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Efficiency and distributive equity are two components of social welfare which cannot be separated unless one's psychology enables him to adopt a utilitarian, empiricist view of the world. In this treatise a standard economic model, based on the logical positivist view, is used to integrate efficiency and equity. The failure of this model, and other traditional economic models, to adequately synthesize efficiency and equity into an arithmomorphic framework useful for decision-making leads one to a reconsideration of welfare economics.

Since area-specific public programs are the prime concern in this study, the distributive impacts of public projects are considered to occur between regions rather than between income categories, racial classes, etc. A theoretical model and several empirical frameworks for deriving regional weights are presented. In the process, a procedure for deriving welfare functions implicit in past public investment decisions is developed. However, the integration of efficiency and equity occurs by weighting the efficiency measure (e.g., benefit-cost ratio) of a proposed project by its regional equity weight; that is, efficiency and equity are separated.

The derived welfare function is used to identify the "best" projects within a set of prospective projects being considered by a public agency. The "best" set is compared with the actual selections, a pure efficiency ranking, and the explicit equity-corrected ranking of a set of prospective projects. The empirical evidence indicates that, while public agencies take into account both efficiency and regional inequities in project selection, they behave inconsistently. It appears that this may be due more to the inadequacy of the conceptual framework applied by economists than actual inconsistency in decision-making.

The observed fickleness in agency selections resulted in a re-evaluation of the "New Welfare Economics" approach, especially as it pertains to the synthesis of efficiency and equity. The discussion shows that the tools used by economists for evaluating the contribution of public projects to social well-being are adapted to the maximization of efficiency only. Equity enters the analysis belatedly and, often, begrudgingly. The analysis also indicates that there may be some serious problems in deriving measures of welfare, such as consumer surplus, from estimated demand functions.

Further, it is argued that psychological differences may account for the failure to adequately resolve the conflict between efficiency and equity. Distributional issues are implicitly ignored by many economists because their psychology is geared to concrete facts--the need to quantify variables. Others, who reject the utilitarian foundation of economics, argue that a course of action leading to a greater overall welfare, but with greater inequality, is less desirable than the status quo. The resolution of this clash between "thinking" and "feeling" psychological types is considered to be the key to the synthesis of efficiency and distributive equity.

The Integration of Efficiency and Equity in Public Decision-Making: Theoretical Issues and Applications

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CHAPTER I

INTRODUCTION

Nominalism Versus Realism in Welfare Economics

The position taken in this treatise is the nominalist view that it is not possible for economists to make policy recommendations which are free of value judgments. The evolution of economic science along logical positivist lines has been a vain attempt to eliminate unscientific, nonarithmomorphic processes from public decision-making. It is time, perhaps, to back off from some of the entrenched dogmas of neoclassical economic thought and re-evaluate current economic methodology. In marked contrast to this view, realists argue that economists are able to make value-free policy prescriptions; indeed, it is their function to do so.

The controversy between realists and nominalists began during the time of Plato [Jung 1921, pp. 26-38] and plagued no less an eminent economist than Pareto, who struggled with the concept of ophelimity [Chipman and Moore 1978, p. 548 footnote; Georgescu-Roegen 1973].[1/] Sir John Hicks, a founder of the New Welfare Economics (an objectivist school of thought), was also troubled by the stance of the nominalists (subjectivists).

> "During the nineteenth century, it was generally considered to be the business of an economist,

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1/ Ophelimity means ordinal utility.

> not only to explain the economic world as it is and as it has been, not only to make prognostications (so far as he was able) about the future course of economic events, but also to lay down principles of economic policy, to say what policies are likely to be conducive to social welfare, and what policies are likely to lead to waste and impoverishment. Today, there is one school of writers which continues to claim that economics can fulfill this second function, but there is another which (formally at least) desires to reject it. According to their view the economics of welfare, the economics of economic policy, is too unscientific in character to be a part of economic science. So long as economics is concerned with explanation, it can hope to reach conclusions which will command universal acceptance as soon as they are properly understood; but once it goes beyond that point, and endeavours to prescribe principles of policy, then (so they hold) its conclusions must depend upon the scale of social values held by the particular investigator. Such conclusions can possess no validity outside the circle in which these values find acceptance" [Hicks 1939, p. 696].

The latter view disturbed Hicks and, not surprisingly, he rejected it outright. Hicks felt that the problem could be resolved by using the compensation tests formulated by Kaldor [1939]. However, subsequent writers found theoretical inconsistencies in the "Kaldor-Hicks Compensation Principle." The other methods (and compensation tests) proposed to prevent welfare economics from becoming unscientific were, in the eyes of the nominalists, also doomed. Hence, Chipman and Moore concluded their summary analysis of the writings of the New Welfare Economists on a pessimistic note.

> "After 35 years of technical discussions, we are forced to come back to Robbin's 1932 position. We cannot make policy recommendations except on the basis of value judgments, and these value judgments should be made explicit.... When all is said and done, the New Welfare Economics had succeeded in replacing the utilitarian smoke-screen by a still

> thicker and more terrifying smoke-screen of its own" [1978, p. 581].

The result is that it is impossible to answer questions related to social well-being unless some device, such as a "hedonimeter," is invented to enable economists to quantify human "happiness," thereby enabling interpersonal comparisons of welfare.[2/] Until such time, the realists must give credence to the criticism of the nominalists.

> "Is there any hope of further progress based on empirical investigation and analysis of the problem of the interdependence of activities of economic units? I cannot pretend to offer even tentative answers. It seems to me, however, that if (economics) is to achieve primary importance for practical men, this question must be faced and answered" [Baumol 1962, p. 167].

The Efficiency and Equity Objectives

The debate between economic realists and nominalists becomes evident in the conflict between the two public policy objectives of efficiency and distributive equity. The conflict highlights the problem that economists have in applying their theoretical framework to real world issues--that is, it emphasizes the tenuity of the realist position. While abstract economic models clearly show that

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[2/] Little [1958, pp. 15-37] takes great care to distinguish between happiness maximization and utility maximization. For example, a person may be maximizing utility by supporting a wife who makes life unbearable for him but he is not maximizing his happiness [pp. 21-22]. (See Broome [1978] for further examples.) Nath argues that "the need arises to provide some goods and services collectively. Hence the fallacy in the assumption that an individual's welfare function coincides with his utility function as revealed by his market choices. This is a very common fallacy in economic writings" [1969, p. 141, emphasis in the original]. The reader should be aware of the distinction between utility and happiness (welfare) although this treatise often treats them as synonymous. Also see Robbins [1932, pp. 84-88] for an excellent discussion of this distinction.

efficiency and equity cannot be separated, applied economists are forced to separate them. The general approach is to ignore distribution by assuming that the existing distribution of income is the desired one. The consequences of public actions are then assumed to be sufficiently small so that this distribution remains essentially undisturbed. Efficiency measures, such as benefit-cost ratios, are then calculated for alternative public policies. Social welfare is maximized by choosing projects with the largest efficiency measures.

When there is a concern with the distributional consequences of policies, the method employed is to weight the efficiency data by equity (distributional) weights. The methods used to derive these weights command the attention of the literature on income redistribution via project selection, and a large part of this treatise as well.

The "divide and conquer" approach to the synthesis of efficiency and equity creates problems which bear out the inadequacy of the traditional framework employed by economists. The model developed and tested in this treatise points to the inability of economists to model the decision-making process. It reflects the enigma of modeling human behavior.

In an attempt to understand the failure of economics to adequately reconcile the divergence of the efficiency and equity objectives, the author sought an explanation in two directions. First, an attempt was made to shed some light on the integration of efficiency and equity by looking at psychological differences between efficiency advocates and egalitarians, abstract and concrete thinkers, and nominalists and realists. In particular, which psychological types [Jung 1921] place all public choices in an arithmomorphic straitjacket? Which

psychological types cannot separate efficiency from distributive issues and which can? Do psychological differences account for the observed inconsistencies in decision-making?

Second, the author examined the philosophical (utilitarian) roots of neoclassical economic theory and the subsequent value judgments (assumptions) required to apply this theory to real world problems. Both the theoretical foundation of neoclassical demand theory and the dominance of empiricism in policy evaluation need to be re-examined.

Plan of the Treatise

The discussion which follows in this treatise is separated into two parts. Part I contains an aesthetic, somewhat esoteric, discussion of psychological types and how they may be a source of conflict in economic thought and policy prescription. The "type problem" is brought to bear upon the methods used to synthesize efficiency and income distribution in some of the constructs of the social welfare function appearing in the literature.

Also included in Part I is a critique of applied welfare economics. The main tool used by welfare economists for evaluating the contribution of public projects to social well-being is benefit-cost analysis. Benefit-cost analysis is adapted, however, to the maximization of a single objective, namely efficiency, and has ignored important psychological needs. Equity enters the analysis belatedly and, often, begrudgingly. The result is that any consideration of issues regarding income distribution are inadequate. Further, for some individuals the assumptions upon which the applied welfare analysis is based are untenable, thereby constituting a possible source of conflict in decision-

making. This problem arises, in part, because the assumptions are rarely made explicit.

Finally, the discussion in the first part focuses on the neo-classical assumption that all individual needs can be reduced to a single basis, known as utility. Georgescu-Roegen [1967, 1976] repudiates this assumption, favoring a return to the classical "Principle of the Irreducibility of Wants," among others. The main reason for Georgescu-Roegen's views is the failure of economists to "recover" the ophelimity-index function from the revealed preferences or market data. The implication for applied welfare economics is that great care is required if one is to derive measures of welfare, such as consumer surplus, from the estimated demand function.

Part II consists of an approach to the synthesis of efficiency and equity in public decision-making which is more in line with the standard realist approach to such problems. A literature review of methods used to analyze the dual objectives in policy-making is presented in Chapter IV. A regional model which integrates efficiency and equity and is used to construct a single index for determining which projects add the most to social welfare follows in Chapter V. A regional income distribution weight is used to adjust the efficiency measure (for example, the benefit-cost ratio), thereby obtaining a corrected measure of social well-being. The adjusted values thus provide a means for revising the rankings of projects.

Upon application of the model to empirical data (Chapter VI), it is found that the framework is somehow lacking. Although it is evident that decision-makers did take into account regional inequities, the model is incapable of predicting future selections, as it is de-

signed to do. The author feels that the reason for this can be ascribed to the decision-making process itself, a process which is difficult, if not impossible, to model using typical economic criteria. Hence, explanation needs to be found outside the traditional, arithmomorphic frameworks employed by economists. Part I is an attempt in this direction.

Although Part I might logically follow Part II, the author considers the current organization of the treatise to be best. Although each part is self-contained, the discussion in Part I may provide the reader with additional background information useful to the discussion on Part II, especially regarding social welfare functions and benefit-cost analysis. However, if the reader's psychology is inclined toward empiricism or concretism, he may want to proceed directly to the second part, thereby avoiding some fundamental philosophical issues regarding economic theory and its application.

PART I

THEORETICAL ISSUES

CHAPTER II

THE PROBLEM OF PSYCHOLOGICAL TYPES AND THE SOCIAL WELFARE FUNCTION

Differences of opinion and approach to problems occur in all branches of science, and economics is not exempt. Carl Jung [1921] argues that the resulting controversies can, in part, be attributed to fundamental psychological differences among individuals. In this chapter, a psychological approach is used to look at conflicting ideas in human thought, including economic thought. The emphasis will be on the relationship between efficiency and equity criteria in public program selection and how psychology can contribute to a better understanding of the reasons for conflict between the two criteria. It is hoped that the discussion in the first section will provide fresh insights into current decision-making mechanisms, such as public hearings, eventually enabling economists to model these processes.

Regardless of the criterion used to make policy recommendations (or decisions), a social welfare function (SWF) is required. Often the existence of a SWF is implied by the action rather than made explicit. The approach taken in Part II of this treatise is that it is important to the decision-making process that the SWF be made explicit so that decision-makers can appropriately examine tradeoffs and, thereby, reach socially more desireable decisions. Explicit formulation of the social welfare function also helps in the identification of

situations where decision-makers, in particular politicians, deviate from national policy for political or personal reasons.

In the second section three social welfare functions are examined. Each of the SWFs includes an explicit tradeoff between efficiency and equity, although each treats this tradeoff somewhat differently. The differences can be traced to variations in individual psyches.

Efficiency Versus Equity and the Type Problem

Despite the empirical approaches discussed in Part II of this treatise, economists have failed to adequately resolve the conflict between efficiency and distributive equity, preferring to leave the resolution to the political process. This failure is due to an inability or unwillingness to recognize "that the economic domain is surrounded by a dialectical penumbra far wider than that of any natural science" [Georgescu-Roegen 1967, p. 102]. In particular, economists have failed to recognize the polarization of thought which occurs due to differences in individual psyches. Carl Jung [1921] refers to this as the "type problem." To a large extent, and as a consequence of increasing specialization and the need to provide arithmomorphic solutions to problems, standard (mainstream) economics has taken "special pride in operating with a man-less picture" [Georgescu-Roegen 1967, p. 104]. Psychology has been increasingly ignored although it offers the best hope for the resolution of the efficiency-equity conflict.

The efficiency-equity problem is not a simple two-dimensional conflict of views but is a multi-dimensional controversy involving two psychological attitudes--introversion and extraversion--and two psycho-

logical function-types--thinking and feeling.[1] In addition, the word "equity" elicits a different emotive response in each individual. Equity is not easily reduced to an arithmomorphic concept, if at all. Although word symbolism will not be discussed here, several examples of the type problem are provided to enable the reader to understand the enormity of the psychological, and hence economic, problem posed by the efficiency-equity debate. The examples illustrate that the conflict is typical of those which have existed in human thought since antiquity. The controversies are the result of a clash between different psychological types.

Examples of the Type Problem

Among the early Greek philosophers two schools of thought emerged. The Platonic school of philosophy was identified with realism while the Cynics and Megarians, who were in many respects the same, were "thoroughly nominalistic and utterly opposed to the realism of Plato's ideology" [Jung 1921, p. 28]. This conflict between nominalists and realists was a

> "Controversy that divided the minds of men for centuries and had incalculable consequences.... By nominalism is meant that school which asserted that the so-called universals, namely generic or universal concepts such as beauty, goodness, animal, man, etc., are nothing but *nomina*, names, or words, derisively called *flatus vocis*.... Realism, on the contrary, affirms the existence of universals *ante rem*, and holds that general concepts exist in themselves after the manner of

[1] Although Jung does not always make this distinction explicit, implicitly, at least, he distinguishes between the objective-subjective and thinking-feeling opposites. Further, these are not the only polarizations to be found. Conflicts occur between abstract and concrete thinking, ideologism and empiricism, and so on.

> Platonic ideas. In spite of its ecclesiastical associations, nominalism is a sceptical tendency that denies the separate existence characteristic of abstractions. It is a kind of scientific scepticism coupled with the most rigid dogmatism. Its concept of reality necessarily coincides with the sensuous reality of things; their individuality represents the real as opposed to the abstract idea. Strict realism, on the contrary, transfers the accent on reality to the abstract, the idea, the universal, which it posits before the thing (ante rem)" [Jung 1921, p. 26].

As an illustration of the conflict, Antisthenes, the leader of the Cynics, changed Plato's name to something the equivalent of a phallic symbol, thereby criticizing the Platonic ideal of looking within oneself rather than seeking pleasure from outside, i.e., from objects.

The type problem also arose in the theological disputes which have appeared throughout Church history. Three such disputes are illustrated. In each case it is evident that the opposing sides represent different psychological types, and each type holds its position in the dispute because this position is the one required for their psychology to accept the biblical teachings. Unfortunately, the losers in these quarrels were often dubbed heretics and put to death.[2/]

First, the Jewish Christians (Ebionites) held that Christ was the son of Mary and Joseph, receiving His Divinity through the Holy Ghost at a later date. The Docetists, on the other hand, believed

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2/ While one is tempted to scoff at this practice, academics are not totally guiltless. Rather than putting the "heretics" to death they are forced out of their profession, as in the case of Princeton physicist Immanuel Velikovsky in the early 1950s. Academics are not as open-minded as one might think.

that Jesus was born of the virgin Mary, being Divine at the outset. This controversy reappeared around the year 320, but in an altered form. The Arians held that Christ was of like substance with the Father while the orthodox Church confessed that Christ was of one substance with the Father. In this case, the orthodox Church (and Docetists) put the emphasis on the purely abstract standpoint while the other side put the emphasis on the concrete--the humanly perceptible. This was simply the conflict between realism and nominalism in a different form.

Second, the idea of transubstantiation was originally introduced by the Abbot Paschasius Radbertus about the middle of the ninth century. Transubstantiation is the belief that the bread and wine are transformed into the actual body and blood of Christ during the sacrament of Holy Communion. (This view was sanctioned by the Lateran Council of 1215.) The opposing view holds that the bread and wine only signify the body and blood of Christ.

Despite Martin Luther's ability to start a reformation against the dogma of the Church in 1517, he could not reject the concept of transubstantiation. He attempted to reconcile his own view with that of other reformers, such as Zwingli, by claiming that the actual substance of the sacred body was present at the Communion beside the bread and wine--the doctrine of consubstantiation. Hence, "it was an acknowledgement, demanded by Luther's own (extraverted) psychology, of the fact of feeling grounded upon the immediate sense-impression" [Jung 1921 p. 65] of the Communion. In contrast, Zwingli was able to hold that the Communion consisted of a spiritual partaking of the body and blood of Christ because he identified the ceremony as an ideal

conception.

Finally, the Calvinist doctrine of predestination holds that God foreordains whatever comes to pass, especially the salvation and damnation of souls. Man has no freedom of choice. The opposing view holds that man has a free will and, hence, is free to choose, or not to choose, salvation. It would appear that only an abstract thinker, a person with a subjective (introverted) orientation, can accept the doctrine of predestination. A person oriented towards objects, i.e., an extravert, would have trouble accepting this doctrine.[3/] Hence, this controversy brings into focus the opposition of two mutually exclusive standpoints--that is, two different psychological types.

A Summary of the Type Problem

Obviously, conflict exists in all the branches of the social and physical sciences, and the position of one side is an enigma to the other. Jung argues that the resulting strife and misunderstanding are consequences of the failure of the individuals involved to recognize the existence of psychologically determined vantage points different from their own. He believes that a recognition of the existence of different psychological types and "the fact that every man is so imprisoned in his type that he is simply incapable of fully understanding another standpoint" [p. 489] is needed. Only then can a synthesis of different views occur.

3/ This does not mean that such a person cannot accept the doctrine of predestination since people can change. Thus Origen changed his prime function from feeling to thinking by self-castration and Tertullian, an acute thinker and intellect, forced himself to condemn abstract thinking and become a man of feeling for the sake of Christianity [Jung 1921, pp. 12-20].

> "As a rule, the partisans of either side attack each other purely externally, always seeking out chinks in their opponent's armour. Squabbles of this kind are usually fruitless. It would be of considerably greater value if the dispute were transferred to the psychological realm, from which it arose in the first place. The shift of position would soon show a diversity of psychological attitudes, each with its own right to existence, and each contributing to the setting up of incompatible theories. So long as one tries to settle the dispute by external compromises, one merely satisfies the modest demands of shallow minds that have never yet been enkindled by the passion of a principle. A real understanding can ... be reached only when the diversity of psychological premises is accepted" [pp. 488-489].[4/]

An Example of the Type Problem in Economics

Mainstream economists have adopted the contemporary scientific attitude which is exclusively concretistic and empirical, with no appreciation of the value of ideas and unable to think in terms of the individual. While this psychologically-based orientation has resulted in important advancements in economic science, it has also stifled the development of standard economic thought. Opposing views are often ignored because they are not well understood from the particular psychological vantage point of the mainstream practitioners. For example, the theory of economic development which proved successful in the advanced capitalist countries is vigorously adopted as the approach for development in the less developed countries. Although shown to be theoretically unsatisfactory by Georgescu-Roegen [1960] and demonstrated to be unsuccessful in practice [Lutz and Lux 1979, pp. 271-296], this approach continues to be advocated by the United Nations International Development Organization (UNIDO) and the World Bank

[4/] Emphasis not in the original.

[Little and Mirrlees 1973; Squire and v.d. Tak 1975].

A view opposite to that of mainstream economics is provided by, for example, humanistic economics which believes in the goodness and eventual self-actualization of man.[5/] The humanistic perspective is based not on concrete facts but on the psychological function of feeling. Jung defines feeling as

> "An entirely subjective process, which may be in every respect independent of external stimuli, though it allies itself with every sensation.... Feeling is a kind of judgment, differing from intellectual judgment in that its aim is not to establish conceptual relations but to set up a subjective criterion of acceptance or rejection. Valuation by feeling extends to every content of consciousness, of whatever kind it may be" [p. 434].

Despite this psychological orientation, however, humanistic economists often appeal to concrete facts to support their arguments.[6/] This is a concession to mainstream economics and, in this case, probably the result of educational experience. However, a definite difference in psychological types is discernible between the standard and humanistic economists.

The Integration of Efficiency and Equity

The need to integrate efficiency and equity in selecting a course of action from among a number of alternatives provides an additional insight into the problem of psychological types. Individuals in favor

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[5/] This author is inclined to agree with Kenneth Boulding who, in the introduction to the book written by Lutz and Lux [1979], writes: "Surely the idea that the self that can be actualized can only be good is unrealistic."

[6/] For example, see Lutz and Lux [1979].

of a more egalitarian distribution of income, for example, do not base their arguments on concrete facts but, rather, on personal feelings. Efficiency criteria are considered to be of minor importance, if at all. In the extreme, the egalitarian position requires that all individuals in society share equally in the benefits of progress. Maoist economists, for example, argue that a course of action leading to increased GNP growth,[7] but with greater inequality, would be less desirable than the status quo.

Standard economists, on the other hand, approach the efficiency-equity issue from an empirical (concrete thinking) standpoint. Since equity is an unmeasurable and efficiency, under certain assumptions, is not, they argue in favor of an efficiency-only approach.[8] However, this requires them to make what, in their opinion, is a logical assumption, namely that the current distribution of income is the one desired by society. (This assumption arouses the wrath of egalitarians.) Distributional issues are ignored because the psychology of mainstream economists is geared to concrete facts--the need to quantify variables. They see the task of the economist as one of providing decision-makers with arithmomorphic information regarding the efficiency of alternative programs and identity of the gainers and losers, leaving the final decision regarding the selection of alternatives to the political process. Thereby, they argue, economics remains scientific.

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[7] In Chapter III it is shown that efficiency and growth in GNP are often considered to be synonymous.

[8] While it may be possible to measure the degree of income inequality in society, it is not possible to measure inequality in any other sense. Further, the word "equity" has a different meaning for all individuals. The assumptions required to enable one to measure efficiency are discussed below and in Chapter III.

Unfortunately, this psychological attitude, coupled with the failure to recognize other psychological attitudes, has endangered the very science that is being defended.

> "The inevitable outcome is scientific separatism and specialist mythology, which spells death to universality. The predominance of empiricism not only means the suppression of active thinking; it also imperils the building of theories in any branch of science" [Jung 1921, p. 307].

By concentrating on the core of economic science and failing to recognize the extent of the penumbra, economists have made economics into a chimera with decreasing usefulness for tackling social problems.

Just as Abelard failed in his effort to reconcile the nominalists and realists [Jung 1921, pp. 46-64], this author feels unable to propitiate the disparate criteria of efficiency and equity. The integration of incommensurable psychological types is required of an individual who is himself rooted in a particular psychological pattern. Although an attempt is made at the integration of efficiency and equity in Part II of this treatise, it falls short because it is founded on the concretistic thinking criticized above. Efficiency and equity are separated despite a desire to the contrary. In the real world, however, this separation does not occur. Decisions regarding efficiency and equity in public project selection are made via public hearings and/or a process of arbitration between divergent decision-makers, a process which economists are currently incapable of modeling.

If the efficiency-equity conflict, or any other conflict for that matter, is to be resolved, then economists need to be more pragmatic, open-minded and universal. In particular, Jung argues that a greater knowledge of psychological processes is required.

> "We have a psychology, a mediatory science, and this alone is capable of uniting the idea and the thing without doing violence to either. This capacity inheres in the very nature of psychology, though no one would contend that psychology so far has accomplished this task" [p. 49].[9]

The Social Welfare Function

In this section three social welfare functions are identified. Each approaches the construction of a SWF and, hence, the problem of integrating efficiency with distribution in a different way. The various constructs are representative of different psychological attitudes, each of which is identified.

Scitovsky Community Indifference Curves (SIC)

Scitovsky [1942] constructs what he calls community indifference curves rather than social iso-welfare contours. (While the former intersect, the latter do not.) The SICs are geometrically derived directly from the individual indifference curves and illustrate the inseparability of efficiency and equity criteria. Since the SICs are impossible to relate to the real world, their construction can be attributed to an abstract thinker (a thinking introvert). This approach to social welfare, which Nath [1969] considers to be superior to the others, is discussed below.[10]

Consider an economy with two individuals, A and B, and a fixed endowment of two commodities, X and Y. Individuals A and B have welfare

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[9] Emphasis not in the original.

[10] A careful reading of Graaff [1963] would indicate that he, as well as Nath and Scitovsky, is also an abstract thinker.

functions indicated by the iso-welfare (indifference) map in Figures 1(a) and 1(b), respectively. The indifference contours are "well-behaved" in the sense that they are convex to the origin and have a negative slope throughout. In other words, the marginal rate of substitution of X for Y (MRS)--defined as the negative of the slope of the indifference curve at any given point--diminishes throughout the relevant region being considered.

An Edgeworth-Bowley trading box can be constructed by translating individual B's indifference map and superposing it upon that of individual A, as shown in Figure 2. The dimensions of the trading box are determined by the amounts of goods X and Y available in the economy.

The line $O_A K N O_B$, in Figure 2, is the efficiency locus for exchange. Along the efficiency locus the MRS is the same for both individuals; i.e., at points along the efficiency locus the indifference curves of the two individuals are tangent. Points on the locus are considered Pareto optimal since any movement away from the efficiency locus will result in a reduction in at least one person's welfare. This is true even if the movement is from one point on the efficiency curve to another point on the curve.

