed in the face of changing demands is to advocate a policy of creating resource immobility and frictions which hinder the attainment

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[57]Pyramid Lake Paiute Tribe of Indians v. Rogers C. B. Morton, U. S. District Court, D. C., No. 2506-70. This suit is currently pending and seeks preliminary relief pending appeal of the *Orr Water Ditch Decree*.

[58]Pyramid Lake Task Force, *Final Report*, p. 31.

of optimal performance from the market system. It has been particularly true of the Reclamation program that the federal government has been reluctant to let the market system work its way and eliminate the marginal farmer.

That marginal farmers are present in the Newlands Project is hardly an issue.[59] The farmers in the Truckee-Carson Irrigation District have repeatedly argued that they cannot afford to pay the cost of modernizing their outdated irrigation project. This, despite the fact they have received relief from 60% of the original investment costs of the project. And yet the farmers pay nothing for the water *per se*. They pay only a flat fee per acre irrigated and an operation and maintenance charge. These fees do not represent equilibrium prices which reflect the value of a scarce resource in its best alternative use. Rather, they represent no more than administrative fees charged to provide management for the Irrigation District and to maintain the conveyance works.

The Secretary is put in an awkward position by the Pyramid Lake Task Force recommendation that all modernization costs be borne by the federal government. To adopt such a policy is to set a precedent which could, if carried to its extreme, commit the federal government to modernizing all outdated Reclamation projects irrespective of financial or economic feasibility. The policy would undoubtedly represent a substantial commitment of resources to

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[59] Data to be presented later indicates that over 50% of the irrigating units with water entitlements on the Newlands Project do not even qualify as farms using the liberal U. S. Department of Agriculture definition.

farming operations which are generally conceded to be marginal. Even if the Secretary were inclined to set such a precedent, it is doubtful that the Office of Management and Budget would allow it because of the sizeable budgetary commitment which would be involved.

While the Secretary can be faulted for not examining the efficiency implications of the Truckee-Carson water allocation problem more thoroughly, he can be criticized even more severely for not taking account of the equity or distributive implications of the problem. It is clear from both Congressional and administrative actions that farmers and Indians are deemed to be special groups by our society. Both groups are the recipients of sizeable transfers of income. Some of the transfers are actually monetary payments, as in the case of the commodity credit or soil bank programs, while others represent transfers of income in kind. The education and health programs of the Bureau of Indian Affairs are examples of the latter. There appears to be ample evidence of rather widely held societal value judgments that the distribution of income among Indians and farmers vis-a-vis the rest of society is not "optimal." As a result, various programs which involve transfer payments have evolved.

In the face of this situation, it is argued here that the Secretary should have ordered an examination of the distributive consequences of Truckee-Carson water allocation as well as the efficiency implications. In the next chapter it will be demonstrated that data on distributive consequences could have been developed.

Such data will be developed in that chapter. The following chapter will examine the distributive consequences of various alternative solutions which the Secretary might have adopted in an effort to solve the problem.

CHAPTER 5

INCOME DISTRIBUTION IN THE LOWER TRUCKEE-CARSON RIVER BASINS

The purpose of this chapter is to develop the reference income distributions for the two principal populations in the lower Truckee-Carson River Basins. Distributions for the two groups, the Pyramid Lake Piaute Tribe of Indians and the members of the Truckee-Carson Irrigation District, have been estimated in different ways. In the case of the Indians a completed questionnaire was obtained from the U.S. Public Health Service Hospital at Schurz, Nevada. This questionnaire attempted to assay a number of demographic features of the tribe including family income. In the case of the TCID the income distribution had to be inferred from data provided by the TCID offices, the Churchill County Tax Assessor and data contained in the 1970 Census. The period of analysis used for the determination of the reference distributions were the years 1969 and 1970. These two years were selected for the simple reason that they were the most recent for which data were available.

The first section describes the procedure used to estimate Indian income. It discusses the problems encountered with the questionnaire responses and the methods used to overcome those problems. The second section discusses the problems in deriving

the incomes of farm families and describes the methods used to overcome those problems. The concluding section presents a statistical comparison of the two income distributions.

The Distribution of Income Among Pyramid Lake Indians

Perhaps the most impressive element associated with any attempt to study Indians is the absolute lack of data.[1] It seems reasonable to conjecture that less is known about the American Indian in a quantitative sense than about any other minority group in the United States. The data that are available must naturally be suspect because of the long history of animosity between Indians and the Bureau of Indian Affairs which is nominally responsible for collecting such data. The Pyramid Lake Piaute Indians are no exception. Despite nearly fifteen years of intense controversy, no comprehensive systematic effort has been made to gather data which might shed light on the welfare of the Indians. There is virtually no published data on these Indians and very little which is unpublished.

The U.S. Public Health Service, in the Department of Health Education and Welfare is charged with providing health services to Indian tribes. In this connection the Public Health Service operates a clinic and hospital at Schurz, Nevada, for the benefit of the Indians. This clinic and hospital is the principal source

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[1]For empirical support of this statement see: U.S., Congress, Joint Economic Committee, *Toward Economic Development for Native American Communities*, Vol. 1, "A Statistical Profile of the Indian: The Lack of Numbers," by Stephen A. Langone, Joint Committee Print (Washington, D.C.: Government Printing Office, 1969), pp. 1-18.

of medical care for the Pyramid Lake Indians. Through the efforts of one dedicated PHS employee a questionnaire was devised and two public health nurses were assigned as enumerators. The questionnaire was designed to provide health personnel at the Schurz Indian Hospital with a profile of the Indian population which it serves. Although the enumerators failed to obtain answers to all questions they were able to contact all reservation residents and accumulated a significant amount of data on each. Unfortunately, constraints on time and funds prevented tabulation and analysis of the results of the questionnaire and it simply languished at the medical facility.

The staff of the Schurz Indian Hospital was cooperative in making the questionnaire data available for use in connection with this study. Although the questionnaire was not well designed and little is known about the competence or performance of the enumerators, the income figures reported in that survey represent the only available source of data on the income of the Pyramid Lake Indians. Some consideration was given to undertaking an independent survey for use in this study. However, this possibility had to be rejected for a number of reasons. Mailed questionnaires were presumed not to be feasible. This presumption was based on an interview with the Tribal Chairman who indicated that members of the tribe were deluged with questionnaires of various sorts from lawyers, industrialists and developers. Members of the tribe had come to regard mailed questionnaires as merely a prelude to an attempt to exploit them in

some fashion and, as a result, failed to respond.[2]

Consideration was then given to undertaking an independent survey utilizing several hired enumerators. It became clear, however, that such a census could never be productive without the complete cooperation of the tribal leaders. Such cooperation would have to take the form of pairing one tribal leader with each enumerator. The tribal leader would then serve to reassure the resident being questioned that it would be in his best interests to answer the questions honestly and forthrightly. Unfortunately, this procedure had two serious drawbacks. First, the tribe was fragmented into two groups and the group currently in control of the Tribal Council was experiencing difficulties in achieving complete cooperation with the other group. Furthermore, the tribe was understandably unwilling to commit the valuable time of their representatives to undertake such a survey unless some guarantee could be given that the census would materially benefit the tribe in its confrontation with the Department of the Interior. To provide such guarantees would have been to pre-judge the results of the study. In order to fulfill the commitment to the tribe, the conclusions of the study would have had to be arrived at before the data was gathered. It might then have been necessary to manipulate the data to support the pre-determined conclusions. Such a procedure would hardly constitute scholarly research. As a consequence, the idea of conducting an independent census was rejected and the data gathered

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[2]James Vidovich, Private meeting held with Tribal Chairman, Pyramid Lake Piaute Indians, Nixon, Nev., November, 1970.

by the Public Health Service was assumed to be the best available even though there were reasons to suspect its reliability.

The problems of using questionnaires to ascertain incomes and willingness to pay are widely documented.[3] Talk is cheap and, furthermore, people may have strong incentives to overstate or understate their incomes. Indians are no exception. It is probable that some Indians have understated their earned income in order to remain eligible for a variety of welfare benefits which are dependent upon the prevailing income of the family and other family circumstances. Therefore, at the outset it must be conceded that there is some likelihood that the income estimates contained in the questionnaire are understated. There remain, however, the possibility of checking the income figures against a Bureau of Indian Affairs' estimate of the mean income of the tribe. Such a comparison is presented at the end of this section.

At this point it should be noted that published Federal statistics on income proved to be unsuitable. Unfortunately, *The Statistics of Income* tabulations are aggregated into three groups and are thus not suitable for use here.[4] Additionally, these statistics are compiled by Zip Code Area

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[3]See for example: Testimony of Henry J. Vaux, Jr. on behalf of the Air Pollution Control District, County of Los Angeles, Federal Power Commission Hearings, *El Paso Natural Gas Company*, RP-72-6, 1972, T126375-TR6396.

[4]U.S., Treasury Department. Internal Revenue Service, *Statistics of Income for 1968* (Washington, D.C.: Government Printing Office, 1969).

and inasmuch as the Pyramid Lake Indian Reservation lies in a Zip Code Area which includes Reno-Sparks as well as half of rural Nevada there is no way in which Indian incomes can be factored out. The U.S. Census tract which contains the Pyramid Lake Reservation also includes an enormous area which contains other Indian tribes as well as ranchers, farmers and prospectors. Thus this source of data was unsuitable as well.

The questionnaire, then, was used as the data source. The questionnaire is reproduced as Figure 5. Questionnaires were completed for some 90 families. These accounted for 425 individuals living on the reservation. There are strong reasons for suspecting that all existing families were enumerated. The Tribal Council, the Bureau of Indian Affairs and the Economic Development Administration have all estimated that the number of Indians living on the reservation is on the order of 415-430.[5] Inasmuch as Indians are constantly moving on and off the reservation the exact number permanently residing there at any one time will tend to vary. However, in view of the fact that the numbers tabulated from the questionnaire did not differ significantly from the figures independently tabulated by three other organizations it was concluded that the enumerators had visited every residence and had obtained an accurate count of the number of reservation residents.

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[5]See for example: Tribal Roles, Pyramid Lake Piaute Tribe of Indians; U.S., Department of Interior, Bureau of Indian Affairs, *Pyramid Lake Reservation* (mimeographed pamphlet); U.S., Department of Commerce, Economic Development Administration, *Federal and State Indian Reservations: An EDA Handbook* (Washington, D.C.: Government Printing Office, 1971), pp. 233-234.

DEMOGRAPHIC SURVEY DATE _____

Community _____ District _____ House No. _____

Head of household _____ No. of families in house _____ No. of rooms _____

Type of house (Circle) Frame, Brick, Stucco, Combination, Trailer Electricity Yes___No___

Source of drinking water (Circle) Well, Spring, Creek, City Water piped in house Yes___No___

Inside Bathroom: Yes___No___ Outside Privy: Yes___No___

Names of people living in home	How Long	Rel.	Date of Birth	Sex	Tribe	Degree	Educ. Level	Employed Yes	Employed No	No. of Mos. Employed	Annual Income
Names of Children in school not living with you:											

Names of people living with you who receive: (Check √)	OAA	ADC	AB	ATD	

Names of people in household eligible for Medicare (65 years of age or older): Do you have a card?	Yes	No

Names of people living in household who have private Hospital and Medical Insurance:

_____

_____

_____

Figure 5. Pyramid Lake Indian Demographic Census Form

While it seemed reasonable to assume that the "head count" was completely accurate, the remainder of the data posed some problems primarily with respect to completeness. Table 4 presents a tabulation of the identified variables and the response rate on each of those variables. The data presents a problem of the sort identified by Lansing and Eapen as the incomplete interview.[6] Only 14 of the variables exhibited a response rate of 97% or higher and thus only these 14 could be subjected to statistical analysis. This would not be a problem if the response rate on income were close to 100%, but since that response rate was only 46%, a method had to be devised to infer the income of income non-respondents from other data which they provided as well as the data provided by the income respondents.

Income is obviously the variable which is of importance in this study. The estimation of income, then, proceeded as follows. All variables except reported income which did not have a response rate of 97% or better were discarded. The ninety Indian families were then partitioned into two groups, those who reported their income and those who failed to report their income. The principal problem in statistically analyzing data such as this lies with the possibility that there exists some clear explanation as to why certain individuals did not respond to the income question. For example, it might be the case that families receiving higher earned

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[6]John B. Lansing and A. T. Eapen, "Dealing with Missing Information in Surveys," *Journal of Marketing*, XXIV (October, 1959), pp. 21-27.

Table 4
Response Rate on Census Variables

Variable No.	Variable	Response Rate (%)
1	Family I.D. No.	100 (assigned)
2*	Family Size	100
3	Date of Response	100
4*	Community of Residence	98
5	District of Residence	0
6	House Number	7
7*	Head of Household (Sex)	99
8	Number of Families Residing in Home	
9	Number of Rooms in Home	90
10*	Type of Home	98
11*	Is Home Electrified?	99
12	Source of Drinking Water	93
13*	Water Piped into House?	98
14*	Inside Bathroom or Outside Privy	97
15*	Number of People Living in the House	100
16	Number of People Receiving Income	81
17	Number of People Employed	76
18	Number Employed Full Time	32
19	Number Employed Part Time	35
20*	Number in Labor Force Age 18 to 65	98
21	Tribe (Head of Household)	86
22	Degree (Head of Household)	71
23	Educational Level (Head of Household)	58
24	Total Annual Income	46
25*	Number of Children in School not Living at Home	100
26*	Number of People Receiving Public Benefits	98
27*	Type of Benefit	98
28*	Number Eligible for Medicare	100
29*	Number Enrolled in Medicare	98
30	Number in Family with Private Hospital and Medical Insurance	32

*Variables which are statistically meaningful.

income would systematically fail to respond to the question either out of fear of having certain welfare benefits cut off or even out of fear of jeopardizing the tribe's case against the Department of Interior over water rights.

The statistical problem, then, was to ascertain whether or not the incomes of the non-respondents differ significantly from the incomes of the respondents. In other words, given the additional data which were available for all families (both income respondents and income non-respondents) was there any statistical explanation for a certain group's failure or unwillingness to report their income? If it could be demonstrated that no variable discriminates between the income respondents and the income non-respondents this would tend to support the hypothesis that the distribution of income among those not reporting income was nearly identical to that of the group which reported income.

Accordingly, three different statistical techniques were utilized in an effort to determine whether any of the 14 variables for which there was a statistically significant response discriminated between income respondents and income non-respondents. The techniques included stepwise discriminate analysis, canonical correlation[7] and Hotelling's T^2 test.[8] These tests are all applications of the basic theory of multivariate statistical analysis.

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[7]For a discussion of the theory of discriminate analysis and canonical correlation see: T. W. Anderson, *An Introduction to Multivariate Statistical Analysis* (New York: John Wiley and Sons, Inc., 1958), pp. 272-306. For an excellent discussion of the application of these techniques see: Phoebus Dhrymes, *Econometrics: Statistical Foundations and Applications* (New York: Harper and Row, 1970), pp. 42-52, 65-77.

[8]See: Donald F. Morrison, *Multivariate Statistical Methods*, (New York: McGraw-Hill Co., 1967), pp. 79-90.

It was reasoned that the use of three tests rather than a single test would provide more reliable information relative to the presence or absence of a good discriminator. Certainly if all three tests yielded substantially the same results conclusions could be drawn with more confidence than if only one test was used. The analysis proceeded as follows.

The Pyramid Lake Indian tribe was initially partitioned into two groups. Group one contained the 42 families which had responded on income and group two contained the 48 families which had failed to respond on income. The groups were then subjected to stepwise discriminant analysis in an effort to ascertain whether any of the 14 common variables discriminated between the groups. The results of the initial discriminate analysis are presented in Table 5 below.

Table 5

	Income Respondents	Income Non-Respondents
Income Respondents	30	12
Income Non-Respondents	11	37

The interpretation of this table is relatively straightforward. If the discriminate function calculated in the course of the analysis discriminated perfectly between the two groups the classification matrix would contain 42 families in the northwest cell and 48 families in the southeast cell. If the discriminate

function was absolutely unable to discriminate among the populations the matrix would look like that depicted in Table 6. This is so because each family would have a 50 per cent chance of being placed in each cell. Table 6 was assumed to be the standard since any deviations from it would tend to indicate the presence of a discriminating variable.

Table 6

	Income Respondents	Income Non-Respondents
Income Respondents	21	21
Income Non-Respondents	24	24

Table 5, then, can be interpreted in the following manner. For the group responding on income the discriminate function classified 78.6 percent in the correct category. For the group failing to respond on income the function classified only 72.9 per cent in the correct category. These results would suggest the presence of one or more variables capable of discriminating between the income respondent population and the income non-respondent population. The results of the discriminate analysis were further confirmed by the canonical correlation and the Hotelling T^2 test. For the groups of 42 income respondents and 48 income non-respondents the Hotelling T^2, which measures the statistical difference between the vector of means for each groups gave the following results.

F = 2.3478 Significance = 0.0094

Thus the Hotelling T^2 confirmed that there was a significant difference between the vector of means for the two populations.

The canonical correlation coefficient was 0.405, a relatively low number. This was interpreted to mean that the variances of the vectors of the two groups were not highly correlated and thus some statistically significant difference did exist. Additionally, the F-statistic calculated as part of the discriminant analysis indicated that variable 15, the number of people living in the home, and variable 20, the number of people in the labor force, provided significant explanation for the differences in the two populations.[9] A careful perusal of the data was then undertaken and it was found that an unusual number of families who failed to report income were single people living alone or couples living alone. The age of all members of all of these families was over 65 and thus none of the persons under consideration were members of the labor force.

Since all of the Indians in the families identified were over 65 it seemed reasonable to assume that they were either retired, unemployed or unemployable by virtue of their age. Therefore it was assumed that their annual earned income was equal to zero. Ten families were identified which fit this category and they were assumed to have reported an annual earned income of zero.

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[9]In order to prevent confusion the variables retain the numbers assigned to them in Figure 4 even though only 14 of those variables were selected for analysis.

These ten families were then placed in the group which had reported income and the various statistical tests were run again. This series of statistical tests presumed that there were 52 income respondents and 38 income non-respondents. The results of these analyses are summarized below.

The discriminate analysis generated the following matrix.

Table 7

	Income Respondents	Income Non-respondents
Income Respondents	33	19
Income Non-respondents	14	24

Utilizing the earlier interpretation it was concluded that for the group responding on income the new discriminate function classified 86.6 percent in the correct category. For the group failing to respond on income the function classified 86.9 percent in the correct category. This was deemed a significant improvement inasmuch as no significant F-statistics emerged from the analysis which would indicate the possibility of other variables which could usefully be employed as discriminators. Furthermore, the canonical correlation coefficient was 0.750, a significant increase over the previous coefficient. The Hotelling T^2 test provided the following results:

F = 1.0743 Significance = .3941

The significance level of 0.39 indicates that there now exists no significant differences between the two populations.

Further attempts were made to reduce the number of non-respondents. An effort was made to estimate incomes for other families based on limited personal knowledge. Attempts were made to impute varying levels of income for families that had the highest rates of non-response among variables which were not statistically useful in terms of response rates. Although numerous permutations and combinations were tried in this latter attempt no statistically significant improvement resulted. As a consequence, it was concluded that, given the data available, it was likely that the distribution of earned income among the income respondents was probably similar if not identical to the distribution of income among income non-respondents.

The next step in the analysis involved an attempt to develop a regression model which would deduce income (for the income respondents) using the 14 other variables. Although log and double log forms were tried and a curvilinear model was tested, no model resulted in a R^2 of greater than 0.3689. As a consequence the use of a regression model to predict income was rejected and cruder methods had to be resorted to.

Simple correlation coefficients were calculated for all 14 variables against income among the original 42 income respondents. The highest correlation coefficient resulted from the pairing between income and the number of people living in the household. The value of this correlation coefficient was .57. While extreme care must always be exercised in interpreting correlation coefficients in cause

and effect terms, there appeared to be reasonable causal grounds for arguing that Indian family income would have a fairly high positive correlation with the number of people living in the household. The more people living in the household the higher the probability of a large number being in the labor force and consequently the better the probability of a large number being employed. If it could be assumed that personal labor skills are more or less constant (and this seems a reasonable assumption for Indians living on small remote reservations), then it would follow that the more people employed the larger the family income.

Assuming this line of reasoning, earned income was allocated among the original 48 income non-respondent families in the following fashion. Households in which no individual in the labor force resided were allocated an earned income of zero. All other households were allocated an income of $684 per person. This figure represented the average per capita earned income of all families reporting income. While this procedure is admittedly crude it probably represents a fair approximation of earned income per family. It is true that particularly large families with many children or elderly persons may have had their earned income overstated. There was no way to verify this, however, and thus it is mentioned only to identify a potential shortcoming of the estimation procedure.

For the Pyramid Lake Piaute Indians earned income represents only one source of monetary income. Many Indians receive supplementary income in the form of assistance from State governments

or the Bureau of Indian Affairs.[10] In the state of Nevada assistance comes in several forms. The state provides Old Age Assistance (OAA), Aid to Dependent Children (ADC), Aid to the Blind (AB) and Aid to the Disabled (ATD). Additionally, the Bureau of Indian Affairs provides general assistance when aid is not forthcoming from the state either because the state lacks the necessary resources or because the Indian in question is not eligible for state assistance.

In computing income for the Pyramid Lake Piaute Indians transfer payments were included as supplementary income and added to earned income to arrive at a total income figure. Figures for various assistance programs were computed from average monthly assistance payments as reported by a variety of sources. The figures used in the computation of supplementary income are summarized in Table 8.

Table 8

Figures Used in Computing Supplementary Income

1. Indian General Assistance	=	$2500 per person per year[11]
2. Old Age Assistance	=	$ 744 per person per year[12]
3. Aid to Dependent Children	=	$1200 per person per year[13]
4. Aid to the Blind	=	$1069 per person per year[14]
5. Aid to the Disabled (No program in Nevada)[15]		

[10]Alan L. Sorkin, *American Indians and Federal Aid* (Washington, D.C.: The Brookings Institution, 1971), pp. 162-165.