Scitovsky community indifference curves are constructed as follows [Scitovsky 1942, pp. 93-95]. Consider the distribution of X and Y (e.g., income) to be such that the individuals trade to point K on the efficiency locus. Individual A is on his indifference curve labeled $a_0 a_0'$; individual B is on his indifference curve labeled $b_2 b_2'$. The Scitovsky community indifference curve SIC_k is constructed by holding O_A stationary while allowing O_B to shift--A's indifference map

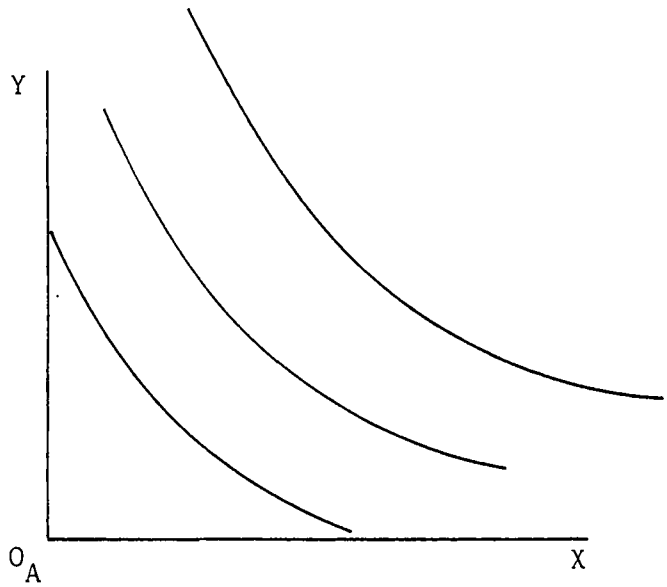

Figure 1(a). Indifference Map for Individual A.

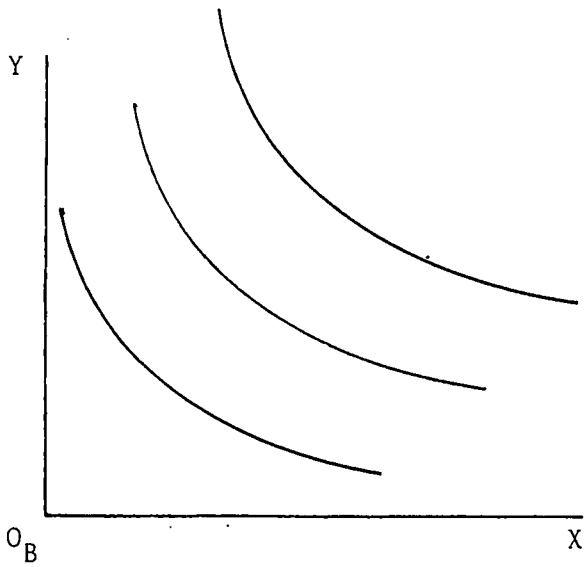

Figure 1(b). Indifference Map for Individual B.

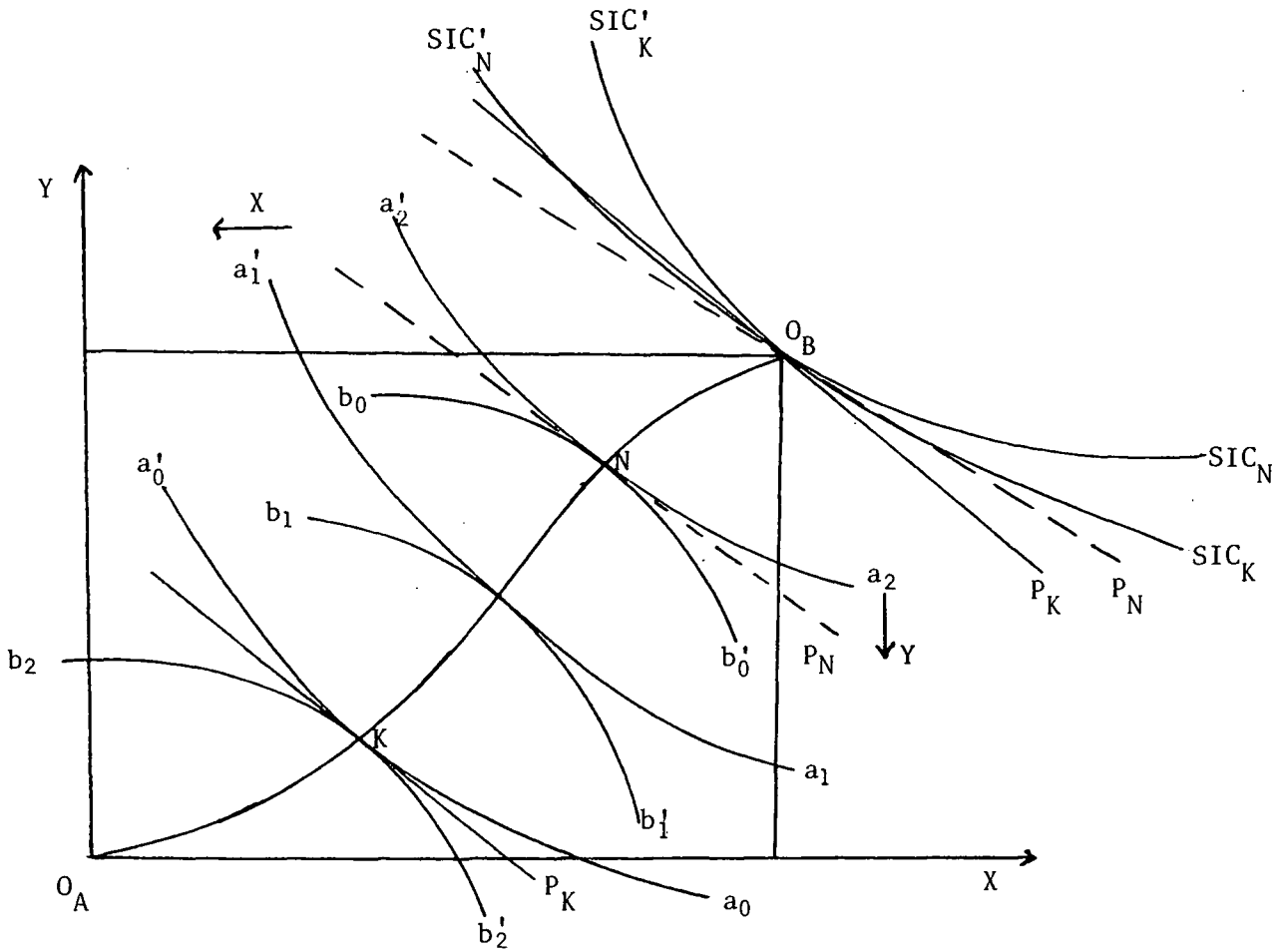

Figure 2. The Construction of Scitovsky Community Indifference Curves.

is held fixed while B's is allowed to shift. By shifting B's indifference map in such a fashion that b_2b_2' remains tangent to a_0a_0', the changing origin for individual B traces out the SIC_k curve.

A Scitovsky community indifference curve can be constructed for every point on the efficiency locus. For example, SIC_N is the Scitovsky indifference curve associated with point N on the efficiency locus. Each SIC going through the (now stationary) point O_B is tangent to a line through O_B having the same slope as the common MRS at the corresponding point on the efficiency locus. Hence, SIC_k is tangent to P_k while SIC_N is tangent to P_N. All the SICs intersect at point O_B.

The intersecting SIC contours indicate that whenever there is a movement along the efficiency locus, a new social indifference curve results. In other words, a redistribution of income results in a new social welfare function!

When production is included, there is only one SIC which is tangent to the production possibility frontier and one distribution of outputs which results in this SIC. In Figure 3 the "best" combination of outputs for society to produce is given by point O_B^E on the production possibility frontier while the "best" distribution of this output is given by point E on the efficiency locus.[11/] Relative to some initial

11/ Here "best" refers to the conditions required to achieve technical efficiency. Technical efficiency occurs where the marginal rate of product transformation (MRT) is equal to the trading ratio between goods X and Y. That is, the SIC is tangent to the production possibility frontier. Each person's marginal rate of substitution (MRS) is equal to the slope of the SIC at the point of tangency--O_B^E in Figure 3--and hence, equal to to the trading ratio and MRT. Finally, if we assume only two factors of production, the marginal rate of technical substitution (MRTS) between the two factors must also be equal to MRT. Hence, technical efficiency occurs where MRTS=MRT=MRS. This occurs at points E in the trading box and O_B^E on the production frontier. Point O_B^E is sometimes referred to as the "Pareto Optimum Optimorum" [Alston 1980].

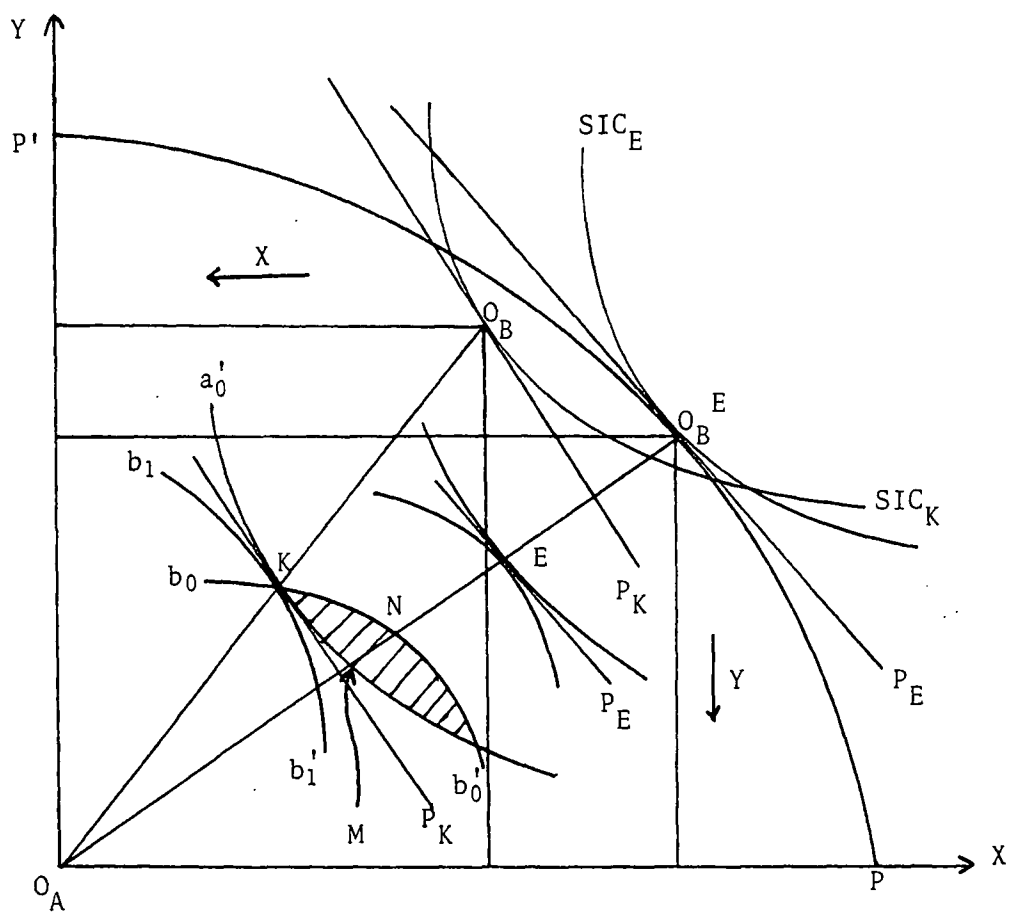

Figure 3. Efficiency-Equity in the Case of Production Inside Versus on the Transformation Frontier.

position, the distribution of output at point E may not, however, be more desirable.

Suppose that society is initially producing at point O_B inside the production possibility frontier (Figure 3). The output is distributed at point K so that individual A is on indifference curve a_0a_0' while B is on curve b_1b_1'. Can a movement from K to E be made without the need for interpersonal comparisons? Is it possible to say that E is unequivocally better than K, given that the economy is initially at K? No! According to Scitovsky's analysis, value judgments must always be made.

Consider person A remaining at point K after the dimensions of the trading box change. Individual B loses Y but gains X as a result of the change in the community's endowments of X and Y. Suppose B ends up on indifference curve b_0b_0' which goes through point K. Curve b_0b_0' may yield a higher, lower or the same level of welfare as b_1b_1'. The trading set associated with distribution K (in the new exchange box) is indicated by the shaded area. Points on the efficiency locus between M and N are superior to K. However, E is not considered superior to K since a movement from K to E requires at least one individual (B) to be made worse off. E cannot be judged better than K without making interpersonal comparisons.

In the above analysis it was assumed that person A maintained the same endowment when the dimensions of the trading box changed. However, any other value judgment regarding the distribution of X and Y when the community endowment of X and Y changed could be made. It becomes clear, therefore, that any policy designed to move the economy from state O_B to O_B^E, which is considered the "first-best" state, cannot

be made without interpersonal comparisons.[12/]

It is also apparent from the discussion that any movement from one Pareto Optimum point to another in the XY-plane results in a new SIC. Since public policy analysis generally assumes the economy is at Pareto Optimum (although not necessarily Pareto Optimum Optimorum), it follows that economics has little to say regarding policy recommendations unless one is willing to make certain value judgments regarding interpersonal comparisons of welfare.

The Bergson/Samuelson Social Welfare Function

Scitovsky demonstrated that the type of community indifference contours needed to generate group demand did not exist [Samuelson 1956, p. 6 footnote]. Therefore, it is not possible to "recover" the social (group) welfare contours from the group demand function. As a result, Samuelson adopted the Bergson [1938] formulation of the social welfare function. Bergson assumed that each person's separate tastes are to count.[13/] If an individual's utility is a function of the amounts of goods and services X, Y, ... the individual consumes--that is, the utility function of the i^{th} individual is $U^i(X^i, Y^i, \ldots)$--and there are n persons in society, then the social welfare function is:

$$SWF = W[U^1(X^1, Y^1, \ldots), \ldots, U_n(X^n, Y^n, \ldots)]. \qquad (1)$$

12/ See Scitovsky [1941] for an excellent discussion regarding the comparison of economic states when the dimensions of the trading box change. A discussion regarding the attainability of "first-best" occurs in Appendix A.

13/ This is a value judgment. Samuelson uses the analogy of a family to formulate the Bergson SWF [1956, pp. 8-12]. Just as a family's preferences may be determined without taking into account one or more of the children's tastes, there is no reason to believe that all individuals are to count. Even if each person is to count, are all persons to count equally? See the discussion in Chapter III.

Samuelson [1956, pp. 17-18] assumed that Equation (1) could also be written as:

$$SWF = w(X, Y, \ldots). \tag{2}$$

The conditions for achieving a maximum social welfare are:

$$\frac{\partial W/\partial x^i}{\partial W/\partial y^i} = \frac{\dfrac{\partial W}{\partial U^i}\dfrac{\partial U^i}{\partial x^i}}{\dfrac{\partial W}{\partial U^i}\dfrac{\partial U^i}{\partial y^i}} = r_{xy}, \text{ etc.}, \quad \forall\, i = 1, \ldots, n, \tag{3}$$

where r_{xy} is the trading (price) ratio between X and Y, etc. In other words, the marginal rate of substitution of commodity Y for commodity X must be the same for all individuals [Bergson 1938, p. 14]. Condition (3) is considered to hold since all individuals are assumed to face the same (constant) prices.

Familiar rules of optimization suggest that a particular commodity always be reallocated among the members of society so as to keep the "marginal social significance of each unit of the commodity" equal, i.e.,

$$\frac{\dfrac{\partial W}{\partial U^i}\dfrac{\partial U^i}{\partial X^i}}{\dfrac{\partial W}{\partial U^j}\dfrac{\partial U^j}{\partial X^j}} = 1, \text{ etc.}, \quad \forall\, i, j = 1, \ldots, n \text{ and } i \neq j. \tag{4}$$

That is, the marginal <u>social</u> utility of one person's consumption of a particular good must be equal to the marginal <u>social</u> utility of every other person's consumption of the same good.

Equation (4) can also be applied to income. "In order for laissez faire to lead to the optimum, there would have to result an equal mar-

ginal social utility of each and every peron's income" [Samuelson 1956, p. 12]. In other words,

$$\frac{\frac{\partial W}{\partial U^i}\frac{\partial U^i}{\partial I^i}}{\frac{\partial W}{\partial U^j}\frac{\partial U^j}{\partial I^j}} = 1, \forall i \neq j, \; i,j = 1, \ldots, n, \tag{5}$$

where $\frac{\partial U^i}{\partial I^i}$ is the marginal utility of income to the i^{th} individual.

Egalitarian Considerations. In order to maximize social welfare the last dollar spent by an individual must contribute as much to social welfare as the last dollar spent by any other individual.[14/] One way to ensure that Equation (5) holds is to redistribute income until the conditions for a social maximum are attained. While the necessity of income redistribution is not denied by the requirements of Equation (5), they do not constitute an argument for income equality. At the same time, the social welfare maximizing conditions do not provide an argument in favor of the status quo distribution of income either.

Only if the marginal utility of income curve is the same for all persons will an equal distribution of income be required to maximize social welfare. However, equality of income (equal marginal utility of income for all individuals) does not automatically ensure that Equation (5) holds. One has to make an additional value judgment. Previously it had been assumed that each person's separate tastes are to count. Now the argument requires that all persons are to count equally--a per

14/ Likewise, according to Equation (4) the last unit of a good consumed by one person must add as much to social welfare as the last unit of the same good consumed by any other individual.

unit increase in one person's welfare adds the same amount to social welfare as a per unit increase in another person's welfare.[15/] Mathematically, if Equation (5), then,

$$\frac{\partial U^i}{\partial I^i} = \frac{\partial U^j}{\partial I^j} \Leftrightarrow \frac{\partial W}{\partial U^i} = \frac{\partial W}{\partial U^j}, \quad i \neq j. \tag{6}$$

Most economists reject the idea of income equality, however. Rather, they assume that the marginal utility of income is constant and equal for all individuals, regardless of a person's income level. If maximization of social welfare is desired then the assumption of constant and equal marginal utility of income also requires the implicit value judgment that all persons are to count equally. This is the basis of benefit-cost analysis which is discussed in Chapter III.

Currently, some economists are trying to determine that distribution of income for which Equation (5) holds [Tinbergen 1980]. However, this work is in its infancy and no attempt is made to extend this research here.

The Shape of the Bergson-Samuelson SWF. An individual's utility function must be "well-behaved" before it is possible to derive the individual's demand curve for a particular commodity. Similarly, Samuelson argues that the SWF must have certain properties [1956, p. 16] if it is to be consistent with observed group demand functions. These

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15/ Consider again Samuelson's parable of the family. Are the preferences of a child to count equally with those of its father and mother in determining the family's optimal allocation of its budget? Are the preferences of a drug addict to count equally with those of other members in society? Are revealed preferences (e.g., as revealed by the drug addict) even a true indicator of a person's welfare? See Broome [1978], Georgescu-Roegen [1954a], and Chapter III.

properties are similar to those required of individual utility functions, and they result in social indifference contours which exhibit diminishing marginal social rates of substitution, and do not intersect (see Figure 4(a)). Each social indifference curve is an envelope of intersecting Scitovsky indifference curves as shown.

In Figure 4, PP' represents society's production possibility, or transformation, frontier.[16/] W_iW_i' represents society's indifference map between X and Y, with W_1W_1' indicating a higher level of welfare than W_0W_0'. In Figure 4(b), society's welfare is maximized at point E, which corresponds with O_B^E in Figure 3. At point E the ratio of prices between goods X and Y is P_0--the price ratio which would result under perfect competition in the absence of externalities.

In Appendix A it is shown that it may not be possible to reach point E in Figure 4(b) if distortions exist in the economy. A second-best solution may be possible under certain restrictive assumptions. Otherwise, it may not be possible to attain even the production frontier.

The conclusion is that, even if it were possible to identify point E as the Pareto Optimum Optimorum, knowledge of the entire social indifference map is required to judge between sub-optimal points. Arrow has shown that construction of a social welfare function based on the assumptions discussed thus far is impossible unless it is to be dictatorial or imposed [Quirk and Saposnik 1968, pp. 108-116]. A major barrier to constructing the social welfare function is an inability to compare utility between individuals.

16/ The transformation function is assumed to be concave to the origin and continuously differentiable.

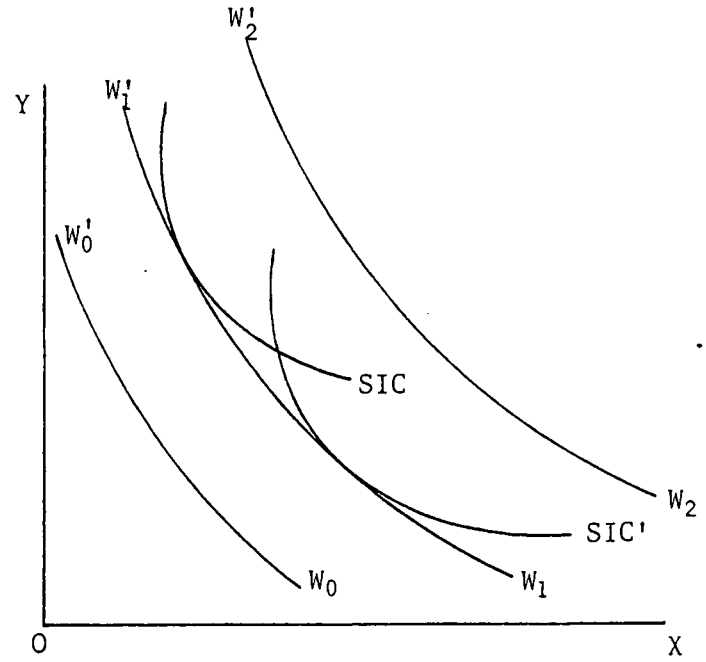

Figure 4(a). Bergson-Samuelson SWF Contours.

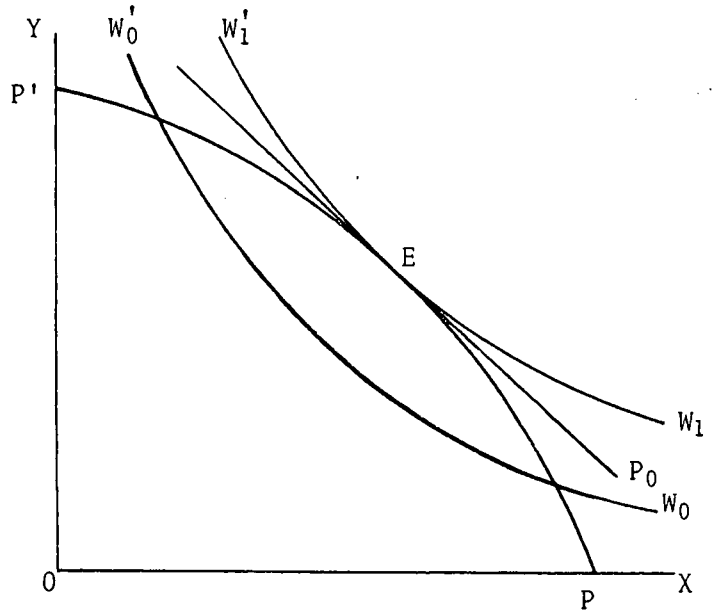

Figure 4(b). Pareto Optimum Optimorum and the Bergson-Samuelson SWF.

Type Characterization of the Bergson-Samuelson SWF. Compared to the Scitovsky approach to social welfare, the Bergson-Samuelson formulation is a major advance for empiricism. As shown in Chapter III, three simple, but crucial, assumptions suffice to enable economists to determine, via measurement, whether one public policy contributes more to social welfare than another. These are:

(1) the distribution of income (the existing one or some other) is assumed given;

(2) an assumption regarding the marginal utility of income curves among individuals is made; and

(3) all persons are assumed to count equally.

Samuelson ignores distribution in his construct of the SWF, preferring to leave unscientific decisions such as policy recommendations to the economist qua citizen, although most economists frequently fail to distinguish between their role as scientist and as citizen.

> "I do not mean to imply that the field of welfare economics has scientific content because a number of its theorems do not require inter-personal comparisons of utility; this after all is a mere detail. That part which does involve inter-personal comparisons of utility also has real content and interest for the scientific analyst, even though the scientist does not consider it any part of his task to deduce or verify (except on the anthropological level) the value judgments whose implications he grinds out" [Samuelson 1947, p. 220].17/

From this quote, one is able to determine that Samuelson, and other mainstream economists, have a psychological type characterized by a

17/ Emphasis in the original.

logical positivist (empiricist) view of the world. Hence, realism characterizes the Bergson-Samuelson formulation of the SWF.

Collective Social Welfare as a List of Social Objectives

The individual utility functions used in the utilitarian approach to welfare economics are a mere metaphysical construct. The construction of a social welfare function requires the aggregation of these individual utility functions. However, there is no reason to believe that individual values are the same as collective values; they may differ. The social welfare function can be determined separately from the individual utility functions. After all, the social welfare function is a metaphysical construct no different from that of an individual or household utility function.

> "The belief that individual wants are the only basis for determining social action is both logical and defensible.... But the belief is clearly not in accord with present public decisions.... Perhaps the approach of aggregating individual wants to derive social wants is overly narrow, based too much on our concept of private markets and consumer sovereignty. Without pretense of analyzing such alternative approaches or even reviewing those currently being considered, two possibilities (exist). One possibility is to regard individuals as possessing social as well as individual interests. This leads to the 'pluralistic' viewpoint of sociologists, anthropologists, political scientists, and even of many economists.... If state decisions are being considered then the preferences revealed by people's actions with respect to state decisions are appropriate rather than those typifying their choice pattern as individuals, and these latter may be different.... A second possibility carries this approach even further, regarding society as a distinct and separate entity. Under this view society possesses its own set of values and preferences and often approves actions to further develop these values.... If one accepts that society

> has its own values and preferences then one can argue that the public can decide to convert an area from commercial timber production to use as a wilderness area, even though this means a reduction in timber supply, an increase in timber costs, and may force some timber business to close" [Gregory 1972, pp. 424-426].

The two possibilities, identified by Gregory, refer to different concepts. The first possibility includes the case where all individuals would like to have some amount of a good, but no one individual is willing to contribute to its provision unless all contribute. The nature of these "public goods" is that once they are available to one person, they are available to all. No one can be excluded and no private market exists to provide them. Defense and provision of wilderness areas are examples. Although individual preferences are considered in determining the quantity of a public good to provide, each individual will prefer a different amount. However, only one level is available for all.

The second possibility includes a collective approach to decision-making, with an emphasis on political (public) institutions. Society's preferences are stated in the form of a set of social objectives. For example, four broad objectives were outlined by the Water Resources Council for project planning [Water Resources Council 1973, pp. 6-10]:

(1) national economic development,

(2) environmental quality improvement,

(3) regional development, and

(4) social well-being.[18]

Each of these broad objectives could, of course, consist of various components, each of which is to be included in a statement of society's preferences. The preferences of society are a function of the various objectives, weighted by appropriate weights. Hence, the social welfare function is:

$$SWF = g(w_1G_1, \ldots, w_iG_i, \ldots, w_mG_m), \tag{7}$$

where G_i refers to the i^{th} objective and w_i refers to the weight attached to that objective. Unfortunately, there is no universally acceptable method for determining what the weights are.[19]

The decision-making process is one of conflict resolution. Even the establishment of priorities requires compromise between many groups and individuals, each having a different view of the world in which they live. The establishment of a list of objectives will enable the decision-maker to more clearly determine the types of tradeoffs involved in choosing one action over another. In practice, however, it is unlikely that a clear set of priorities exists.

There are other problems when the social welfare function consists of a list of objectives. Too often the objectives are vague and,

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[18] The last two objectives were dropped in the 1979 guidelines, presumably not because they were inappropriate. Rather, requiring the benefit-cost accountant to decide on the weights to attach to the objectives placed too large a burden on him. No guidance, regarding the weights to be used and the method of evaluating regional benefits and costs and social well-being, was provided in the guidelines. Perhaps the same could be said of the second objective as well. A methodology for incorporating the last two objectives is suggested in Chapter V.

[19] Some methods for determining the weights are discussed in Chapter IV.

as a result, there is no empirical basis for determining whether a particular policy moves one closer to achieving the stated objectives. A more serious concern is that one seizes upon some practical goal and treats as correct any means effective in reaching it. "It seems liberating, but in fact one is subject to the terrorism of practical goals, which at first are simply proposed but then canonized" [Cramp 1975, p. 15].[20/]

Finally, this construct ignores the fundamental ethical postulate that individuals' preferences are to count in the social ranking. Hence, the construct allows for government action which ignores the preferences of certain individuals or groups in society.

The psychological type associated with this formulation of the SWF is one of extreme logical positivism. In essense, this procedure relies on calculations derived via a Bergson-Samuelson approach to social welfare but seeks to make the final choice of public policies more scientific by providing the analyst with weights to use in calculating which public projects contribute the most to social welfare.

Summary Regarding Social Welfare Functions

Three forms of social welfare functions have been discussed. Nath [1969, p. 139] gives no credence to the Bergson-Samuelson formulation of the SWF because it is based on individual utility functions, which can never be fully known, and on restrictive assumptions regarding the convexity of social indifference curves. But if the Bergson-Samuelson SWF can be "recovered" from observed group demand functions,

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[20/] Cramp quotes from B. Goudzwaard, A Christian Political Option (Toronto, 1972), p. 19.

then the construction of social indifference contours may still be possible. However, this needs to be demonstrated.

While Scitovsky community indifference curves are also based on imaginary surfaces, they have the advantage of making clear the inseparability of distribution from efficiency. The Scitovsky formulation is not conducive to arithmomorphic methods and is thought of as an abstract and, hence, otiose curio by concretistic thinkers. Therefore, applied welfare economists have rejected the SICs for one of the other social welfare functions discussed.

Considering the social welfare function as a list of objectives (targets or priorities) has some promise, although appealing primarily to empirical psychological types. This form of SWF allows the analyst to consider both efficiency and equity as objectives. However, there is no single decision-maker and, as a consequence, no single SWF. Further, if efficiency is a desired good, a Bergson-Samuelson-type SWF is used to measure this objective. The logical positivist technique for measuring efficiency will be discussed further in the next chapter. Finally, a mechanism is required to determine what weights to attach to social objectives. This issue is addressed in Part II of this treatise.

CHAPTER III

TOWARDS A CRITIQUE OF APPLIED WELFARE ECONOMICS

Economists are interested in recommending courses of action which they consider to be "best" for society. Applied welfare economics was developed to provide guidelines for making arithmomorphic calculations which enable decision-makers to unambiguously select those policies which lead to the maximization of society's welfare. Unfortunately, applied welfare economics fails in this task because (i) it has adopted a single objective to be maximized and (ii) it has ignored important psychological needs when modeling human behavior.

In the first section of this chapter, the technique of benefit-cost analysis is critically examined. Although the objective functions of public decision-makers are intricate, benefit-cost analysis is geared to only one goal.

> "The objective functions of most government programs are complex; yet benefit-cost analysis has been adapted to only a single objective--economic efficiency. Thus, benefit-cost analysis may be largely irrelevant, or relevant to only a small part of the problem of evaluating public projects and programs" [Maas 1966, p. 312].

The argument that the function of the economist is simply to provide the decision-maker with data regarding efficiency is rejected since it is impossible to separate the scientific and the philosophical.

Efficiency and equity are only two objectives of policy-makers. Benefit-cost analysis, by assumption, ignores equity. However, economists have devised compensation tests as a means to bring equity

back into the analysis. However, as the discussion indicates, the compensation tests are unscientific, requiring interpersonal comparisons of utility. This is exactly what applied welfare economics sought to avoid in the original assumption that the distribution of income is irrelevant for social welfare.

A critique of welfare economics due to Georgescu-Roegen, which strikes at the philosophical foundation of the neoclassical theory of demand, is discussed in the second section. Since the standard utility function (indifference map) cannot always be "recovered" from the demand function observed in the market place, a return to the postulates of the classical economists is suggested. In particular, the "Principle of the Irreducibility of Wants," rejected by the neoclassical economists, needs to be reinstated. Finally, a serious doubt regarding the method of deriving and, hence, the usefulness of the welfare measure known as consumer surplus is presented.

The Foundations of Benefit-Cost Analysis

Logical positivism reached an apex in the paper and pencil operations of applied welfare economics known as benefit-cost analysis. Benefit-cost analysis is designed to enable the analyst to unambiguously rank public policies according to their contribution to social welfare. Although the benefit-cost calculations are based on certain restrictive assumptions, these are often implicitly ignored in discussions regarding the welfare implications of projects. Nonetheless, the assumptions are necessary for empiricism.

Benefit-cost analysis resolves the problem of interpersonal comparisons of utility by invoking the classical Cambridge school notion

that group welfare is simply the sum of the cardinal utilities of the men comprising the group [Bergson 1938, p. 17; Graaff 1967, p. 10; Georgescu-Roegen 1973, p. 314]. The Bergson-Samuelson social welfare function then becomes:

$$W = U^1 + U^2 + \ldots + U^n. \tag{8}$$

Although interpersonal comparison of utility is possible, a unit of measurement is lacking.

The assumption of constant and equal marginal utility of income for all individuals is now invoked (see Chapter II). This assumption implies that the utility of the i^{th} individual is some constant multiple of his income; i.e., $U^i = k \cdot I^i$, where I^i is the income of the i^{th} individual and k is the marginal utility of income, which is the same for all individuals.[1/] Setting the units in which income is measured as numeraire, it is possible to write Equation (8) as:

$$W = \sum_{i=1}^{n} k \cdot I^i = \sum_{i=1}^{n} I^i = \text{National Income}. \tag{9}$$

Therefore, to maximize society's welfare one needs to maximize national income [Winch 1971, pp. 22-23].

It is important to recognize that benefit-cost analysis assumes that distributive equity and interaction effects between individual utility functions are unimportant as determinants of social welfare. Hence, it does not matter if an increase in national income accrues

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[1/] It is important to note that assuming constant marginal utility of income implies that the marginal utility of income is the same whether the person earns $1 or $1 million. Hence the marginal and average utility of income are the same. Only then is it possible write $U^i = k \cdot I^i$.

entirely to a millionaire or is spread among the most disadvantaged in society. However, economists often feel uncomfortable with this implication. Other psychological functions, particularly feeling, intrude upon their concretistic thinking and they feel compelled to consider the distributional consequences of public policies. This creates an anomaly since equity was initially assumed to be unimportant.

In devising compensation tests, however, the thinking aspect of the benefit-cost practitioner's psychology once again dominates the feeling side. Although the compensation tests are designed to be scientific, they are internally inconsistent when the decision-maker is forced to decide between sub-optimal positions--that is, positions which are not on the production possibility frontier [Nath 1969, pp. 95-101; Chipman and Moore 1978]. The inconsistencies of the compensation criteria are discussed in the following digression.

A Note Concerning the Compensation Criteria and Other Tests

Section One. Real world economies cannot, in general, attain their social production possibility frontiers.[2/] Therefore, policy-makers are forced to compare sub-optimal situations. Any comparison of economic situations requires knowledge regarding the desirability of the change. To avoid making value judgments due to interpersonal comparisons of utility, a number of compensation tests have been devised to enable decision-makers to compare states of the economy based on efficiency. The arguments here demonstrate that the various criteria devised to allow economists to rank states, based solely on efficiency criteria and without resort to ethical judgments, are in-

2/ For a discussion, see Appendix A.

consistent and, therefore, can never be fulfilled. While the arguments follow the geometric technique used by Nath [1969], an excellent criticism and discussion is found in Chipman and Moore [1978].

Section Two. Nath [1969, pp. 20-21] constructs what he calls "point utility-possibility curves." Consider the Edgeworth-Bowley trading box in Figure 5(a). The dimensions of the box are determined by a single point in output space, either on the social production frontier or inside the frontier. The contract curve between individuals A and B is translated into ordinal utility space in Figure 5(b). U^A is the measure of ordinal utility indicators for individual A; U^B is the measure for individual B. U_1U_1' is a utility-possibility curve for a point on the transformation frontier; U_2U_2' is a utility-possibility curve for a point located inside the social production frontier.

Costless lump-sum transfers (redistributions) of income enable the two individuals to move along a utility-possibility curve without changing the fixed bundle of commodities on which the point utility-possibility locus is based--that is, without changing the composition of national product.[3/] Samuelson [1950, pp. 18-19] argues that lump-sum transfers of income are an ideally perfect and unattainable system for moving people to different points on the utility-possibility function. Instead he proposes the use of utility-feasibility curves. These are based on politically feasible methods of redistributing income, such as the progressive tax system and the allocation of public

3/ This follows from the implicit assumption of constant marginal utility of income, which is a necessary assumption of the New Welfare Economists. It should be noted that this assumption could be replaced with the assumption of vertically parallel indifference curves to implement a lump-sum transfer system.

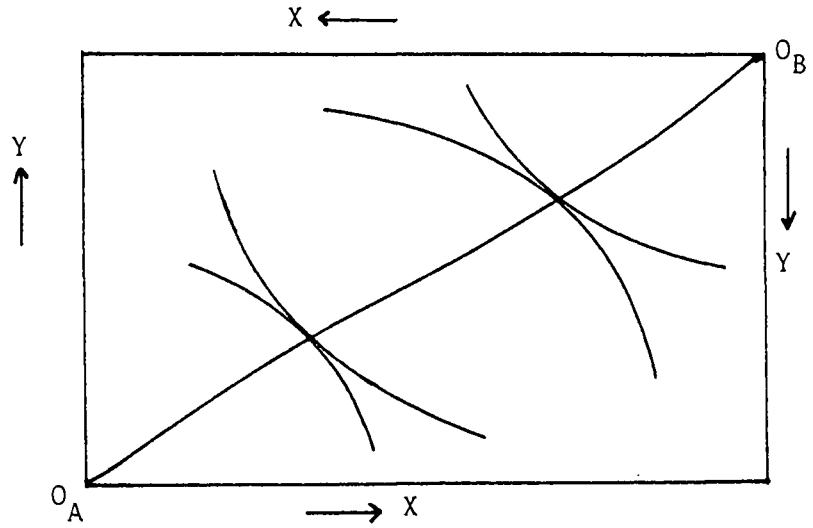

Figure 5(a). Edgeworth-Bowley Exchange Box and Contract Curve.

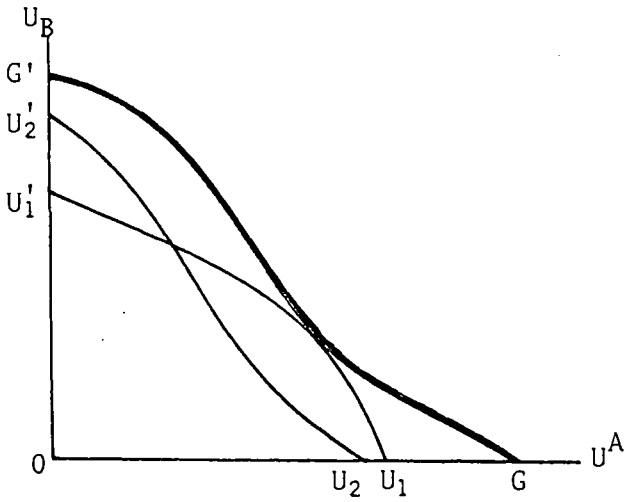

Figure 5(b). Utility-Possibility Curves and the Utility-Possibility Frontier.

programs to needy groups. While movement along the utility-possibility curves does not result in changes in the composition of national income, movements along the utility-feasibility curves do. However, no real difference is made in the analysis of the compensation criteria and other tests by interpreting the loci in either of these ways [Nath 1969, p. 98].

Section Three. Before considering the criticism of the compensation and other tests, however, it is useful to consider the relationship between the utility-possibility and utility-feasibility loci and, thereby, illustrate a particular egalitarian concept. Point X in Figure 6 is the initial state of the economy. The utility-possibility and utility-feasibility loci are indicated in the figure. Equality between the two individuals is defined to occur along the 45° line if the tastes and abilities of the two individuals are identical so that similar indicators of their ordinal preferences can be used [Samuelson 1950, p. 18]. If the decision-maker desires an equal income distribution, then movement from X to E in Figure 6 is desired but not feasible. Movement from X to Y is feasible but may not be desired since it might place the individuals on a utility-possibility locus (through Y) which lies everywhere inside the utility-possibility locus through point E.[4/]

In the following it is assumed that costless lump-sum transfers are possible. The reason is that the ethical judgments required by the proponents of the various compensation tests are the same as those

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4/ In light of this, Nath's argument that it does not matter how the loci are interpreted seems wrong. See section five of this note for a further discussion of the concept in the text.

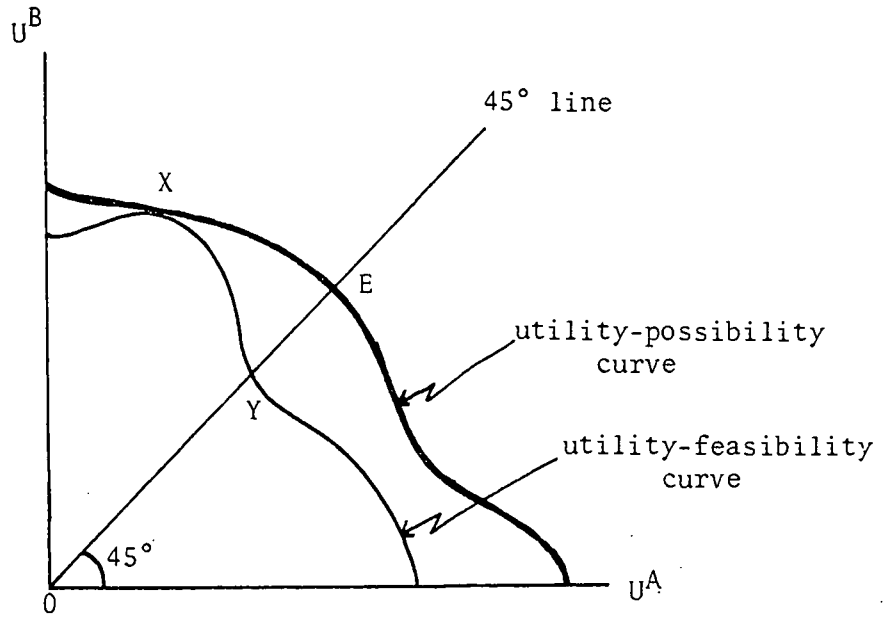

Figure 6. Egalitarian Concepts and the Utility-Possibility and Utility-Feasibility Curves.

which allow lump-sum redistributions along a utility-possibility curve, without changes in the composition of national product.

Section Four. The Kaldor-Hicks compensation criterion [Kaldor 1939; Hicks 1939] states that there has been an unambiguous increase in society's welfare in moving from one state to another if the gainers of a public program can compensate the losers and still be better off than in the absence of the project. In Figure 7, curves U_1U_1' and U_2U_2' are utility-possibility curves passing through points Q_1 and Q_2, respectively. Initially the two-person (two-group) economy is located at Q_1. A program is proposed which will move the individuals to Q_2, with B gaining and A losing. According to the Kaldor-Hicks compensation criterion, the program is considered to increase social welfare if, in state Q_2, income can be transferred (in lump-sum fashion) to A such that a point on U_2U_2' between M and N is achieved.

Scitovsky [1941 and 1942] recognized that, just as situation Q_2 can be considered better than situation Q_1, state Q_1 could be considered better than state Q_2. By a lump-sum redistribution of income the gainers (individual A), in moving from Q_2 to Q_1, could compensate the losers (individual B) to achieve a situation between J and K which is better than Q_2. Hence, Q_1 is better than Q_2 at the same time that Q_2 is shown to be better than Q_1. As a result, Scitovsky proposed the reversal (double) criterion: A project which moves the economy from state Q_1 to state Q_2 is deemed to increase social welfare (is efficient) if the gainers from the project can compensate the losers in moving from Q_1 to Q_2 but the losers cannot bribe the gainers to oppose the project. This would happen if the second state is located at a point such as Q_2' in Figure 7.

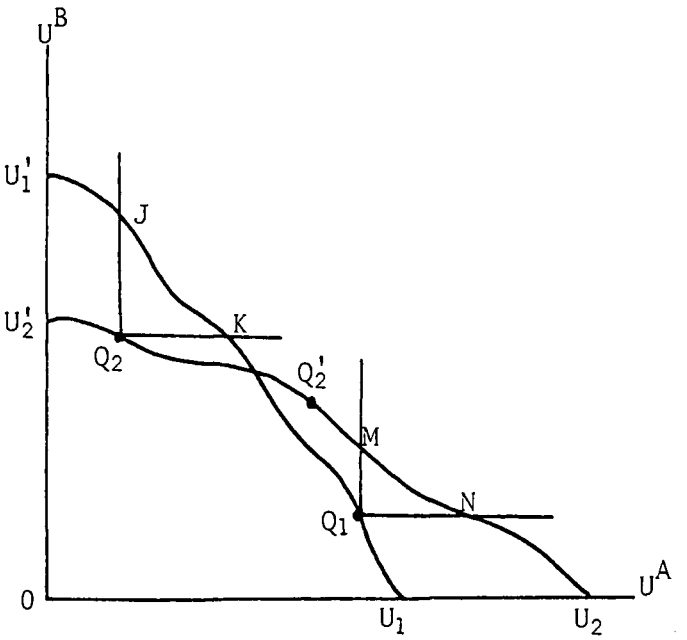

Figure 7. The Scitovsky Paradox and the Kaldor-Hicks Compensation Test.

However, if the choice is to be made from more than two possible situations then the reversal criterion breaks down. In Figure 8, Q_2 is superior to Q_1, Q_3 is superior to Q_2, and Q_4 is superior to Q_3. Since, in comparing Q_1 and Q_4, Q_1 is found to be superior to Q_4, transitivity of choices does not hold [Nath 1969, pp. 100-101].

Finally, while the Kaldor-Hicks compensation test could fail in both optimal and sub-optimal situations, the Scitovsky reversal criterion always holds in comparing points located on the situation utility-possibility frontier. But, as Appendix A demonstrates, economists are confined to choosing between sub-optimal situations, i.e., those located inside the production possibility frontier and, hence, inside the situation utility-possibility frontier. Hence, neither the Kaldor-Hicks nor the Scitovsky criteria are considered very useful for decision-making purposes.

Section Five. The Pareto-Samuelson criterion provides an unequivocal method of comparing two situations. According to Pareto, a public program is considered desirable only if at least one person gains by the program while no single individual loses. To this Samuelson adds the requirement that the reversal test hold. In terms of our previous diagrams, the Pareto-Samuelson criterion implies that a movement from Q_1 to Q_2, as a result of a particular public program, is deemed desirable only if the utility-possibility curve through Q_2 lies outside that passing through Q_1 in the relevant region.

Section Six. Little felt that the income distribution must be admitted as an explicit ethical variable so that "every reader of the economist's conclusions can decide this issue (equity) for himself"

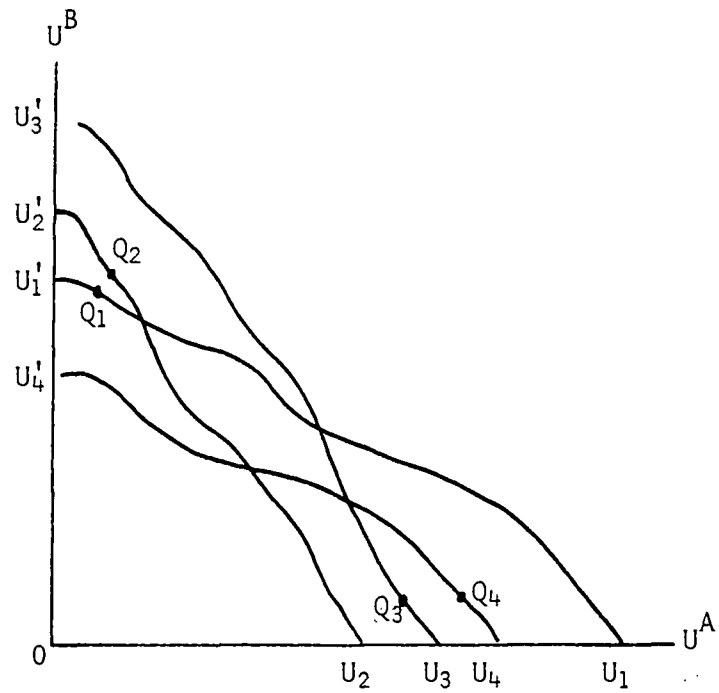

Figure 8. Intransitivity in the Reversal Test.

[1957, p. 100 footnote]. He proposed a three-fold criterion:

"(a) Is the Kaldor-Hicks criterion satisfied?

(b) Is the Scitovsky criterion satisfied?

(c) Is any redistribution good or bad?" [1957, p. 101].

If either (a) or (b) and (c) are satisfied, then Little considers the policy desirable.

If equity is defined as in section three above, Nath [1969, pp. 107-109] shows that an economic state X may be superior to an original state Q_1 on distributional grounds, but inferior to Q_1 based on the Paretian assumption of section five, to which Little claims to adhere. This paradox results because Little compares between X and Q_1 based on some intermediary state Q_2. Figure 9 illustrates the paradox. Point X is considered to be better than Q_1 or Q_2 in a distributional sense since X is closer to the 45° line. However, Q_2 indicates an improvement in one person's welfare without loss to another--that is, Q_2 satisfies the strict Pareto-Samuelson criterion as compared to X. But the original state Q_1 is superior to Q_2 since a movement to Q_2 does not satisfy the Kaldor-Hicks criterion. One way to avoid this problem is to judge between states on distributional grounds only.

Chipman and Moore consider the Little criterion a

> "Wholesale retreat from the basic tenet of the New Welfare Economics, which was that the Compensation Principle can take the place of distributional value judgments in the formation of policy recommendations. Perhaps still more noteworthy is the fact that if one accepts Little's approach, one no longer has any basis for advocating measures that would remove existing discrepancies between marginal rates

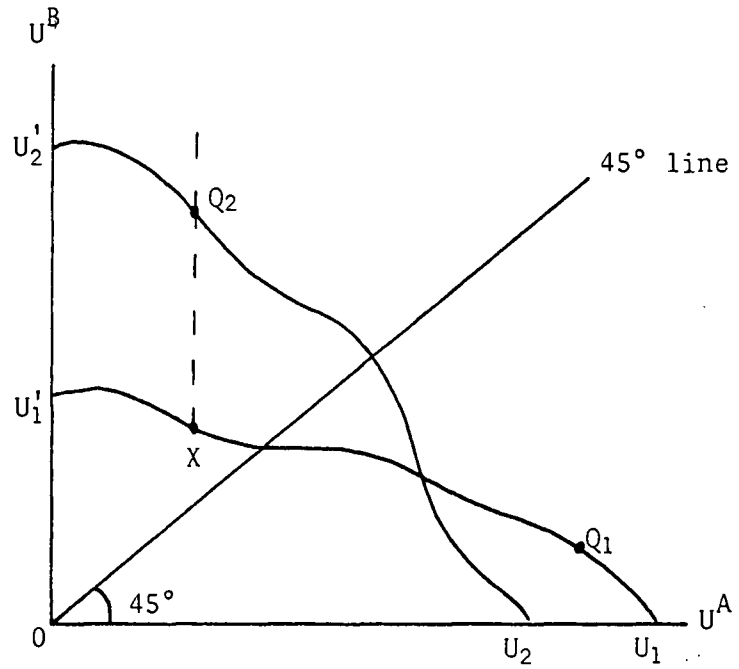

Figure 9. A Criticism of the Little Criterion.

> of transformation, i.e., one no longer has any basis for advocating efficiency and Pareto optimality as necessarily desirable goals" [1978, p. 578].

Section Seven. One is forced to conclude that there is no satisfactory (scientific) method for choosing between different states of the economy and, therefore, among a variety of public programs. As a result, public decisions are made in the political arena rather than by appeal to scientific authority. One role for the economist, therefore, is to identify equity weights to aid the authority in making consistent decisions. This view comes from a concretistic, thinking psychological type, however, and will form the basis of the models discussed in Part II of this treatise.

A Further Comment Regarding Benefit-Cost Analysis

Economics has its philosophical roots in the utilitarian philosophy of Thomas Hobbes, David Hume, Jeremy Bentham and J.S. Mill. In making choices regarding appropriate public policy it is impossible to distinguish moral from practical issues, although benefit-cost analysis seeks to do just that. For example, there is the moral question of ignoring some of the consequences of public actions because they are not foreseeable.

> "First, the concept of the total consequences of an action is of little value; there is no satisfactory way of delimiting the consequences of any given action. Second, even if the concept can be used, there is clearly no possibility of ever knowing the value of the total consequences of all the possible courses of action on a particular occasion. To meet these two objections, it is sometimes said that appeal should be made to the total foreseeable consequences only; but this modification makes it impossible to recognize the proper distinc-

> tion between correct moral decisions and honest errors of moral judgment arising from ignorance of fact. We may surely be justified, but mistaken, in acting on the basis for foreseeable consequences only" [Urmson 1968, p. 225].