[11]Joe Braswell, Inter-Tribal Council of Nevada, Personal Letter, dated August 24, 1971.

[12]U.S., Department of Health, Education and Welfare, *Welfare in Review, 1970*, Vol. 8, No. 6 (Washington, D.C.: Government Printing Office, 1971), p. 41.

[13]*Ibid.*, p. 41.

[14]*Ibid.*, p. 41.

[15]*Ibid.*, p. 41.

Supplementary incomes were then computed for each family using the information obtained from the questionnaires.

Supplementary incomes and earned incomes were then added to obtain family income. The resulting incomes were assumed to be after tax incomes. While reservation Indians pay no state or local taxes they are subject to the Federal personal income tax. However, the Indians were asked to report after tax income during the census enumeration. Furthermore, it would appear that many of the Indians pay no federal taxes in view of their small incomes and relatively large families.

The after tax distribution of family income among the Pyramid Lake Piaute Indians is depicted in Figure 6. Table 9 identifies the averages of the various income components on both a family and per capita basis. In connection with Table 9 it should be noted that the Bureau of Indian Affairs has made an estimate of mean earned income per family for the year 1971 of $3,500.[16] This estimate compares rather favorably with the independently calculated estimate in this study of $3115.38.

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[16]U.S., Department of Interior, Bureau of Indian Affairs, *Pyramid Lake Reservation* (Mimeographed pamphlet).

FIGURE 6

INCOME DISTRIBUTION AMONG PYRAMID LAKE INDIAN FAMILIES

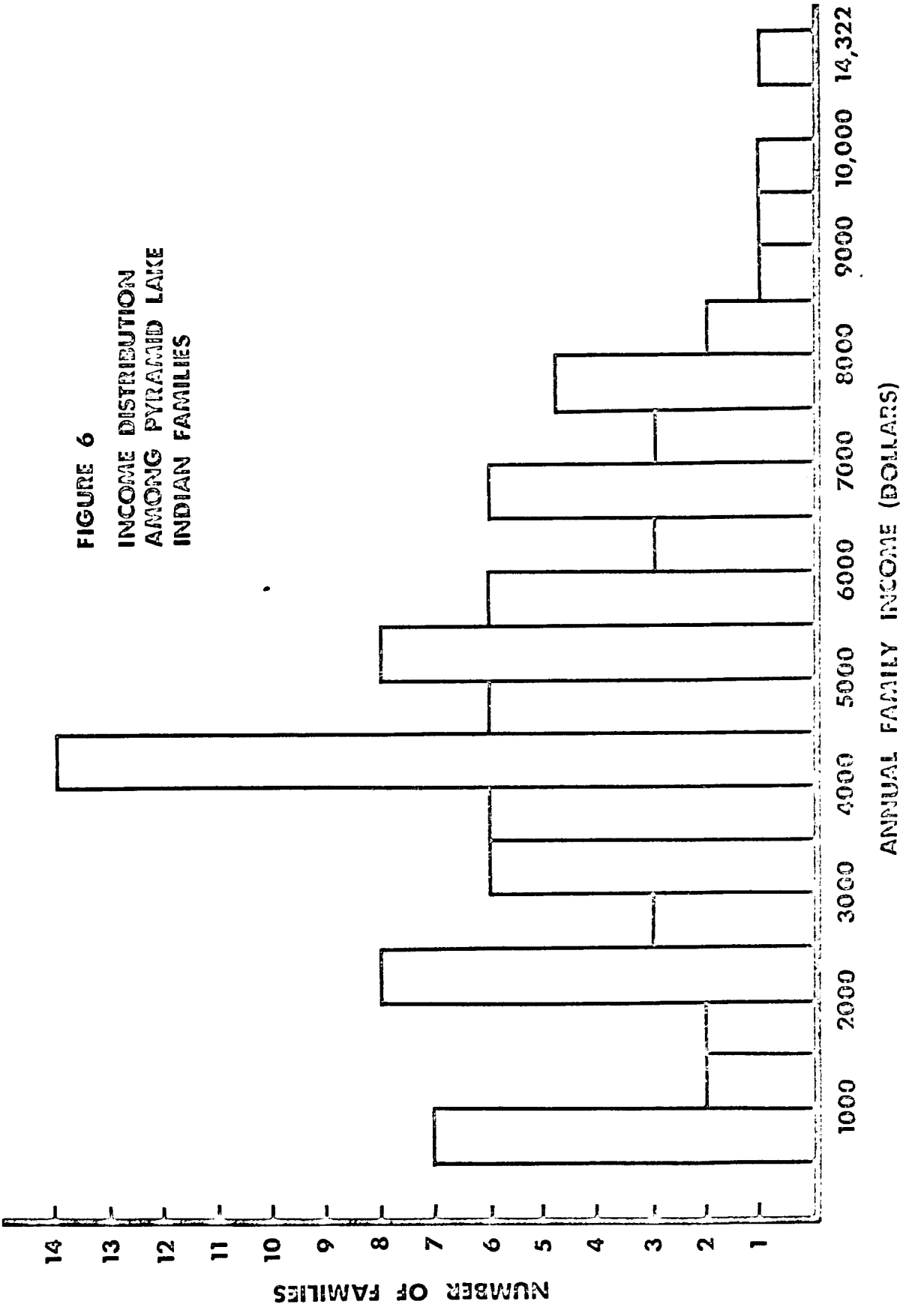


Table 9

Income Characteristics of Pyramid Lake Indians

Population = 425		
Mean earned income per family per year	=	$ 3115.38
Mean earned income per capita per year	=	659.73
Mean supplementary income per family per year	=	1558.66
Mean supplementary income per capita per year	=	330.07
Mean total income per family per year	=	4674.04
Mean total per capita income per year	=	989.80

The Distribution of Income Among Members of the Truckee-Carson Irrigation District

Ascertaining the reference income distribution for the members of the Truckee-Carson Irrigation District presented a somewhat different set of data and statistical problems. The TCID contains 1632 members, most of whom are heads of households. It was obviously impossible to conduct a census of all members of the District and therefore a 25% random sample was used. Individuals to be included in the sample were selected at random from the TCID files. The staff of the District was cooperative in making available all non-proprietary information relating to each of these families or individuals.

Each individual in the sample was assigned an identification number and the name and address were noted. A record was made of the project district in which the individual resided and his water rights. The actual amount of water actually used in 1970

was recorded. Additionally, it was possible to obtain for each family or individual data on the type and quantity of crops grown during the calendar year 1970. The data obtained from the TCID was then supplemented with data from the Churchill, Lyon and Storey County Tax Assessors.

The Assessors were able to provide data on the total assessed value of the property owned by each individual in the sample. Total assessed value, which represents 35% of "fair market" value, was broken down into land type, value of personal property and the value of improvements on the property. Figures 7 and 8 show the forms on which the data was compiled.

The quality of the data collected on members of the TCID was in all probability somewhat better than that collected for the Indians. It was true that the data collected from the Irrigation District Office was somewhat suspect in that the District was understaffed and staff personnel freely admitted that they had some difficulty in keeping their records up to date. Furthermore, the report of a researcher for the Pyramid Lake Task Force indicated that the administration of the irrigation project was somewhat lax.[17]

Care must always be exercised in utilizing tax assessment data as a surrogate for fair market value. Tax assessors and

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[17]Clyde, Criddle and Woodward, Inc., *Report on Water Use Improvement Study of Truckee-Carson River Basin* (1971), pp. 57-61.

CENSUS OF INFORMATION

Truckee Carson Irrigation District

A. Serial Number

B. District

1. Derby	2. Factory	3. Fernley	4. Hazen
2. Island	6. Lahontan	7. Old River	8. St. Clair
3. Sheckler	10. Smart	11. Stillwater	12. _____

C. Name: _____

D. Address: _____

_____

E. Map Division: _____

F. Water Right Acres: _____

G.

	Crop Type	Acreage	Total Quantity	Price
1.				
2.				
3.				
4.				
5.				
6.				

H. Assessed Valuation: _____

Figure 7

FIGURE 8

CLASSES OF LAND FOR ASSESSMENT

County _____ Parcel No. _____

Unit No. _____

Owner _____ Tax District _____

Address _____ Appraiser and date _____

Land Class	Per Acre	No. of acres	Amount Assessed each class	Legal Description	Acres	Remarks
1st Cult.	$80		$			
2nd Cult.	$70					
3rd Cult.	$60					
4th Cult.	$50					
1st W.Hay	$40					
2nd W.Hay	$30					
1st Pasture	$40					
2nd Pasture	$30					
3rd Pasture	$20					
4th Pasture	$10					
1st Grazing	$ 6					
2nd Grazing	$ 3					
3rd Grazing	$ 2					
4th Grazing	$ 1.25					
Special	$					
Other	$					
Total	XX		$			

appraisers possess varying degrees of training and experience. Where assessors are elected, as they are in the state of Nevada, there is the possibility that political pressures can be brought to bear by influential members of the community with the result that assessments may understate fair market value. There were two reasons for believing that the tax assessment data obtained for this study were relatively accurate. First, the state of Nevada has a Tax Commission which specifies rigorous regulations which govern the assessment of all property.[18] Additionally, the Commission has the authority to conduct investigations of possible violations of its instructions. Second, spot checks were made with local real estate brokers to see how recent sales of all types of property compared with the assessed valuation carried on the tax roles. In no case was an instance discovered where the price actually paid in a real estate transaction differed significantly from the value assigned to the property in question on tax roles. As a result it was concluded that the tax assessment data was probably a reliable surrogate for fair market value.

An initial perusal of all the data indicated that there were a large number of "irrigators who were neither growing crops nor utilizing their water entitlements. The data was then systematically analyzed in an effort to discover which properties were actually farms. The criterion used to define farms was adopted

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[18]Nevada Tax Commission, *Instructions for Assessment of Land, Livestock, Merchandise Stock, Mobile Homes, Oil and Gas Leases*, Bulletin No. 125, July 1, 1970, Carson City, Nev., pp. 1-7.

from the definition used by the Bureau of the Census. The Bureau defines a "place" as a farm if 1) it consists of ten or more acres from which the sale of farm products amounted to $50 or more in the preceding year, *or* 2) it consists of less than ten acres from which the sales of farm products amounted to $250 in the preceding year.[19] Under this liberal definition it turned out that out of the 408 "irrigators" in the sample only 185 qualified as farmers. In view of the fact that the Newlands Project was and is a federally financed irrigation project constructed to promote small family farming it was rather surprising to learn that only 45% of the members of the Irrigation District qualified as farmers.

The 223 non-farmers in the sample used 1,968 acre feet of water in 1970. A simple extrapolation from the sample yields the conclusion that non-farmer members of the TCID utilized 7,782 acre feet of water in 1970. This is roughly 2% of the water taken by the District. This water was used primarily to grow hay, to irrigate small pasture acreages and for watering lawns. (It is interesting to note that lawn watering in rural areas is accomplished by flood irrigation rather than through sprinklers.) No further efforts were made to develop income distributions for the non-farmer group since it was obvious that their principal sources of income were not in the farm sector and therefore any reallocation of water away from the District would affect this group only through linkages between the farm sector and the non-farm sectors of the local economy.

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[19] U.S., Department of Commerce, Social and Economic Statistics Administration, Bureau of the Census, *Detailed Characteristics, Nevada* (Washington, D.C.: Government Printing Office, 1972), p. App. 2.

For the remaining 185 farmers in the sample a detailed income distribution was developed. Net farm income was calculated by multiplying the quantity of the crop sold by the prevailing price. Data on the quantity and type of crops grown by each farmer were obtained directly from the TCID. Data on the net income per acre of crop were obtained from the Bureau of Reclamation which publishes such data annually.[20] The revenues for each crop were then added together to obtain farm income for each farmer. The distribution of farm income among the 185 families is presented in Figure 9.

A further step in the computation of the reference distribution for the TCID farmers involved the estimation of non-farm income accruing to farm families. Many of the farmers moonlight or hold second jobs and in many farm households individuals other than the farm operator hold non-farm jobs. Thus it was necessary to infer for each family the income earned off the farm in order to develop a distribution which included all sources of income.

The distribution of non-farm income proved somewhat difficult to estimate. The only data available on rural farm income in this area are contained in the 1970 Census.[21] This data is presented in Figure 10. It should be noted that the sample size

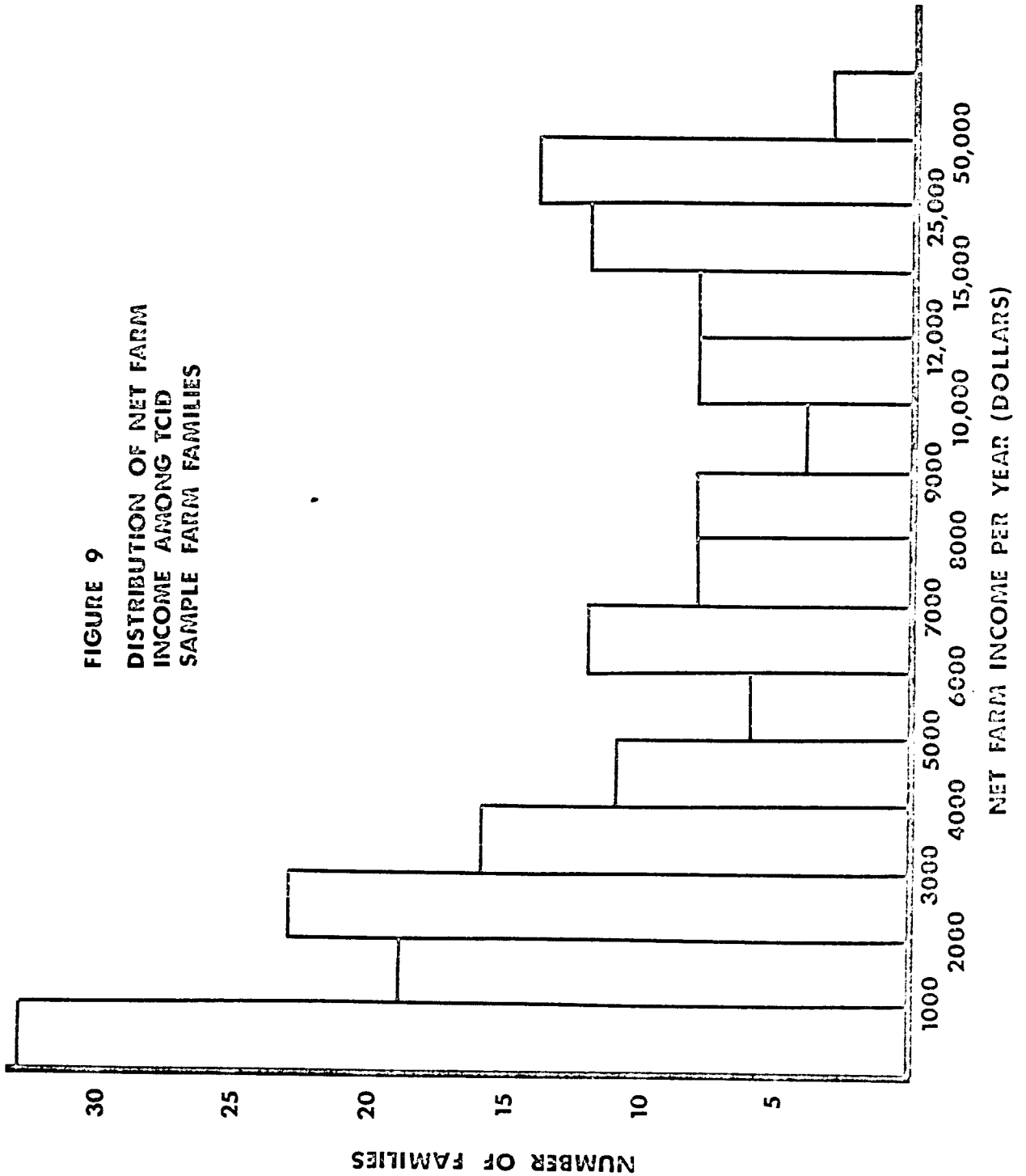
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[20] U.S., Department of Interior, Bureau of Reclamation, *Crop Report and Related Data, Federal Reclamation Projects, 1970* (Washington, D.C.: Government Printing Office, 1971), p. 52.

[21] U.S., Department of Commerce, Bureau of the Census, *General Social and Economic Characteristics, Nevada: 1970 Census of Population* (Washington, D.C.: Government Printing Office, 1972), pp. 191-192.

FIGURE 9

DISTRIBUTION OF NET FARM INCOME AMONG TCID SAMPLE FARM FAMILIES



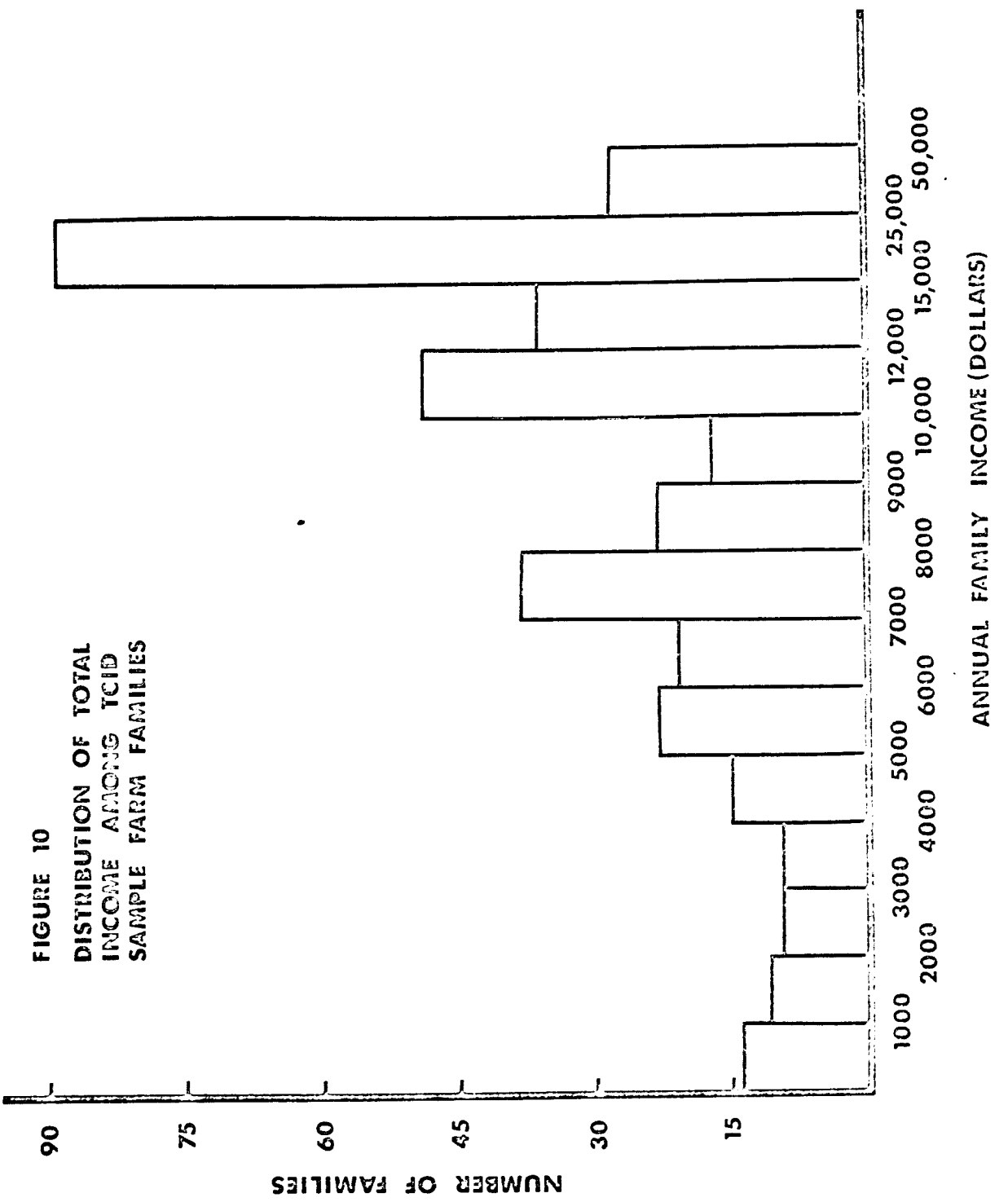


FIGURE 10
DISTRIBUTION OF TOTAL INCOME AMONG TCID SAMPLE FARM FAMILIES

used by the Census Bureau is roughly twice that used for this study. This accounts for the numerical difference between Figures 9 and 10. The Bureau presents the data in an aggregative fashion in order to avoid violations of its regulations regarding disclosure of the incomes of individual families. The relatively aggregative nature of the Census data made it necessary to utilize a rather crude procedure to estimate non-farm income.

Initially, the distributions of net farm income and total income to farmers were examined on a basis od the percentage of families in each income class. This allowed the two samples to be compared since they were of absolutely different sizes. These distributions are plotted on Figure 11. This graph suggests that many families making relatively low farm incomes tend to supplement their incomes with off-farm work while those making farm incomes of $7,500 or more are less likely to engage in off-farm work. In order to verify this interpretation a dynamic programming technique was used in order to determine whether the two data sets imply that, as total income grows, the percentage of total income accounted for by farm income also grows.[22] The results of this analysis are plotted in Figure 12.

Although it is not possible to verify the results statistically, the relationship appears at least intuitively plausible. For farm families earning $455 or more in net farm income the percentages of total income accounted for by farm income increases

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[22]For a discussion of dynamic programming techniques see: George L. Nemhauser, *Introduction to Dynamic Programming* (New York: John Wiley and Sons, Inc., 1966), pp. 46-91.