This is not meant as an attack on the usefulness of benefit-cost analysis in decision-making. Rather, it is meant as a warning to those who rely exclusively on the results of such analysis because they are considered scientific. Further, in deciding what is foreseeable and what is not--that is, in deciding what to include and what to exclude in the benefit-cost calculations--it is necessary to recognize that it is impossible to separate the economist qua scientist from the economist qua citizen.

The Critique Due to Georgescu-Roegen

The two scissors of supply and demand are needed to determine the equilibrium price and quantity in any market. While economists feel comfortable with the theory which enables them to derive the supply function, some dissatisfaction with the theory underlying the demand function exists. In the latter case, economists are forced to model human behavior. This is a difficult task and requires, among other things, a knowledge of psychological processes. Determined not to operate with nonarithmomorphic psychological and sociological functions, applied welfare economists have relied on the theory of revealed preference to derive the preference structure (the ophelimity varieties) from actual market data. Georgescu-Roegen, in a series of articles [1936, 1950, 1954(a), 1954(b), 1968, and 1973], has conclusively shown, however, that revealed preference cannot always be used to derive the estimates of consumer surplus which economists use in benefit-cost

analysis.

Although Georgescu-Roegen's devastation of the theory of revealed preference was complete as early as 1954, his work seems to have been largely ignored.[5/] In this section, the main tenets of his criticism and its implication for applied welfare economics are discussed. The reader is encouraged, of course, to consult the original articles as the discussion here is necessarily superficial.

The Nonintegrability Problem

Inspired by an Italian engineer named Antonelli, Pareto suggested two methods for constructing an ophelimity index based on behavioral data. The first is rather simple and of little use to applied economists. The individual's ophelimity index can be constructed by observing whether the individual chooses one bundle of commodities over another, or considers himself indifferent between the two bundles when asked his preference. This is the "postulate of binary choice." With the "indifference postulate," which asserts the existence of indifference combinations,[6/] and the "transitivity postulate", this postulate allows one to construct the ophelimity varieties (utility curves) as presented in the traditional economic textbooks. The indifference surfaces need not, however, be convex to the origin although the additional assumption of decreasing marginal rate of substitution ensures

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[5/] A notable exception, as far as this author is aware, is Lutz and Lux [1979]. At this point, it may also be useful, and interesting, to note that Georgescu-Roegen can be considered a thinking introvert (abstract thinker).

[6/] The methods suggested by Pareto imply that he considered utility to lose its cardinality. However, as soon as one accepts indifference then one is forced back to a cardinal measure of changes in utility [Georgescu-Roegen 1968, p. 262].

that they are.

The second method for constructing an ophelimity index is based on data regarding the prices and quantities demanded as observed in the market place. Included in this are the theory of directional choice [Georgescu-Roegen 1954(b)] and the theory of revealed preference [Samuelson 1947, Chapter 5; Houthakker 1950]. Without delving into the complex mathematics required, the crux of the problem can, nonetheless, be examined.

Suppose that the indifference varieties are given as a function of the commodities, X_i:

$$\phi(X_1, X_2, \ldots, X_n) = \text{constant}. \tag{10}$$

The resulting total differential equation is:

$$\phi_1 dx_1 + \phi_2 dx_2 + \ldots + \phi_n dx_n = 0. \tag{11}$$

By maximizing utility subject to the budget constraint, $\sum_{i=1}^{n} p_i X_i = m$, the market equilibrium conditions are obtained:

$$\frac{\phi_1}{p_1} = \frac{\phi_2}{p_2} = \ldots = \frac{\phi_n}{p_n}, \tag{12}$$

where p_i is the price of X_i and m is the budget. The demand functions can be derived from equation (12) as:

$$X_i = D_i(\vec{p}; m), \tag{13}$$

as can be the inverse demand functions:

$$P_i = p^i(\vec{X}; m). \tag{14}$$

From the market equilibrium conditions (12) and the inverse demand functions (14), it is possible, assuming the p^i are differentiable, to write (11) as:

$$\sum_{i=1}^{n} p^i(\vec{X};\, m)\, dx_i = 0 \Rightarrow \sum_{i=1}^{n} dp^i dx_j < 0, \qquad (15)$$

the convexity condition. Since the $P_i = p^i(\vec{X})$ are observed in the market place, it should be possible to obtain the ophelimity-index function by integrating (15). Indeed, "as long as one abides by Pareto's theory of binary choice, this position is faultless" [Georgescu-Roegen 1973, p. 331]. However, it may fail if one adopts the method of revealed preference.

For the case of two commodities, the family of "integral curves," which are a solution to the differential equations (15), are everywhere convex, with at least one integral curve passing through each ordinary point in commodity space. However, the integral curves may not necessarily have properties which allow one to identify them as the indifference contours postulated in the theory of demand. The following are some of the possible shapes which the integral curves may take:

(i) nonintersecting ellipses about a bliss (complete satiation) point, B, as indicated in Figure 10;

(ii) spirals coverging asymptotically toward B, as in Figure 11;

(iii) half-curves originating in B, as in Figure 12; or

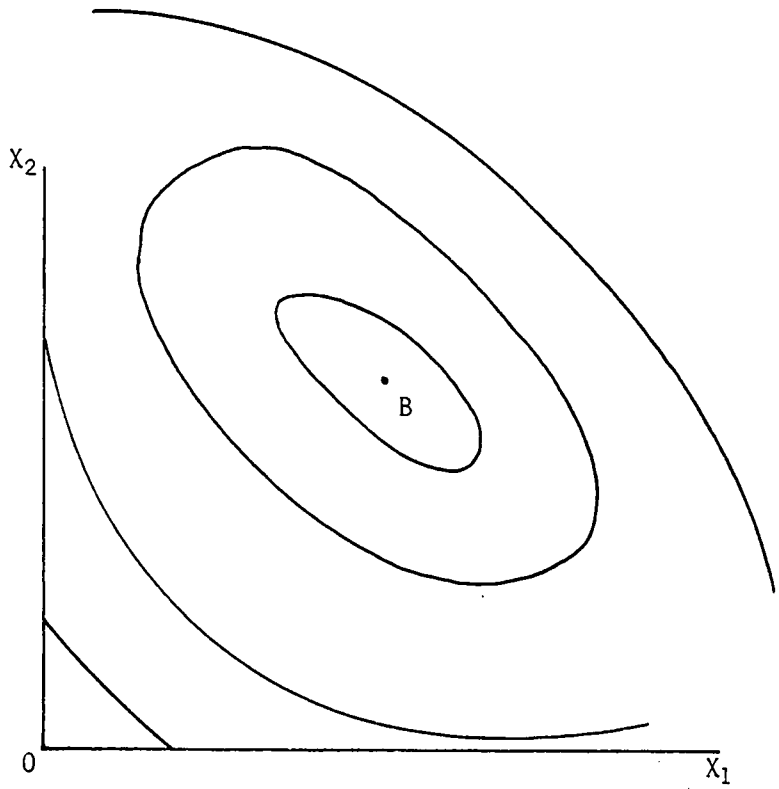

Figure 10. Ellipse-Like Integral Curves.

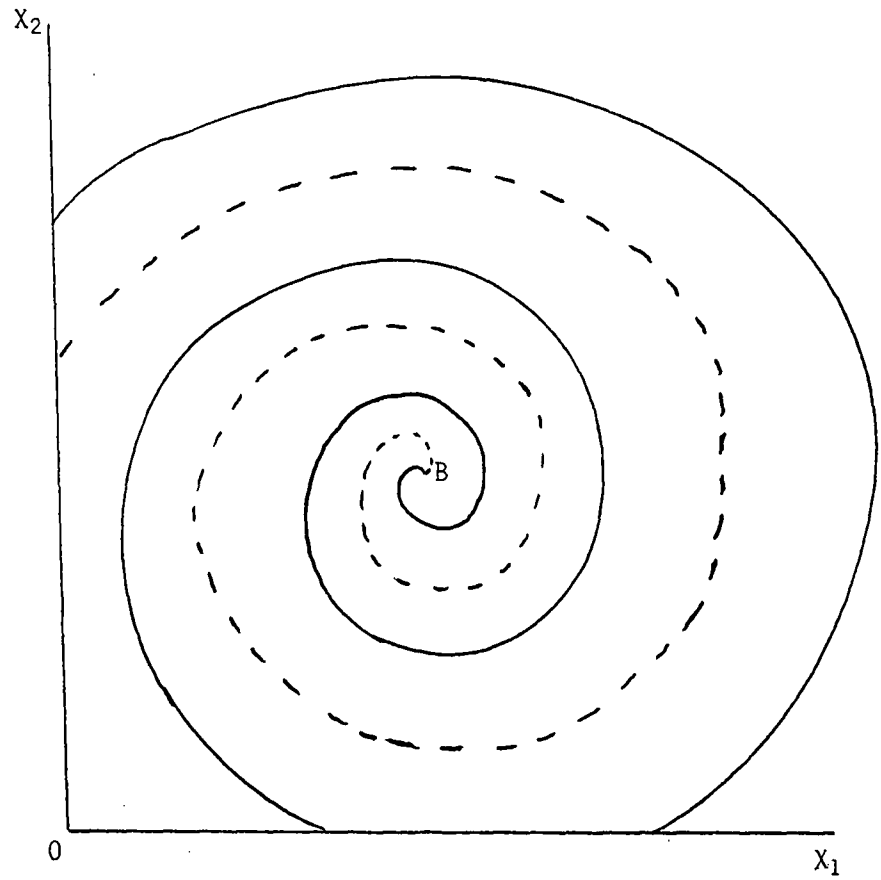

Figure 11. Spiral Integral Curves.

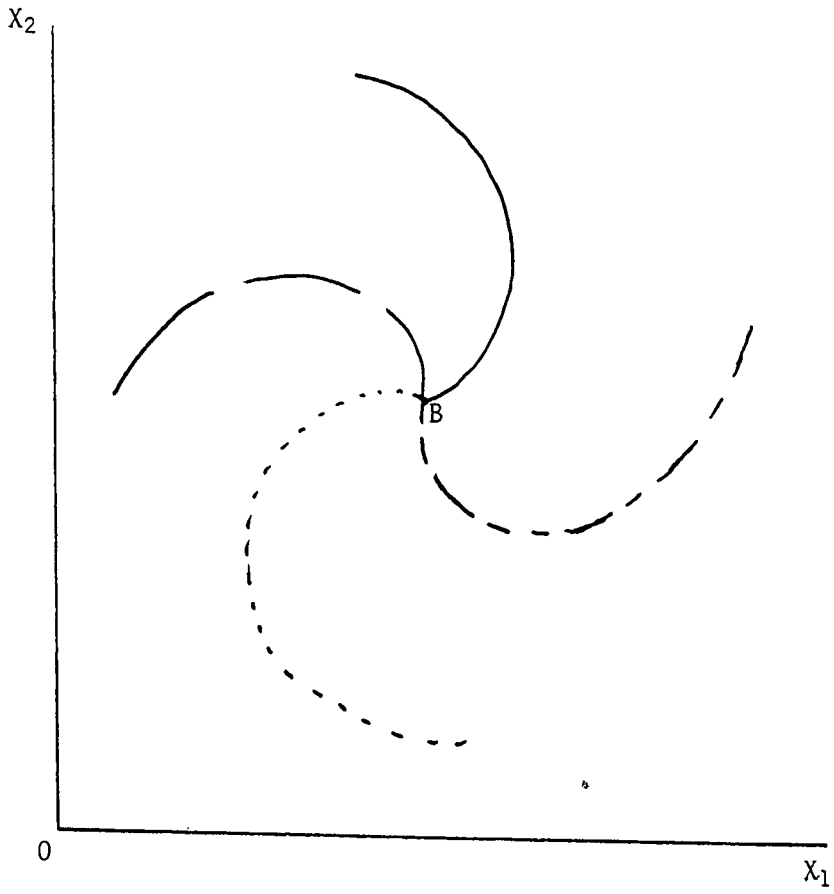

Figure 12. Half-Curve Integral Lines.

(iv) curves that may intersect and/or meet, as in Figure 13 [Georgescu-Roegen 1936, pp. 145-145; 1954(a), p. 200; 1968, p. 256; 1973, pp. 336-342].

Only in the case where the integral curves are ellipse-like can an index of ophelimity comparable to that postulated in traditional demand theory be constructed analytically. In the case of spirals, for example, the index of ophelimity (level of utility) increases and decreases in sinoidal fashion as the quantity of a commodity increases, the amount of the other commodity remaining fixed [Georgescu-Roegen 1936, p. 146]. However, it was the integral curves of Figure 13 which led Georgescu-Roegen to postulate his theory of lexicographical orderings discussed below.[7/]

For the case of more than two commodities, the differential equation (15) "may not be integrable and, hence, the integral varieties do not always exist" [Georgescu-Roegen 1968, p. 256]. This is the "nonintegrability problem." Hence, the paradox: why can an ophelimity index be derived from market (demand) data for two commodities, but not for more than two commodities? Unfortunately, this paradox seems to have overlooked the serious problem posed in the case of two commodities, namely, in only one case (Figure 10) is the analytically derived ophelimity index transitive. Hence, even if the "nonintegrability problem" were resolved--in the sense that analytic solutions are found--it is not a sufficient condition to allow economists to construct an ophelimity index from market data, i.e., from revealed

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7/ This was not the only contributing factor, of course. As shown below, classical economic thought also influenced his ideas.

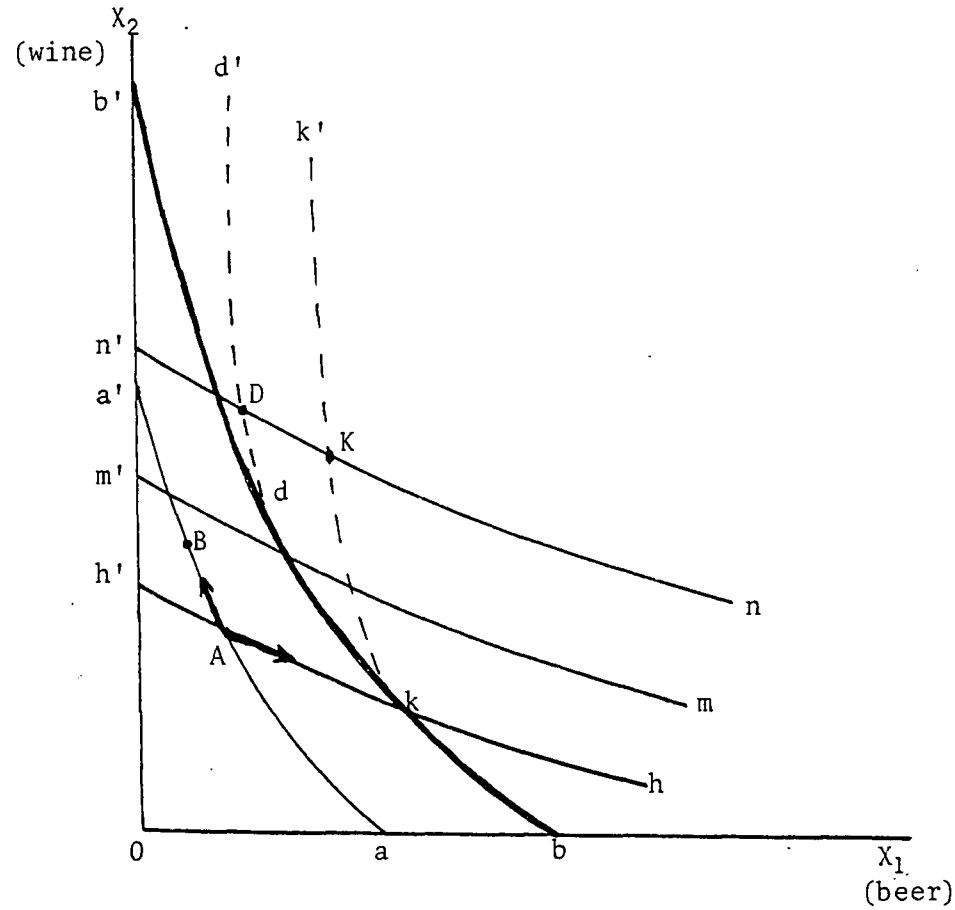

Figure 13. Intersecting Integral Curves and Lexicographical Orderings.

preferences.

The Hierarchy of Wants

The inability to derive, from the revealed preferences, the ophelimity varieties corresponding to the indifference maps postulated by standard economists led Georgescu-Roegen to abandon the neoclassical utility model. He rejected the idea that all human wants can be reduced to a common basis, known as utility, opting instead for retention of the "Principle of the Irreducibility of Wants," a classical vestige repudiated by the neoclassical economists. He also accepted the classical notion of a hierarchy of wants.

> "It has long been observed that human needs and wants are hierarchized. In fact, as the reader may convince himself by looking at random in the literature, this hierarchy is the essence of any argument explaining the principle of decreasing marginal utility" [Georgescu-Roegen 1954(a), p. 194].

Finally, since there is no one-to-one correspondence between wants and commodities, Georgescu-Roegen proposed a lexicographical ordering of commodity bundles. The lexicographical ordering was subsequently adopted by the humanistic economists in an attempt to construct a need-based, rather than utility-based, economics [Lutz and Lux 1979].[8/]

The principles of hierarchial wants, irreducibility of wants and lack of a one-to-one correspondence between wants and goods require lexicographical orderings as illustrated in Figure 13. Con-

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8/ Georgescu-Roegen also accepted the Principle of Subordination of Wants [1954(a), p. 194] which implies Gossen's law of satiable wants [1968, p. 262]. This can be seen by point B, the bliss or satiation point, in Figures 10 through 12.

sider an individual having at least the following wants: for thirst, for prestige and for the companionship of friends, in that order. Suppose only beer and wine are available to satisfy these needs.

Given the hierarchy of wants, "the choice between two combinations is always decided by the lowest relevant want that can be reflected in any of the two combinations" [Georgescu-Roegen 1954(a), p. 199]. Lines aa' and bb' (Figure 13) represent iso-thirst lines--that is, combinations of beer and wine along aa' have equal capacity to satisfy thirst and, similarly, for combinations along bb'. Any point lying on iso-thirst lines above aa' are preferred (subject to the exception discussed below). Combination B is preferred to A, however, because wine is assumed to better satisfy the prestige need. (The arrows in Figure 13 indicate preference directions.) Contours hh', mm' and nn' are each iso-prestige lines with prestige increasing as one moves from hh' to mm', etc. These contours determine preferred combinations of beer and wine when the bundles have an equal capacity to satisfy thirst.

Now assume that bb' represents satiation of the thirst want in a given time period. Choices between combinations on bb' are determined by the iso-prestige lines. Choices between bundles lying on the same iso-prestige curve, but to the northeast of bb', are determined by the need to satisfy the third want--the companionship of friends. Hence, if beer is assumed to satisfy this desire better than wine, combination K would be preferred to D. The iso-companionship lines dd' and kk'--points on kk' are preferred to those on dd', ceteris paribus--enable the individual to make choices between bundles in this case.

The resulting lexicographical ordering is consistent with the classical postulates and the analytic structure deduced from the neoclassical notion of revealed preference. In the process, the indifference postulate falls by the wayside, thereby destroying the foundation of the neoclassical theory of demand.

> "It is the principle of irreducibility, not the postulate of indifference, that should be a realistic theory of choice [Georgescu-Roegen 1968, p. 263]. This conclusion was reached not because it would constitute a more convenient approach or lead to a simpler scheme, but because it offers a more adequate interpretation of the structure of our wants" [Georgescu-Roegen 1954(a), p. 200].

Given the existence of a hierarchy of wants, Georgescu-Roegen argues that interpersonal comparisons of wants may be possible, although not in all circumstances. Certainly it makes economic sense to tax luxury items, such as trips to Hawaii, to help starving people. It is more difficult, however, to determine whether luxury items, such as video tape recorders, should be taxed to provide greater recreational facilities for hiking enthusiasts. In the former case, interpersonal comparisons are possible; in the latter case, economists may never be able to shake off the dogma of interpersonal noncomparability. Therefore, only in advanced societies may it be difficult, if not impossible, to resolve the issue of efficiency versus distributive equity.

The Implications for Applied Welfare Economics

The foregoing discussion has important implications for applied welfare economics, in particular, for the method of determining con-

sumer surplus from the estimated demand function.[9] When using empirical data to estimate the demand function for a particular good or service, one of two approaches can be taken. Whichever approach is decided upon, the analyst must be aware of the one he has chosen.

First, the analyst can assume that "individuals belonging to the same culture are likely to have in common a greater number of wants at the top of the hierarchy than those common to all men" [Georgescu-Roegen 1954(a), p. 198]. For advanced economies, therefore, a "well-behaved" utility function for a representative individual can be postulated and society's demand curve for the commodity derived directly, given the assumption that individual utility functions are nearly identical.[10] This solves the problem of aggregating over individuals. However, the demand function subsequently estimated may not be "neat" in the statistical sense of having high t-statistics and a high R^2. The reason is that economists cannot be expected to model human behavior exactly.

If a utility function is not postulated a priori, but the analyst believes the approach just described is the appropriate one, he must be careful in choosing a functional form for the demand curve to be

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[9] As a measure of welfare, consumer surplus is, of course, important in determining the benefits in benefit-cost analysis.

[10] Suppose the demand curve for the representative individual turns out to be $q_i = 3/5\ p_i - 15$. If there are 30 individuals in society, the true market demand function, which is to be estimated, is

$$Q = \frac{90}{5} p - 450.$$

The representative individual's (estimated) demand function is found by simply dividing both sides of the estimated market demand function by n (=30). This individual demand curve then forms the basis for recovering the representative individual's ophelimity-index function.

estimated. In particular, the ophelimity-index function should be recoverable from the estimated demand curve, even though the integral curves thus obtained can be given the title of indifference curves "by courtesy" only [Georgescu-Roegen 1968, pp. 257-258].

Consumer surplus can be determined directly from the ophelimity map (or postulated indifference map), in this case, and there is no need to be concerned about what the appropriate measure of welfare (e.g., consumer surplus) is. The analyst can use any welfare measure he desires [see Freeman III 1979, pp. 34-38]. If the integral lines cannot be recovered from the estimated demand function (i.e., no utility function is specified a priori), then another functional form needs to be tried, or another position regarding the theoretical derivation of the demand function needs to be adopted.

Second, the economist can assume that each individual has a different utility function and, hence, a different demand for the commodity in question. In this case, aggregation problems arise unless every individual's preference function is known, or postulated, a priori--an impossible task. Given that the individual utility functions are not known, it is argued that the best one can do is to allow the empirical evidence to determine the functional form and the explanatory variables to be included, subject to the restriction that the functional form be "reasonable." (For example, the own price elasticity of demand should, at least, be negative.) However, the meaning of consumer surplus is lost in the process and, hence, its measurement

is an irrelevant exercise![11/]

The approach preferred by this author is to postulate a utility function for a representative individual ex ante. In this way, the economist's views regarding social and human behavior are made explicit. Rather than being a strict statistical manipulator or, the preferred term, social engineer, the economist is required to develop skills in psychology, sociology and political science as well as economics. This will, in turn, better enable him to resolve conflicts such as those regarding efficiency and equity.

11/ A third approach can also be identified. Since the concept of an individual's utility function is merely a metaphysical one, there is no reason why one cannot postulate a group utility function with the same mathematical properties [Newman 1965, pp. 173-178]. However, in practice this situation is no different than the first. Integration of the differential equation obtained from the market data (i.e., Equation 15) must lead to integral curves which maintain the transitivity of choices.

PART II

APPLICATIONS

CHAPTER IV

LITERATURE REVIEW

In this treatise it is assumed that the object of public policy is to increase social welfare. Based on the past actions of the United States Congress and other public decision-making bodies, it is further assumed that social welfare has two major components: (i) the size of the economic pie, and (ii) the distribution of that pie. The aim of public policy is, therefore, to foster growth by selection of efficient programs and to provide for a more egalitarian distribution of income.[1/]

While practicing economists are not adverse to the dual objectives, efficiency and equity, many prefer to keep them separate. They argue that the function of the economist is to provide the authority with efficiency measures, while it is the purview of the politician, not the economist, to decide on distribution. Often they claim that the equity objective should not enter decisions regarding public project selection since distributional goals can best be achieved by fiscal means, namely transfer payments. However, the ability of the government to implement such transfers is severely limited by political and administrative constraints. Using public programs to affect income redistribution is often preferred to lump-sum transfers of income.

1/ This may simply imply that governments prevent a worsening of the existing inequality in society, or prevent the gap between rich and poor from growing too quickly.

> "One of the simpler means of income distribution may, in fact, be project selection. For example, the choice may be between project A to be located in a poor region or project B to be placed in a rich area, or between project X, which uses a large amount of poor, unskilled labor, which might otherwise be unemployed, and project Y, which uses factors of production supplied by rich people. Project choice has distributional implications, and sometimes it may be politically or socially more feasible to redistribute income this way rather than through taxes or other direct means. We have, therefore, quite a legitimate reason to consider distributional questions in evaluating social gains from a project" [UNIDO 1972, p. 23].

Since active participation in increasing one's own living standards enhances the self-respect of those to whom income is redistributed, and is more acceptable to those from whom income is transferred, public projects may be a better means for affecting income redistribution.[2/]

Other economists prefer to integrate efficiency and equity because this method makes explicit the value judgments upon which the analysis is based. It attempts to facilitate a distinction between personal interest and societal interest in public decision-making.

> "This is not meant to justify the notorious attempts by irresponsible politicians to influence project decisions on an ad hoc basis to obtain votes or money. Indeed, one of the advantages of having the political leadership articulate its judgments in the form of national parameters is that the articulation takes place in advance of taking decisions on specific projects. In this way the separation of judgments with respect to personal interest is facilitated. For before specific projects are at issue, the implications that different numerical

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2/ As indicated in Chapter III, there are also theoretical problems in relying on transfer payments to correct inequities resulting from program selection based only on the growth objective.

> values of national parameters may have for particular projects cannot be known, and the articulation of value judgments is more likely to be in terms of the policy makers' conception of the national interest than in terms of their personal interest. Special pleading later on would then show up more clearly as an attempt to gain exception to general national policy" [UNIDO 1972, p. 138 footnote].

Hence, it is argued that value judgments be made explicit rather than implicit.

Since economists need to take into account the distributional consequences of projects, it is necessary to determine ways to integrate efficiency and equity. While a social welfare function underlies all economic analyses, in practice the integration of efficiency and equity has sometimes resulted in the explicit specification of a SWF. In some cases, synthesis of the two objectives has been accomplished by allowing the social discount rate to vary. In other cases, integration involves the construction of a weighting scheme, with flexible weights and an emphasis on the need for consistency in project selection. A review of different methods for integrating efficiency and distributive equity is found in this chapter.