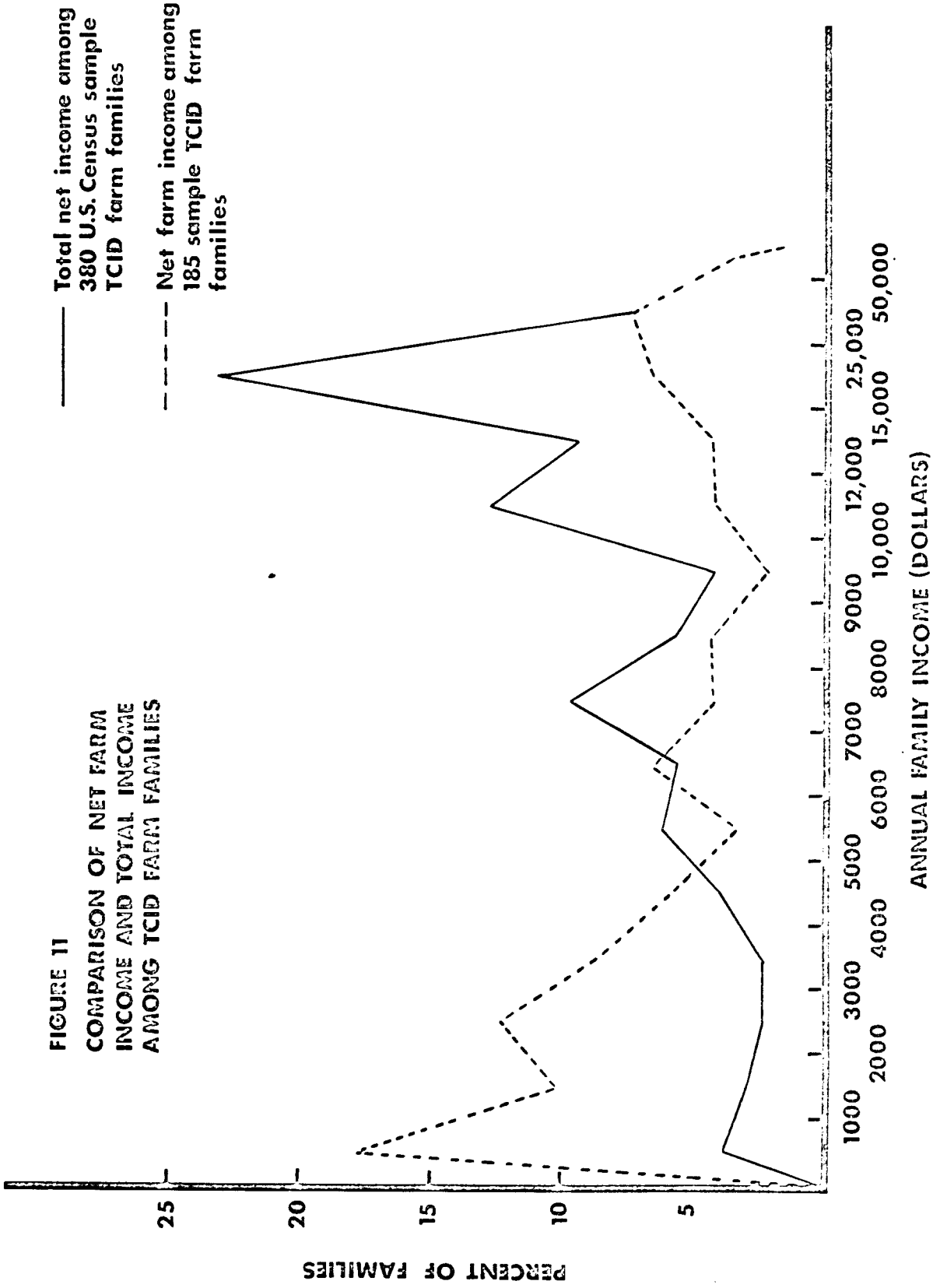


FIGURE 11
COMPARISON OF NET FARM INCOME AND TOTAL INCOME AMONG TCID FARM FAMILIES

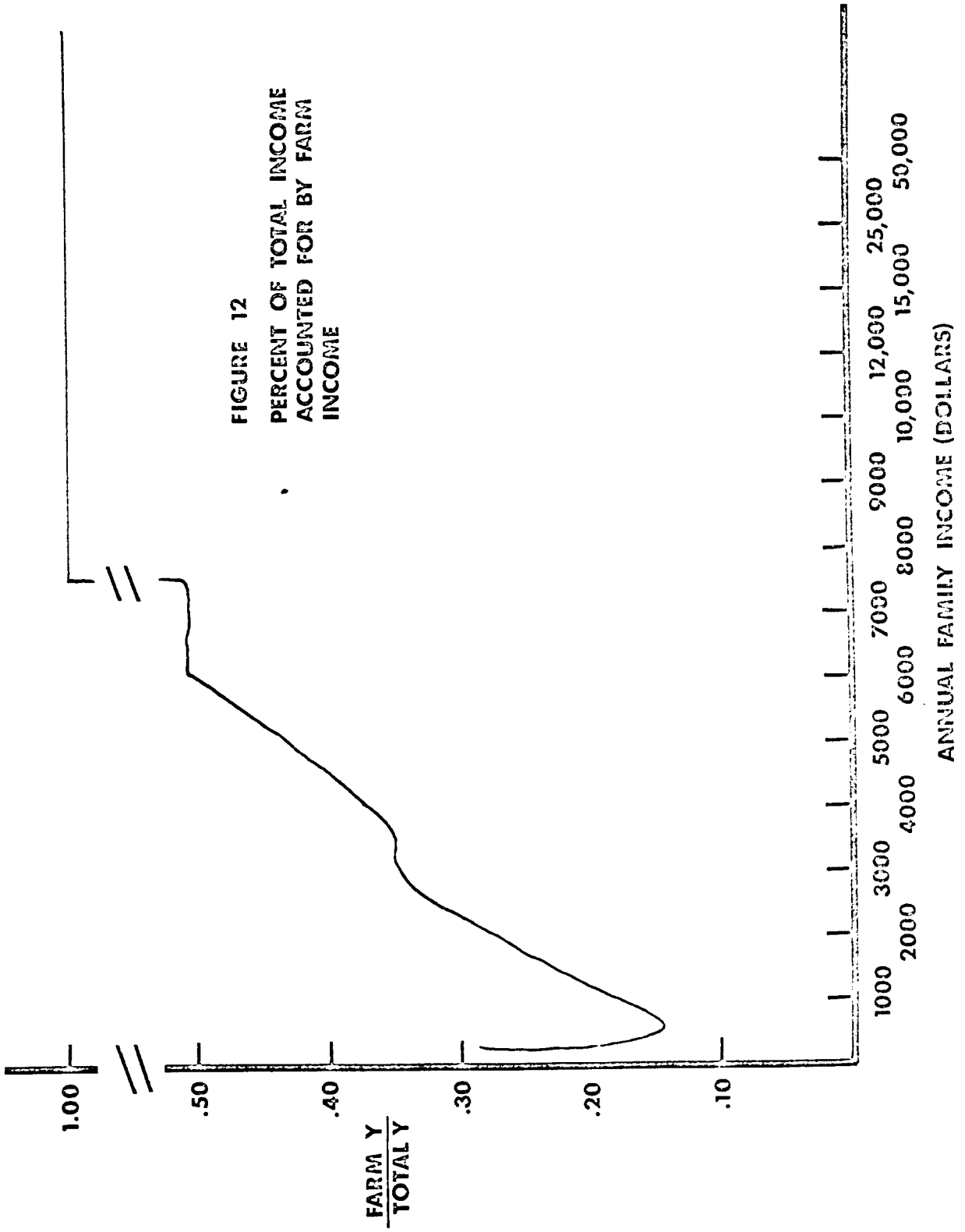


FIGURE 12

PERCENT OF TOTAL INCOME ACCOUNTED FOR BY FARM INCOME

monotonically. At approximately $7500 it appears that farmers and their families no longer engage in off farm work and thus net farm income accounts for all of total income. Below $7500 farm income accounts for decreasing percentages of total income as farm income decreases. The results below $455 net farm income are not considered to be particularly meaningful. It is obvious that despite the definitions of the Census Bureau people earning less than $455 per year from farm operations are not primarily farmers. This would appear to account for the decline in the farm income as a per cent of total income in that range.

Following this analysis the coefficient developed were applied to net farm income to obtain total income for each farm family. This income is assumed to be after tax income inasmuch as the Census Bureau generally applies a tax adjustment to reported net income. The reference distribution of the TCID farmers is plotted on Figure 13. For purposes of comparison the reference distribution of the Pyramid Lake Indians has been plotted on the same graph.

Conclusion

This chapter has reported the results of efforts to infer and develop the reference income distributions for the Pyramid Lake Piaute Indians and for the farmer members of the Truckee-Carson Irrigation District. These two groups are the only groups that would be *directly* affected by any substantial reallocation of water in the lower Truckee-Carson River Basins. To be sure, there are

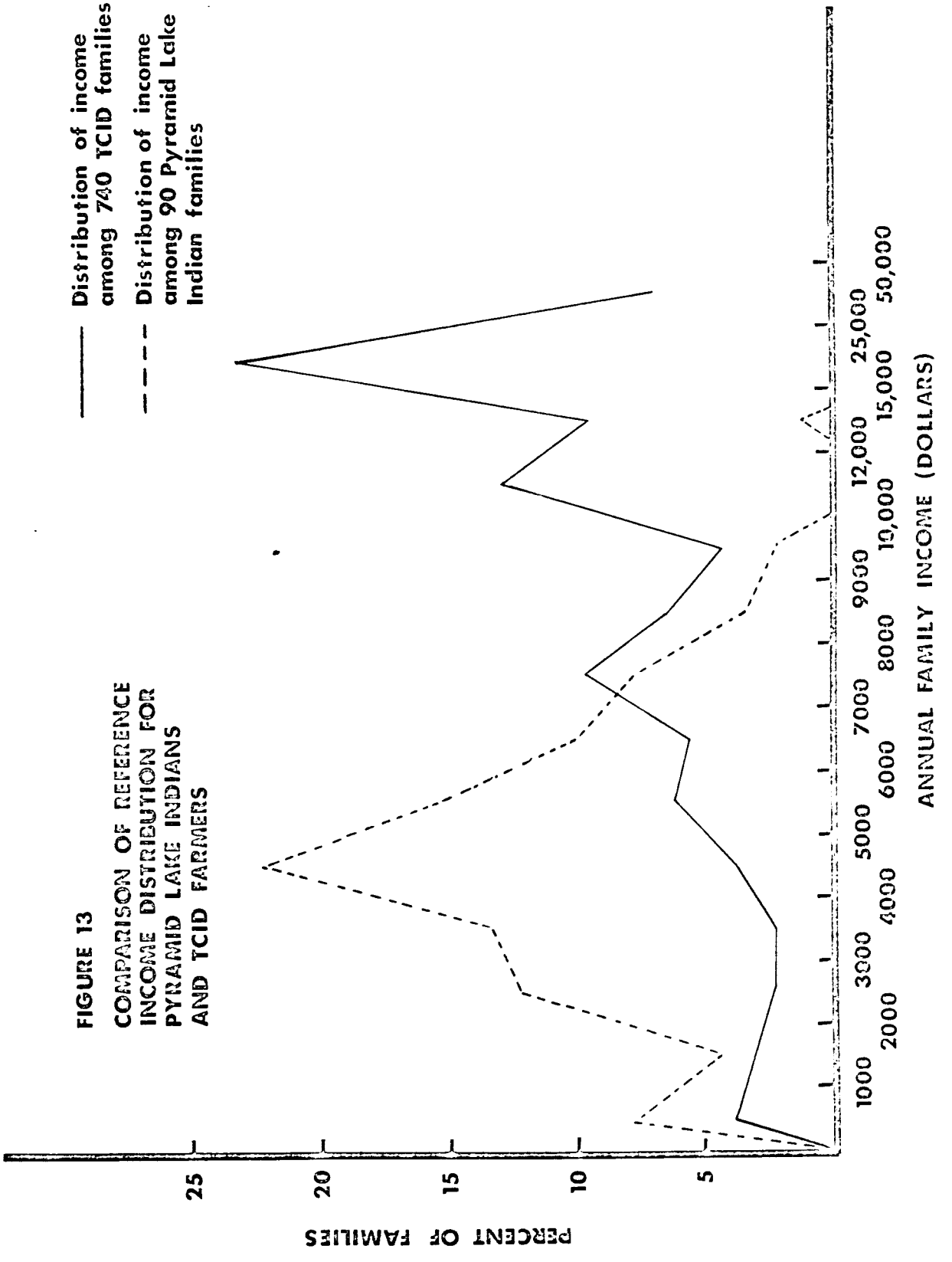


FIGURE 13
COMPARISON OF REFERENCE INCOME DISTRIBUTION FOR PYRAMID LAKE INDIANS AND TCID FARMERS

non-Indians and non-farmers in this area who would be affected secondarily. In order to ascertain who these individuals would be it would be necessary to construct a dynamic model of the region and estimate reference incomes for every resident (or at least a representative sample) and to develop a regional input-output table. This was deemed to be infeasible because of the difficulty of imputing incomes to people in the non-farm and non-Indian sectors. Consequently, attention was focused solely on the groups which would be directly affected by a water reallocation. A complete analysis would include such a dynamic model but the data requirements precluded the development of such a model here.

The next chapter examines the income redistribution consequences of a reallocation of Truckee-Carson River water away from the Irrigation District for use in stabilizing Pyramid Lake. Income changes will be estimated and the normative implications of the resulting redistribution of income will be examined.

CHAPTER 6

REDISTRIBUTIVE CONSEQUENCES OF WATER ALLOCATION IN THE TRUCKEE-CARSON RIVER BASINS

The last chapter developed and presented the reference income distributions for the Pyramid Lake Piaute Indians and the farmer members of the Truckee-Carson Irrigation District. It is obvious that these distributions are attributable in some measure to the allocation of waters in the Truckee and Carson River basins. With the diversion of waters away from the Truckee River and Pyramid Lake to the Irrigation District the levels of Pyramid Lake have declined on the average of one foot per year. This has resulted in the destruction of the cutthroat trout fishery in Pyramid Lake and has deprived the tribe of a relatively stable lake level. A stable lake level is viewed as a necessary condition for investment in recreation facilities on the Pyramid Lake Reservation.[1] As a consequence, it may be argued that the tribe has been deprived of two potential sources of income.

On the other hand, the diversion of water from the Truckee River for use on the Newlands Reclamation Project has undoubtedly enabled certain farmers to make a living on that Project who could not otherwise have located there. Similarly, other farmers are undoubtedly receiving more net income from their farm operations than would be the

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[1] Wilsey and Ham, *Water Resources and Land Use of the Pyramid Lake Indian Reservation*, p. 120.

case if the diversion did not exist or was reduced in quantity. Given the levels of rainfall in the lower Carson Basin it is obvious that an agricultural industry could not thrive and probably never would have developed in the absence of irrigation. It is true that the Fallon Auxiliary Naval Air Station provides a number of employment opportunities. Additionally, Fallon's location on a major east-west route is responsible for the existence of service type jobs to travellers and truckers. Still, the economy is predominately agricultural and as such can retain its present character only as a result of supplies of water delivered by the Newlands Project.

Chapter 4 reviewed the controversy over the allocation of water in the Truckee-Carson basins. It was suggested in that chapter that the Secretary of Interior had been remiss in not considering the income distribution consequences of alternative allocation schemes. The purpose of this chapter is to examine the income redistribution consequences of various alternative allocation schemes and evaluate those consequences. The estimates of potential redistributive consequences are necessarily built upon the reference distributions developed in the previous chapter.

The Case of No Change

There is general agreement that the proper bases for evaluation of any proposed public undertaking is to consider the projected effects of the undertaking in question and compare them with conditions which

would have existed without the undertaking.[2] This is the so-called "with and without" analysis which is conceptually superior to "before and after" analyses. "Before and after" analyses tend to attribute all changes over the specified time period to the undertaking in question. "With and without" analyses attempt to factor out changes that would have occurred anyway and thus provide more accurate bases against which to examine the undertaking in question.

In attempting to project conditions which would exist without any policy change it is, of course, necessary to make a number of assumptions. Forecasts can be little more than educated estimates but even so it is important to spell out the assumptions which underlie the estimates. The period of analysis chosen here is the time span 1970-1990. Given the available data and techniques it seemed unreasonable to attempt to deal with a time span of more than 20 years. Anything beyond that was deemed to be unduly speculative. Additionally, it was assumed that birth rates and net in-migration would be exactly equal to death rates. In other words, although there remains the possibility that Indians might return to the reservation or leave the reservation under differing circumstances it was assumed that the composition and size of the reservation population would remain constant. Similarly, it was assumed that the size and composition of the Indian labor force would remain constant. These assumptions were maintained throughout the analysis of the two policy alternatives.

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[2]Robert Haveman, *The Economic Performance of Public Investments* (Baltimore: Johns Hopkins Press, 1972), pp. 7-8.

Over the 20 year time span it was assumed that Indian and farmer incomes prevailing in 1970 would grow by 5% per year in the case of no change. This is a little higher than the historical trend but in view of recent inflationary pressures and in view of the evidence of a shifting Phillips Curve, this appears to be a reasonable assumption.[3] The incomes of both populations were then projected ahead for twenty years at an annual rate of growth of 5% per year. It was assumed that in the absence of change in the water allocation regime there would be no change in the distribution of income. That is to say, income would remain *proportionally* the same throughout the twenty year period. It is possible, of course, that the patterns of demand for agricultural products might change or that federal policies towards Indian tribes might result in some substantial alteration in the distribution of income among Indians themselves as well as between Indians and other groups in society. However, in view of the smallness of the Newlands Project relative to the agricultural productive capacity of the United States and in view of the relative ineffectiveness of the Bureau of Indian Affairs, it appears most reasonable to assume a situation in which there will be no sharp departures from current conditions.

Once the incomes have been projected over the 20-year period of analysis it is then necessary to calculate the present discounted

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[3]U.S., Council of Economic Advisors, *Annual Report of the Council of Economic Advisors, 1971* (Washington, D.C.: Government Printing Office, 1971), p. 184; Charles L. Schultz, "Has the Phillips Curve Shifted? Some Additional Evidence," *Brookings Papers on Economic Activity*, Arthur M. Okun and George Perry, eds., 3 (Fall, 1971), pp. 36-47.

value of the stream of incomes which accrue to each family. This immediately raises the difficult question of the appropriate interest rate to use. While there is a wide literature dealing with this question, there appears to be general agreement that the problem cannot be objectively resolved.[4] Inasmuch as the issues being considered here are water resource issues it was decided to use the interest rates promulgated by the Water Resources Council. The Water Resource Council states that a rate of 7 percent approaches both the opportunity cost and the total cost of federal borrowing. The Council further suggests that such rate might be as high as 10 percent.[5] The 7 percent rate adopted by the Water Resource Council was assumed to be the appropriate rate for the members of the Truckee-Carson Irrigation District.

The rate to be used for the Indians presented somewhat of a problem. On the one hand, it could be argued that the Indians should be assigned the same discount rate as the farmers in order that the distributions and redistributions could be considered on a comparable basis. On the other hand, there are reasons for believing that it would be inappropriate to treat the income streams of both the farmers and the Indians identically. For the most part, it is true that the

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[4]See for example: Robert Haveman, "The Opportunity Cost of Displaced Private Spending and the Social Discount Rate," *Water Resources Research*, 5 (December, 1969), pp. 947-957.

[5]U.S., Water Resources Council, Notice of Public Review and Hearing, "Proposed Principles and Standards for Planning Water and Related Land Resources," *Federal Register*, xxxvi, No. 245, Part II, Dec. 21, 1971, pp. 24166-24167.

Indians have been economically deprived over long periods of time. Indians, like other minority groups, have experienced a sense of rising economic expectations and yet have not shared in the general growth of economic prosperity in this country. Therefore it could be concluded that the pure rate of time preference for Indians is higher than the pure rate of time preference for farmers who, as a group, have tended to share more generally in the increased national prosperity. Consequently, a discount rate of 10 percent has been adopted for Indian incomes.

The use of different interest rates for different groups is not common procedure. The most commonly used method for arriving at interest rates involves averaging the weighted rates which have been assigned to different groups.[6] The joint weighted rate, then, is utilized in evaluating all cost and benefit streams irrespective of the incidence. Such a procedure does not seem warranted in the present case. Here, there are two discreet groups and it is possible to conjecture intelligently about the relative time preferences of both groups. Consequently, it appears that the use of a weighted average rate for both groups would make the analytical outcomes less accurate. Furthermore, there has been recognition in the literature that different rates should be assigned to different groups and utilized in analyses

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[6]See for example: John Krutilla and Otto Eckstein, *Multiple Purpose River Development* (Baltimore: Johns Hopkins Press, 1957), pp. 84-91; Robert Haveman, "The Opportunity Cost of Displaced Private Spending and the Social Discount Rate," pp. 947-957.

where possible.[7] It is clear that while use of the averaging technique may be unavoidable in certain circumstances different interest rates should be utilized where possible.

Figure 14 depicts the distribution of present discounted values of incomes for the TCID farmers and the Pyramid Lake Indians. The initial incomes developed in Chapter 5 have been made to grow at 5 percent per year for twenty years and then discounted back at rates of 7 percent for the farmers and 10 percent for the Indians. Figure 14 depicts the data contained in Figure 13 on a present discounted value basis assuming a 5 percent annual rate of growth and no changes in water allocation. The distribution presented in Figure 14 is the base-line distribution against which redistributions of income resulting from policy and/or investment decisions will be compared.

For purposes of this study it will be assumed that proportional distribution of after-tax benefits constitutes distributional neutrality. This is a value judgment which is made to facilitate the analysis. Other definitions could be used and would be equally as valid as has been shown in Chapter 3. It is useful to adopt this definition since it means that the "without" distribution is distributionally neutral over the 20-year period of evaluation.

In the following sections two policy changes and their associated investments and income redistributions will be examined and

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[7]See for example: Gunter Schramm, "The Design of a Resource Allocation Function," *Canadian Journal of Economics*, 9(November, 1972), pp. 515-530.

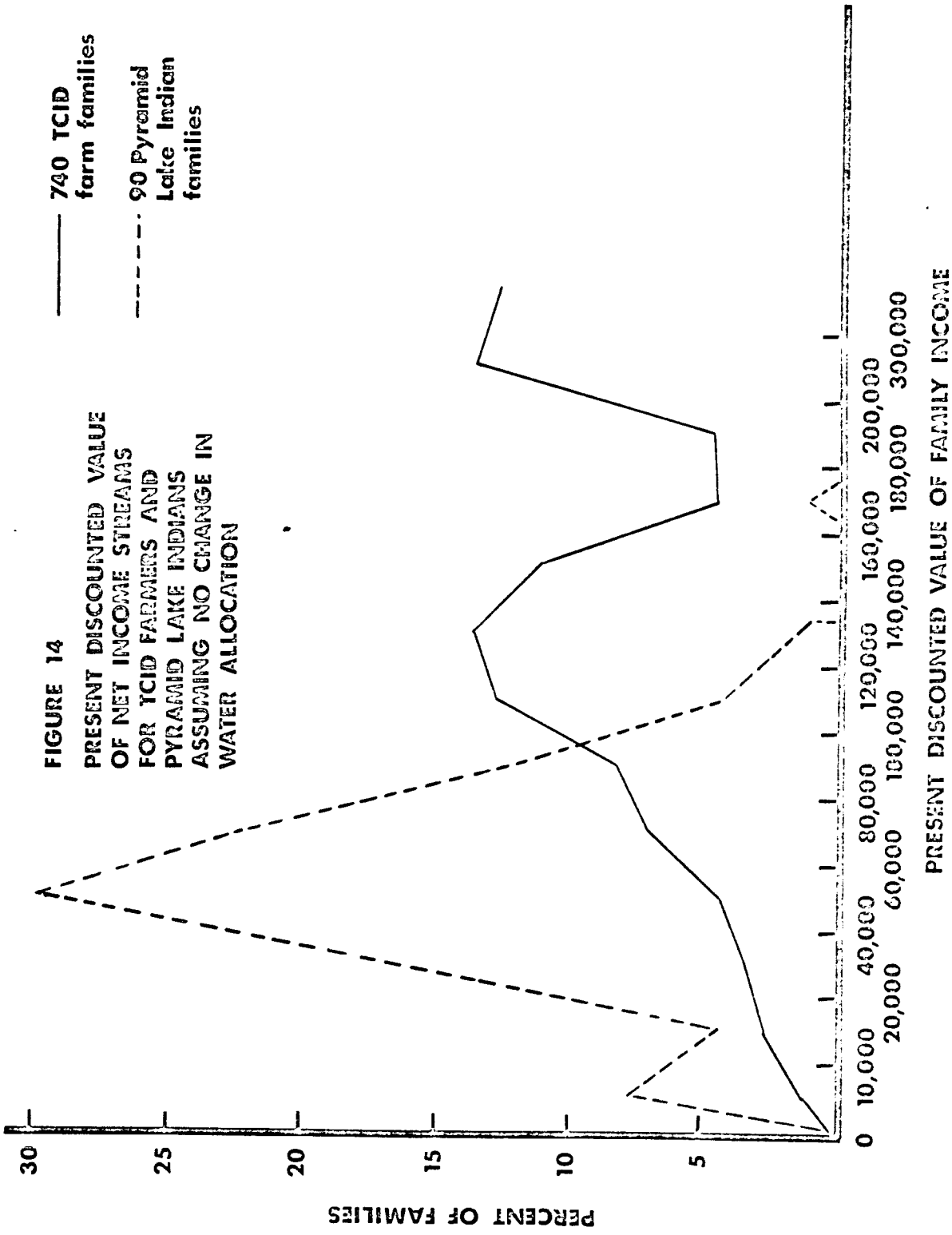


FIGURE 14
PRESENT DISCOUNTED VALUE OF NET INCOME STREAMS FOR TCID FARMERS AND PYRAMID LAKE INDIANS ASSUMING NO CHANGE IN WATER ALLOCATION

compared with the "without" case of no policy change. In the case of the various policy changes no effort has been made to develop new or refined data pertaining to the hydrology of the Truckee-Carson River basins nor has any effort been made to develop new or refined data relating to the values and benefits from the agricultural and/or recreational activities which could be or are supported in part by the waters within that system. This is not to concede that all of the data made available to the Secretary and utilized here is correct or could not be improved upon. Rather this data is used in keeping with the hypothesis stated at the end of Chapter 4 to the effect that the Secretary of Interior in evaluating available data should have examined income redistribution consequences. The following discussion of the two policy alternatives, then, simply accepts the data available to the Secretary as the best available to him and identifies their distributional implications.

Policy Alternative 1: Require Modernization and Efficient Management of the Newlands Project

Reputable researchers have documented the fact that the Newlands Project is inefficient.[8] There are two reasons for the claimed inefficiency. The Newlands Project was one of the first reclamation projects ever built and consequently it is technologically outdated. Many of the canals and laterals are unlined. This results

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[8]Pyramid Lake Task Force, *Final Report*, pp. A-21, A-22.

in the loss of water by both seepage and leakage. There are no modern headgates or other types of equipment installed to regulate the flow of water into the lateral canals and then into the fields. Second, the Newlands Project is not well managed. While the personnel employed by the Truckee-Carson Irrigation District do a reasonably adequate job there is no modern management plan and there are not enough ditchriders to ensure compliance with the District's water allocation. In many cases farmers are allowed to open and close headgates themselves and no accurate records are kept as to precisely how much water they take. Additionally, since there are no measuring devices at some of the diversion points the amount of water delivered is often estimated. This further contributes to loose management. It also appears that the management philosophy employed is inappropriate. The ditchrider apparently perceives his first objective to involve satisfying the farmers in the District by providing them with adequate service while the second objective is to reduce operating spill and waste.[9] This type of philosophy undoubtedly results in inefficiencies due to uncontrolled spills and inefficient use.

One policy option that might be open to the Secretary of the Interior would be to insist that the facilities of the District be modernized and that management practices be tightened up in order to make efficient use of water. This would result in a substantial

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[9]Clyde, Criddle and Woodward, Inc., *Report on Water Use Improvement Study of Truckee-Carson River Basin* (1971), pp. 57-58.

saving of water which could then be allocated to the Pyramid Lake Indians and presumably improve their economic situation. The engineering consulting firm of Clyde-Criddle-Woodward, Inc. recommended to the Pyramid Lake Task Force a series of modernization improvements which would result in a savings of approximately 86,000 acre feet of water per year. The initial investment cost of the modernization would be $1.5 million and the annual operation and maintenance costs would be increased by $60,000. The Task Force recommended that these improvements be undertaken at federal expense. The Secretary apparently rejected this recommendation on the grounds that it would set a precedent which could oblige the Department of Interior to bear the capital costs of modernizing all outmoded reclamation projects. While the Courts have been reluctant to force farmers to bear the costs of modernizing reclamation projects, the Secretary could direct the TCID to bear the costs of modernization and, at the same time, request the Congress to enact legislation requiring irrigators to bear the costs of eliminating inefficiencies. Enactment of such legislation would forestall traditional Court findings and place the burden of modernization squarely on the irrigators. It is argued here that this would have been one policy option open to the Secretary which might have gone some ways towards resolving the water allocation controversy.

In order to analyze the redistributive consequences of such a policy it is first necessary to know how the Irrigation District would allocate the costs among its members. Current District policy requires

allocating the majority of costs borne by the District on the basis of the water right acres held by each member. Accordingly, it is assumed that the costs of modernizing the project will be allocated according to the water right acres held by the farmer beneficiaries of the project. Since the effect of this policy is to insist that the farmers operate efficiently and efficient operations happen to entail increased costs it appears reasonable to argue that the costs to the farmers which result from adoption of this policy are merely input costs. In this case, then, the normative reimbursement adjustment shown in equation 5) in Chapter 3 appears to be inappropriate. Rather the farmers are simply being forced to bear certain costs of production that had previously been avoided through wasteful use of the water. Accordingly, equation 5) can be modified as follows to eliminate the terms which are equal to zero. This modification is written as equation 8) and utilized to analyze the redistributive consequences of policy 1 on TCID farmers.

8) $NB_j = GB_j - A_j$

where

NB_j = net benefits to income class j.

GB_j = gross benefits to income class j.

A_j = total costs to income class j as determined by water right assignment.

All terms in the equation are to be discounted over a 20-year period at an interest rate of 7%.

For purposes of the analysis it is assumed that the Truckee-Carson Irrigation District acquires a loan of $1.5 million repayable over a 20-year at 7% interest. Additionally, it is assumed that the operating and maintenance costs grow at 5% per year over the 20-year period of analysis. Capital costs are allocated proportionally according to the water right acres held by each farmer. This means that each farmer must bear a total capital cost of $19.05 per water right acre plus the interest. This figure has been obtained by dividing the total capital cost of $1.5 million by the total number of water right acres. Similarly, the additional increments of operation and maintenance costs occasioned by the improvements were allocated on the basis of water right acres. This cost amounts to $0.76 per water right acre per year although it has been assumed to grow at 5% per year in accordance with the assumption about the general increase in the price level.

The present discounted value of the capital costs and the additional operating and maintenance costs were added together to obtain $\sum_{j=1}^{20} A_j . \quad GB_j$ for all j is necessarily zero since the benefits of the efficiency improvement in the form of additional water would accrue to the Indians. Table 10 depicts the distribution of the costs and net benefits (which are negative) by income class. The data presented in Table 10 are difficult to interpret because there are different numbers of families in each income class. Therefore the data have also been presented in Table 11 in the form of costs

Table 10

Distribution of Net Costs to TCID Farmers
Under Policy Alternative 1

Base Year Annual Income (classes j=1, ..., 15)	Present Discounted Values		
	GB_j	A_j	NB_j*
$0-$999	$0	$6,494	-$6,494
$1,000-$1,999	0	7,829	-7,829
$2,000-$2,999	0	8,985	-8,985
$3,000-$3,999	0	10,943	-10,943
$4,000-$4,999	0	8,185	-8,185
$5,000-$5,999	0	61,028	-61,028
$6,000-$6,999	0	66,369	-66,369
$7,000-$7,999	0	129,261	-129,261
$8,000-$8,999	0	110,310	-110,310
$9,000-$9,999	0	131,041	-131,041
$10,000-$11,999	0	158,440	-158,440
$12,000-$14,999	0	187,352	-187,352
$15,000-$24,999	0	334,850	-334,850
$25,000-$49,999	0	362,520	-362,520
$50,000-over	0	196,953	-196,953
Total	$0	$1,780,560	-$1,780,560

*Negative net benefits (NB_j) represent costs.

Table 11

Distribution of Net Benefits to TCID Farm Families
Under Policy Alternative 1

Base Year Annual Income (classes j-1,...,15)	Present Discounted Values		
	Gross Benefits per Family	Total Costs per Family	Net Benefits per Family
$0-$999	$0	$ 406	-$ 406
$1,000-$1,999	0	245	-245
$2,000-$2,999	0	998	-749
$3,000-$3,999	0	304	-304
$4,000-$4,999	0	292	-292
$5,000-$5,999	0	954	-954
$6,000-$6,999	0	1,037	-1,037
$7,000-$7,999	0	2,020	-2,020
$8,000-$8,999	0	1,379	-1,379
$9,000-$9,999	0	1,638	-1,638
$10,000-$11,999	0	2,330	-2,330
$12,000-$14,999	0	2,342	-2,342
$15,000-$24,999	0	6,976	-6,976
$25,000-$49,999	0	6,474	-6,474
$50,000-over	0	16,413	-16,413

(negative net benefits) per family by income class. These data, in turn, have been plotted in Figure 15.

The interpretation of Figure 15 may be facilitated by referring to the dotted "line of proportionality." Following the value judgment made earlier to the effect that a neutral redistribution of additional (or, in this case, negative) income involves a redistribution which is proportional to the distribution which would have prevailed in the absence of the policy change, the dotted line depicts the distribution of net benefits (costs) among the TCID farmers that would have to obtain if the distribution of those costs were to be "neutral." Accordingly, it can be seen that the allocation scheme likely to be used by the District is not neutral. Generally, people in the very low income classes and those with incomes of $10,000 per year or higher tend to bear more than their proportional share of the negative benefits, or costs. Those in between tend to bear less than a proportional share with the exception of those in the $7,000 to $7,999 bracket.

No general statement can be made which characterizes the distribution of the negative net benefits since the relationship of the estimated redistribution to the proportional redistribution varies widely among the classes. In fact, close examination of Figure 15 and Table 11 indicates that the costs do not even increase monotonically by income class. Given the cost allocation rule which the District is assumed to adopt, monotonicity and perhaps linearity of redistribution by income classes would prevail if the relationship between

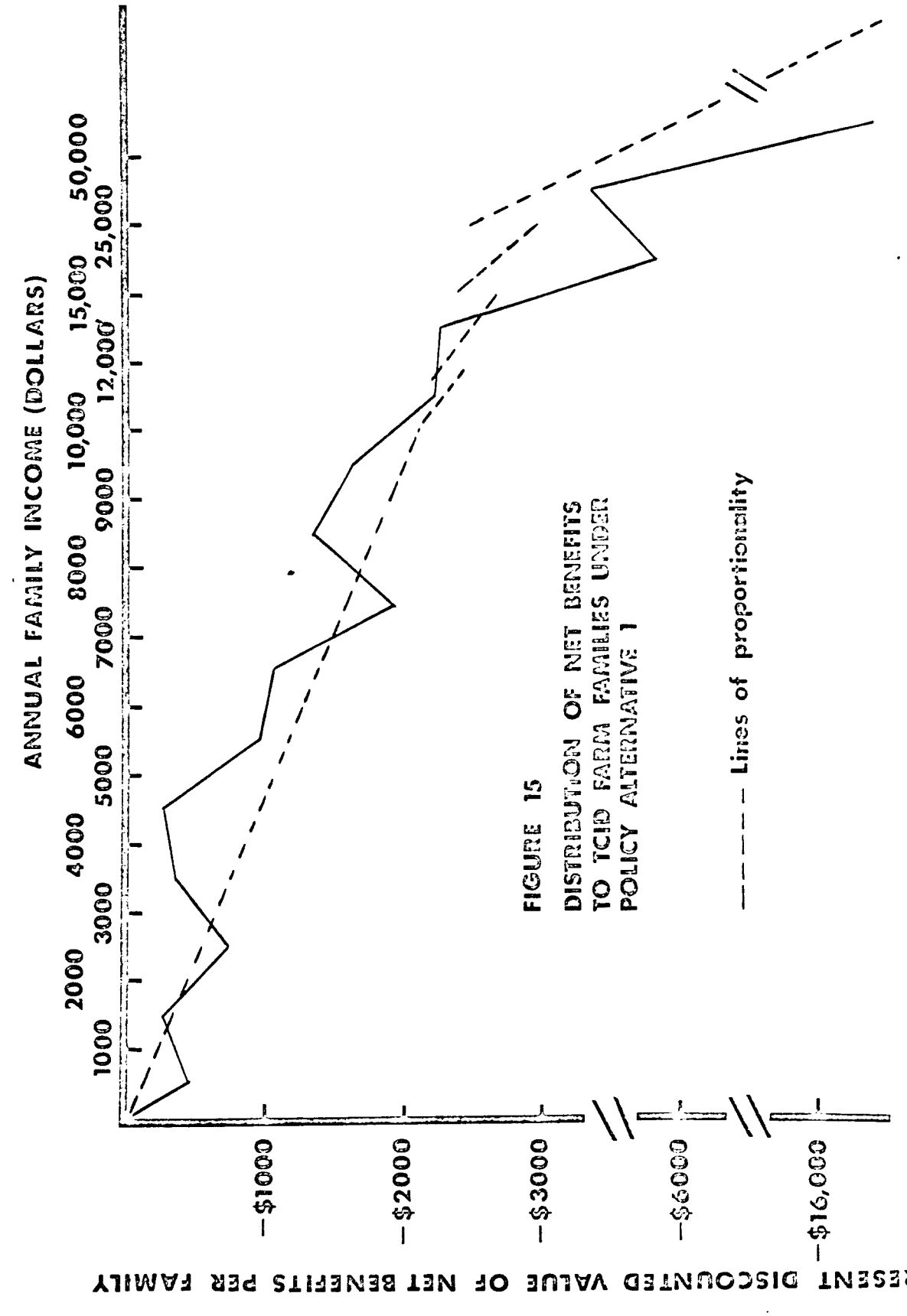


FIGURE 15
DISTRIBUTION OF NET BENEFITS TO TCID FARM FAMILIES UNDER POLICY ALTERNATIVE 1

income and water right acres were monotonic or linear. This is obviously not the case.

There are several possible explanations for the behavior of the redistribution estimates. First, there are a number of members of the TCID who qualify as farmers by virtue of the Bureau of Census definition but who hold water rights which they did not exercise during 1970 for irrigation purposes. Additionally, these families have a high assessed property valuation accounted for mainly by expensive homes. They have acreage which is suitable for agriculture but which was not used for that purpose in 1970. It appears likely that these individuals conduct small farming operations either for recreation or for tax advantages. They apparently hold their water rights principally for speculative purposes, realizing the importance of water rights in determining property values.

Second, the higher income brackets appear to be occupied by farmers with large, capital-intensive operations. The average assessed valuations of the farmers in the top 5% of the income distribution, for example, is $77,342.00. Much of this is accounted for by farm machinery and other capital equipment. Consequently, it may be argued that farmers with substantial investment in inputs which compliment water in farm production are likely to be risk averters where water is involved. Since the supply of water available to the District in any one year is uncertain because of the variability of meterological conditions, these farmers are likely to acquire more water right acres than they will nominally use in

order to hedge against the occasional dry year when water deliveries will be cut back thus forcing them to curtail their farming operations. Such curtailments are likely to be particularly expensive because of the costs attached to idle capital.

A third possible line of explanation concerns the possible existence of economies of scale. The cost and revenue figures utilized in developing farm incomes do not take account of possible economies of scale. Accordingly, it may be that the presence of economies of scale offers an explanation for the lack of monotonicity in redistribution estimates.

A final explanation which should not be overlooked may be found in the sampling procedure. Although the sample is random it is, of course, possible that there will be outliers in certain of the income classes which would tend to influence the average negative benefits calculated for those classes extremely heavily.

In accordance with these potential explanations it seems reasonable to interpret the negative net benefits per farm family calculated for policy alternative 1 in the following fashion. Reference to Figure 12 in Chapter 5 indicates a relationship between farm income and total income for farmers in the $0-$999 class which is opposite that observed to exist for all other income classes. Since the farmers in this class have surprisingly high assessed valuations, it is inferred that they are probably retired persons who are holding their property for speculative purposes. This appears to explain the relatively high per family negative benefit for that income class.

The farmers in the income class which receives a base annual income between $2000 and $2,999 per year also bear relatively high costs. The explanation for this observation is probably similar to that offered for those in the $0-$999 class. Four farm families occupy the $2,000-$2,999 class sample. Of these, two have an assessed valuation in excess of $36,000. The data also reveal that these farmers have irrigable land (and the requisite water rights) far in excess of what was actually cultivated in 1970. Accordingly, the high negative net benefit accruing to this group is attributable to the fact that 50% of the members of the group are apparently holding the land for speculative purposes. Given the amount of land and the water right acres which these families hold and given the extremely small scale of their farming operations in 1970 it is hard to believe that the high costs associated with policy alternative 1 for this group could be otherwise explained.

The group of farmers occupying the $7,000-$7,999 income class also appear to bear relatively high negative net benefits under policy alternative 1. However, the explanation does not appear to lie with speculative activities since only about 10% of the farmers in this group have assessed valuations in excess of $25,000 and most of the remainder have assessed valuations which are significantly less than that figure. Again, Figure 12 in Chapter 5 provides the apparent explanation. From the data developed and plotted in that figure it was inferred that farmers making $7,000 or more from their farm operations were full-time farmers who did not have supplementary

income from off-farm employment. Given the existence of economies of scale in farming operations it seems apparent that farmers in this income class are the "marginal" full time farmers. Because they cannot and have not invested heavily in capital equipment and are thus unable to employ many modern farming techniques they are likely to be relatively inefficient users of water. Indeed, analysis of water use by these farmers indicates that they use significantly more water per acre in growing crops than do the farmers in the $6,000-$6,999 and $8,000-$8,999 income classes.

The behavior of the negative net benefits attributable to policy alternative 1 over the remainder of the classes is intuitively plausible except for the relatively steep increases beginning with the $15,000-$24,999 class. There are two sources of explanation for the steepness of the increase. First, the width of the income class becomes progressively wider. It was necessary to adopt this particular income classification because of the limitations of the data reported in the U.S. Census. A second explanation involves the risk averting behavior alluded to earlier. For the most part, farmers making $15,000 or more from their farm operations have fairly capital intensive operations and apparently act to avoid the possibility of having to bear the costs of a temporary water shortage by acquiring more water rights than the farming operation would need during an average year. 1970 was an exceptionally bountiful year in terms of water yield in the region and this may explain why most of these farmers did not exercise all of their assigned rights during that year.

The other side of policy alternative 1 involves the distribution of benefits among the Indians. As noted in Chapter 4 the tribe would require an additional 150,000 acre feet in order to stabilize the level of Pyramid Lake, Only if the lake level is stabilized will the investment necessary to develop a recreation industry occur. The 86,000 acre feet which would be provided to the tribe as a result of the Truckee-Carson Irrigation District's improvement program would not be enough to stabilize the level of the lake. Instead it would merely slow the decline but not by enough to make investment in recreation facilities attractive. The Secretary of the Interior, then, would still be confronted with demands from the Indians to deliver the full 150,000 acre feet necessary to stabilize the lake.

It is possible that the tribe might alternatively argue that they could reap a source of livelihood from the reservation through irrigated agriculture. This argument might be based on the special trust obligation of the Secretaty to the Indians which could require that he provide them, at zero capital cost, with an irrigation project which the tribe would subsequently operate and maintain. Surveys undertaken by the Bureau of Indian Affairs indicate that there are 8,987 acres of irrigable land on the Pyramid Lake Reservation. It is conceivable that the Secretary and the tribe might agree on an irrigation project for this land as a reasonable means through which the Secretary could fulfill his trust obligation. Such an irrigation project could presumably provide an adequate source of livelihood for the Indians. If such a project were to be constructed, the

Indians would bear only the annual operating and maintenance costs. On the basis of annual operating costs for modern irrigation projects of comparable size the annual operating and maintenance costs for this project are estimated to be $320,000 per year.