Bases for Income Distribution

Since it is important to know what is meant by distribution, four different, but not necessarily mutually exclusive, types of income distribution are identified. First, income can be considered to be distributed intertemporally. The concern is with the distribution of resources between present and future generations. The question is basically one of how much to allocate to investment as

opposed to present consumption.[3/] Intertemporal distribution is resolved once the appropriate rate of social discount is determined. A lower discount rate weights the present less, while a higher rate weights the present more.

Second, there is the problem of how much income to allocate to the public sector as opposed to the private sector. This problem can only be resolved, if ever, by appeal to historical, political, economic and other factors, and is beyond the scope of this analysis.

Third is the problem of interregional income distribution. It is related to the fourth basis of income distribution, namely, interpersonal income distribution. Decision-makers are often interested in redistributing income to the lower income groups in society. If it is assumed that the allocation of projects is an appropriate means of achieving the desired income redistribution (given that transfer payments may not be feasible), project selection amounts to choosing one region over another if the projects are area specific. Hence, decision-makers interested in transferring income to low income groups may, in fact, allocate projects to low income regions. If this is the case, intra-regional equity effects of projects should also be considered. The regional issues are discussed further in Chapter V.

Efficiency Versus Equity

The public administrator is faced with a set of legally accept-

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[3/] Present consumption includes both private and government consumption of goods and services as is seen in the well-known income identity: $Y \equiv C + I + G$.

able projects, the financing of which would require more funds than his budget allows. How does the decision-maker select among the various projects given that he wishes to take into account certain objectives? In particular, suppose that the executive wishes to allocate his budget among those projects which give the "best" tradeoff between efficiency and equity. He will then choose those projects which maximize his particular concept of social welfare, his tradeoff between efficiency and need.[4/] To do this he needs to weight the various objectives.

> "Economists, as scientists, are unwilling to make any explicit assumptions regarding the relative importance of a marginal dollar of benefits (or of costs) to different people. This retinence, which I regard as the primary explanation of the disregard for distributional effects, means that the implicit assumption has been that the marginal importances are all equal--that is, a dollar's worth of marginal income or cost has been given an equal weight (equal to one) regardless of the people who received that benefit or who bore the cost. This implicit assumption cannot bear scrutiny, however, and economists have simply made it for convenience" [Weisbrod 1968, p. 182].

McGuire and Garn suggest five possible rules which a manager might adopt to guide his decisions.

> "1. Ignore questions of need and exhaust the budget on the most efficient projects.
> 2. Ignore efficiency and (select on the basis of) those who most need it.
> 3. Establish a minimum efficiency and select according to need; look at the outcome and re-evaluate the constraints.

[4/] In light of Arrow's Impossibility Theorem [Sen 1970, pp. 41-46], Robbin's comment seems appropriate: "Scratch a would-be planner and you usually find a would-be dictator" [1932, p. 125 footnote].

4. Establish a minimum level of need and select according to efficiency; look at the outcome and re-evaluate the constraints.
5. Develop an explicit preference function between need and efficiency" [1969, p. 888].

While the weights between efficiency and equity are obvious for rules 1 and 2, they are not so for the other choice rules. Resolution of the efficiency-need tradeoff by rules 3 or 4 is recommended by Marglin [1962].[5/] If these rules are used, the weighting scheme underlying the decision-maker's preference function is implied. Ex post quantification of the "weights between objectives may be possible and ultimately helpful in narrowing the bounds of conflict in public decision making issues" [Stevens 1979, p. 29]. If, on the other hand, the weighting scheme is desired to be made explicit (rule 5), it is necessary for the executive to announce the tradeoff between equity and efficiency a priori. Some consider an explicit "method of expressing interpersonal welfare comparisons (which every bureaucracy makes) superior to implicit bureaucratic groping" [McGuire and Garn 1971, p. 933].

Methods Used to Derive Weights

Most, but not all, of the weighting schemes require estimates of the marginal social utility of income.[6/] This estimate is then used to weight the measure of efficiency to get the true social ranking

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[5/] These are his methods III and I, respectively.

[6/] It should be noted that most writers claim that the marginal utility of income is the appropriate weight to apply to the efficiency measure. However, this is true only if it is also assumed that all persons are to count equally. Recall Equations (5) and (6).

of projects. The efficiency rating commonly employed is either the benefit-cost ratio or net present worth of a project.[7/]

Study One

Haveman [1965] studied Congressional allocation of public programs to various states. He concluded that low-income regions and regions with high resource development potential tended to receive a greater share of public funds. As a result, many of the projects for which funds were appropriated were less efficient than rejected projects. Therefore, regional economic aid or income redistribution was a consideration in Congressional selection of projects. The social welfare ranking, therefore, must be different than the strict efficiency ranking of benefit-cost analysis.

To determine the true ranking, Haveman developed arbitrary weights based on marginal income tax rates. Choosing the arbitrary weight of 1.0 for the income class having a marginal tax rate of 0.2, for example, results in weights of 0.5 and 2.0 for income classes with marginal tax rates of 0.4 and 0.1, respectively. Having chosen the weighting scheme, Haveman then developed weights for each state based on the distribution of state income classes. Using these state weights, Haveman obtained a ranking which was closer to the actual Congressional ranking than the ranking based on benefit-cost criteria.

The major criticism of Haveman's analysis is the concern that

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7/ The benefit-cost criterion is an indicator of efficiency under certain restrictive assumptions only. For present purposes, however, this is not important. As long as the authority equates the benefit-cost criterion with efficiency, this surrogate is an appropriate measure of efficiency. As indicated in Chapter V and VI, other surrogates may also exist.

marginal tax rates do not represent the appropriate equity weights since they do not adequately account for regional differences. Further, the method used to derive the state weights is somewhat arbitrary.

Study Two

Weisbrod [1968] assumed that there is an implicit tradeoff between equity and efficiency and, using ex post analysis of conflict resolution, he estimated a weighting scheme. Weisbrod proceeded by ranking a sample of projects according to an efficiency measure--the benefit-cost ratio, in this case. Among the rejected projects in the sample, the project with the highest benefit-cost ratio is used as a benchmark for comparing those accepted projects which have lower benefit-cost ratios than the rejected projects.[8/] The difference between the accepted projects and the benchmark project is used to determine the weighting scheme.

Initially Weisbrod assumed all projects have the same cost. The benefits of a project accrue to different categories (nonpoor whites, poor whites, nonpoor blacks, and poor blacks) and simultaneous equation estimation is used to determine the weighting scheme. The system of simultaneous equations is:

$$a_1B_1 + a_2B_1 + \ldots + a_mB_1 = B_1 \geq B^*$$

$$a_1B_2 + a_2B_2 + \ldots + a_mB_2 = B_2 \geq B^*$$

$$\vdots$$

$$a_1B_n + a_2B_n + \ldots + a_mB_n = B_n \geq B^*$$

[8/] In practice, Weisbrod uses those projects with higher benefit-cost ratios, but started at a later date than those with lower benefit-cost ratios, as the method of comparison.

where $B_1, \ldots, B_n$ are the adjusted benefits of the n different projects (adjusted to be at least as large as the benefits of the benchmark project); B* are the benefits of the banchmark project as measured by usual benefit-cost techniques; and $a_1, \ldots, a_m$ are the weights applied to the m different groups. (In Weisbrod's analysis m = 4.) Sensitivity analysis was used to allow the adjusted benefits of the various accepted projects to exceed those of the benchmark project by varying amounts. Weisbrod accounted for the different costs of projects by adjusting the benefits (multiplying the right-hand side of each equation) by the ratio of the costs of a specific project to the cost of the benchmark project, i.e., multiplying the right-hand side by Cj/C*.

There are several problems with Weisbrod's methodology. First, the analysis assumes that the authority knew the distributive effects of all the sample projects. Therefore, an arbitrary assignment of equity effects to arbitrarily chosen categories was made. An attempt at sensitivity analysis in this respect was not very successful. Second, the system of equations is easily over-identified and, as a consequence, no unique weighting scheme exists.

Weisbrod only suggested the use of this approach but did not actually apply the model. The lack of appropriate data may be one reason for this.

Study Three

McGuire and Garn [1969] develop an explicit preference function between efficiency and need for the U.S. Economic Development Administration. Recognizing that there is no single decision-maker within

the E.D.A., they proceeded to determine a functional form for the weights used by the administrators. The functional form was determined by asking the administrators for their preferences between efficiency and need, and then experimenting with E.D.A. project data until an adequate preference function for E.D.A. administrators was found--a Bergsonian-type welfare function. While the benefit-cost ratio was used as the measure for efficiency, McGuire and Garn estimated the following function for determining the appropriate regional weight:

$$q^i = 0.5(\bar{E}/E^i)^{22.4} + 0.5(\bar{Y}/Y^i)^{2.5},$$

where

q^i = area need indicator (or weight);

$\bar{E}$ = national average employment rate;

E^i = area employment rate;

$\bar{Y}$ = national median family income; and

Y^i = area median family income [1969, pp. 885-887].

Study Four

Stevens [1972], following a suggestion by Marglin [1962, p. 80], integrated efficiency and need by discounting the net benefits of a project at different rates of discount, depending upon the income group to which the benefits accrue. Sensitivity analysis was used to allow for different value judgments regarding the appropriate income distribution.

An argument for using the discount rate to take account of equity effects is that a higher discount rate tends to favor less

capital intensive projects.[9/] Emphasizing less capital intensive projects results in the use of more labor which, it is argued, constitutes a redistribution of income towards the poor. This may not be the case, however, if the labor employed is highly skilled or comes from outside the region or county. Further, capital intensive projects designed to provide services to the poor (e.g., education facilities, roads, sewers, etc.) may be neglected when a higher discount rate is used.

Another reason for rejecting this procedure is that it places a burden on the discount rate which it was not meant to bear. The discount rate is used to determine society's intertemporal distributions and is varied, by some analysts, to account for the riskiness of projects as well. Therefore, requiring the discount rate to further take into account nontemporal distributive effects makes it much more difficult to determine the appropriate social discount rate to use. As a result, adjusting the discount rate to take into account distributive effects does not provide a general method for integrating efficiency and need.[10/]

[9/] Capital intensive projects have high initial costs with benefits accruing in later years. A low discount rate would favor construction of capital intensive projects since the future benefits are worth more today than they would be if a higher discount rate is used.

[10/] Little and Mirrlees [1974] vary the discount rate to select projects when a budget constraint exists. Their methodology requires the decision-maker to keep increasing the discount rate used to discount the stream of net benefits on every project until only enough projects with a positive net present value remain to just exhaust the budget. Their approach is considered improper since important capital intensive projects may be eliminated.

Study Five

The approach taken by UNIDO [1972] to account for the tradeoff between efficiency and need in underdeveloped countries is to make the distributional weight an unknown parameter. "Switching values" for the weight parameter are determined as follows. Each project is assumed to have a tradeoff between two groups--the nation and some sub-group such as a region. If the net present values of aggregate (national) consumption and the consumption of peasants, for example, are denoted by B_1 and B_2, respectively, then the goal is to maximize $V = B_1 + wB_2$, where w is the unknown weight on peasants' consumption. Values of w and the discount rate (i) are chosen so that a switching curve where V=0 can be drawn, as illustrated in Figure 14. Values of w and i to the left of the curve imply an increase in social welfare while values to the right indicate a fall in social welfare. By observing a sufficient number of projects and project variants "one will, it is hoped, be able to converge to the values of those national weights that reflect the policy makers' judgments" [p. 290].

The major problem with the UNIDO approach is that only one project at a time can be analyzed. It is difficult to consider a set of projects and rank them, according to a set of derived weights, among more than two beneficiary groups. The reason for this is the authors' desire to avoid specifying a social welfare function.

Study Six

Little and Mirrlees [1974] also suggest a method for analyzing projects in less developed countries (LDCs). Their method requires the "calculation" of shadow prices, wages and exchange rates to take

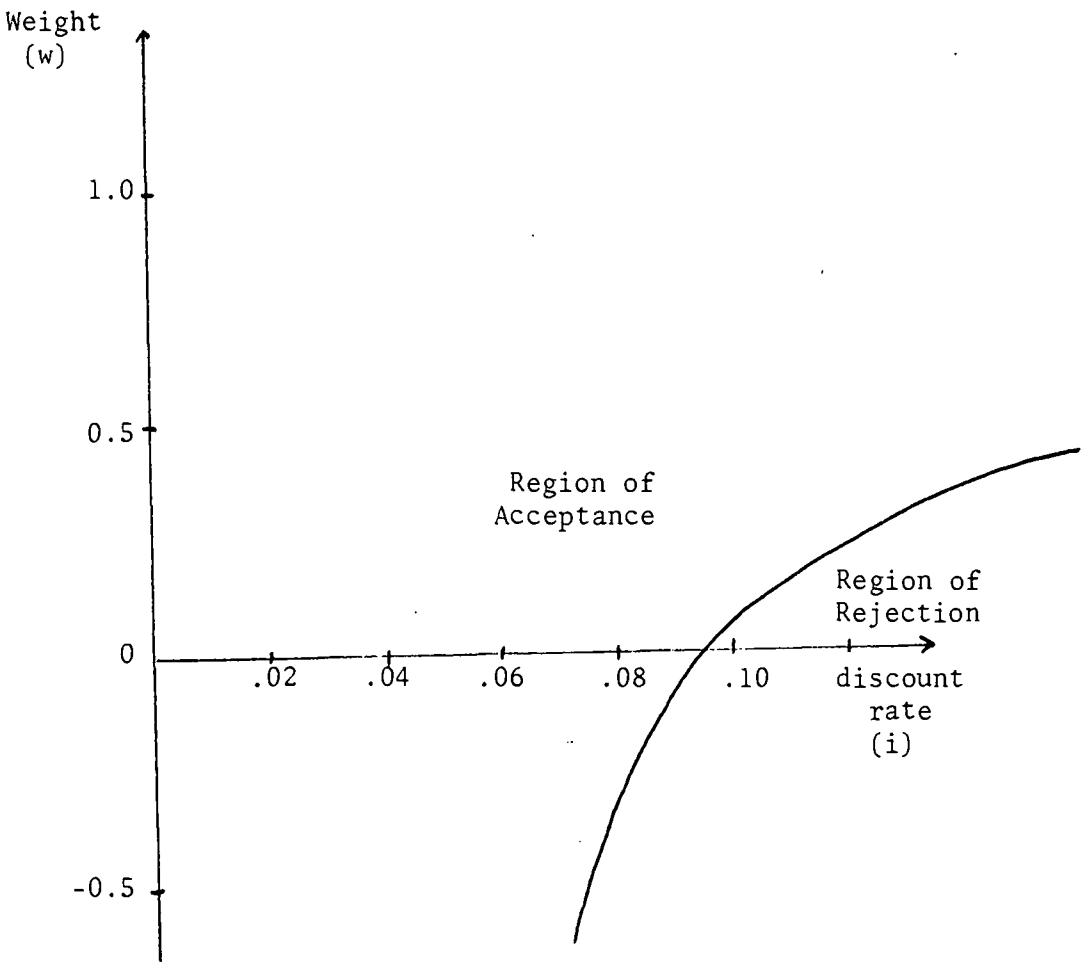

Figure 14. Switching Curve for Project Acceptance or Rejection.

SOURCE: UNIDO 1972, p. 290.

into account externalities, market imperfections and price distortions occurring as a result of public programs. Unfortunately, as Georgescu-Roegen [1960] demonstrated, underdeveloped economies do not function according to the principles of marginal productivity theory. Therefore, the approach suggested in the Little and Mirrlees study, and other World Bank publications (see Study Seven), may not be the correct one.

Although the discussion here is not meant to consider the problem of development in third world nations, Little and Mirrlees do provide a means for determining distributional weights for different consumption classes. Although they measure their distributional parameters in terms of shadow prices, they could just as easily have been measured at market prices.[11/] A base consumption level, b, is interpreted as (a) the level of consumption below which people are subsidized, (b) the level of consumption which just escapes the direct tax net, or (c) some average of (a) and (b). If c_i is the consumption level of consumption group i, then the weight to use for group i is simply b/c_i. However, this method of weighting is considered unworkable because it requires politicians to commit themselves to a system of inflexible explicit weights.

Since Little and Mirrlees desire to retain the use of an explicit weighting scheme, they suggest that decision-makers use the following function to derive consumption weights:

$$v = (b/c)^a, \tag{16}$$

11/ Little and Mirrlees convert the distributional weighting factor at shadow prices to the weighting factor at market prices by multiplying the former by the ratio of the value of each group's consumption at shadow prices to its value at market prices [1974, p. 238].

where

v is the marginal social welfare of consumption (i.e., the consumption weight),

b is the base consumption level,

c is the value of consumption, and

a is the elasticity of the consumption weight.

The elasticity of the consumption weight can be found from (16):

$$a = -\frac{c}{v}\frac{dv}{dc}.$$

Assuming that $v > 0$ and that there is diminishing marginal social welfare of consumption, $a > 0$.

The decision-maker's concept of an individual's welfare function is:

$$V = \begin{cases} A + b \ln c & \text{if } a = 1 \\ A - \frac{1}{a-1}\left[\frac{b^a}{c^{a-1}}\right] & \text{if } a \neq 1,\ a > 0, \end{cases} \tag{17}$$

where A is a constant (of integration). Hence, $v = dV/dc$.

Explicit weights for various values of b/c (b = constant) and a are given in Table 1. While a large number of different consumption groups are considered in Table 1, Little and Mirrlees argue that it might be easier for policy implementation to use only three or four broad groups of consumers.

Little and Mirrlees' methodology is expanded by Squire and v.d. Tak [1975], whose method is reviewed below. However, the emphasis in that discussion is on income rather than consumption categories since it is easier to classify according to income classes than by consumption groups.

Table 1. Values of the Consumption Distribution Weight (v) for Marginal Changes in Consumption.

Value of Distribution Weight, v			
	a		
c/b	1	2	3
0.25	4	16	64
0.50	2	4	8
0.75	1.33	1.78	2.38
1.0	1	1	1
1.5	0.66	0.44	0.30
2.0	0.5	0.25	0.125
3.0	0.33	0.11	0.04
5.0	0.20	0.04	0.01
10.0	0.10	0.01	0.001

SOURCE: Little and Mirrlees 1974, p. 240; Equation (16).

Study Seven

Squire and Van Der Tak [1975] recommend that the World Bank use an explicit weighting scheme to determine the social ranking of projects. Since the World Bank is primarily concerned with the allocation of funds among developing countries, Squire and v.d. Tak derive several different weights. The authors consider the distribution of benefits and costs between the public and private sector, and the impact of projects on the availability of foreign exchange. Projects which result in domestic goods replacing imported ones, increased exports and general saving of foreign exchange are preferred to those projects which do not provide these foreign exchange savings.[12/]

While these concerns may be important for developing countries, the distinction is less important for industrial countries, such as the United States, which already have high levels of public services, a broad revenue base and a viable balance on international transactions. The Squire and v.d. Tak methodology regarding income distribution is the concern here.

The derivation of equity weights is based on three assumptions:

(i) There are no consumption externalities.

(ii) All individuals have identical utility functions with diminishing marginal utility of income.[13/]

12/ For an opposite view see Georgescu-Roegen [1960] and Lutz and Lux [1979].

13/ This is a neoclassical assumption rejected by the New Welfare Economics [Mishan 1980, p. 146]. See also Chapter II.

(iii) The total welfare of society is the sum of the individual levels. Hence, a SWF is assumed.

Squire and v.d. Tak postulate the following marginal social utility of real income for an individual (group):

$$U_y = y^{-n} \quad , \quad n > 0, \tag{18}$$

where n is a parameter and y is the current level of real income (per capita). The utility function is then

$$U(y) = \begin{cases} \frac{1}{1-n}\ y^{1-n} + \text{constant} & \text{for } n \neq 1, n > 0, \\ \ln y + \text{constant} & \text{for } n = 1 \end{cases} \tag{19}$$

such that $U_y > 0$ and $U_{yy} < 0$.[14/]

The value of the parameter n is important in determining the weighting scheme. If n is equal to zero then the marginal utility of income is independent of the level of income. The larger n, the more value is income accruing to a poor man.

> "With n set equal to zero, as in traditional analytical methods, all additional consumption (income) is considered equally valuable regardless of the recipient's existing level of consumption. As n is increased, so the egalitarian bias is increased: a value of n equal to unity implies quite a pronounced bias in favor of the poor, the weight on additional consumption decreasing proportionately with increases in the existing level of consumption. With n equal to 2, the weight falls with the square of the pro-

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14/ The individual (or group) utility function in Equation (19) is actually the individual's (group's) contribution to societal welfare. Further, it should be noted that this is not the individual's utility function but, rather, the authority's perception of that utility function. The same is true of the welfare function found in Equation (17).

> portionate increase in the existing consumption level; and ... this leads to a set of weights that implies a marked egalitarian bias" [Squire and v.d. Tak 1975, p. 64].

For most governments, n is equal to one, with n equal to zero or two considered to be extremes [p. 63].

The weighting scheme can be determined in any one of three ways. While the first two schemes are similar, the third scheme relies on a measure of the inequality of income among individuals, income groups or regions. The schemes are briefly discussed below.

Scheme One. The first weighting scheme defines the income distribution weight, d, for marginal changes in income as:

$$d = \frac{U_y}{U_{\bar{y}}} = \left[\bar{y}/_y \right]^n , \tag{20}$$

where $\bar{y}$ is the average level of real income.[15/] From Equation (20) a table such as Table 1 can be constructed.

If some individual's income relative to the average diverges at a constant rate, k, over time, then a time-dependent distribution weight can be found:

$$d_t = \left[\frac{\bar{y}_t}{y_t} \right]^n = \left[\frac{\bar{y}_o e^{kt}}{y_o} \right]^n = d_o \cdot e^{ktn} , \tag{21}$$

where the subscript "o" refers to the initial (starting) time period.

15/ Note than n is defined in the same way as a in the previous section--i.e., n is the elasticity of the income weight. In fact, Equation (20) is simply (16). However, Squire and v.d. Tak provide a stricter derivation of the weight than do Little and Mirrlees. The major (and important) difference between (20) and (16) is the use of $\bar{y}$ as opposed to b_y, although $\bar{y}$ is not defined as a base but rather as an average.

If $k > o$, the weight attached to that individual (group, region) increases over time; if $k < o$, d_t decreases over time; and if $k = o$ then $d_t = d_o$.

Scheme Two. For non-marginal changes in income the appropriate weight is defined to be:

$$d = \frac{U(y_2) - U(y_1)}{\bar{U}_y (y_2 - y_1)} \quad , \quad y_2 > y_1 \tag{22}$$

Substituting (18) and (19) into (22) gives:

$$d = \begin{cases} \dfrac{\bar{y}^n (y_2^{1-n} - y_1^{1-n})}{(1 - n)(y_2 - y_1)} & \text{for } n \neq 1,\ n > 0. \\ \dfrac{\bar{y} (\ln y_2 - \ln y_1)}{(y_2 - y_1)} & \text{for } n = 1. \end{cases} \tag{23}$$

The values of income weights for non-marginal changes can be tabulated from Equation (23).

Scheme Three. Squire and v.d. Tak [1975, pp. 137-139] derive a global (summary) distribution weight, D, which is used when it is not possible to identify the individuals or groups affected by a project. This derivation assumes that an increment of income is distributed among the population in the same way as current income.

To determine the distributional weights, the analyst evaluates the impact on each income class and then integrates over the affected classes; i.e.,

$$\text{distribution weight} = \frac{1}{\bar{U}_y} \int_{y_m}^{\infty} U_y \, g(y) \, dy, \tag{24}$$

where y_m is the subsistence (or minimum) income level and g(y) describes the distribution of the increase in income across classes.[16/] In the absence of information about g(y), the assumption that increases in income are distributed as is current income implies that:

$$g(y) = f(y) \cdot (y/\bar{y}), \tag{25}$$

where f(y) is the current income density function.

Assume income is distributed according to the Pareto distribution function:

$$F(y) = 1 - (y_m/y)^p, \tag{26}$$

where $p > 1$ is a parameter. The corresponding density function is:

$$f(y) = F_y = p\, y_m^p\, y^{-(p+1)}. \tag{27}$$

Inserting (27) into (25) and the result into (24) gives:

$$D = p\, y_m^p\, y^{n-1} \int_{y_m}^{\infty} y^{-(n+p)}\, dy. \tag{28}$$

Since $E(y) = \bar{y} = (\frac{p}{1+p})y_m$ for the Pareto distribution, it is possible to solve (28) to obtain:

$$D = \frac{p^n\,(p-1)^{1-n}}{(n+p-1)}. \tag{29}$$

The advantage of using the Pareto distribution is that the Pareto parameter (p) is related to the Gini coefficient (G), which can be used to measure relative income inequality, as follows:

16/ It might be appropriate to define y_m in the same way as b was defined in the previous section.

$$p = (1+G)/2G.$$

The Gini coefficient is calculated in one of the following two ways:

(a) G = the area between the Lorenz curve and the diagonal divided by the total area under the diagonal.

(b) G = 1 - 2 · (the area under the Lorenz curve).[17/]

The Pareto distribution is unrealistic, however, for describing regional income distributions. In Chapter V, a method for deriving the summary distribution weight using the gamma distribution is described.

As illustrated in Table 2, n values must be greater than one before the summary weights will differ much from unity. This implies that the authority must give considerable weight to income distribution.

Study Eight

Harberger [1978 and 1980] criticizes the approach used in the previous two studies because it results in too wide a spread in weights. For example, in Table 1, a weight of 64 is indicated when a is chosen to be 3. For this case, "a transfer from a typical family to one that was only one-fourth as well off could entail a waste up to 63 times the amount transferred and still be, in principle, acceptable" [1978, p. S112].

Harberger makes the following proposals:

17/ See Atkinson [1970] for a discussion of the Lorenz curve and Gini coefficient.

Table 2. Values of the Summary Distribution Weight (D).

Pareto Parameter (p)	n				
	0	0.5	1.0	1.5	2.0
1.5	1.0	0.86	1.0	1.3	1.8
2.0	1.0	0.94	1.0	1.1	1.3

SOURCE: Squire and v.d. Tak 1975, p. 67; Equation 29.

(i) The distribution of income should have a wide span--say, a factor of ten or more.

(ii) Distributional weights should not be tightly clustered about 1.0 (as in Harberger's 1978 paper) nor should they be too dispersed (as in Table 1). "For a 10-fold range of income distribution, the range of weights might be 0.50-2 or 0.33-3 or 0.25-5" [1978, p. S116].

(iii) Society should be indifferent regarding income transfers among the upper income classes, however defined.

(iv) A critical premium of ten percent, or 20 percent at the outside, should be used as the opportunity cost of redistributing income via a particular project.[18/] The net distributional benefits or costs of the program under study is the lesser of the derived distribution weight and the alternative cost premium times the net change for the group in question.

Harberger argues that if his method is applied only to groups below the poverty line, then there are only two parameters which require ethical judgments--the alternative cost premium and the definition of the poverty line. Policy-makers, however, are concerned with the distributional effects among all income levels and not only with those transfers accruing to groups below the poverty line. Further, public projects may be allocated to a particular group for

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18/ Layard [1980] argues that the empirical evidence indicates the cost of transferring income is higher than that suggested by Harberger.

reasons other than income distribution or efficiency.

Summary and Conclusions

There is sufficient evidence in the literature to indicate that economists are concerned about devising a methodology to enable decision-makers to take into account the distributional consequences of their actions. One approach is to determine equity weights *ex post* and use these to guide the authority in making future decisions. The other approach is to determine equity weights *a priori*.

While the latter approach seems to be preferred in the literature, the construction and use of such explicit weights needs to be kept rather flexible to prevent the authority (especially politicians) from becoming "locked-in"--that is, pressured to choose a particular project because it ranks higher than some preferred project on the equity-corrected ranking scale.[19] Therefore, it is important to provide the authority with a number of different weighting schemes so that he can readily see how project rankings are affected by different value judgments regarding the desired degree of income inequality between groups or regions. If the decision-maker chooses a weighted scheme then he will be consistent in his value judgments and, hence, his project selection.

In Chapter V methods for constructing both *ex post* and *ex ante* equity weights are considered. The emphasis is on regional distribution of projects and, hence, redistributional effects between regions. An *ex post* quantification of "area specific" weights en-

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[19] This may be desired if one wants to reduce graft in project selection.

ables the analyst to predict a social ranking of projects based on past project selection. The ex ante method of Little and Mirrlees, and Squire and v.d. Tak, is modified to determine project rankings under different value judgments.

CHAPTER V

MODEL DEVELOPMENT

An important aspect of public policy and program assessment is the identification of those who gain, those who lose and why [Nelson 1977]. In this chapter it is argued that, for many public projects, a simple means to identify benefactors and beneficiaries is by region. The limitations of regional classification, and its advantages and disadvantages, are discussed in the first section below.

Two models for determining the weighting scheme to be used by decision-makers to synthesize efficiency and equity are compared. The first model determines weights based on information regarding previous project selection by policy-makers, thereby allowing the analyst to predict future weights. Using the predicted weights, new projects can be ranked, integrating both efficiency and need. Since prediction is based on the past actions of executives, continual revision of the model will be required if it is desired to gain knowledge regarding how a public agency will likely spend its limited funds among the many projects available to it.

The model can also be used to identify those proposed projects where the tradeoff between efficiency and need deviates substantially from that existing in the past. In this case the authority could be asked to identify additional factors which might lead to the proposed project's selection.[1/]

1/ Weisbrod [1968, p. 192] suggests that ex post quantification of weights could be used for these purposes, although he did not attempt such use.

The second model relies on ex ante derivation of weights, similar to the method used by the World Bank (see Chapter IV). Both specific income distribution weights and summary weights are considered. Once constructed, these weights can be used to determine an equity-corrected ranking of projects. Further, the ranking obtained via the second model can be compared with that of the first model.

The social welfare function (SWF) is explicitly determined in the two models. It turns out that the SWF needs to be dictatorial to determine the weighting scheme. This is primarily because the SWF is dictatorial in practice.

Identification of Program Beneficiaries and Losers

Classification by Region

When a decision maker chooses among projects on the basis of need as well as efficiency, it is important that he is able to distinguish the groups in society that benefit and lose. Since specific geographic areas are often easiest to identify, it is argued that decision-makers consider distributive impacts as occurring between regions rather than between income categories, racial classes and so on.[2/] While regional versus other classifications are not mutually exclusive, the need index generated in this analysis "is based upon the assumption that Federal (state) grants are 'area specific,' and choosing one project over another is tantamount to choosing one area over another"

2/ While this is true of many programs, especially water resources projects, it may not be true of programs such as food stamps, welfare, and so on.

[Mathur 1971, p. 929].[3/]

The emphasis is on "area specific" weights since the incidence of benefits and costs by specific individuals or income categories is often unknown. While it may be possible to identify the direct burden of a public project on an individual or group via the tax system, it is a difficult task to identify recipients of project benefits, whether the benefits are positive or negative.[4/] This is particularly true when benefits are nonmarket benefits. Unfortunately, the identification problem does not altogether disappear when a regional classification is used. When projects are allocated to a specific region, individuals or groups within the region are unlikely to share the benefits and costs equally. Yet, tracing through these intra-regional effects is a very difficult task.

UNIDO [1972] takes the view that "regional classification makes sense (but) only if one has confidence that benefits and costs in poor regions will, at the very least, be distributed uniformly among the population" [p. 77]. This position is adopted here.[5/] It is argued that the regional classification used in this analysis results in the identification of regions which are sufficiently homogeneous to enable decision-makers to consider benefits accruing to the region as being

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[3/] Mathur argues, however, that the need index should be project specific. But his argument applies only to the explicit construction of a need index as proposed by McGuire and Garn [1969]--an agrument which McGuire and Garn [1971] refute. UNIDO [1972] also prefers regional identification of the distribution of costs and benefits.

[4/] Negative benefits occur, for example, when a project results in the loss of a favorite 'fishing hole,' a tranquil environment or a reduction in the game available to hunters.

[5/] Flacco [1978] adopts this assumption when he determines the net loss to different income categories in Douglas County, Oregon, as a result of predicted cutbacks in timber output in that county.

distributed uniformly.

Extraregional Benefits

Several problems remain, however. Often program benefits accrue to individuals or groups located outside the identified region. Outsiders may visit the region to enjoy the recreational benefits of a project, or they may benefit from regional exports resulting from the project. For example, a dam providing irrigation benefits to local residents may also increase the availability of electricity to nonlocal households thereby reducing their electricity costs. The dam may also provide flood control benefits to nonlocal households. Perhaps labor migrates into the region to take advantage of employment opportunities. While the total income of a region may increase as a result, benefits to current residents may remain unchanged or even decline. Hence, it is necessary to compare per capita income for the region, with and without the program, rather than total income.

The Use of Regional Per Capita Income

If a project results in a sufficient increase in the income of the higher income classes, with little or no increase in the income of the poor, then an increase in regional per capita income is not an appropriate measure of redistribution. Once again the assumption that benefits are uniformly distributed needs to be invoked if change in per capita regional income is used as an indicator of redistributional effects.

Employment as an Indicator of Distributive Effects

Employment is an attractive surrogate for benefits and income redistribution. "Often employment will be an important vehicle of income redistribution and the fact that its political feasibility is somewhat greater than pure distribution of money, except in special situations, cannot be overlooked" [UNIDO 1972, p. 93]. However, an increase in regional employment does not always imply that those currently unemployed in the region benefit, nor does it always result in the reduction of a region's unemployment problems. If labor is sufficiently mobile, it is possible that unemployment is the same or greater after a public program than before it. This could occur if (i) migration of unemployed workers from outside the region offsets employment gains due to the public program, or (ii) if no benefits accrue to unskilled, unemployed residents because the project provides jobs for skilled workers only.

Regional Multipliers and Resource Mobility

The direct redistributional benefits are not always the only benefits of a public project. A proportion of the income paid to workers, for example, is spent in the local community. The merchants receiving these dollars will increase their purchases of inputs, some of which are purchased locally. This results in another round of spending. Hence, the initial net benefit of a public program will result in a multiplied effect on the region's economy.

If m is the marginal proportion of the direct net redistributional benefits (R^D) which, when respent, results in additional net benefits to the region, then the total net redistributional benefit (R^T) to

the region is given as the sum of direct and indirect net redistributional benefits; viz.,

$$R^T = R^D + R^I = R^D(1+m+m^2+m^3+ \ldots) = R^D(\frac{1}{1-m}),\ 0 < m < 1.$$

The regional income multiplier is 1/(1-m) and can be determined, for any sector, from the matrix of direct and indirect coefficients in the region's input-output model.

Unless there is substantial regional unemployment, the indirect benefits of a project are merely a redistribution of economic activity from one region to another. From a national standpoint these inter-regional redistributions are not important unless they result in greater benefit to the poor. With perfect resource mobility, the assumption that project benefits are distributed uniformly implies that they are distributed uniformly over the entire population. Therefore, choosing the most efficient projects results in the greatest benefits to the poor--that is, no weighting scheme is needed.[6/]

If full employment does not exist but resources are perfectly mobile, then the direct benefits of projects need to be multiplied by the corresponding regional income multiplier to determine the true benefits. However, no weighting of distributive effects is required in this situation since the best one can do is to choose according to the efficiency criteria. But the assumption that resources (especially labor) are perfectly mobile between regions is unrealistic and, therefore, a method to weight regional equity effects is desired.

6/ This requires the further assumption that resources can move from one locale to another costlessly. It also requires an unambiguous measure of efficiency which, as noted in Chapter III, may not exist.

The Tradeoff Between the Incomes of Regions[7/]

In Figure 15 it is assumed that project planning has two objectives--an increase in aggregate income and an increase in the income of the "poorest" region(s).[8/] Regional income, which is a surrogate for the income of the poorest region, is plotted along the abscissa while aggregate (or the rest of the nation's) income is plotted along the ordinate. Given the assumptions in the first section of this chapter, an increase in regional income results in an increase in per capita income for all those living in the region, even those with the lowest income.

Curve FF' in Figure 15 is the locus of feasible national development plans and is called the "income transformation frontier." Each point on the frontier represents the selection of a different set of projects from the almost infinite number available to the national decision-maker. There is no conflict between the rest of the nation's income and regional income as long as there is no desire to increase the income of the applicable region beyond y_R^*. In other words, there is no need to sacrifice aggregate income, or efficiency, to increase regional income in the range F'G of the income transformation frontier. The rest of the nation's income needs to be sacrificed only in the declining portion of the curve.

Between G and F on the transformation frontier redistribution via project selection can only occur at the expense of the rest of the

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7/ The model found in this section is suggested by Marglin [1967, pp. 25-37]. However, his analysis is inadequate and flawed, perhaps due to a desire to provide a simple, nontechnical discussion.

8/ The word "poorest" is set off in quotation marks because the model can apply to any region whose income society (or the authority) wishes to increase.

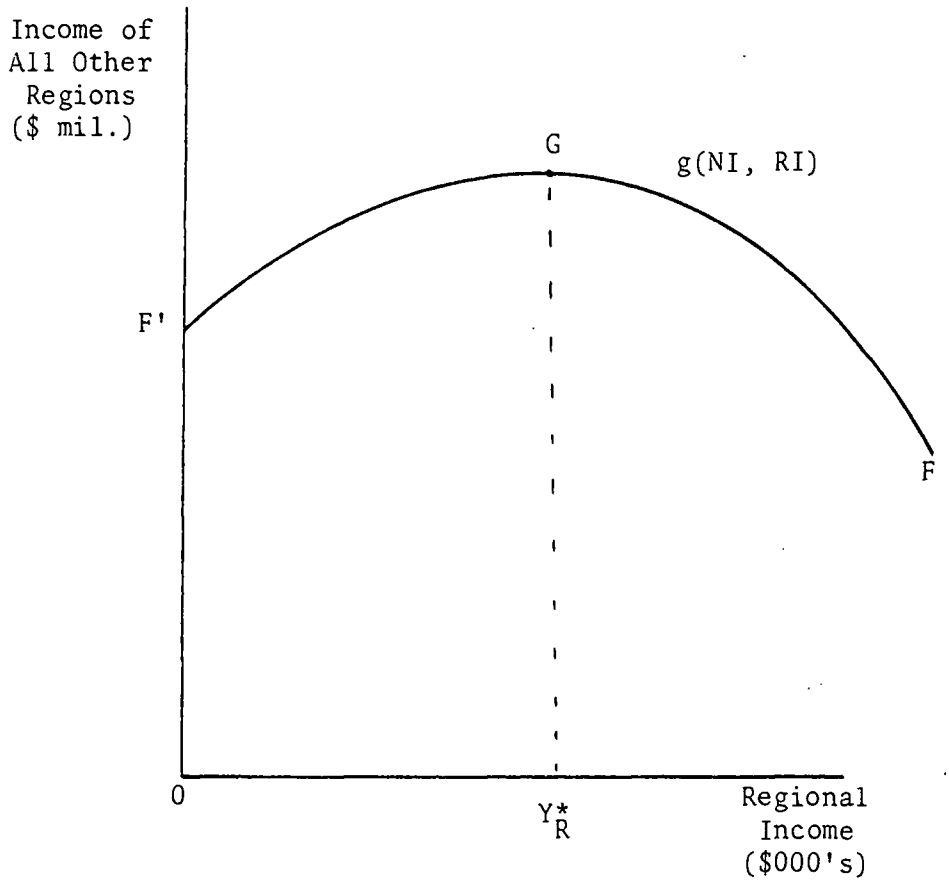

Figure 15. Regional/Rest-of-Nation Income Transformation Frontier.

nation's income--that is, at the expense of efficiency. The portion of the transformation frontier that has a negative slope is concave to the origin because more and more efficient projects outside the region are replaced by less and less efficient projects within the region as regional income is increased beyond y_R^*. The absolute slope of the relevant portion of the curve (GF) is the marginal rate of income transformation (MRIT) between the aggregate and regional sectors of the economy. It is the amount of rest-of-nation income which must be sacrificed for a dollar increase in regional income. The MRIT is defined as:

$$MRIT = -dNI/dRI = g_{RI}/g_{NI},$$

where RI is the income of the particular region being considered, NI is the income of the rest of the nation, g(NI,RI) is the income transformation locus, and the subscripts refer to the partial derivative of the function with respect to that argument.

The relevant portion of the income transformation curve, with a social iso-welfare map superposed on it, is shown in Figure 16. The social welfare function is assumed to be of a Bergson-Samuelson type. The social welfare contours are convex to the origin and the marginal rate of social substitution (MRSS) between aggregate and regional income is diminishing. The MRSS is defined as the negative of the slope of an iso-welfare countour; i.e.,

$$MRSS = -dNI/dRI = w_{RI}/w_{NI},$$

where SWF = w(NI,RI).

Society attains its highest welfare contour at point E, where

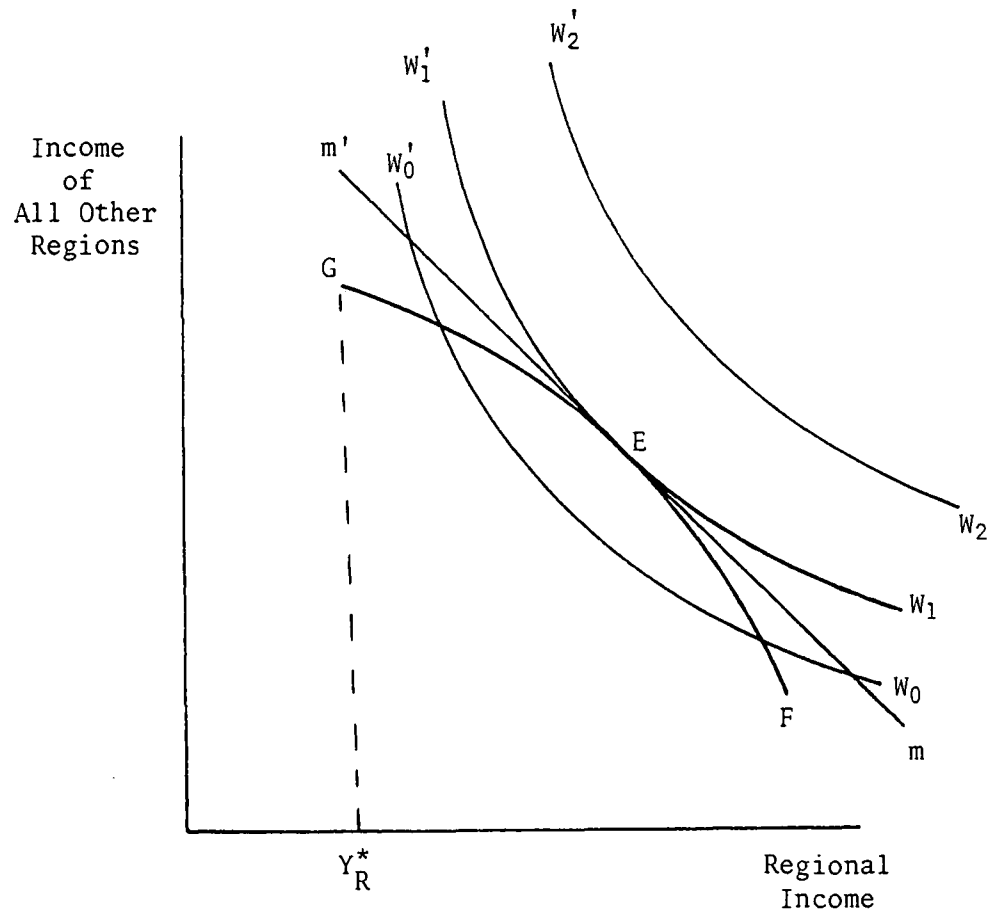

Figure 16. The Transformation Frontier and Social Iso-Welfare Map.

MRSS=MRIT. At point E, the tangent to the income transformation curve and the social indifference curve is mm'. The slope of mm' is the negative of the ratio of the regional income distribution weight to the weight for the rest of the country. Choosing the aggregate weight to be one and the regional weight to be q, the slope of mm' is then -q. Therefore, in equilibrium MRSS=MRIT=q.

It is obvious that the social welfare maximizing problem reduces to the problem of maximizing NI + q · RI. It remains only to determine q.

Figures 15 and 16 are drawn for a single region. If there are k regions in the country, the income transformation frontier can be generalized as $G(RI_1, \ldots, RI_k)$. Similarly, the SWF can be generalized as $W(RI_1, \ldots, RI_k)$. For each region there is a different y_R^* and regional weight. The multi-regional problem is then to maximize $q_1 \cdot RI_1 + \ldots + q_k \cdot RI_k$ subject to the available sets of public programs--that is, subject to the transformation function.[9/] Once again, it is

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9/ In equilibrium the social welfare maximizing conditions for this problem are:

$$\text{(i)} \quad W_{RI_i}/W_{RI_j} = q_i/q_j = G_{RI_i}/G_{RI_j}, \quad i,j=1, \ldots, k, \; i \neq j.$$

Condition (i) can be restated as:

$$\text{(ii)} \quad G_{RI_1}/q_1 = G_{RI_2}/q_2 = \ldots = G_{RI_k}/q_k, \text{ and}$$

$$\text{(iii)} \quad W_{RI_1}/q_1 = W_{RI_2}/q_2 = \ldots = W_{RI_k}/q_k.$$

Condition (i) is the same as that already discussed in the case of a single region. Condition (ii) implies that the weighted marginal efficiency of projects must be the same for all regions. Condition (iii) states that the marginal contribution of each region's income to social welfare, properly weighted, must be the same for all regions. Note that any one of the q_i could be chosen to be equal to one.

necessary only to determine the regional weights. In the following sections, two models are discussed which enable the analyst to determine these weights.

The Derivation of Regional Weights

The object of this section is the derivation of an ex post and ex ante method for arriving at the regional weights discussed in the previous section. The regional weights obtained from the two models can then be used to provide an equity-corrected ranking of a set of proposed projects. These rankings can be compared with each other and with those based solely on efficiency criteria. The actual derivation of regional weights and a comparison of rankings is provided in Chapter VI.

Several assumptions are required. First, it is assumed that public programs are individually small by national standards, although their impact on the region may be substantial. While a public program has no effect on national prices, changes in relative prices may occur locally. However, it is assumed that net benefits are distributed uniformly within the region so that local redistributive effects can be considered negligible.

Second, the regions analyzed are sufficiently small so that each region, toward which a government agency wishes to redistribute income, receives only one program to meet the agency's redistribution objective for that region. The assumption that the regions chosen are small also implies regional homogeneity, thereby supporting the assumption that net benefits are to be uniformly distributed.

Third, direct program costs are borne by all taxpayers. Since

the public programs are small, the increased tax burden of a particular program is imperceptible nationally and, as a consequence, the costs borne locally can be considered negligible. Therefore, it is not necessary to develop weights based on marginal tax rates as was done by Haveman [1965].

The Ex Post Model

Policy-making tends to be decentralized with a large number of administrators and politicians involved in the final decision to grant funds, build dams, and otherwise allocate public monies to a particular region.[10/] The selection of a public agency's proposed projects which are to be given the "green light" depends on a large number of variables. While efficiency is an important determinant, regional inequities and so-called "political concerns" are also influential in the decision-making process.

A dictatorial SWF for project selection can be constructed for a particular federal or state agency as follows:

$$S_A = S_A(E, D_1, \ldots, D_m, P_1, \ldots, P_n), \tag{30}$$

where E is some efficiency measure; $D_1, \ldots, D_m$ are measures of inequality between regions; and $P_1, \ldots, P_n$ are political factors. The efficiency measure most commonly used is the benefit-cost ratio. Measures of inequality include the ratio of the regional employment rate to the overall employment rate, the ratio of regional per capita

10/ Eckstein [1961, pp. 2-6] and Haveman [1965, pp. 13-21] describe the stages through which a water development project must pass before funds are allocated and construction can begin. A large number of factors are considered in the decision-making process as discussed below.

income to overall per capita income, indexes of social well-being, and so on. Political variables are extremely hard to quantify and they include the ability of local groups to organize and bring pressure to bear on the relevant agency, the politician's need to get re-elected, friends and family ties, personal preferences for a particular program or region, political "log-rolling," and so on.

The efficiency measure is considered to be determined outside an individual agency's decision-making process. For example, the rules for determining the benefits and costs of a project may be laid out by the central planning office. The efficiency measure in Equation (30) can be considered strongly separable from the distributive and political measures. Hence, it is possible to rewrite (30) as:

$$S_A = S_A[f(E) + h(D_1, \ldots, D_m, P_1, \ldots, P_n)] \tag{31}$$

A monotonic transformation of (31) does not change the ordinal welfare ranking.[11/] Hence,

$$s_A = \phi(E) \cdot \Psi(D_1, \ldots, D_m, P_1, \ldots, P_n). \tag{32}$$

where s_A is a monotonic transformation of S_A.

Now assume that $\phi(E)$ has the general Cobb-Douglas form: $\phi(E) = kE^a$, where k and a are constants ($a > 0$).[12/] Then an appropriate mono-

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[11/] A monotonic transformation is defined as follows: If $s_A = m(S_A)$ is a monotonic transformation of S_A, then

$$ds_A / dS_A = m' > 0.$$

While a linear transformation would be necessary if the welfare rankings are cardinal, it is assumed that this is not the case here.

[12/] Other functional forms, such as $k \cdot \ln(E)$ or $k \cdot \exp(E)$, are also permissable. It is only noted that there are restrictions on the form of $\phi(E)$.

tonic transformation of (32) makes it possible to write the public agency's concept of the welfare function as:

$$W_A = E \cdot q(D_1, \ldots, D_m, P_1, \ldots, P_n). \tag{33}$$

Dividing both sides of (33) by E gives:

$$W_A/E = q(D_1, \ldots, D_m, P_1, \ldots, P_n) \tag{34}$$

where $q = W_A/E$ is the regional income distribution weight.

The assumption of strong separability allows direct empirical estimation of distributional weights and, thereby, reveals the preferences of decision-makers. Further since (34) can take any functional form desired, the explicit assumption of strong separability can provide a rationale for the use of functional forms such as those used, but not justified, by McGuire and Garn [1969].

Function q consists of two weakly separable groups--the group of distributive (inequality) variables and the group of political parameters. Weak separability implies that the distributive factors are closer substitutes to each other than to members of the political subset in the decision-making process, and vice-versa. Therefore, it is possible to write (34) as:

$$q = F(D, P), \tag{35}$$

where $D = d(D_1, \ldots, D_m)$, and

$P = p(P_1, \ldots, P_n)$.

Weak separability between the two groups of decision variables does not imply independence between the variables in one subset as opposed to those in the other subset. It only implies that the mar-

ginal rates of substitution between any two variables belonging to the same group are independent of the value of any variable in the other group as indicated by the Leontief condition for weak separability:

$$\frac{\partial}{\partial P_k}\left(\frac{\partial F/\partial D_i}{\partial F/\partial D_j}\right) = 0;\ i \neq j = 1, \ldots, m;\ \text{and } k = 1, \ldots, n. \quad (36)$$

The notion of two different sets of parameters determining the regional distribution weights (i.e., the notion of weak separability) is an intuitive one which might be rejected on empirical grounds. Since (36) can be simplified as $F_i F_{jk} - F_j F_{ik} = 0$, it is obvious that weak separability is related to the properties of the second order cross-partials, F_{ik} and F_{jk}, of the F-function. This has important implications regarding the choice of functional-structure of the regional weight function. Choice of the Cobb-Douglas, constant elasticity of substitution or a linear functional form presupposes strong separability, and strong separability implies weak separability. Therefore, a flexible form called transcendental logarithm, or translog, is chosen [see Blackorby, et al. 1977; and Denny and Fuss 1977]. This allows one to test for weak separability while maintaining a useable (and flexible) functional form if weak separability does not hold.

The attraction of translog is that any general function can be approximated with it, up to a second order Taylor expansion. But the test for weak separability is local, not global. Using an exact translog specification, however, is not merely a test of the weak separability assumption but also a test of inflexibility of functional form. Hence,

an exact translog formulation is unduly restrictive.[13/]

The model is specified as follows. Let $\vec{X}' = (\vec{I}_1', \vec{I}_2')$ be a partitioned 1x(m+n) vector, where $\vec{I}_1' = (\ln D_1, \ldots, \ln D_m)$ and $\vec{I}_2' = (\ln P_1, \ldots, \ln P_n)$ are 1xm and 1xn vectors of explanatory variables, respectively; $\vec{\alpha}' = (\alpha_1, \ldots, \alpha_{m+n})$ a 1x(m+n) vector of coefficients; and

$$\vec{\delta} = \begin{bmatrix} \delta_{1,1} & \cdots & \delta_{1,m+n} \\ \vdots & & \vdots \\ \delta_{m+n,1} & \cdots & \delta_{m+n,m+n} \end{bmatrix}$$

a symmetric matrix of (second order cross-partial) coefficients. Then the translog function (corresponding to (34) or (35)) to be estimated is:

$$Q = \ln q = \vec{\alpha}'\vec{X} + \vec{X}'\vec{\delta}\vec{X}. \tag{37}$$

A test for weak separability is a test of the hypothesis that

$$\delta_{rs} = 0 \quad \forall r \in \vec{I}_1,\ s \in \vec{I}_2$$

Equation (37) can be estimated and used to predict values for the regional income redistribution weights.