The engineering consulting firm of Wilsey and Ham have assumed the following cropping patterns for the irrigation project based on data gathered by the Bureau of Indian Affairs and the University of Nevada.[10]

Crop	Acres
Alfalfa	4494
Irrigated pasture	1669
Corn	1919
Small grains	905
Total	8987

Assuming 60% efficiency, including conveyance and distributional losses, the diversion requirements for the irrigation project would be as follows:

Crop	Diversion Requirements
Alfalfa	14,515.62 acre feet
Irrigated pasture	4,706.58 acre feet
Small grain	1,647.10 acre feet
Corn	4,931.83 acre feet
Total	25,801.13 acre feet

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[10]Wilsey and Ham, *Water Resources and Land Use of the Pyramid Lake Indian Reservation*, p. 145.

The irrigation project, then, would only require about 30% of the total water made available from the TCID modernization program. The remainder of the water could be allowed to flow into the lake where it would slow the rate of decline and probably improve the quality of the water in the lake over what it would have been without the improvement program. This would result in a higher likelihood that the cutthroat trout fishery could be restored. No attempts have been made to estimate the benefits which would accrue to the tribe as a result of increasing the flow of water into the lake by 60,000 acre feet annually. Certainly some benefits will accrue but they would most likely be intangible and it is impossible to do more than speculate on the magnitude of such benefits. As a result, the following analysis understates the benefits of the modernization program to the Indians to the extent that benefits would accrue to the tribe as a result of increased flows into Pyramid Lake.

It is a widely documented fact that Indians tend to distribute income or resources more or less equally among themselves. Lamphere, in a study of the Navaho, states:

> The notion of cooperation is generalized and diffuse; it is not specific to particular types of situations or specific kin roles.[11]

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[11]Louise Lamphere, "The Navajo Cultural System: An Analysis of Concepts of Cooperation and Autonomy and Their Relation to Gossip and Witchcraft," in *Apachean Culture, History and Ethnology*, Keith Basso and M. Opler, eds., *Anthropological Papers of the University of Arizona, No. 21* (Tucson: University of Arizona Press, 1967), p. 94.

Jorgensen, in a study of the Utes and Shoshones to whom the Northern Piautes are very closely related, makes numerous references to the collective Indian ethic.

> Indian collectivism has worked to allocate meager resources and to pool and share Indian labor and skills.[12]

Jorgensen also cites a specific misunderstanding between whites and the Utes over the notion of Indian collectivism.

> BIA employees, particularly those in the social service (welfare) division, were dismayed over the Ute practice of sharing money between households and throughout wider networks of kin. The reciprocity of networks among kin greatly alarmed the (white) director of BIA social services at Northern Ute when he learned about them in the early 1960's. The welfare director had preached the federal line of family independence and self-sufficiency. When he learned how Utes shared their resources--particularly how elderly people took youngsters (usually their grandchildren) into their homes--the local social service director issued a statement in the tribal newspaper. He pleaded with the elderly people not to take children into their homes, arguing that the old folks were being duped and that the young people did not contribute to the support of the household....and have actually taken funds from the elderly individuals.
>
> The protestations of the BIA employee did not stop the Utes from joining together in larger households and pooling their skills, labor and resources.[13]

In discussing another incident, Jorgensen relates the beliefs of the Utes relative to the division of proceeds from a favorable land claims judgment.

> Although the meeting had no effect on ... decisions about how the funds would be allocated once they were deposited with the tribe, the Indians met and listened to the influential leaders. The main point made by most speakers

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[12]Joseph Jorgensen, *The Sun Dance Religion* (Chicago: University of Chicago Press, 1972), p. 238.

[13]*Ibid.*, p. 155.

> was that Utes, Shoshones, and Paiutes were one people--*nuc*, in the Ute language--before the federal government tore them apart. The collective ethic preached throughout the meeting was that *nuc* had to stay together, had to help each other.[14]

Jorgensen concludes:

> These examples from the early 1960's are only a few of the many conflicts between federal government policies and the collective Indian ethic, between Indian needs and the nature of the political economy that created Indian problems.[15]

Wax and Steward and many other anthropologists have made note of the Indian collective ethic and its implications for the egalitarian sharing of resources.[16] Indeed recent votes on Indian reservations have shown that Indians favor dividing the awards from claims on a per capita basis or, failing that, on an equal per family basis.[17]

In the face of this evidence, it appears reasonable to assume that the Pyramid Lake Paiutes would attempt to divide the irrigated acreage on an equal basis. Accordingly, the following assumptions were made relative to the allocation of irrigable land. Each Indian family would receive an equal assignment of 98.55 acres initially. However, the fact that there are some 14 families who have no member in the labor force (e.g. no member of the family was less than age 65)

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[14] *Ibid.*, p. 156.

[15] *Ibid.*, p. 156.

[16] See for example: Murray Wax, *Indian Americans: Unity and Diversity* (Englewood Cliffs, N.J.: Prentice-Hall, 1971), p. 81; Julian H. Steward, *Basin-Plateau Aboriginal Sociopolitical Groups* (Washington, D.C.: Government Printing Office, 1938), pp. 3-30.

[17] See for example the Umatilla Judgment Fund Hearing: U.S., Congress, Senate, *Hearing Before the Sub-Committee on Indian Affairs of the Committee on Interior and Insular Affairs*, Hearings on S. 2357 and H.R. 9477, 91st Cong., 2nd Sess., 1970, p. 79.

must be accounted for. It was assumed that these families would lease their acreage to other families in the tribe for a royalty amounting to 10% of net revenues obtained from the land. It should be noted that the retirees could not sell their allotments since reservation land is not owned by the Indians but rather held in trust for them by the Department of Interior. It was further assumed, in keeping with the collective ethic, that the leased land would be divided equally among the 76 families with members in the labor force. Each of these families, then, would have 118.25 acres to work but would have to pay a royalty to the retired Indians on 20 of those acres.

Utilizing the same net revenue figures applied to crop yields on the Newlands Project, the previously assumed operating and maintenance costs and the royalty scheme, it was calculated that each assignee without a family member in the labor force would receive $649.60 per year. This is assumed to grow at 5% per year and is subsequently discounted at a rate of 10%. Further calculations show that families with members in the labor force would earn $7,647.82 per year. This figure is obtained by adding the $6,496.07 (net revenue minus operating and maintenance costs) earned on the original 98.55 acre assignment to $1,151.75 earned on the additional 20 acres leased from the retirees. (In arriving at this latter figure the royalty payment is, of course, taken into account.)

In attempting to be as realistic as possible further assumptions had to be made. An interview with Joseph Jorgensen revealed that Indian families rarely give up jobs in order to farm

fulltime.[18] Rather various members of the family will help to work the farm in order that existing wage earners do not have to give up their existing work entirely. Thus it was assumed that existing wage earners would decrease outside work by 50% to work the irrigated farms. Furthermore, Old Age Assistance, Aid to the Blind and Aid to Dependent Children benefits were retained in calculating the new incomes since these benefits are not dependent upon income. Income dependent welfare assistance was subtracted out where appropriate.

Income dependent welfare assistance was assumed to be available to the family on a continuing basis in the absence of the project. Consequently equation 5) was modified as follows to take account of the costs and income dependent welfare assistance.

9) $NB_j = GB_j - GB_{j,w} - A_j$

where

NB_j = net benefits to income class j.

GB_j = gross benefits to income class j with the project.

$GB_{j,w}$ = benefits from income-dependent public assistance programs to income class j without the project.

A_j = total project-related costs to income class j with the project.

All figures were assumed to grow at 5% per year and were discounted at a rate of 10% over the 20-year period of analysis.

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[18] Joseph G. Jorgensen. Private interview at Ann Arbor, Michigan, December, 1972.

The results of the redistributional analysis for the entire tribe are presented in Table 12. As with the analysis of the redistributive effects on the Truckee-Carson Irrigation District the present net value of benefits *per family* have been computed and are presented in Table 13. The same data are plotted in Figure 16. A "line of proportionality" has also been plotted in Figure 16 to aid in the interpretation. It shows that the distribution of net benefits is decidedly not "neutral." Rather the incidence of benefits is generally regressive. Those Indian families with current annual incomes of $5,000 or less receive benefits which are in excess of proportional benefits while those making more than $5,000 annually receive benefits that are less than proportional. The incidence of benefits to the Indians, then, is regressive and this is not surprising in view of the fact that Indians will behave in such a fashion as to equalize resource endowments or incomes.

There are several underlying reasons which explain the behavior of the net benefits across income classes. All families currently receiving wage or salary income have had that income reduced by 50%. This is a proportional reduction and thus cannot be expected to explain deviations from the line of proportionality. Families with one or more members in the labor force all receive identical increments of additional earned income from the farming operations. The proportion of total income accounted for by these identical increments would thus be expected to decrease as the base year income increases *ceteris paribus*. This provides a partial explanation for the regressive

Table 12

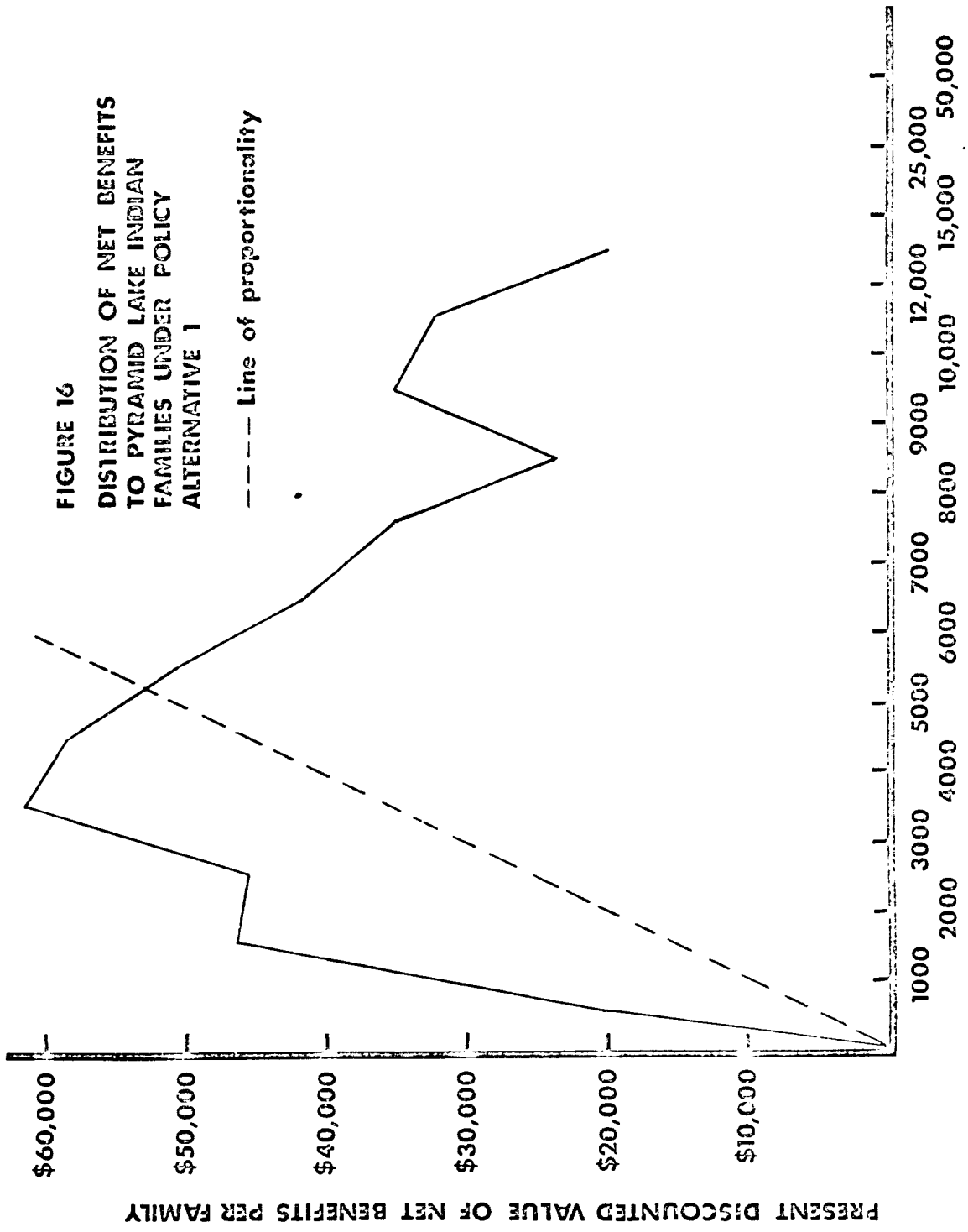
Distribution of Net Benefits to Pyramid Lake Indians
Under Policy Alternative 1

Base Year Annual Income (classes j=1,...,15)	Present Discounted Values		
	$GB_j - GB_{j,w}$	A_j	NB_j
$0-$999	$282,650	$146,933	$135,717
$1,000-$1,999	268,380	83,961	184,419
$2,000-$2,999	663,454	209,904	453,550
$3,000-$3,999	987,198	251,884	735,314
$4,000-$4,999	1,584,884	419,807	1,165,077
$5,000-$5,999	790,958	230,894	560,064
$6,000-$6,999	755,785	251,884	503,901
$7,000-$7,999	281,838	104,952	176,886
$8,000-$8,999	223,748	104,952	118,796
$9,000-$9,999	112,183	41,981	70,202
$10,000-$11,999	53,063	20,990	32,073
$12,000-$14,999	40,951	20,990	19,961
$15,000-$24,999	0	0	0
$25,000-$49,999	0	0	0
$50,000-over	0	0	0
Total	$6,045,092	$1,889,132	$4,155,960

Table 13

Distribution of Net Benefits to Pyramid Lake Indian Families Under Policy Alternative 1

Base Year Annual Income (classes j=1,...,15)	Present Discounted Values		
	Gross Benefits per Family	Total Costs per Family	Net Benefits per Family
$0-$999	$40,378	$20,990	$19,388
$1,000-$1,999	67,095	20,990	46,105
$2,000-$2,999	66,345	20,990	45,355
$3,000-$3,999	82,266	20,990	61,276
$4,000-$4,999	79,244	20,990	58,254
$5,000-$5,999	71,905	20,990	50,915
$6,000-$6,999	62,982	20,990	41,992
$7,000-$7,999	56,367	20,990	35,377
$8,000-$8,999	44,749	20,990	23,759
$9,000-$9,999	56,091	20,990	35,101
$10,000-$11,999	53,063	20,990	32,073
$12,000-$14,999	40,951	20,990	19,961
$15,000-$24,999	0	0	0
$25,000-$49,999	0	0	0
$50,000-over	0	0	0


FIGURE 16
DISTRIBUTION OF NET BENEFITS TO PYRAMID LAKE INDIAN FAMILIES UNDER POLICY ALTERNATIVE 1
---- Line of proportionality
PRESENT DISCOUNTED VALUE OF NET BENEFITS PER FAMILY
$60,000
$50,000
$40,000
$30,000
$20,000
$10,000
1000
2000
3000
4000
5000
6000
7000
8000
9000
10,000
12,000
15,000
25,000
50,000
ANNUAL FAMILY INCOME (DOLLARS)

nature of the distribution of net benefits. The $7,648 of additional increment is obviously proportionally less for a family making a base year income of $10,000 than it is for a family making a base year income of $2,000.

An equally significant reason for the non-linear and non-monotonic behavior of the income distribution lies with the distribution of income determined public assistance benefits. The principal payments of interest here are the general assistance payments. These are not proportionally nor even monotonically related to family income as might be suspected. Rather qualification for these benefits will sometimes depend on per capita income rather than family income. Per capita incomes are not wholly monotonic across the Indian income classes. Furthermore, although general assistance benefits are identified as income related they may depend upon factors other than income. Having an income below a certain level may be only a precondition for eligibility. Beyond this, certain other requirements may have to be met which relate to the number and age of people in the household, the presence of sick or aged in the household and so forth. As a result, the amount of public assistance lost does not vary monotonically across income classes.

Remembering that family income earned from the irrigation project will be constant and would therefore tend to account for the relatively regressive nature of the distribution of net benefits, the non-monotonic aberrations in the graph can be explained as follows. The dip in net benefits observed to accrue to families in the $2,000-

$2,999 class can be explained by the fact that half of the families in that class have no family member in the labor force. These families receive only the lease payment from the irrigated acreage allotment and thus receive far less additional income from the policy than do families with members in the labor force. The relatively high proportion of "unemployable families" in this group accounts for the fact that they receive relatively fewer net benefits than do families occupying the income classes on either side.

The other significant aberration in the distribution of net benefits occurs in the $8,000-$8,999 income class. Indians in this class appear to receive a disproportionately low share of the net benefits as compared with families in the $9,000-$9,999 class. This aberration is accounted for by the fact that families in the former class have income related benefits which account for 29% of their total base year income while income related assistance for families in the latter class amount to only 12.5% of base year income. This means that families in the $8,000-$8,999 class lose significantly more of their original income than do families in the $9,000-$9,999 class under policy alternative 1.

Thus it can be concluded that the redistribution of benefits among the Indians under policy alternative 1 is a function both of the amount of public assistance income lost and the fact that the constant per family income attributable to irrigated farming is proportionally less relative to base year income across income classes. The interaction of these two factors plus the fact that families without

any eligible wage earners tend to be concentrated in the $2,000-$2,999 class appears to explain the way in which net benefits are distributed among Indian families.

Policy Alternative 2: Require that the Indians be Given the Full Entitlement of Water Necessary to Stabilize Pyramid Lake

If, as the Counsel for the Pyramid Lake Piautes has argued, the Secretary of Interior has a legal obligation to ensure that the Tribe receives an entitlement of water necessary to stabilize the lake, the Secretary could select policy alternative 2 which would require the Truckee-Carson Irrigation District to reduce its diversions from Derby Dam by 150,000 acre feet annually. Such a policy could be implemented through two actions. First, the Secretary could direct that the District undertake the modernization improvements discussed under policy alternative 1. Second, the remaining 64,000 acre feet would have to be obtained by revoking certain water rights currently exercised by the district which are "impliedly reserved" to the Indians. This would involve the transfer of some rights from the Irrigation District to the Indians. The Irrigation District would not be entitled to compensation, however, since this would not be a taking in the legal sense of the word. Rather, it is argued that the irrigators have historically used water which belongs by right to the Indians and the Indians are simply invoking their rights. As a consequence policy alternative 2 would require the Secretary to order the District to make the efficiency improvements at its own

expense, request Congressional action to require Districts to make such improvements at their own expense and require the District to discontinue diverting an additional 64,000 acre feet at Derby Dam.

An analysis of the redistributive consequences of such a policy for the TCID farmers must take account of three considerations. First, a certain number of water right acres will have to be transferred from farmers in the District in order to obtain release of the required amount of water. Second, once those rights have been transferred, the per water right acre charge levied against the farmers for the efficiency improvement will have to be adjusted to reflect the fact that there are now fewer water right acres. Third, annual operating and maintenance costs tend to be fixed in that they do not vary with the amount of water delivered. The salaries of ditchriders and the watermaster as well as the costs of normal maintenance work will remain the same irrespective of how much water is put through the system. Of course, if portions of the system are shut down there may be some savings but a reduction in deliveries of the magnitude considered here would not seem to require closing any portion of the system. As a consequence, the operation and maintenance costs will have to be spread over fewer water right acres and this must be accounted for.

The Pyramid Lake Task Force Report contains data which makes it possible to estimate the efficiency of the Newlands Project even with the recommended efficiency improvements in place.[19] The report

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[19]Pyramid Lake Task Force, *Final Report*, p. A-12.

suggests that even with the improvements in place the project will still only deliver approximately 27.5% of the water diverted from the Truckee River to fields for irrigation. (It is interesting to note that modern irrigation projects have efficiencies in the neighborhood of 60-70%.)[20] Accordingly, in order to realize a 64,000 acre foot savings at the Derby Dam Diversion it will be necessary to curtail water deliveries to the farm fields by 17,600 acre feet. The average application of water on the Newlands project is reported to be 3.5 acre feet per water right acre.[21] While there are grounds for believing that this figure is low there is no solid documentation and therefore it must be assumed for purposes of analysis that the figure is correct. Thus, the TCID farmers must give up 5,028 water right acres if the Indians are to receive all waters "impliedly theirs."

Although it is difficult to predict the outcome of any deliberation on the part of the Board of Directors of the TCID relative to the issue of who is to give up how many rights, it appears reasonable to assume that it would be done on a proportional basis. Five thousand twenty-eight water right acres represents 6.8% of the total water right acres held by members of the District. Thus, it

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[20] Cummings, for example, describes an irrigation project in a very hot portion of northern Mexico which has an efficiency of approximately 61%. See: Ronald Cummings, *Water Resource Management in Northern Mexico* (Baltimore: Johns Hopkins University Press, 1972), p. 30.

[21] U.S., Department of Interior, Bureau of Reclamation, *Crop Report and Related Data, Federal Reclamation Projects, 1970* (Washington, D.C.: Government Printing Office, 1971), p. 52.

follows that under a policy of proportional reduction each member would have his allotment reduced by 6.8%. It has been calculated that the annual worth of a water right acre to a farmer on the Newlands Project is roughly $10.50 if average irrigation applications are assumed.[22] As a result each farmer will bear an annual cost of $0.72 per water right acre held. This cost represents the direct cost of the water right acres which must be foregone to affect policy alternative 2.

Once the water rights have been given up by the farmers, a change in the financing of the efficiency improvement must necessarily occur. Since there are now 6.8% fewer water right acres against which to levy the charges for the efficiency improvements, those charges will be 7.2% greater per water right acre than was the case under policy alternative 1. Thus the capital costs of the efficiency improvement increase from $19.05 to $20.42 per water right acre. The capital costs are, of course, repayable over a twenty-year period at an interest rate of 7%. The additional operating and maintenance costs occasioned by the efficiency improvements also increase by 7.2% from the $0.76 per year levied under policy alternative 1 to $0.81 per year to be levied under policy alternative 2. These costs are assumed to grow at a rate of 5% per year and, of course, all costs are discounted at a rate of 7%.

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[22]Wilsey and Ham, *Water Resources and Land Use of Pyramid Lake Indian Reservation*, p. 106.

A third and final increase in cost attributable to policy alternative 2 stems from the fact that general operation, maintenance and repair costs associated with the nominal operation of the project are assessed on a water right acre basis. These costs are not associated with any efficiency improvements. Rather, they are the current day-to-day operational costs which have to be borne irrespective of any policy changes. Of course, they would be reduced if portions of the project were closed but that does not appear warranted or necessary under policy alternative 2. Present annual operation, maintenance and repair costs amount to $4.50 per water right acre. As a consequence of the decrease in the number of water right acres held by District members, these costs will increase by $0.32 per water right acre annually. Table 14 summarizes all costs per water right acre which would accrue under policy alternatives 1 and 2.

In analyzing the redistributive consequences of policy alternative 2 for the farmers it is possible to again make use of equation 8). This is so because all of the cost and benefit terms in the "without" expression in equation 5) are equal to zero. Additionally, no normative tax reimbursement adjustment appears warranted. The loss of the water rights is viewed here as a risk of doing business. The allocation of water in the Truckee-Carson basins has been controversial and the subject of litigation for nearly 50 years. No final decree has been entered in the case of the allocation of Carson River waters and the allocation of waters from both rivers is now likely to be the subject of litigation before the

Table 14

Costs Per Water Right Acre to
Truckee-Carson Irrigation District Under
Policy Alternatives 1 and 2*

	Alternative 1	Alternative 2
Costs of Water Transferred Directly to Indians	$0.00/year	$0.72/year
Costs of Efficiency Improvements		
1. Capital Costs	$19.05 @ 7% over 20 years	$20.42 @ 7% over 20 years
2. Operation and Maintenance of Improvements	$0.76/year	$0.81/year
Additional Costs of Regular Operation, Maintenance and Repair	$0.00/year	$0.32/year
Present Discounted Value of Costs per Water Right Acre	$22.63	$43.02

*Capital costs are repayable over 20 years at 7% interest. All other costs are assumed to grow at 5% per year over a 20-year period. All costs are discounted at 7%.

Supreme Court of the United States. No successful businessman could fail to heed the innate uncertainty attendant to the allocation of waters in these basins. Indeed, the larger farmers appear to have taken account of hydrologic uncertainty in acquiring water rights which are excessive in normal years. There is no conceivable justification for the farmers to ignore legal uncertainty while hedging against hydrologic uncertainty. The loss of the water rights, then, must be viewed as a cost of doing business. Consequently, no normative tax reimbursement adjustment is warranted and equation 8) is the appropriate identity for use in analyzing the redistributive consequences.

Table 15 presents the costs (negative net benefits) to the TCID farmers under policy alternative 2. For ease of interpretation this data has been converted to a per family basis which is shown in Table 16 and depicted in Figure 17. Figure 17 is similar to Figure 15 except with respect to the magnitude of present discounted costs. The relationship between the assigned distribution of costs and the line of proportionality in Figure 17 is identical to that in Figure 15. This is so because the distribution of costs to the farmers under both policy alternatives are directly related to water right acres and, as a consequence, the distribution of costs under policy alternative 2 is simply a linear transformation of the distribution of costs under policy alternative 1. The result is that the explanation for the lack of monotonicity in the distribution of costs under policy alternative 2 is identical to that provided for policy alternative 1.

Table 15

Distribution of Net Costs to TCID Farmers
Under Policy Alternative 2

Base Year Annual Income (classesj=1,...,15)	Present Discounted Values		
	GB_j	A_j	NB_j*
$0-$999	$0	$11,494	-$11,494
$1,000-$1,999	0	13,857	-13,857
$2,000-$2,999	0	15,903	-15,903
$3,000-$3,999	0	19,369	-19,369
$4,000-$4,999	0	14,487	-14,487
$5,000-$5,999	0	108,020	-108,020
$6,000-$6,999	0	117,473	-117,473
$7,000-$7,999	0	228,792	-228,792
$8,000-$8,999	0	195,249	-195,249
$9,000-$9,999	0	231,943	-231,943
$10,000-$11,999	0	280,439	-280,439
$12,000-$14,999	0	331,613	-331,613
$15,000-$24,999	0	592,684	-592,684
$25,000-$49,999	0	641,660	-641,660
$50,000-over	0	348,607	-348,607
Total	$9	$3,151,590	-$3,151,590

*Negative net benefits (NB_j) represent costs.

Table 16

Distribution of Net Benefits to TCID Farm Families
Under Policy Alternative 2

Base Year Annual Income (classes j=1,...,15)	Present Discounted Values		
	GB_j	A_j	NB_j*
$0-$999	$0	$718	-$718
$1,000-$1,999	0	433	-433
$2,000-$2,999	0	1,325	-1,325
$3,000-$3,999	0	538	-538
$4,000-$4,999	0	517	-517
$5,000-$5,999	0	1,688	-1,688
$6,000-$6,999	0	1,836	-1,836
$7,000-$7,999	0	3,375	-3,375
$8,000-$8,999	0	2,441	-2,441
$9,000-$9,999	0	2,899	-2,899
$10,000-$11,999	0	4,124	-4,124
$12,000-$14,999	0	4,145	-4,145
$15,000-$24,999	0	12,348	-12,348
$25,000-$49,999	0	11,458	-11,458
$50,000-over	0	29,051	-29,051

*Negative net benefits (NB_j) represent costs.

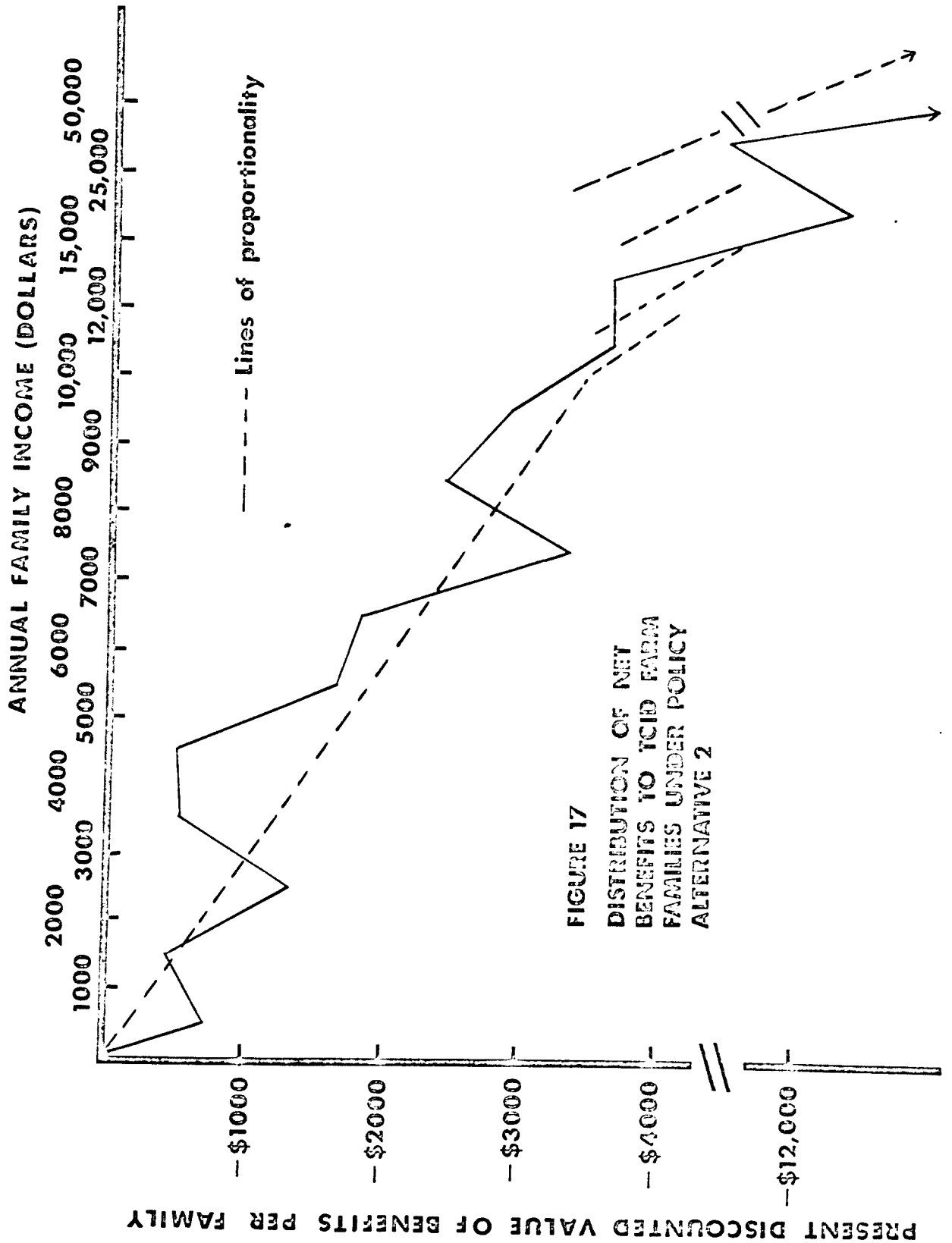


FIGURE 17
DISTRIBUTION OF NET BENEFITS TO TCID FARM FAMILIES UNDER POLICY ALTERNATIVE 2

The analysis of the redistributive consequences of policy alternative 2 for the Pyramid Lake Indians presents some difficulties. There exist only two studies of potential recreation benefits which would accrue to the Indians if the level of the Lake were to be stabilized and the requisite public or private investment were to be forthcoming. The conclusions of these studies vary somewhat. The Bureau of Outdoor Recreation has published a study on the total recreation potential of Pyramid Lake together with a plan for federal development.[23] That study concludes that between 1970 and 2000 recreation development at Pyramid Lake would generate a total income for Indians of $232,825,000. There are several reasons for rejecting the conclusions of this study. First, visitation rates were developed through simple extrapolations of past trends. No systematic effort was made to explore substitution possibilities nor was any effort made to examine or test differing hypotheses about the growth of population in the region.[24] Estimates of willingness to pay were obtained from another study conducted at the University of Nevada in which an investigator questioned campers and other recreators as to what they would be willing to pay to come to Pyramid Lake and utilize the contemplated facilities.[25] The weaknesses of techniques such as this were discussed in Chapter 5.

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[23] U.S., Department of Interior, Bureau of Outdoor Recreation, *Pyramid Lake Recreation Study* (Washington, D.C.: Government Printing Office, 1968), pp. 1-151.

[24] *Ibid.*, pp. 91-92.

[25] *Ibid.*, p. 123.

A second study of recreation and other economic potentials for the Pyramid Lake Reservation was undertaken by the firm of Wilsey and Ham under contract to the Economic Development Administration.[26] In conjunction with Economic Research Associate, Inc. Wilsey and Ham developed two economic models to predict recreational patterns at Pyramid Lake assuming that the lake level could be stabilized. The first model assumed public development and was based on past experience at Lake Meade which is very similar to Pyramid Lake in terms of location and ease of access.[27] The second model assumed private development and was based on the experience at Lake Tahoe.[28] Some consideration was given to examining the income distribution consequences of both public development model and the private development model. Indeed, a preliminary analysis indicated that under private development the Indians might expect to receive a total of $4,935,505 discounted over the twenty-year period while private development yielded some $2,347,853.

There were a number of reasons, however, for rejecting the private development model. First, the experience at Lake Tahoe with private development is not likely to be repeated at Pyramid Lake. Lake Tahoe is some 50 miles closer to the major centers of population

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[26]Wilsey and Ham, *Water Resources and Land Use of the Pyramid Lake Indian Reservation*, pp. 1-167.

[27]*Ibid.*, pp. 110-117.

[28]*Ibid.*, pp. 118-125.

and thus is more accessible. The locale of Lake Tahoe is fortuitous in that it provides excellent opportunities for both winter and summer recreation. Since Pyramid Lake is not only lower in elevation but is situated in the rain shadow of the Sierra Nevada it offers no opportunities for skiing or other winter sports. Additionally, Lake Tahoe is surrounded by a significant amount of private land which can be bought and sold outright. On the Pyramid Lake Indian Reservation the land is held in trust for the tribe by the Department of Interior. Private development and the construction of second homes could occur only under a lease arrangement. Each lease would have to be approved by the Secretary of Interior. This would create a significant friction in the land market at Pyramid Lake which would undoubtedly retard development.

The Wilsey and Ham model of private development contains another shortcoming in that it fails to recognize that Lake Tahoe and Pyramid Lake would likely be close substitutes as far as the "consumption" of recreation was concerned. This substitution possibility would also likely retard the development of Pyramid Lake over the rates observed at Tahoe.

Finally, the model of private development appears unrealistic on cultural and historic grounds. Historically, Indians have not been the primary beneficiaries of successful efforts to attract private development and investment to reservation lands. Even lease agreements which provide that a certain proportion of the jobs made available by such industries be reserved for Indians have not helped.

Jorgensen points out that between 1962 and 1968 some 10,000 jobs were created through development of industries on or near reservations. Yet approximately 60% of those jobs were ultimately held by non-Indians.[29] Jorgensen further states:

> Private corporations are using Indian capital to expand, yet using Indian labor only when it is adequate to the task. Indians do not maintain ownership or control.[30]

Brophy and Aberle suggest that Indian labor is not often "adequate to the task."

> Industrial development has often been further inhibited because Indian populations are undereducated and underskilled.[31]

There is absolutely no evidence to indicate that the Pyramid Lake Paiutes are an exception to this rule. The educational level of the Pyramid Lake Paiutes is about the average for that for rural Indians and their current employment situation does not suggest that they are highly or even moderately skilled in the trades which firms most often demand.

Additionally, it will be recalled from Chapter 5 that the tribal leadership had indicated that any attempts to mail questionnaires or canvas tribal members would be fruitless because of the mistrust which exists between members of the tribe and outsiders whom

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[29]Joseph G. Jorgensen, "Indians and the Metropolis," in *The American Indian in Urban Society*, ed. by Jack Waddell and Michael Watson (Boston: Little, Brown and Company, 1971), p. 83.

[30]*Ibid.*, p. 83.

[31]William Brophy and Sophie Aberle, *The Indian: America's Unfinished Business* (Norman: University of Oklahoma Press, 1966), p. 80.

they believe are attempting to exploit them. Because of the failure of Indians elsewhere to benefit substantially from private development and because of the prevailing attitude of mistrust between the Pyramid Lake Indians and potential developers it was concluded that private development of any magnitude which would be satisfactory to both Indians and developers was not likely to occur. Consequently, it was assumed that the development of recreation facilities at Pyramid Lake would be undertaken publicly with the Indians receiving lease or royalty payments. This assumption seems quite defensible in view of the interest of the Department of Interior and several conservation groups in giving Pyramid Lake National Recreation Area status.[32]

The following assumptions were made about the economic performance of a federally funded and supervised National Recreation Area at Pyramid Lake. The total annual revenue generated by the recreation development is estimated by Wilsey and Ham to be $1,773,150.[33] This estimate was calculated from the model which used the Lake Meade experience as a prototype for Pyramid Lake. In keeping with current recreational lease arrangements on Indian Reservations it was further assumed that the Indians would receive a royalty payment amounting to 15% of total revenue annually. Total revenue was assumed to grow at

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[32]See for example: "The California-Nevada Interstate Compact: A Great Betrayal," *Cry California*, 7 (Winter, 1971-72), pp. 32-38.

[33]Wilsey and Ham, *Water Resources and Land Use of the Pyramid Lake Indian Reservation*, p. 116.

5% per year over the period of analysis and thus the royalty payments would grow at the same rate. It was further assumed that the royalty payments would be divided on a *per capita* basis among the members of the tribe. Accordingly, each tribal member residing on the reservation would receive $626 per year which would grow at 5% per year over the period of analysis.

Evidence cited earlier in this chapter indicated that Indians have a preference for per capita distribution of royalty payments or other types of cash payments. While per capita distribution of the irrigated farm land did not seem to be a likely outcome under policy alternative 1 (families are really required to work farms) per capita distribution of royalty payments would appear to be the most probable consequence of tribal deliberations and votes relative to the distribution of the royalty payments.

All employed Indians were assumed to maintain their current employment and their salaries were assumed to remain the same. They would, of course, grow at 5% per year. Where Indian families would lose eligibility for general assistance or other types of public benefits by virtue of the effect of royalty payments on income, these benefits were subtracted from the incomes expected to prevail in the presence of the recreation project. It was assumed that no Indian would receive a better paying job as a result of the recreation project. This assumption is probably unrealistic inasmuch as the recreation development would create jobs for unskilled labor. To the extent that Indians would find employment opportunities associated

with the recreation development which yielded incomes higher than those they are currently making, the net benefits have been understated.

Equation 9) which was used to analyze the redistributive consequences of policy alternative 1 is used here also. That equation is appropriate here because income related family assistance would vary between the "with and without" case. A discount rate of 10% is maintained here, also. The distribution of net benefits to Pyramid Lake Indians by income class under policy alternative 2 is presented in Table 17. These benefits have been adjusted to a per family basis in Table 18 and the data contained in that table is plotted in Figure 18.

Figure 18 shows that Indians in the income classes below $5,000 receive benefits which are more than proportional to their base year incomes while those in income classes above $5,000 receive benefits that are less than proportional to their base year incomes. Here again the distribution of net benefits to the Indians is neither linear nor monotonic. The lack of linearity can be explained by the fact that there is a relatively low correlation coefficient between family size and income (.58). The lack of monotonicity is explained by two factors, non-monotonic variations in family size among income classes and the fact that certain income classes have a disproportionately high general assistance component of their income. This general assistance component is foregone when incomes are increased by virtue of the royalty payments which accrue from the recreation project.

Table 17

Distribution of Net Benefits to Pyramid Lake Indians
Under Policy Alternative 2

Base Year Annual Income (classes j=1,...,15)	Present Discounted Values		
	$GB_j - GB_{j,w}$	A_j	NB_j
$0-$999	$60,658	$0	$60,658
$1,000-$1,999	45,493	0	45,493
$2,000-$2,999	257,710	0	257,710
$3,000-$3,999	274,884	0	274,884
$4,000-$4,999	707,772	0	707,772
$5,000-$5,999	251,545	0	251,545
$6,000-$6,999	271,893	0	271,893
$7,000-$7,999	106,285	0	106,285
$8,000-$8,999	151,753	0	151,753
$9,000-$9,999	98,581	0	98,581
$10,000-$11,999	45,481	0	45,481
$12,000-$14,999	75,798	0	75,798
$15,000-$24,999	0	0	0
$25,000-$49,999	0	0	0
$50,000-over	0	0	0
Total	$2,347,853	$0	$2,347,853

Table 18

Distribution of Net Benefits to Pyramid Lake Indian Families
Under Policy Alternative 2

Base Year Annual Income (classes j=1, ..., 15)	Present Discounted Values		
	$GB_j - GB_{j,w}$	A_j	NB_j
$0-$999	$8,665	$0	$8,665
$1,000-$1,999	11,373	0	11,373
$2,000-$2,999	25,771	0	25,771
$3,000-$3,999	22,907	0	22,907
$4,000-$4,999	35,389	0	35,389
$5,000-$5,999	22,868	0	22,868
$6,000-$6,999	22,658	0	22,658
$7,000-$7,999	21,257	0	21,257
$8,000-$8,999	30,351	0	30,351
$9,000-$9,999	42,290	0	42,290
$10,000-$11,999	45,481	0	45,481
$12,000-$14,999	75,798	0	75,798
$15,000-$24,999	0	0	0
$25,000-$49,000	0	0	0
$50,000-over	0	0	0

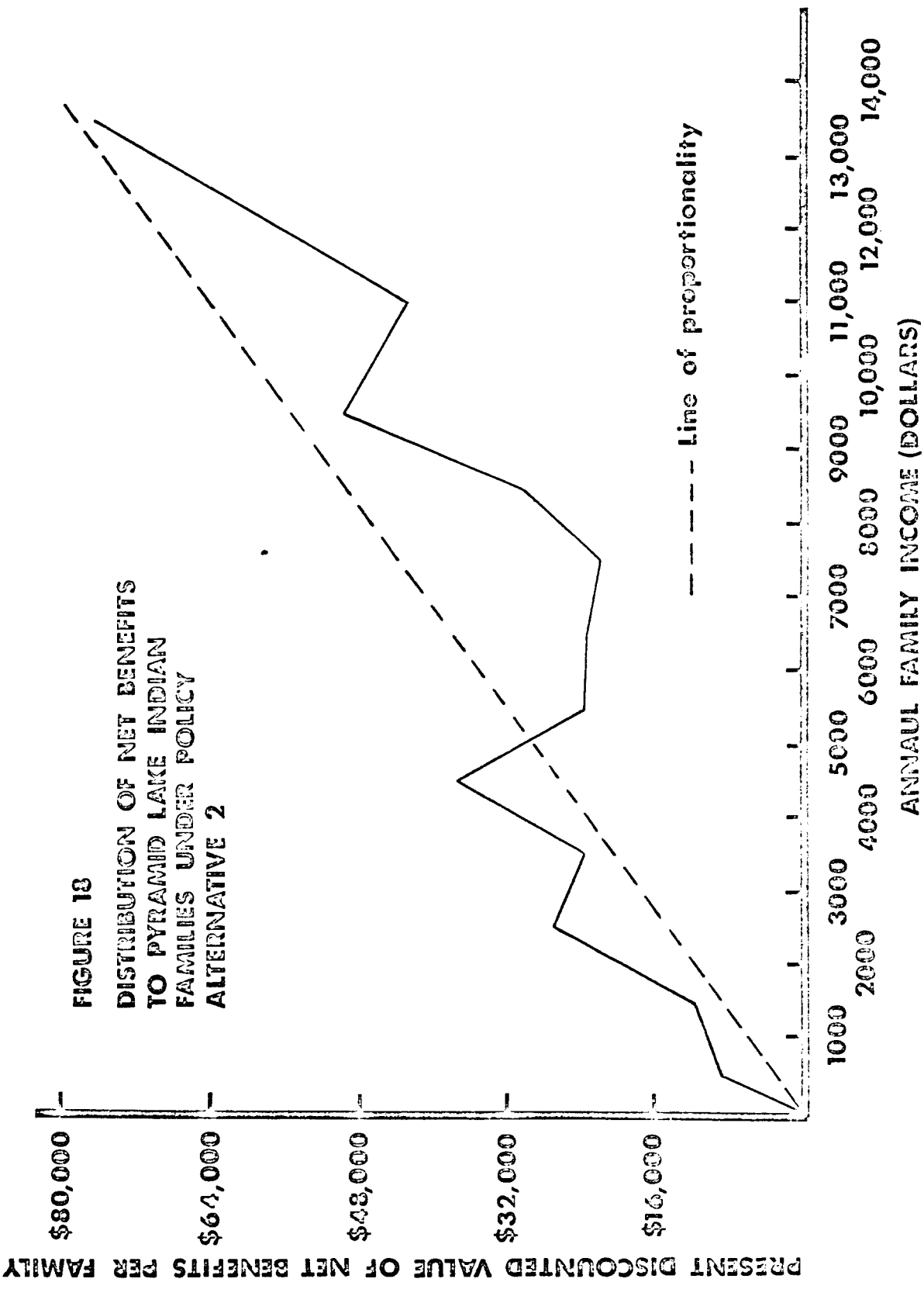

FIGURE 18
DISTRIBUTION OF NET BENEFITS
TO PYRAMID LAKE INDIAN
FAMILIES UNDER POLICY
ALTERNATIVE 2
PRESENT DISCOUNTED VALUE OF NET BENEFITS PER FAMILY
$80,000
$64,000
$48,000
$32,000
$16,000
1000
2000
3000
4000
5000
6000
7000
8000
9000
10,000
11,000
12,000
13,000
14,000
ANNAUL FAMILY INCOME (DOLLARS)
Line of proportionality

Table 19 shows the average family size per income class. Given that the royalty payments are made on a per capita basis it is to be expected that families occupying the $5,000-$5,999 and $10,000-$11,999 classes will receive smaller royalty payments than those in the adjacent income classes. This accounts for the marked dips in the graph which are observed for those income classes. The $3,000-$3,999 and $7,000-$7,999 income classes turn out to have proportionally more of their income accounted for by general assistance benefits than the adjacent classes. Since a larger percentage of these benefits will be lost when the royalty payments are made, these two classes receive relatively less net benefit than do the adjacent classes. This accounts for the dips that are observed in the graph for those two classes. The remainder of the variation in the graph is accounted for primarily by family size and its variation between income groups. Except for the two classes noted the distribution of public benefits appears to be relatively proportional.