The model is capable of predicting the regional weights which an agency is likely to apply to a proposed project. These weights are then used to rank projects, with the "best" projects chosen until the agency's budget is exhausted. The particular weight to apply to a region is determined by the region's relative employment rate, relative regional income, measures of regional social well-being, politi-

[13/] An exact translog specification implies that either F (in Equation (35)) is Cobb-Douglas in translog-D and translog-P or F is translog in Cobb-Douglas-F and Cobb-Douglas-P. For a proof of this and a more complete discussion of the problems associated with the tests of separability and function forms see Bhadra [1981].

cal factors and so on. If the predicted weights differ substantially from the actual weight used, then the agency is not using the same weights as it did in the past. Therefore, the model provides a method of checking agency rankings as well as predicting rankings based on past agency behavior.

Unfortunately this approach is status quo oriented. If the object of social planning is to move society toward a more egalitarian base, then the ex post method for deriving regional weights may be inappropriate. Haveman [1973] argues that the political process tends to favor those with an ability to organize and exert pressure on decision-makers. "The effect ... is to increase the already serious inequality in the national distribution of wealth holdings" [p. 873]. Therefore, it may be more useful to construct equity weights ex ante rather than based on past behavior. Two methods for developing ex ante weights are examined in the next section.

Ex Ante Models

The World Bank models discussed in Chapter IV rely on a specified government utility function as a proxy for the social welfare function. The utility function is specified in Equation (19) as:

$$U(y) = \begin{cases} \dfrac{y^{1-n}}{1-n} + \text{constant} & \text{for } n \neq 1,\ n > 0, \\ \ln y + \text{constant} & \text{for } n = 1, \end{cases} \tag{38}$$

where $U_y > 0$ and $U_{yy} < 0$. As before, y is the current level of regional per capita income and n is a parameter. The value of n is im-

portant in determining the weighting scheme.[14/] Two weighting schemes based on (38) can be constructed.

Scheme One. The regional distribution weight (d) is defined as:

$$d = U_y/U_{\bar{y}} = (\bar{y}/y)^n, \tag{39}$$

where $\bar{y}$ is the average level of per capita real income in the supra-region. The weights derived from (39) are used to construct an equity-adjusted ranking of projects in Chapter VI.

Scheme Two. A summary distribution weight (D), based on per capita income between regions, can also be constructed. These weights are appropriate when knowledge regarding the intra-regional distribution of income is available and the weight which the authority attaches to the supra-region (state) is known. The distributional weight is then the product of the summary distribution weight and the supra-region weight. As indicated in Chapter VI, federal agencies could use this method when choosing among site-specific projects located in different states.

To determine the summary distribution weights, the impact on each region (county) is evaluated and then integrated over all regions (i.e., over all counties within the state):

$$D = \frac{1}{U_{\bar{y}}} \int_0^{\infty} U_y \, g(y) \, dy, \tag{40}$$

where g(y) describes the distribution of the increase in per capita income across regions. (Equation (40) and (24) are identical.) In

[14/] See Study Seven in Chapter IV for a discussion of the values n can take.

the absence of information about g(y), the assumption that increases in national income are distributed among the regions as is current income implies that:

$$g(y) = f(y) \cdot (y/\bar{y}), \tag{41}$$

where f(y) is the current income density function and $\bar{y}$ is the expected value of f(y).

The gamma density function provides a flexible functional form for describing the distribution of regional per capita incomes.[15/] The density function for regional per capita incomes is, therefore, assumed to be:

$$f(y) = \frac{y^{a-1} e^{-y/b}}{b^a \Gamma(a)}, \tag{42}$$

where a and b are parameters to be determined and $\Gamma(a) = \int_0^\infty u^{a-1} e^{-u} du$ is the gamma function.[16/] Substituting (42) into (41) gives:

$$g(y) = \frac{y^a e^{-y/b}}{\bar{y}\, b^a \Gamma(a)}. \tag{43}$$

15/ Use of the gamma density function was suggested by Professor Dave Thomas of Oregon State University. Brunk [1975, pp. 252-254, 279-280] provides a good discussion of the gamma function and distribution.

16/ For the gamma density function in Equation (42) it can be shown that E(y) = ab and Var(y) = ab^2. Therefore, it is possible to derive estimates for a (the shape parameter) and b (the scale parameter). The method of moments is used in the derivation. Estimates of the expected value and variance are $\bar{y}$ and

$$s^2 = \frac{1}{n-1} \sum_{i=1}^{n} (y_i - \bar{y})^2,$$

respectively. Then,

$$\hat{a} = (\bar{y}/s)^2 \quad \text{and} \quad \hat{b} = s^2/\bar{y}.$$

Inserting (43), and the marginal (social) utilities of income and average income (Equation (18)), into (40) gives:

$$D = \bar{y}^{-n} \int_0^{\infty} y^{-n} \frac{y^a e^{-y/b}}{\bar{y}\, b^a\, \Gamma(a)}\, dy$$

$$= \bar{y}^{-n-1} b^{1-n} \frac{\Gamma(a - n+1)}{\Gamma(a)} \int_0^{\infty} \frac{y^{(a - n+1)-1} e^{-y/b}}{b^{a - n+1}\, \Gamma(a - n+1)}\, dy.$$

Since the integral of the gamma density function with parameters $(a - n+1)$ and b is equal to 1.0, the summary distribution weight is:

$$D = \bar{y}^{-n-1} b^{1-n} \frac{\Gamma(a - n+1)}{\Gamma(a)}, \qquad n > 0 \tag{44}$$

In Chapter VI Equation (44) is used to determine a summary distributional weight for the state in which a proposed project is to be located. This value is then multiplied by the distributional weight for that state to decide the appropriate ex ante weight for finding the equity-adjusted rankings.[17/] The state weight is determined a priori by the first method described, using average per capita income for the state rather than the particular county. The key assumption in using this technique is that income from a public program is to be distributed among the counties within the state in the same way as current income.

17/ One can, of course, assume that the state weights are all equal to 1.0. The assumption of identical equity weights for each nation, regardless of per capita income, is implicit in Squire and v.d. Tak's [1975] construct of the summary distributional weight. They leave the decision regarding country-specific weights to the World Bank executives.

Summary

The discussion and theoretical model developed in this chapter indicate a need for regional distributional weights. An *ex post* and *ex ante* method for determining these weights were also presented. In the following chapter the models are used to construct *ex post* and *ex ante* weighting schemes which are then used to rank projects. The rankings obtained via each of the weighting schemes are compared with the pure efficiency ranking and the ranking based on actual choices.

CHAPTER VI

EMPIRICAL RESULTS

Numerous public and quasi-public, state and federal agencies were contacted to determine the reasons for selecting certain projects while rejecting others. In particular, it was necessary to determine the methods used by agencies to rank projects. As indicated in the case studies discussed below, the ranking, or priority, scores can be used as surrogates for efficiency. However, in support of the hypothesis presented in Chapter V, agencies recognize that projects cannot be chosen according to their priority score only. For example, in a memorandum regarding an Environmental Quality Commission meeting to approve the 1981 construction priorities list, it was indicated that "the FY 81 priority list ... need not be adopted as an administrative rule" [1980, p. 1] for final decision-making regarding project selection. Other factors, such as income redistribution and political influence, have to be considered as well.

Methods Used to Rank Projects

Nearly all of the public agencies contacted used a different method for judging projects--that is, for making final project choices. While this is not surprising given the different mandates of the agencies, there was sufficient similarity to allow the analyst to identify three general procedures.

Benefit-Cost Analyses

The Office of Management and Budget requires Federal government

agencies to calculate benefits and costs for their programs. However, many federal agencies do not calculate even rudimentary benefit-cost ratios for proposed projects. The Army Corps of Engineers and the Department of Interior's Bureau of Reclamation are notable exceptions. Both these agencies calculate benefit-cost ratios according to the Water Resources Council's "Principles and Standards for Planning Water and Related Land Resources" [1979(b)]. Although projects are not selected solely on the basis of the benefit-cost rankings, these agencies do provide the decision-maker (Congress) with consistent efficiency scores.[1/]

Both the Bureau of Land Management (BLM) and the U.S. Forest Service are attempting to implement benefit-cost analysis in future rankings of rangeland improvement projects and other programs. (In Appendix B examples of the types of scoring sheets used to calculate the efficiency of rangeland projects are provided.) Although benefit-cost methods are used within these agencies (for example, net present worth is calculated for management alternatives at the Lolo National Forest in Montana), they are not used consistently. Further, due to decentralized decision-making, there is no attempt to compare projects in one district with those in another.

The State of Oregon's Department of Transportation has computed benefit-cost ratios for some highway projects and for rail abandonment proposals. In the former case the calculations are experimental and, to some extent, a direct result of the Farness, et al. [1972]

1/ As noted in Chapter III, however, the benefit-cost criteria are based on a set of assumptions which may not be acceptable to all individuals. Further, the benefit-cost calculations refer to national economic efficiency only, ignoring regional considerations.

report to the Oregon State Highway Division. In the latter case, a benefit-cost analysis is required to be eligible for federal grants designed to reinstate rail lines ticketed for abandonment.

Some of the reasons why there is no consistent use of benefit-cost methods among and within public agencies include the following:

(i) A benefit-cost analysis for each project may simply be too costly given the size of the project.

(ii) Many agencies lack the expertise or will power to make the necessary benefit-cost calculations.

(iii) In some cases the public managers may be unfamiliar with benefit-cost methodology. This is particularly true for the BLM and U.S. Forest Service where the district administrators (rangers) may be foresters or rangeland biologists. Further, the requirement for benefit-cost studies is relatively recent.

Priority Scores

It seems that the most common method for determining an efficiency ranking for possible projects within a public agency is the use of a more-or-less subjective scoring system. The general procedure is to identify a number of categories relating to the objectives which the projects being considered should meet. For each project the analyst assigns an arithmetic value to each category--the number may be either subjective or based on a series of predetermined calculations. The amounts in each category are multiplied by the weight for that category with the weighted sum determining the priority score for the particular

project. Projects are then ranked according to these scores. (In Appendix B, examples of the score sheets are presented.)

It is necessary to recognize that the priority score may not reflect the true net national or regional benefits of a project. The priority score may reflect only the project's success at achieving the desired or stated goals of the particular agency. Nonetheless, the priority score reflects a project's efficiency as a basis for final project selection.

Ongoing Selection

A final method for selecting projects uses a modified "first-come, first-served" principle. This method is generally used by public agencies, such as the Farmers Home Administration, which provide loans and/or grants to needy private corporations, municipalities, and so on. If a proposal meets the criteria of the agency providing the funds then the project will, in theory, eventually be funded. However, if insufficient funds are available in a given time period, an acceptable project may have to wait until a future date for funding, or settle for a reduced grant or loan. If this occurs, other, more urgent, projects may be ranked ahead of the given project at the future date. However, due to the nature of the projects requiring this kind of assistance, local, private, or other financing may be found if a long delay is anticipated. Quite often the need for a project disappears over time.[2/]

[2/] This is the situation when grants and/or loans are needed to prevent a firm located in a single-industry community, for example, from going out of business

Some discrimination in project selection may occur in processing applications and judging which projects are urgently in need of financing. In these situations, however, it is difficult to obtain the empirical data required for the models presented in the previous chapter.

Before proceeding to the actual case studies, two additional observations are made. First, in large agencies the function of determining the efficiency scores for proposed projects is the responsibility of a particular group within the agency. Other groups within the same agency which are also involved in the planning process may be unaware of the existence of the efficiency indexes.

Second, where subjective scores are used to rank projects, several individuals and agencies may be involved in the decision-making process. For example, in the U.S. Department of Agriculture's (USDA) soil conservation program, several agencies, including, for example, the Environmental Protection Agency (EPA), ranked the same set of proposed projects. Although the Agricultural Stabilization and Conservation Service of the USDA made the final choice regarding the actual projects selected, the score sheets of the other agencies influenced the final decision.

Case Studies

The models of Chapter V are applied to three public agencies--one state agency and two federal agencies. Each agency's project selection is analyzed to determine the extent to which efficiency is sacrificed for other objectives, primarily a redistribution of income. A major obstacle in the analysis is the poor quality of the

empirical data. However, the main objective is to illustrate the techniques for integrating efficiency and equity.

The empirical data available supports the ideas discussed in Chapters II and III. Public decision-makers do not select projects solely on the basis of efficiency since they wish to take into account equity (and other) objectives as well. However, equity is an ambiguous concept, evoking a different emotive response in individuals and, therefore, difficult to quantify. The empirical evidence indicates that actual choices are sensitive to public lobbying and that decision-makers' choices are not consistent from one time period to the next.

Case Study: Oregon State Highway Division

The Oregon State Highway Division is responsible for construction and maintenance of all interstate, primary and secondary highways within the State of Oregon. Between 31 and 36 percent of Oregon highway projects are funded by the federal government. The authority for this federal aid comes from the Federal Highway Act of 1976. As indicated in Table 3, the federal-aid program falls into a number of different categories. The state does, however, have a "voice in the selection of projects, matters of location and standards of construction" [Oregon Transportation Commission 1980, p. 49] for many of the projects. In addition, with the approval of the Governor and U.S. Secretary of Transportation, Interstate funds not critical to the national system may be used for highway or transit improvements in urbanized areas.

In this case study only major reconstruction projects are considered. These are highway improvements, such as road widening, sur-

Table 3. Federal and State Cost Sharing for Selected Oregon Highway Improvement Projects, 1980.

Type of Project	Estimated 1980 Construction Costs ($1,000)	Cost Sharing	
		Federal (%)	State (%)
Interstate Highways	114,975	92	8
Interstate RRR (Resurfacing, Restoring, Rehabilitation)	5,041	75	25
Federal-Aid Primary Highways[a/]	34,506	88	12
Federal-Aid Secondary Highways[b/]	3,741	88	12
Federal Forest Highways	10,950	100	--
Federal Lands Highways[c/]	1,434	100	--
Hazard Elimination	1,090	90	10
R.R.-Highway Crossing	821	90	10
Economic Growth Center Highways[d/]	------	88	12
Highway Bridge Replacement	7,209	80	20

a/ Mileage of Oregon's Federal-aid primary highways (including Interstate) is limited by Federal law to not more than seven percent of the State's rural public road mileage.

b/ Part of this system consists of state highways and part composed of county roads. By an agreement between the State and the Association of Oregon Counties, 50 percent of Federal secondary money must be expended on county roads.

c/ Funding determined by Congressional allocation according to need. These funds can only be applied to roads on public domain, Indian reservations, or other federal holdings.

d/ No projects in 1980.

SOURCE: Oregon Transportation Commission 1980.

face upgrading, hazard elimination and so on, whose estimated cost is at least one million dollars. An attempt is made to determine whether the Highway Division allocates projects based on the condition of the road or on criteria such as a desire to redistribute income to low (or high) income counties via project selection.

The State Highway Division is divided into five geographic regions, but the separation does not always follow county lines (Figure 17). Each regional engineer submits a list of projects to the Oregon Transportation Commission. These projects reflect the engineer's perceived needs of his district, however those needs are defined. In addition, private citizens may also submit highway proposals to the Commission.

Every two years the Transportation Commission holds public hearings throughout the State and determines a final ranking and, hence, choice of proposed projects. (During the public hearings, additional projects may be added to the list of proposals.) The final rankings for the next six fiscal years are published biennially as the Six-Year Highway Improvement Program. Since the decision-making cycle is two years, it can be argued that the Commission makes choices for two years only, rather than for the entire six-year period. However, the Commission does rank projects over the entire six-year period and these can be used to determine the revealed preferences.

Employees of the State Highway Division indicated that two factors were important in determining the final choice of major reconstruction proposals. First, the Transportation Commission seeks to allocate funds, in some equitable fashion, throughout the State. Although no attempt is made to allocate the same amount to each highway region,

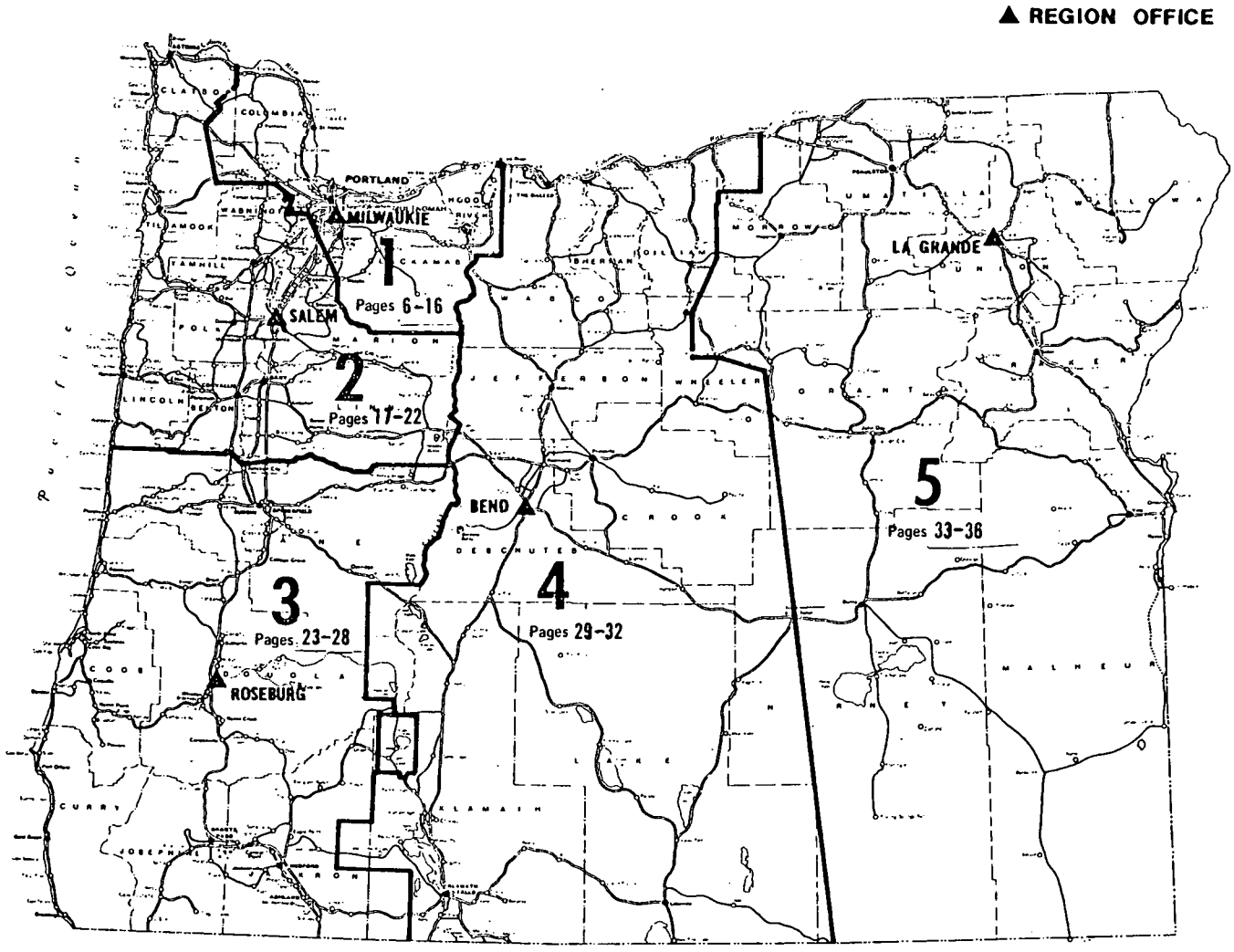

Figure 17. Oregon State Highway Division Region Map.

each region is guaranteed that some of its projects will be funded.[3] The analysis should then indicate that efficient projects in one region are sacrificed for less efficient projects in another region.

Second, citizen groups have a substantial impact on the final selection of projects by the Transportation Commission.[4] Public hearings enable citizen groups to lobby for those projects which affect them most. Therefore, it is possible that less efficient projects are chosen over more efficient projects within the same county. Further, since involvement in politically active groups is positively correlated with income, it is possible that higher income groups receive a disproportionately large share of highway improvement funds.

Data Used to Derive the Distributional Weights

The Highway Division determines a deficiency index for each homogeneous section of the State's highways. The deficiency index is based on the curvature and width of the road, vehicular traffic volume, and condition of the road surface. The deficiency index provides a rough measure of the maximum potential benefits to be gained by improving a particular section of highway--the larger the deficiency index (which has no upper limit), the greater the benefit to be gained.

Deficiency indexes were obtained from Highway Division records (computer sheets) for the proposed major reconstruction projects listed in the 1978 and 1980 six-year plans. Efficiency indexes were

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[3] In the 1980 six-year plan the ratio of spending in regions one through five, respectively, was 54:17:13:5:11. See Figure 17.

[4] One employee stated: "In the past we have been able to grease all of the squeaks. With the reduction in available funds (due to inflation and reduced federal revenue) we can only grease the loudest squeaks."

constructed by dividing each project's deficiency index by the project's estimated cost. Hence, the efficiency index measures the potential reduction in "bad road features" per dollar spent. An efficiency ranking for the proposed projects was formed with these index numbers.

The 1978 Six-Year Highway Improvement Program provided the data for application of the ex post model. Projects in the 1978 plan were classified into three categories--black, green and red. While projects listed in the black category were assured of funding, projects in the green category would receive funds only if additional revenues became available. Red projects would be funded only if revenues beyond those which could be anticipated became available--that is, these projects were rejected.[5/] Since many of the green projects also appeared in the black category, but at a later date (which was not true of red projects), the author decided to look at project rankings in the black and green categories for the years 1979 through 1981 only. Fifty-one major projects located in 30 counties were identified.

Regression Results

A perusal of the Transportation Commission reports indicated that the Commission often chose less efficient projects over more efficient ones, including projects within the same county. Due to this problem and a desire to take into account total expenditures by county, same

5/ It should be noted that many of these projects had efficiency indexes substantially higher than those of accepted projects and some of these projects were subsequently chosen in the 1980 plan, despite little or no revision. This is an indicator of inconsistency in project selection.

county projects were initially combined and a weighted efficiency index (weighted by project costs) constructed for those counties for which observations were available. By dividing the resulting efficiency indexes by the index of the opportunity cost project (an average of the best projects in the red category), it was possible to determine the individual county weights.

It is argued that members of the Transportation Commission have a feel for differences in lifestyle and standard of living among Oregon counties. As proxies for these inherent decision variables, a number of variables reflecting county differences were considered, including four indicators of county social well-being constructed by Ross, et al. [1979a]--socioeconomic status, health status, family status and alienation. Principal component analysis was used to determine which explanatory variables were important determinants of the county weights. A translog function was estimated with the choice of the final translog variables made by dropping variables with a t-statistic less than 1.0 and, at the same time, attempting to minimize the standard error of the regression.[6/] The regression results and a description of the variables occurs in Table 4.

The elasticities of the dependent variable (redistributional weight) with respect to the explanatory variables are given in Table 5. Notice that the income elasticity of the weight has the correct expected sign (negative) in only nine of the 30 cases. However, the average per capita income for those counties for which it was negative was $9,542

6/ Dropping variables with a t-statistic less than 1.0 is equivalent to maximizing $\bar{R}^2$ [Pindyck and Rubinfeld 1980, p. 80 footnote]. There were too few projects in the red category for a binary choice model to be used, although a binary dependent variable was considered in explaining ACP water quality project selection.

Table 4. Regression Results--Oregon Transportation Commission Project Selection, 1979-1981, by County.[a/]

Dependent Variable: Weight			
Right-Hand Variable	Estimated Coefficient	Standard Error	t-Statistic
Y	2,099.94	384.55	5.46
POP	- 35.54	18.26	-1.95
SOCIO	-3,067.68	747.84	-4.10
ALIEN	- 887.21	279.67	-3.17
Y*Y	- 129.13	21.71	-5.94
Y*POP	8.70	2.01	4.33
Y*COST	- 0.64	0.14	-4.51
COST*COST	1.40	0.36	3.86
SOCIO*SOCIO	320.55	78.36	4.09
ALIEN*ALIEN	61.93	15.20	4.07
Y*HEALTH	- 1.89	0.34	-5.47
Y*ALIEN	42.59	20.51	2.08
POP*ALIEN	- 9.52	2.45	-3.88
R^2 = 0.8232	$\bar{R}^2$ = 0.6984	$\tilde{\sigma}$=1.074	$F_{12,17}$=6.596
Mean of dependent variable = 2.457		Σe_i^2 = 19.6117	n=30

[a/] All variables are in natural log form.

Y = average per capita county income[1/]
POP = county population[1/]
COST = Total estimated county project costs[2/]
SOCIO = index of county socioeconomic status[3/]
ALIEN = index of alienation for the county[3/]
HEALTH = index of county health status.[3/]

SOURCES: [1/] Bureau of Economic Analysis 1980.
[2/] Oregon Transportation Commission 1978.
[3/] Ross, et al. 1979(b).

Table 5. Elasticities of the Weight With Respect to the Explanatory Variables.

Elasticity of the Weight With Respect to		Number of Times Elasticity is Positive[a]
Y	$el_Y = 2{,}100 - 258Y + 8.7POP - 0.6COST - 1.89HEALTH + 42.6ALIEN$	21
POP	$el_P = -35.5 + 8.7Y - 9.5ALIEN$	8
COST	$el_C = 2.8COST - 0.6Y$	12
SOCIO	$el_S = -3{,}100 + 641SOCIO$	8
ALIEN	$el_A = -887 + 123.9ALIEN + 42.6Y - 9.5POP$	26
HEALTH	$el_H = -1.9Y$	0

[a] n = 30.

SOURCE: Table 4.

compared to $7,318 for those counties for which it was positive. This provides some evidence that the Transportation Commission does redistribute income to low-income counties via project selection.

Additional support for this hypothesis comes from the elasticity of the redistributional weight with respect to socioeconomic status, which includes a measure of income different from that used here [Ross, et al. 1979(a), p. 4]. It has the correct expected sign (negative) in 22 cases. Also, the elasticity with respect to population is negative in 22 cases.