A comparison between Table 15 and Table 17 might seem to suggest that policy alternative 2 is, on the whole, inefficient since the costs to the Truckee-Carson Irrigation District Farmers exceeds the benefits to the Indians. In all probability this is not so since significant benefits have been ignored and virtually all costs have been accounted for. This study has made no attempt to account for either the magnitude or distribution of net benefits which would accrue to individuals who would recreate at Pyramid

Table 19

Relation Between Income Classes and Family Size

Base Year Income Class	Average Family Size
$0-$999	1.1
$1,000-$1,999	1.5
$2,000-$2,999	3.4
$3,000-$3,999	4.5
$4,000-$4,999	5.2
$5,000-$5,999	4.8
$6,000-$6,999	5.6
$7,000-$7,999	6.0
$8,000-$8,999	7.2
$9,000-$9,999	8.5
$10,000-$11,999	6.0
-	-
$14,000-$15,999	10.0

Lake. Furthermore, Pyramid Lake is one of the last great desert lakes remaining in the United States and is generally conceded to be the most beautiful.[34] It is likely, therefore, that there exists some option demand for preservation of the lake. No attempt has been

[34]U.S., Department of Interior, Bureau of Outdoor Recreation, *Pyramid Lake Recreation Study* (Washington, D.C.: Government Printing Office, 1968), pp. 14-16.

made to measure the magnitude or distribution of net benefits which might be attributable to the existence of such an option demand. Additionally, no attempt has been made to calculate the net benefits which would accrue in the event the Lahanton Cutthroat Trout fishery were to be reestablished and the more remote possibility that it might again become a commercially valuable species. Reestablishment of the fishery is probable in the event that the lake level were to be restored. To the extent that these benefits would exist, the over-all magnitude of the benefits accruing from policy alternative 2 has been understated. Consequently, there is a strong probability that policy alternative 2 would prove to be economically acceptable from an efficiency point of view.

Conclusion

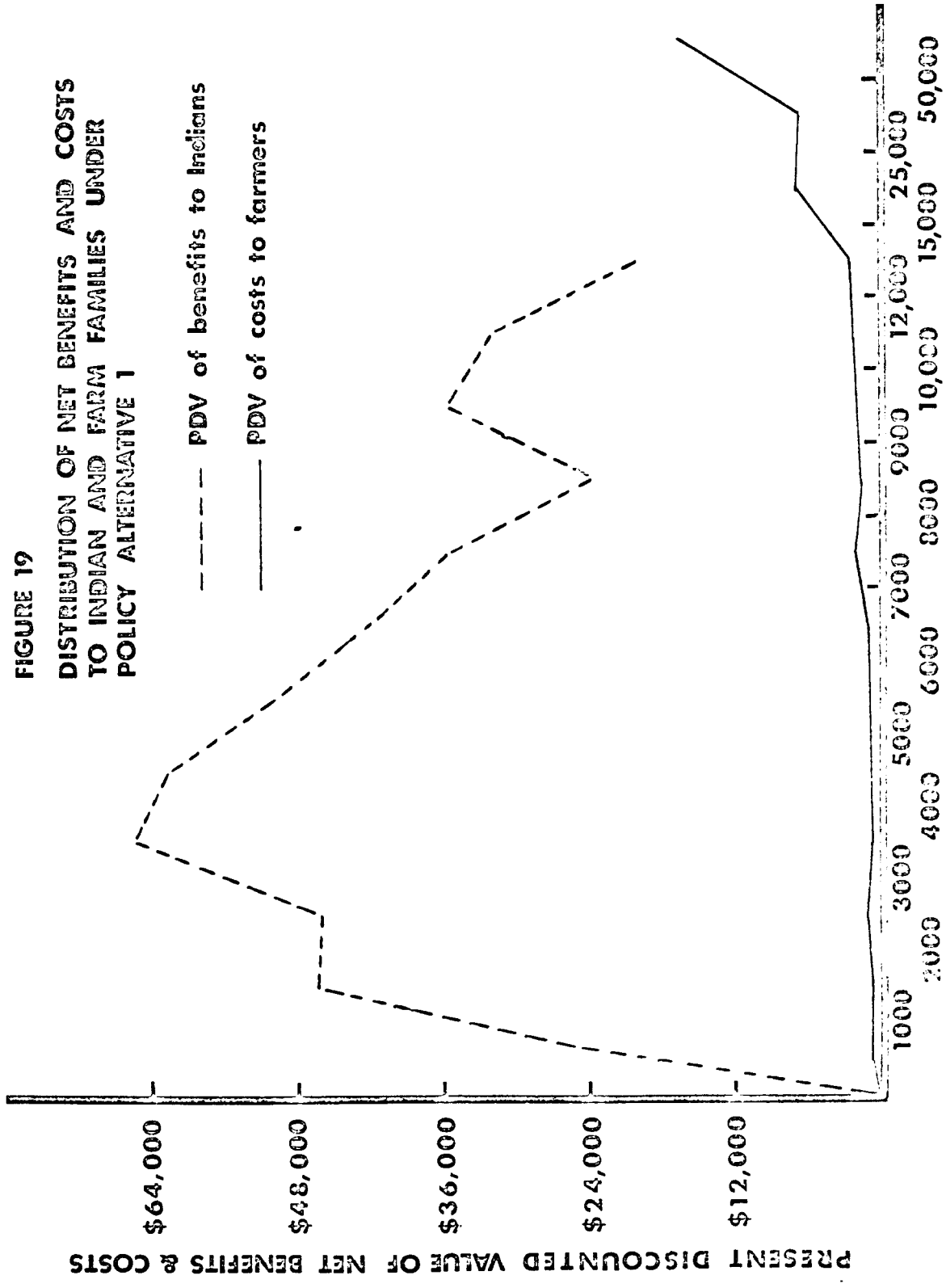
This chapter has examined the income redistribution effects of two policy alternatives which might be adopted to resolve the water allocation controversy in the lower Truckee-Carson River Basins. The primary focus of the discussion was on the within-group redistribution of income. The distribution of positive and negative net benefits accruing to the TCID farmers and the Pyramid Lake Paiute Indians was examined to learn the relationship between the estimated redistributions and "neutral" redistribution which was defined as being proportional to the original or base year incomes. The general conclusions were that the distribution of costs among the farmers were, for the most part, progressive while the distribution of net

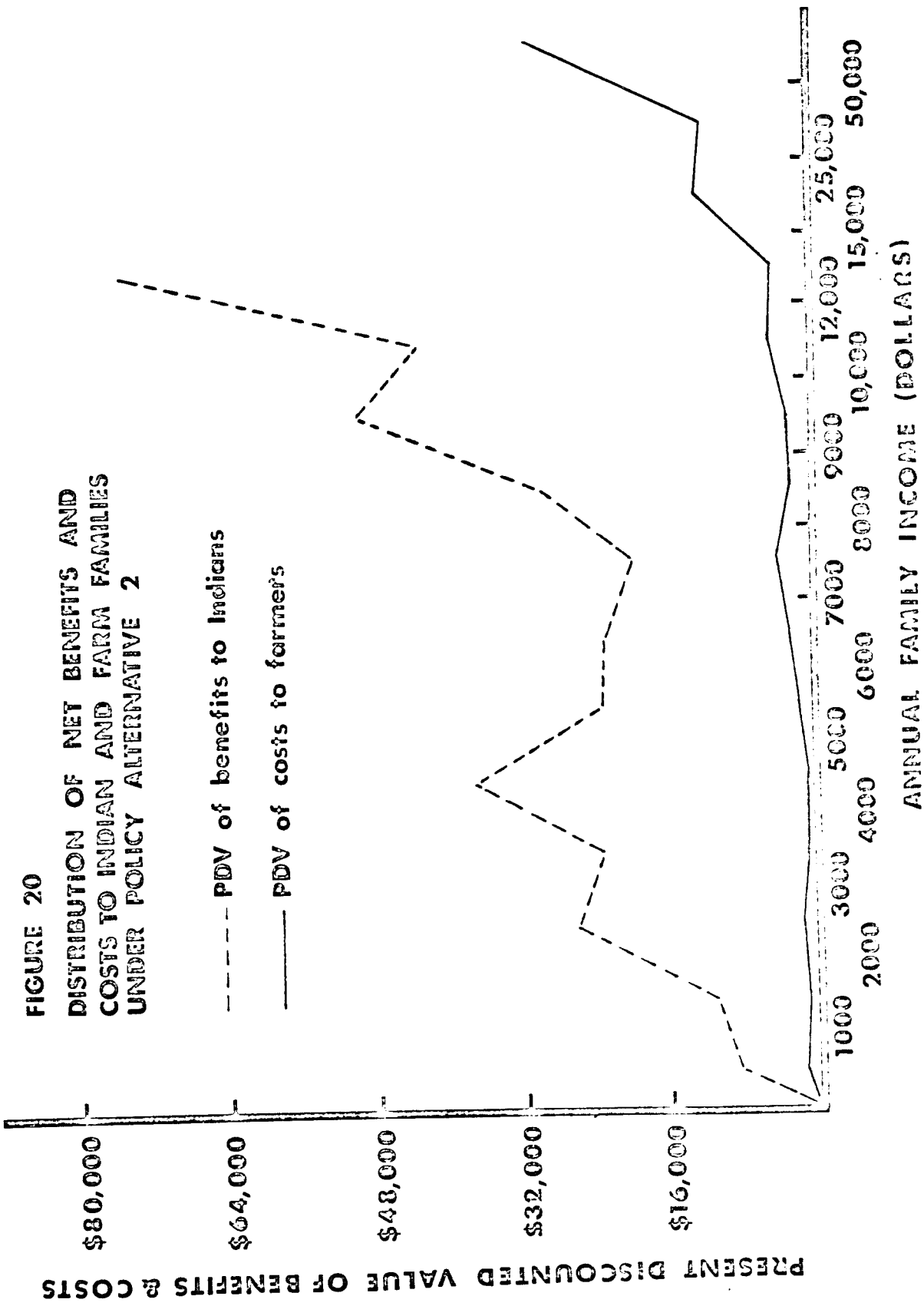
benefits among the Indians were, for the most part, regressive. Generally, these conclusions held for both policy alternatives.

While the principal focus was on within-group distributions it is also useful to examine the redistributions between groups under the two policy alternatives. The present discounted values of the costs to the farmers and the benefits to the Indians, assuming adoption of one or the other of the policy alternatives, are plotted in Figures 19 and 20. Both of these plots indicate that the per family net benefits to the Indians are far in excess of the per family net costs to the farmers. It appears that each farm family bears very small costs relative to the benefits received by Indian families in comparable income categories. The figures are somewhat deceiving, however, in that a significant portion of the difference is accounted for by the fact that there are approximately 8 times as many farm families as there are Indian families. As a consequence, the costs of each policy alternative are spread over many more families than are the benefits. Thus the striking gap between the magnitude of costs and benefits shown in Figures 19 and 20 is somewhat misleading. If the graphs were to be standardized for the discrepancy in the number of families, the size of the gaps would be significantly reduced. The figures also indicate that the wealthier farmers bear more than a proportionate share of the costs of a policy which provides disproportionately high benefits to low income Indians.

FIGURE 19

DISTRIBUTION OF NET BENEFITS AND COSTS TO INDIAN AND FARM FAMILIES UNDER POLICY ALTERNATIVE 1




FIGURE 20
DISTRIBUTION OF NET BENEFITS AND COSTS TO INDIAN AND FARM FAMILIES UNDER POLICY ALTERNATIVE 2
PDV of benefits to Indians
PDV of costs to farmers
PRESENT DISCOUNTED VALUE OF BENEFITS & COSTS
$80,000
$64,000
$48,000
$32,000
$16,000
1000
2000
3000
4000
5000
6000
7000
8000
9000
10,000
12,000
15,000
25,000
50,000
ANNUAL FAMILY INCOME (DOLLARS)

The conclusions of this chapter relative to both within-group and between-group income redistribution would differ substantially if another definition of neutrality had been chosen. Additionally, the conclusions are importantly conditioned by the assumptions made relative to the allocation of additional costs and benefits between the farmers and Indians respectively. However, the assumptions chosen for the analysis of both policy alternatives appear to be the most realistic given the assessment criteria which the TCID has used historically and given the collective ethic which prevails among Indian tribes.

CHAPTER 7

CONCLUSIONS

The conclusions of this study may be summarized as follows:

1. Economists have traditionally deemphasized the discussion of income distribution in their theoretical and applied work. They have been inclined to deal with income distribution problems by making simplifying assumptions which, it is often contended, are devoid of normative significance. The most common assumptions are: a) income distribution or redistribution does not matter, b) income redistribution can be accomplished through a series of taxes and transfers and thus need not impede the application of welfare economics to practical problems, c) because of the non-normative nature of their field, economists have no competence to prescribe or evaluate distributional changes and thus should simply assume that prevailing distributions are optimal.

It is true that economists have failed to generate conclusions about income distribution with which a significant number of people are likely to concur. It is not true that economists have exhausted all approaches or avenues for dealing with the problem of income distribution. There are numerous difficulties in measuring and predicting the distribution of income. Additionally, there are

problems of interpreting what those measures and predictions mean. This study has attempted to develop and explore some measures of income distribution and provide some interpretation relative to one of those measures as applied to an empirical case.

2. Applied welfare economics has had its principal manifestation through the techniques of benefit-cost analysis. While benefit-cost analysis has traditionally ignored income distribution or redistribution effects, a number of investigators have proposed methods whereby the income distribution consequences of public policies or investment decisions may be accounted for within the context of benefit-cost analysis. Most of this work is subject to one or both of two serious shortcomings. A number of workers have relied on arbitrarily developed social welfare functions in order to reach conclusions relative to income distribution. No one has offered a method whereby social welfare functions can be explicitly identified and utilized by decision makers. Consequently, such functions are of no practical use. Other studies are *ex post* in nature. While these studies are useful in ascertaining how past policies have worked they provide no help in identifying income redistribution consequences of policy alternatives which may be the subject of current considerations.

3. Kalter and Stevens have developed a technique which avoids both of these shortcomings. Appropriately applied, this technique will enable the analyst and/or decision maker to take

account of the distributive consequences of investment or policy alternatives before any one alternative is selected. This technique was found to contain a number of errors which were corrected. The revised methodology was then presented as a reasonable means through which to account for distributive effects *ex ante*.

4. It recognized that definitions of distributional neutrality necessarily involves value judgments. Consequently, economists can make no prescriptions relative to the normative superiority of one or another of the potential definitions. However, economists can say much about the appropriate measures of net gain or loss to be used in varying circumstances. These measures and the circumstances under which they could appropriately be utilized were described and discussed and the potential normative significance of each measure was analyzed.

5. A difficult policy dilemma surrounding the allocation of the waters of the lower Truckee-Carson River Basin between the Truckee-Carson Irrigation District and the Pyramid Lake Tribe of Indians was described. It was argued that this policy dilemma involved income redistribution issues. Accordingly, the dilemma was presented as an appropriate situation to which the previously developed and refined methodology might be applied. Much time and many dollars had been spent in gathering and analyzing data which might aid the Secretary of the Interior in reaching an enlightened solution to the problem. It was argued that some of these resources

should have been committed to a study of potential income redistribution consequences.

6. Survey research techniques as well as common statistical and dynamic programming techniques were utilized in developing estimates of the existing distribution of income within the two groups most prominently affected by the existing allocation of water. The resulting distributions were then used as reference distributions against which to compare the redistributive impact of two potential policy alternatives which were open to the Secretary of Interior.

7. The first policy alternative would require the farmer-irrigator group to make certain efficiency improvements in its project which would result in substantial savings of water. These savings could then be diverted to the Indian reservation where they could be utilized to service an Indian irrigation project as well as to slow the decline of Pyramid Lake. Certain assumptions were made about how the farmers would allocate the costs of modernization among themselves and how the Indians would allocate the benefits among themselves. An analysis of the redistributive consequences of the policy alternative was then made. This analysis demonstrated that the costs to the farmers were generally progressive and the benefits to the Indians were generally regressive if distributional neutrality was defined as requiring the distribution of costs and benefits to each family *in proportion* to their base year or reference income. Other definitions of neutrality could have been selected

and the results would undoubtedly have differed. The proportional definition was selected because it is among the most popular. There was no normative justification for selecting this particular definition.

8. The second policy alternative would require the farmers to make the efficiency improvements associated with the first policy alternative and, in addition, to give up certain water rights which are "impliedly reserved" by the Indians. The analysis of this policy alternative indicated that it would be inefficient if only the incidence of costs and benefits to the farmers and Indians were considered. However, it was argued that there were a number of other groups who were potential beneficiaries. If the benefits (and costs) accruing to these groups had been counted it appeared likely that the second policy alternative would have proved efficient. As with the first policy alternative, the redistributional analysis indicated that the costs to the farmers would be relatively progressive while the benefits to the Indians would be relatively regressive.

9. Subsequently, a brief analysis of the between-group income redistribution under both policy alternatives was undertaken. The analysis showed that the per family benefits to the Indians were far in excess of the per family costs to the farmers under either policy alternative. This conclusion was tempered somewhat by the fact that

there are eight times as many farm families as Indian families. Withal, it was demonstrated that the relatively wealthy farmers would bear a disproportionately high share of the costs while the low-income Indians would receive a disproportionately high share of the benefits.

10. This study represents a first approximation at measuring and interpreting income redistribution benefits of government investment and policy alternatives. The analysis was static in nature to the extent that it relied heavily on extrapolation of past conditions or conditions which were assumed to exist or occur. No attempt was made to take explicit account of uncertainties or of the inherently dynamic nature of regional economies. Consideration of these two factors would undoubtedly improve the reliability of the estimates but the application of such techniques to income distribution problems needs further refinement before it can be utilized in examining the behavior of income shares over time. Finally, it should be noted that there exists no satisfactory theory of income distribution. Until such time as such a theory is developed economists will have to be content to work at the simpler but still useful task of developing and interpreting information relating to income redistribution effects of government policies and investments.

SELECTED BIBLIOGRAPHY

Aaron, Henry, and McGuire, Martin. "Public Goods and Income Distribution." *Econometrica*, XXXVIII (November, 1970), 907-920.

Altouney, Edward G. *The Role of Uncertainties in the Economic Evaluation of Water-Resource Prospects*. Stanford, Calif.: Institute in Engineering Economic Systems, 1963.

Anderson, T. W. *An Introduction to Multivariate Statistical Analysis*. New York: John Wiley and Sons, Inc., 1958.

Arrow, Kenneth J. *Social Choice and Individual Values*. 2nd ed. Cowles Commission, Monograph No. 15. New York: Wiley, 1963.

Back, W. B. "Estimating Contributions of Natural Resource Investments to Objectives in Regional Economic Development." *American Journal of Agricultural Economics*, L (December, 1969), 1442-1448.

Bator, Francis M. "The Anatomy of a Market Failure." *Quarterly Journal of Economics*, August, 1958, pp. 351-379.

Bator, Francis M. "The Simple Analyses of Welfare Maximization." *The American Economic Review*, XLVII (March, 1959), 22-59.

Bellman, Richard E., and Dreyfus, Stuart E. *Applied Dynamic Programming*. Princeton, N.J.: Princeton University Press, 1962.

Bergson, Abram. *Essays in Normative Economics*. Cambridge, Mass.: Harvard University Press, 1966.

Bowman, Mary Jean. "A Graphical Analysis of Personal Income Distribution in the U.S." *Readings in the Theory of Income Distribution*. American Economic Association. Philadelphia: The Blakiston Co., 1949.

Boyne, David H. "Changes in Income Distribution in Agriculture." *Journal of Farm Economics*, ILVII (December, 1965), 1213-1224.

Braswell, Joe. Inter-Tribal Council of Nevada. Personal letter dated August 24, 1971.

Bromley, Daniel W., Lord, William B., *et al.* "Procedures for Evaluation of Water and Related Land Resource Projects: An Analysis of the Water Resources Council's Task Force Report." Center for Resource Policy Studies and Programs, The University of Wisconsin, 1970 (mimeographed).

Brophy, William, and Aberle, Sophie. *The Indian: America's Unfinished Business.* Norman, Okla.: University of Oklahoma Press, 1966.

Buchanan, James M. "What Kind of Redistribution Do We Want?" *Economica*, XXXV (May, 1968), 185-190.

Budd, Edward C., and Radner, Daniel B. "The OBE Size Distribution Series: Methods and Tentative Results for 1964." *American Economic Review*, LIX (May, 1969), 435-449.

California Agricultural Experiment Station, Giannini Foundation of Agricultural Economics. *Analyses of California Farm Income Relationships.* Giannini Foundation Research Reports No. 297 (August, 1918).

Cameron, Gordon C. *Regional Economic Development: The Federal Role.* Baltimore: Johns Hopkins Press, 1970.

Chambers, Leslie. "Classification and Extent of Air Pollution Problems." *Air Pollution*, Edited by Arthur Stern. New York: Academic Press, 1962.

Cicchetti, Charles J., Davis, Robert K., Hanke, Steven H., Haveman, Robert H., and Knetsch, Jack L. *Benefits or Costs? An Assessment of the Water Resources Council's Proposed Principles and Standards.* Baltimore: Department of Geography and Engineering, The Johns Hopkins University, 1972.

Ciriacy Wantrup, S. V. "Some Economic Issues in Water Rights." *Journal of Farm Economics.* XXXVII (December, 1955), 875-885.

Coase, Ronald. "The Problem of Social Cost." *Journal of Law and Economics.* No. 3 (October, 1960), 1-44.

Colorado State University Agriculture Experiment Station. *Marginal Values of Irrigation Water. A Linear Programming Analysis of Farm Adjustments to Changes in Water Supply.* Technical Bulletin 70 (1960).

Cummings, Ronald. *Water Resource Management in Northern Mexico.* Baltimore: Johns Hopkins University Press, 1972.

Davidson, Paul. "Rolph on the Aggregate Effects of a General Excise Tax." *The Southern Economic Journal*, XXVII (July, 1960), 37-42.

Davis, O. A., and Whinston, A. B. "Piecemeal Policy in the Theory of Second Best." *The Review of Economic Studies*, XXXIV (July, 1967).

Dhrymes, Phoebus. *Econometrics: Statistical Foundations and Applications*. New York: Harper and Row, 1970.

Dolbear, F. Trenery, Jr. "On the Theory of Optimum Externacity." *American Economic Review*, LVII (March, 1967), 90-103.

Eckstein, Otto. "A Survey of the Theory of Public Expenditure Criteria." *Public Finances: Needs, Sources and Utilization.* Universities - National Bureau Committee for Economic Research. Princeton, N.J.: Princeton University Press, 1961, pp. 439-494.

Eckstein, Otto. *Water Resource Development.* Cambridge, Mass.: Harvard University Press, 1958.

Economic Report of the President, February 1971. Together with *The Annual Report of the Council of Economic Advisors.* Washington, D.C.: Government Printing Office, 1971.

Economics Department, Utah State University Foundation. *Regional Economic Development - The Role of Water.* Prepared for the National Water Commission. Springfield, Va.: National Technical Information Service, 1971.

Ferguson, C. E. "Transformation Curve in Production Theory: A Pedagogical Note." *Southern Economic Journal*, XXIX (1962), 96-102.

Fisher, Franklin M. "Income Distribution, Value Judgements, and Welfare." *Quarterly Journal of Economics*, LXX (August, 1956), 380-424.

Foldes, Lucien. "Income Redistribution in Money and Kind." *Economica*, XXXIV (February, 1967), 30-41.

Foldes, Lucien. "A Note on Redistribution." *Economica*, XXXIV (May, 1967), 203-205.

Foldes, Lucien. "Redistribution: A Reply." *Economica*, XXXV (May, 1968), 198-204.

Freeman, A. Myrick III. "Adjusted Benefit Cost Ratios for Six Recent Reclamation Projects." *Journal of Farm Economics*, ILVIII (November, 1966), 1002-1012.

Freeman, A. Myrick. "Income Distribution and Planning for Public Investment." *The American Economic Review*, LVII (June, 1967), 495-508.

Freeman, A. Myrick. "Six Federal Reclamation Projects and the Distribution of Income." *Water Resources Research*, III (Second Quarter, 1967), 319-332.

Freeman, A. Myrick, and Haveman, Robert H. "Benefit-Cost Ratios for Projects in Multiple Objective Investment Programs: A Comment." Unpublished Manuscript.

Friedman, Milton. "The Marshallian Demand Curve." *Journal of Political Economy*, LVII (December, 1949), 463-495.

Goode, Richard. *The Individual Income Tax*. Washington, D.C.: The Brookings Institute, 1964.

Gordon, Robert J. "The Incidence of the Corporation Income Tax in U. S. Manufacturing, 1925-62." *American Economic Review*, LVII (September, 1967), 731-758.

Graaff, J. de V. *Theoretical Welfare Economics*. Cambridge, England: Cambridge University Press, 1967.

Green, Paul E., and Tull, Donald S. *Research for Marketing Decisions*, 2nd ed. Englewood Cliffs, N.J.: Prentice Hall, Inc., 1970.

Harberger, Arnold C. "Three Basic Postulates for Applied Welfare Economics: An Interpretive Essay." *The Journal of Economic Literature*, IX (September, 1971), 785-797.

Haveman, Robert H. "Benefit Cost Analysis: Its Relevance to Public Investment Decisions. Comment." *Quarterly Journal of Economics*, LXXXI (November, 1967), 695-699.

Haveman, Robert H. *Economic Performance of Public Investments: An Ex Post Evaluation of Water Resources Investments*. Baltimore: Johns Hopkins Press, 1972.

Haveman, Robert H. "The Opportunity Cost of Displaced Private Spending and the Social Discount Rate." *Water Resources Research*, V (December, 1969), 947-957.

Haveman, Robert H. *Water Resource Investment and the Public Interest.* Nashville, Tenn.: Vanderbilt University Press, 1965.

Henderson, James M., and Quandt, Richard E. *Microeconomic Theory: A Mathematical Approach.* New York: McGraw-Hill Book Company, 1958.

Hicks, J. R. *Value and Capital.* Oxford: Clarendon Press, 1950.

Hirshleifer, Jack, DeHaven, James C., and Milliman, Jerome W. *Water Supply: Economics, Technology, and Policy.* Chicago and London: The University of Chicago Press, 1960.

Hochman, Harold M., and Rodgers, James D. "Pareto Optimal Redistribution." *American Economic Review.* LIX (September, 1969), 542-550.

James, L. Douglas. "A Case Study in Income Redistribution from Reservoir Construction." *Water Resources Research.* IV (June, 1968), 499-506.

Jorgensen, Joseph. "Indians and the Metropolis." *The American Indian in Urban Society.* Edited by Jack Waddell and Michael Watson. Boston: Little, Brown and Company, 1972.

Jorgenson, Joseph. *Sundance Religion.* Chicago: University of Chicago Press, 1972.

Kaldor, Nicholas. "Welfare Propositions in Economics." *Economic Journal.* XLIX (September, 1939), 549-552.

Kalter, Robert J., and Stevens, Thomas H. "Resource Investment, Impact Distribution, and Evaluation Concepts." *American Journal of Agricultural Economics*, LIII (May, 1971), 206-215.

Klappholz, Kurt. "What Redistribution May Economists Discuss?" *Economica*, XXXV (May, 1968), 194-197.

Knetsch, Jack L., Haveman, Robert., Howe, Charles, Krutilla, John V., and Brewer, Michael F. *Federal Natural Resources Development: Basic Issues in Benefit and Cost Measurement.* Washington, D.C.: Natural Resources Policy Center, The George Washington University, 1969.

Krutilla, John V. "Welfare Aspects of Benefit-Cost Analysis." *Journal of Political Economy*, LXIX (June, 1961), 226-235.

Krutilla, John V., and Eckstein, Otto. *Mulriple Purpose River Basin Development.* Baltimore: Johns Hopkins Press, 1958.

Krzyzrniak, Marian., and Musgrave, Richard. *The Shifting of the Corporation Income Tax.* Baltimore: Johns Hopkins Press, 1963.

Lamphere, Louise. "The Navaho Cultural System: An Analysis of Concepts of Cooperation and Autonomy and Their Relation to Gossip and Witch Craft." *Apachean Culture, History and Ethnology.* Edited by Keith Basso and Morris Olper. Tucson: University of Arizona Press, 1967.

Lansing, John B., and Eapen, A. T. "Dealing with Missing Information in Surveys." *Journal of Marketing.* XXIV (October, 1959), 21-27.

La Rivers, Ira. *Fishes and Fisheries of Nevada.* Nevada State Fish and Game Commission. Carson City, Nev.: State Printing Office, 1962.

Lebergott, Stanley. "The Shape of the Income Distribution." *American Economic Review.* June, 1959, pp. 328-347.

Lipsey, R. G., and Lancaster, Kelvin. "The General Theory of Second Best." *The Review of Economic Studies*, XXV (1956-1957), 11-32.

Little, Ian M. D., and Mirrlees, James A. *Manual of Industrial Project Analysis in Developing Countries.* Social Cost Benefit Analysis, Vol. II. Paris: Development Centre of the Organisation for Economic Co-operation and Development, 1968.

Maass, Arthur. "Benefit-Cost Analysis: Its Relevance to Public Investment Decisions." *Quarterly Journal of Economics*, LXXX (May, 1966), 208-226.

Maass, Arthur. "Benefit-Cost Analysis: Its Relevance to Public Investment Recisions: Reply." *Quarterly Journal of Economics*, LXXXI (November, 1967), 700-702.

Maass, Arthur, Hufschmidt, Maynard, Dorfman, Robert, Thomas, Harold A. Jr., Marglin, Stephen A., and Fair, Gordon Maskew. *Design of Water Resource Systems.* Cambridge, Mass: Harvard University Press, 1962.

Major, David C. "Benefit Cost Ratios for Projects in Multiple Objective Investment Programs." *Water Resources Research*, V (December, 1969), 1174-1178.

Meade, J. E. *The Theory of International Economic Policy.* Vol. II *Trade and Welfare.* London and New York: Oxford University Press, 1955.

Mincer, Jacob. "Investment in Human Capital and Personal Income Distribution." *Journal of Political Economy.* August, 1958, pp. 281-302.

Mishan, Ezra J. *The Costs of Economic Growth.* New York: Frederick A. Praeger, Publishers, 1967.

Mishan, Ezra J. "Redistribution in Money and in Kind: Some Notes." *Economica*, XXXV (May, 1968), 191-193.

Mishan, Ezra J. "A Survey of Welfare Economics, 1939-1959." *Welfare Economics.* Edited by E. J. Mishan. New York: Random House, 1964.

Mishan, Ezra J. *Welfare Economics.* New York: Random House, 1964.

Morgan, James. "The Anatomy of an Income Distribution." *Review of Economics and Statistics*, XLIV (August, 1962), 270-283.

Morrison, Donald F. *Multivariate Statistical Methods.* New York: McGraw-Hill Co., 1967.

Musgrave, Richard A. "Cost-Benefit Analysis and the Theory of Public Finance." *Journal of Economic Literature*, VII (September, 1969), 797-806.

Musgrave, Richard A. *The Theory of Public Finance.* New York: McGraw-Hill Co., 1959.

Neenan, William B. "Distribution and Efficiency in Benefit-Cost Analysis." *Canadian Journal of Economics*, IV (May, 1971), 216-224.

Nemhauser, George L. *Introduction to Dynamic Programming.* New York: John Wiley and Sons, Inc., 1967.

Nevada, Nevada Tax Commission. *Instructions for Assessment of Land, Livestock, Merchandise Stock, Mobile Homes, Oil and Gas Leases.* Bulletin No. 125, Carson City, Nevada, July 1 1970.

Pechman, Joseph A. "Distribution of Federal and State Income Taxes by Income Classes." *The Journal of Finance*, XXVII (May, 1972), 179-191.

Pechman, Joseph. "The Rich, The Poor, and the Taxes They Pay." *The Public Interest*, No. 17 (Fall, 1969), 21-43.

Prest, A. R., and Turvey, Ralph. "Cost-Benefit Analysis: A Survey." *Economic Journal*, LXXV (December, 1965), 683-735.

Rolph, Earl. *The Theory of Fiscal Economics*. Berkeley, Calif.: University of California Press, 1954.

Samuelson, Paul A. "Consumption Theory in Terms of Revealed Preference." *Economica*, XV (November, 1948), 243-253.

Samuelson, Paul A. "Evaluation of Real National Income." *Oxford Economic Papers*, January, 1950, pp 1-21.

Sax, Joseph L. *Defending the Environment*. New York: Alfred A. Knopf, Inc., 1971.

Schramm, Gunter. "The Design of a Resource Allocation Function." *Canadian Journal of Economics*, IX (November, 1972).

Schramm, Gunter. "Regional Benefits in Federal Project Evaluations." *The Annals of Regional Science*, VI (June, 1972), 84-95.

Schramm, Gunter, and Burt, Robert E., Jr. *An Analysis of Federal Water Resource Planning and Evaluation Procedures*. School of Natural Resources, University of Michigan, Ann Arbor, Michigan, June, 1970 (mimeographed).

Schultz, Charles L. *The Distribution of Farm Subsidies: Who Gets the Benefits?* Washington, D.C.: The Brookings Institute, 1971.

Scitovsky, Tibor. "A Note on Welfare Propositions in Economics." *Review of Economic Studies*, IX (November, 1941), 77-88.

Smith, Lowell, and Devel, Pamela. "The California-Nevada Interstate Water Compact: A Great Betrayal." *Cry California* VII (Winter, 1971-72), 24-35.

Smith, Stephen. "Legal and Institutional Controls in Water Allocation." *Journal of Farm Economics*, XLII (December, 1960), 1345-1358.

Soltow, Lee. "The Distribution of Income Related to Changes in the Distribution of Education, Age, and Occupation." *The Review of Economics and Statistics*, XLII (November, 1960), 450-453.

Soltow, Lee. "Shifts in Factor Payments and Income Distribution." *American Economic Review*, XLIX (June, 1959), 395-398.

Soltow, Lee, ed. *Six Papers on the Size Distribution of Wealth and Income*. New York: National Bureau of Economic Research, Columbia University Press, 1969.

Sorkin, Alan L. *American Indians and Federal Aid*. Washington, D.C.: The Brookings Institute, 1971.

Steward, Julian H. *Basin-Plateau Aboriginal Sociopolitical Groups*. Washington, D.C.: Government Printing Office, 1938.

Sumner, Francis H. "The Decline of the Pyramid Lake Fishery." *American Fisheries Society Transactions*, 1969, pp. 216-224.

Tax Foundation, Inc. *Tax Burdens and Benefits of Government Expenditures by Income Class, 1961 and 1965*. Research Publication No. 9. New York: Tax Foundation, Inc., 1967.

U.S. Bureau of the Budget. "Circular A-47." (Mimeographed pamphlet issued by the Bureau of the Budget).

U.S. Congress. House. *Report on Gila River Basin, New River and Phoenix City Streams, Arizona*, H. Doc. 216, 89th Cong., 1st sess., 1965.

U.S. Congress. House. *Report on San Diego River (Mission Valley), California*, H. Doc. 212, 89th Cong., 1st sess., 1965.

U.S. Congress. House. *Report on Tahquitz Creek, Whitewater River Basin, California*, H. Doc. 223, 89th Cong., 1st sess., 1965.

U.S. Congress. House. *Report on Washoe Project, Nevada - California*, H. Doc. 181, 84th Cong., 1st sess., 1955.

U.S. Congress, Joint Economic Committee. "Collective Action and the Distribution of Income: A Conceptual Approach," by Burton A. Weisbrod. Joint Committee Print *The Analysis and Evaluation of Public Expenditures: The PPB System*. Washington, D.C.: Government Printing Office, 1969.

U.S. Congress, Joint Economic Committee. *Toward Economic Development for Native American Communities*. A Compensium of Papers submitted to the Subcommittee on Economy in Government of the Joint Economic Committee. Washington, D.C.: Government Printing Office, 1969.

U.S. Congress. Senate. *Hearings Before the Sub-Committee on Indian Affairs of the Committee on Interior and Insular Affairs*, 91st Cong., 2nd sess., 1970.

U.S. Congress. Senate. *Policies, Standards, and Procedures in the Formulation, Evaluation, and Review of Plans for Use and Development of Water and Related Land Resources*, S. Doc. 97, 87th Cong., 2nd sess., 1962.

U.S. Department of Agriculture. Economic Research Service. *Farm Income Situation*. Farm Income Situation Supplement 218. July, 1971.

U.S. Department of Agriculture. Economic Research Service. *Farm Income: State Estimates 1949-1968*. Farm Income Situation Supplement 214. August, 1969.

U.S. Department of Commerce, Area Redevelopment Administration. *Migration Into and Out of Depressed Areas*, by Eva Mueller, N. Barth and W. Ladd. September, 1969.

U.S. Department of Commerce, Bureau of the Census, Social and Economic Statistics Administration. *Detailed Characteristics, Nevada*. Washington, D.C.: U.S. Government Printing Office, 1972.

U.S. Department of Commerce, Bureau of the Census. *1964 Census of Agriculture. Eight Selected Drainage Areas. Western United States*. Special tabulations prepared for U.S. Department of Interior, Bureau of Reclamation.

U.S. Department of Commerce, Bureau of the Census. *1970 Census of Population. General Social and Economic Characteristics, Nevada*. Washington, D.C.: U.S. Government Printing Office, 1972.

U.S. Department of Commerce, Bureau of the Census. *Statistical Abstract of the United States, 1970*. Washington, D.C.: U.S. Government Printing Office, 1970.

U.S. Department of Commerce, Economic Development Administration. *Federal and State Indian Reservations, An EDA Handbook*. Washington, D.C.: U.S. Government Printing Office, 1971.

U.S. Department of Commerce, Economic Development Administration. *Water Resources and Land Use of the Pyramid Lake Indian Reservation*, by Wilsey and Ham, Architect-Engineers, Menlo Park, California. Washington, D.C.: U.S. Government Printing Office, 1970.

U.S. Department of Commerce, National Bureau of Standards. *Federal Cost-Sharing Policies for Water Resources.* Prepared for the National Water Commission. Springfield, Va.: National Technical Information Service, 1972.

U.S. Department of Commerce, Social and Economic Statistics Administration, Bureau of the Census. *1969 Census of Agriculture, Part 45, Nevada.* Vol. 1. Washington, D.C.: U.S. Government Printing Office, 1971.

U.S. Department of Health, Education and Welfare. *Welfare in Review, 1970.* Vol. VIII, No. 6. Washington, D.C.: U.S. Government Printing Office, 1971.

U.S. Department of the Interior. *Action Program for Resource Development Truckee and Carson River Basins California - Nevada.* Prepared by a Task Force of Department of Interior Agencies., October 1964.

U.S. Department of Interior, Bureau of Indian Affairs. *Annual Report of Commissioner of Indian Affairs, 1871.* Washington, D.C.: Department of Interior, 1871.

U.S. Department of Interior, Bureau of Indian Affairs. *Pyramid Lake Reservation.* (Mimeographed pamphlet)

U.S. Department of Interior, Bureau of Reclamation. *Crop Report and Related Data, Federal Reclamation Projects, 1970.* Washington, D.C.: U.S. Government Printing Office, 1971.

U.S. Department of the Interior, Office of the Secretary. "Operating Criteria and Procedures; Truckee and Carson Rivers." *Federal Register,* XXXV (March 26, 1970), 5131.

U.S. Federal Inter-Agency River Basin Committee. Subcommittee on Benefits and Costs. *Proposed Practices for Economic Analysis of River Basin Projects.* May, 1950.

U.S. Federal Power Commission. *In the Matter of: El Paso Natural Gas Company. Hearings.* Washington, D.C., 1972.

U.S. Treasury Department, Internal Revenue Service. *Statistics of Income for 1968.* Washington, D.C.: U.S. Government Printing Office, 1969.

U.S. Water Resources Council. *Findings and Recommendations.* Prepared by the Special Task Force. Washington, D.C., 1970 (Mimeographed).

U.S., Water Resources Council. Notice of Public Review and Hearing. "Proposed Principles and Standards for Planning Water and Related Land Resources." *Federal Register*, XXXVI, No. 245, Part II (December 21, 1971), 24144-24194.

U.S., Water Resources Council. *Principles for Planning Water and Land Resources*. Report to the Water Resources Council by the Special Task Force. Washington, D.C., 1970 (Mimeographed).

Universities-National Bureau Committee for Economic Research. *Public Finances: Needs, Sources and Utilization*. Edited by James Buchanan. Princeton, N.J.: Princeton University Press, 1961.

Wax, Murray. *Indian Americans: Unity and Diversity*. Englewood Cliffs, N.J.: Prentice-Hall, 1971.

Weisbrod, Burton A. "Income Redistribution Effects and Benefit-Cost Analysis." *Problems in Public Expenditure Analysis*. Edited by Samuel B. Chase, Jr. Washington, D.C.: Brookings Institute, 1968.

Weisbrod, Burton A., and Hansen, W. Lee. "An Income-Net Worth Approach to Measuring Economic Welfare." *American Economic Review*, LVIII (December, 1968), 1315-1329.