These data support the contention by Highway Division employees that there is an effort to allocate projects to all of the Highway Division regions. On the other hand, positive values for these elasticities provide support for the contention that pressure groups are influential in the project selection process.

The signs on the remaining elasticities are difficult to interpret. The signs for the elasticities with respect to health and alienation are strongly negative and positive, respectively, but the sign for the health status index is opposite of that which might be expected. The alienation effect is itself difficult to interpret. Although the inter-county effect of cost on the county weights was unpredictable, further analysis indicated that the county weight tended to fall as the size of the project increased.

A second regression did not combine projects located in the same county. This regression was used to predict the distributional weights on future projects. The regression results are presented in Table 6. A careful analysis of these results suggested that they are similar to those of the earlier regression although, when it came to predicting

project weights, project costs proved a better explanatory variable than total expenditures within a county.[7/]

7/ Total expenditures in a particular county could not be known in advance whereas estimated project costs could.

Table 6. Regression Results: Oregon Transportation Commission Project Selection, 1979-1981.[a/]

Dependent Variable: Weight			
Right-Hand Variable	Estimated Coefficient	Standard Error	t-Statistic
Y	-1,239.29	230.1	-5.39
POP	- 41.58	11.2	-3.71
COST	- 88.20	35.9	-2.46
HEALTH	2,417.90	440.0	5.50
Y*Y	58.74	12.0	4.90
SOCIO*SOCIO	208.55	41.4	5.04
Y*COST	9.86	4.0	2.45
Y*ALIEN	39.70	9.4	4.22
POP*ALIEN	12.26	2.2	5.63
POP*FAM	- 2.58	1.6	-1.61
SOCIO*HEALTH	- 426.88	84.3	-5.06
HEALTH*ALIEN	- 86.42	18.4	-4.69
HEALTH*FAM	3.10	1.4	2.25
R^2 = 0.7669	$\bar{R}^2$ = 0.6933	$\tilde{\sigma}$ = 1.073	$F_{12,38}$=10.418
Mean of dependent variable = 2.497		Σe_i^2 = 43.7586	n=51

[a/] All variables are in natural log form.

Y = average per capita county income[1/]
POP = county population[1/]
COST = estimated project cost[2/]
SOCIO = index of county socioeconomic status[3/]
HEALTH = index of county health status[3/]
ALIEN = index of alienation for the county[3/]
FAM = index of county family status[3/]

SOURCES: [1/] Bureau of Economic Analysis 1980.
[2/] Oregon Transportation Commission 1978.
[3/] Ross, et al. 1979(b).

A Comparison of Ranking Schemes

Eighty-four projects chosen by the Oregon Transportation Commission [1980] for construction during the years 1980 through 1982 were ranked according to four different ranking schemes. The first was based on the actual choices made by the Commission, ranks being assigned according to (a) the year in which the project was scheduled for construction and (b) the value of its efficiency index. The efficiency index itself provided the second ranking, while the regression equation in Table 6 was used to establish a third ranking of the 84 projects. Finally, an ex ante model was used to rank the projects. The regional income redistributional weight (d) is defined as:

$$d = (\bar{y}/y)^n,$$

where $\bar{y}$ is the average per capita income in Oregon and y is the average per capita income of the county in which the project is located. The value of the parameter (n) was chosen to be 2.0, indicating a marked egalitarian bias in project selection (see Chapters IV and V).

The four rankings of the 84 projects are presented in Table 7. The Spearman rank coefficients and associated t-statistics for each pair of ranking schemes are presented in Table 8.[8/] According to the

[8/] The Spearman rank coefficient is defined as:

$$r_s = 1 - \frac{6\left(\sum_{i=1}^{n} D_i^2\right)}{N(N^2 - 1)},$$

where D_i is the difference in the ranks for the i^{th} observation. The t-statistic is then:

$$t = \frac{r_s\sqrt{N - 2}}{\sqrt{1 - r_s^2}}$$ [Hays 1963, pp. 643-647].

Table 7. A Comparison of Four Rankings of Eighty-Four Oregon Highway Improvement Projects for the 1980 Six-Year Plan.

Efficiency Rank and Project Identifier	Efficiency Index	Oregon Transportation Commission Rank	Ex Post Model			Ex Ante Model			Cost 1978 ($ m.)
			Weight	Corrected Efficiency Index	Rank	Weight	Corrected Efficiency Index	Rank	
1	4,436	62	3.13	13,885	3	1.59	7,053	1	1.5
2	2,621	63	1.49	3,905	16	0.98	2,569	8	1.8
3	2,564	64	3.26	8,359	10	1.08	2,769	3	1.3
4	2,417	1	0.73	1,764	27	1.57	3,795	2	1.0
5	2,331	2	3.63	8,462	9	1.17	2,727	4	1.4
6	2,240	43	1.46	3,270	18	1.21	2,710	6	1.0
7	2,223	65	3.97	8,825	8	1.17	2,601	7	1.0
8	2,179	3	1.07	2,332	23	0.98	2,135	9	1.1
9	2,154	44	25.01	53,872	1	1.26	2,714	5	1.4
10	2,024	45	3.65	7,388	12	1.04	2,105	11	2.8
11	1,683	4	14.75	24,824	2	1.26	2,121	10	3.3
12	1,636	5	6.82	11,158	6	1.18	1,930	12	2.1
13	1,368	46	6.78	9,275	7	1.18	1,614	13	2.1
14	1,297	47	3.20	4,150	15	1.24	1,608	14	1.2
15	1,149	6	0.95	1,092	30	1.33	1,528	15	1.6
16	1,054	48	2.85	3,004	19	1.24	1,307	16	1.5
17	1,039	7	7.87	8,177	11	1.18	1,226	17	1.4
18	848	8	2.76	2,340	22	1.17	992	18	3.9
19	787	9	2.75	2,164	24	1.17	921	20	3.9
20	692	66	16.34	11,307	5	1.26	872	21	2.8
21	690	67	5.11	3,526	17	1.18	814	23	5.1
22	663	68	17.34	11,496	4	1.28	849	22	1.4
23	656	69	4.08	2,676	20	1.51	991	19	2.2
24	621	49	9.45	5,868	13	1.05	652	26	1.6
25	606	70	7.05	4,272	14	1.33	806	24	2.0
26	599	50	0.17	102	50	0.99	593	29	3.8
27	569	51	3.51	1,997	25	1.24	706	25	1.0
28	548	10	0.13	71	53	0.92	504	32	1.1
29	533	52	4.53	2,414	21	1.18	629	28	7.4
30	520	11	3.69	1,919	26	1.08	562	31	3.0
31	482	71	2.67	1,287	28	1.17	564	30	4.4
32	473	53	2.59	1,225	29	1.33	629	27	6.2

Table 7. A Comparison of Four Rankings of Eighty-Four Oregon Highway Improvement Projects for the 1980 Six-Year Plan (continued).

Efficiency Rank and Project Identifier	Efficiency Index	Oregon Transportation Commission Rank	Ex Post Model			Ex Ante Model			Cost 1978 ($ m.)
			Weight	Corrected Efficiency Index	Rank	Weight	Corrected Efficiency Index	Rank	
33	404	12	2.30	929	35	1.17	473	33	7.6
34	351	13	1.37	481	36	1.21	425	35	1.2
35	277	54	1.27	352	40	1.59	440	34	2.4
36	241	14	3.94	950	34	1.30	313	36	4.2
37	226	15	0.79	179	47	1.33	301	37	2.0
38	177	72	5.92	1,048	32	1.30	230	38	2.5
39	167	16	0.24	40	59	1.11	185	39	1.0
40	133	17	0.68	90	51	1.33	177	40	2.4
41	133	73	0.49	65	54	1.21	161	41	1.3
42	131	74	0.42	55	55	1.19	156	43	3.6
43	127	18	2.23	283	41	1.24	157	42	2.3
44	102	55	0.39	40	60	0.79	81	54	2.2
45	88	19	4.75	418	37	1.18	104	47	6.4
46	85	20	0.54	46	58	1.19	101	48	1.8
47	83	21	0.46	38	61	1.33	110	45	3.6
48	81	75	3.01	244	42	1.17	95	52	2.8
49	80	22	0.13	10	65	1.57	126	44	2.8
50	76	56	0.03	2	73	1.28	97	50	2.0
51	75	23	0.73	55	56	1.33	100	49	2.2
52	74	76	5.13	380	38	1.30	96	51	3.0
53	72	77	3.34	240	43	1.17	84	53	1.9
54	68	78	1.61	109	49	1.59	108	46	2.1
55	66	24	2.00	132	48	1.11	73	55	2.8
56	54	25	6.63	358	39	1.33	72	56	2.2
57	50	79	0.08	4	71	0.85	43	58	1.0
58	49	80	4.39	215	45	0.65	32	63	1.8
59	45	26	0.12	5	69	0.92	41	60	1.0
60	39	27	1.25	49	57	1.33	45	57	1.2
61	31	28	0.05	2	75	1.16	36	61	1.5
62	29	81	7.31	212	46	1.51	44	59	1.5
63	26	57	0.48	12	64	1.33	35	62	3.5
64	23	58	0.40	9	67	1.19	27	64	4.1

Table 7. A Comparison of Four Rankings of Eighty-Four Oregon Highway Improvement Projects for the 1980 Six-Year Plan (continued).

Efficiency Rank and Project Identifier	Efficiency Index	Oregon Transportation Commission Rank	Ex Post Model			Ex Ante Model			Cost 1978 ($ m.)
			Weight	Corrected Efficiency Index	Rank	Weight	Corrected Efficiency Index	Rank	
65	21	29	0.24	5	70	1.11	23	65	1.3
66	16	30	0.63	10	66	1.33	21	66	2.6
67	14	59	0.07	1	78	1.09	15	68	3.8
68	13	31	17.31	225	44	1.36	18	67	1.3
69	10	60	8.47	85	52	1.05	11	70	1.0
70	8	82	0.18	1	77	0.65	5	73	1.5
71	5	32	0.03	---	80	2.45	12	69	1.4
72	5	83	2.95	15	63	1.59	8	71	1.5
73	4	33	1.42	6	68	1.59	6	72	2.3
74	4	34	0.02	---	81	1.28	5	74	2.6
75	3	35	1.33	4	72	1.46	4	76	3.5
76	3	84	0.68	2	74	1.59	5	75	3.4
77	2	61	0.75	2	76	1.21	2	77	4.9
78	1	36	16.29	16	62	1.36	1	79	1.4
79	1	37	1,038.82	1,039	33	1.28	1	80	1.1
80	1	38	1,062.88	1,063	31	1.28	1	81	1.1
81	1	39	0.73	1	79	1.59	2	78	3.3
82	1	40	0.02	---	84	1.28	1	82	3.5
83	1	41	0.06	---	82	1.09	1	83	1.6
84	1	42	0.06	---	83	1.09	1	84	1.1

SOURCE: Oregon Transportation Commission, 1980.

Table 8. Spearman Rank Coefficients and T-Statistics for Four Rankings of Oregon Highway Projects.

Pairwise Comparison	Spearman Rank Coefficient	t-Statistic
Actual - Efficiency	0.1805	1.662
Actual - Predicted	0.0662	0.601
Actual - Ex Ante	0.1850	1.663
Efficiency - Predicted	0.8574	15.086
Efficiency - Ex Ante	0.9953	93.070
Predicted - Ex Ante	0.8628	15.455

SOURCE: Table 7.

Spearman rank coefficients, the actual choices are unrelated to any of the other choices, including the predicted choices. However, the predicted choices seem to correspond to those based on an explicit desire to redistribute income to low-income counties--that is, to the ex ante model.

Since the rank assignment was somewhat arbitrary, a second test was employed to determine whether there was a significant difference between the ranking schemes. Projects chosen by one scheme but rejected by another, for 1980 and 1980-81 selections, were compared using McNemar's test [Hays 1963, pp. 601-603].[9/] The results are presented in Table 9. While these results confirm those in Table 8, there is slight evidence that the predicted rankings differ from the efficiency and ex ante rankings. The efficiency and ex ante rankings are nearly identical.

Conclusion

The actual project choices made by the Oregon Transportation Commission were significantly different from those which would occur under any of the ranking schemes investigated. The implication is that the actual choices were not based solely on a desire to redistribute income to low-income counties via project selection nor are they an attempt to choose projects based on efficiency criteria only. Further, the actual choices differ from those predicted on the basis of past choices. Therefore, the Commission may not be consistent in its choices from one period to the next. Before reaching this conclusion, however,

9/ Projects which the Commission chose for construction in 1982 were considered rejected because (a) a new rankings would occur in 1982 and (b) there was a chance, as the Commission warned, that few of the projects actually chosen would be funded due to inflation and federal cutbacks. McNemar's chi-square test was used to compare rejections and acceptances between rankings schemes. It was used in lieu of a binary choice model, such as the logit model.

Table 9. Comparison of Four Rankings of Eighty-Four Oregon Highway Improvement Projects for the 1980 Six-Year Plan.

Ranking Scheme	Time Period[a]	Number of Projects Chosen[b]	Number of Projects Chosen by the Scheme in the Left-Hand Column but Rejected by the Scheme at the Top of the Table.[c]			
			Actual	Efficiency	Ex Ante	Ex Post
ACTUAL	A	42		27 (25.037)	27 (25.037)	26 (24.039)
	B	61		19 (17.053)	19 (17.053)	17 (15.059)
EFFICIENCY	A	38	23 (21.044)		0 (d)	4 (2.250)
	B	61	20 (18.050)		0 (d)	5 (3.200)
EX ANTE	A	38	23 (21.044)	0 (d)		4 (2.250)
	B	61	20 (18.050)	0 (d)		5 (3.200)
EX POST (Predicted)	A	37	21 (19.048)	3 (1.330)	3 (1.330)	
	B	63	19 (17.053)	7 (5.143)	7 (5.143)	

[a] A refers to the first year of the six-year plan; B refers to the first two years of the plan.

[b] The number of projects chosen in each category is determined by the constraint that the total estimated cost of the projects chosen does not exceed $97.6 m. for category A and $151.5 m for category B.

[c] McNemar's chi-square statistic is given in parentheses. For comparison $X^2_{0.90}(1) = 2.71$ and $X^2_{0.95}(1) = 3.84$.

[d] Value of chi-square is infinite.

SOURCE: Table 7.

other explanations should be considered.

Three factors could account for the failure of the regression equation to predict actual selections. First, a substantial change could have occurred in the choice set faced by the Commission. A comparison of projects between the two time periods revealed that, although new projects appeared in the choice set, the choices faced by the Commission in 1980 were comparable to those which it confronted in 1978. Second, there could have been a change in the Commission's utility function. This is unlikely. Four of the five members on the 1978 Commission also served in 1980, and the author has uncovered no obvious explanation for what appears to have been a dramatic turnabout in a short period of time. However, this explanation cannot be conclusively dismissed.

Finally, the Transportation Commission relies almost exclusively on public hearings to decide which projects to undertake. Since the choice set did not change significantly and the Commission would deny that its behavior is inconsistent, the information and political pressures which emerge in the hearing process provide the most satisfactory explanation for the empirical results. The public hearing process may or may not produce satisfactory results, but it is clear that the study provides very limited support for the conceptual framework often employed by economists to study public decisions. Part I of this treatise explores ideas which may eventually enable economists to fruitfully study these processes in the future.

Case Study: Agricultural Conservation Program

The Agricultural Conservation Program (ACP) water quality special

project selection was started in 1979. It "provided for a national reserve to fund special projects with a national focus; including ... the MIPs (USDA-EPA Model Implementation Program for water quality improvement), Small Farmers and new water quality projects" [Magleby 1979]. The head of the Agricultural Stabilization and Conservation Service (ASCS), an agency within the USDA, chaired the National ACP Development Group (NDG) to which each State ACP Development Group was asked to submit one water quality project for consideration as a "special project."[10/] The eligibility guidelines for projects are set out in Notice RE-229 [1979].

In 1979, 44 projects were submitted to the NDG for consideration. Each of the agencies represented in the NDG filled in score sheets for each of the proposed ACP water quality projects. Using the score sheets as a basis for discussion, the NDG eventually selected 21 of the projects for financing.

Since the decision regarding final project selections was made "in committee," the score sheets of a single agency were not necessarily a good indicator regarding the projects finally chosen. The score sheets became a source of controversy and embarassment for the NDG since some members of Congress, who did not get projects for their district, gained access to the score sheets of some of the agencies. As a result, the score sheets were not available to this author, nor

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10/ In addition to the ASCS, the National Development Group includes the Environmental Protection Agency and the following USDA agencies: Forest Service; Economics, Statistics and Cooperatives Service; Farmers Home Administration; Soil Conservation Service; and Science and Education Administration. The State Development Groups include the State leaderships of the above agencies and the leadership of the appropriate state agencies (e.g., Conservation Commission; Fish and Wildlife; etc.).

did the NDG plan to use score sheets in future selection processes.[11/]

Data Used

The author constructed surrogate benefit-cost ratios (BCRs) for 43 of the 44 proposed projects. (Insufficient information was available for one project, subsequently rejected.) Using Notice RE-229 and information, obtained via telephone interviews with national and state leaders within the ASCS, as guidelines, it was possible to calculate project scores from the project data provided by the ASCS [Hanson 1981]. The surrogate benefit-cost ratios were obtained by dividing the project scores by 1,000. These were then used to (a) determine which variables were important in explaining project selection (Table 10) and (b) construct an efficiency ranking of the 43 projects (Table 11).

Two ex ante regional income redistributional weighting schemes were also constructed. In the first scheme, the regional income redistributional weight (d) is defined as:

$$d = (\bar{y}/y)^n,$$

where $\bar{y}$ is average per capita U.S. income and y is the average per capita income of the county in which the project is located.[12/] The value of the parameter (n) was chosen to be 2.0, indicating a marked egalitarian

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[11/] This author is indebted to W. Robert Wilson for interviewing ASCS leaders in Washington, D.C. (July 7 and 8, 1981) to gain this information. John VanCalcar, head of the Oregon Development Group, also provided helpful insights into the method by which final projects were selected.

[12/] For Puerto Rico, average income for the territory was used.

Table 10. Regression Results--ACP Water Quality Special Project Selection, 1979.[a/b/]

Dependent Variable: Weight			
Right-Hand Variable	Estimated Coefficient	Standard Error	t-Statistic
SOCIO	22.65	7.02	3.23
COST	-14.52	4.74	-3.07
Y*COST	1.56	0.54	2.92
Y*SOCIO	- 2.53	0.79	-3.19
COST*COST	0.06	0.03	2.09
UNEM*UNEM	0.15	0.10	1.51

$R^2 = 0.5447$ $\bar{R}^2 = 0.3821$ $\tilde{\sigma} = 0.266$

Mean of dependent variable = -0.175 $\Sigma e_i^2 = 0.988$

$F_{5,14} = 3.350$ n=20

a/ All variables are in natural log form.

Y = average per capita county income[1/]
SOCIO = index of county socioeconomic status[2/]
COST = ACP share of total project cost[3/]
UNEM = unemployment in the state in which the project is to be located.[4/]

b/ Excludes the project for Puerto Rico due to insufficient data.

SOURCES:
1/ Bureau of Economic Analysis 1980.
2/ Ross, et al. 1979(b).
3/ Hanson 1981.
4/ Statistical Abstract of the U.S. 1979.

Table 11. A Comparison of Four Rankings of ACP Water Quality Project Selections, 1979.

Efficiency Scheme			Ex Ante Weighting Scheme #1			Ex Ante Weighting Scheme #2			ACP Share of Project Cost
Rank	BCR	Actual Rank	Weight (d)	Corrected BCR	Rank	Weight W	Corrected BCR	Rank	($000s)
1	1.32	1	1.20	1.59	10	0.89	1.17	17	4,729.5
2	1.29	2	1.08	1.39	13	1.02	1.31	8	192.2
3	1.27	3	3.54	4.50	1	3.54	4.50	1	575.0
4	1.11	4	1.12	1.24	17	3.08	3.42	2	738.8
5	1.09	5	1.26	1.38	14	1.59	1.73	3	582.0
6	1.07	6	1.62	1.73	8	0.80	0.86	25	400.0
7	1.04	7	2.57	2.67	5	1.57	1.63	4	4,000.0
8	0.97	22	1.44	1.39	12	1.43	1.39	6	237.1
9	0.93	23	1.40	1.30	15	0.86	0.80	30	36.0
10	0.93	24	3.59	3.33	2	1.39	1.29	10	11,600.0
11	0.90	8	1.95	1.77	7	1.49	1.35	7	2,740.0
12	0.90	25	1.83	1.65	9	1.45	1.30	9	100.0
13	0.89	26	1.10	0.98	28	1.11	0.99	19	95.5
14	0.87	27	2.35	2.04	6	1.45	1.26	11	2,282.8
15	0.86	9	1.15	0.99	27	1.10	0.95	21	790.5
16	0.86	28	1.40	1.20	18	1.38	1.19	15	122.5
17	0.85	29	1.38	1.18	21	1.01	0.86	24	2,367.0
18	0.85	10	1.80	1.53	11	1.48	1.26	12	2,022.4
19	0.84	30	0.79	0.67	38	0.87	0.73	32	150.0
20	0.83	31	1.30	1.08	23	1.45	1.20	14	225.0
21	0.83	32	1.30	1.08	24	1.42	1.18	16	760.0
22	0.81	11	1.20	0.98	29	1.21	0.99	20	1,503.0
23	0.81	12	0.89	0.72	37	1.05	0.85	26	462.0
24	0.80	33	1.18	0.94	31	0.86	0.69	35	1,500.0
25	0.79	34	1.02	0.81	36	1.12	0.88	22	1,200.0
26	0.77	35	1.10	0.85	34	0.81	0.62	39	1,200.0
27	0.75	13	0.87	0.65	39	0.96	0.72	33	375.0
28	0.74	14	1.31	0.97	30	1.08	0.80	29	525.0
29	0.73	15	4.22	3.09	3	1.68	1.23	13	620.0
30	0.73	16	1.19	0.87	33	1.14	0.83	27	64.0
31	0.71	17	1.69	1.20	19	0.92	0.65	36	150.0
32	0.71	18	3.86	2.74	4	2.03	1.44	5	1,073.8

Table 11. A Comparison of Four Rankings of ACP Water Quality Project Selections, 1979 (continued).

Efficiency Scheme			Ex Ante Weighting Scheme #1			Ex Ante Weighting Scheme #2			ACP Share of Project Cost ($000s)
Rank	BCR	Actual Rank	Weight (d)	Corrected BCR	Rank	Weight W	Corrected BCR	Rank	
33	0.69	36	0.82	0.57	41	0.82	0.56	41	225.0
34	0.68	37	0.95	0.64	40	1.33	0.90	22	472.0
35	0.67	19	1.74	1.16	22	1.50	1.00	18	968.0
36	0.66	38	1.89	1.25	16	1.19	0.79	31	461.9
37	0.66	39	1.54	1.01	25	1.05	0.69	34	100.0
38	0.66	40	1.79	1.18	20	0.94	0.62	40	330.0
39	0.66	41	1.35	0.89	32	1.26	0.83	28	360.0
40	0.62	42	1.33	0.82	35	1.01	0.63	38	350.0
41	0.62	20	1.63	1.00	26	1.05	0.65	37	1,621.8
42	0.32	43	0.49	0.16	43	0.72	0.23	42	188.5
43	0.27	21	1.34	0.36	42	0.78	0.21	43	201.7

SOURCE: Hanson 1981.

bias in project selection.

Scheme two uses a combination of the summary distribution weight (see Chapter V) and an ex ante state income distributional weight. The summary distribution weight is defined as:

$$D = \bar{y}_c^{\,n-1} b^{1-n} \qquad \frac{\Gamma(a - n + 1)}{\Gamma(a)} \quad ,$$

where $\bar{y}_c$ is the expected value of the gamma distribution of a state's per capita county incomes. For n = 2,

$$D = a/(a-1),$$

where $a = (\bar{y}_c/s)^2$ and s is the standard deviation of the average per capita incomes of the counties for a particular state. The state weights are determined as in scheme one; i.e.,

$$w = (\bar{y}/y_k)^n$$

where $\bar{y}$ is average per capita U.S. income and y_k is the average per capita income of the state in which the project is to be located. The value of the parameter (n) is again chosen to be 2.0. The weight used in scheme two is then defined by:

$$W = D \cdot w.$$

In Table 11, equity-corrected BCRs for the two ex ante weighting schemes are provided, as are the subsequent rankings. The actual rankings are also given, ranks being assigned according to the value of the unadjusted (efficiency) BCRs.

Regression Results and Comparison of the Ranking Schemes

An attempt was made to determine whether regional variables were instrumental in resolving project selection. The regression results, presented in Table 10, indicate that project cost is an important variable in explaining variation in the regional weights.[13/] In addition, regional differences in well-being, as measured by average per capita county income, the index of county socioeconomic status and, to a lesser extent, state unemployment, were important in project selection.[14/] However, regional differences accounted for less than half the variation in the dependent variable--that is, the regional weights. Other factors, which could not be quantified, must have influenced final project choices.

By comparing the four ranking schemes discussed above, a further attempt was made to find out if distributive equity was important in the decision-making process. The Spearman rank coefficients and associated t-statistics for the four rankings are found in Table 12. These indicate that there is a significant relationship between the ranking schemes. This may be due, in part, to the arbitrariness of rank assignment. Hence, another statistical test, NcMemar's chi-square test, was employed to compare only project rejections and acceptances between the schemes. The results are presented in Table 13.

It is clear that the actual choices were significantly different from those which would have occurred under either the pure efficiency

[13/] The dependent variable was obtained by dividing project BCRs by the BCR of an opportunity cost project.

[14/] A binary choice model failed to produce better results. This was due to the failure of the binary model to capture the diverse factors used to construct the surrogate BCRs.

Table 12. Spearman Rank Coefficients and T-Statistics for Four Rankings of ACP Water Quality Special Projects.

Pairwise Comparison	Spearman Rank Coefficient	T-Statistic
Actual - Efficiency	0.6303	5.20
Actual - Scheme #1	0.4905	3.60
Actual - Scheme #2	0.5772	4.53
Efficiency - Scheme #1	0.6077	4.90
Efficiency - Scheme #2	0.7293	6.83
Scheme #1 - Scheme #2	0.7378	7.00

SOURCE: Table 10.

Table 13. Comparison of Four Rankings of Forty-Two ACP Water Quality Special Projects, 1979.

Ranking Scheme	Number of Projects Chosen[a]	Number of Projects Chosen by the Scheme in the Left-Hand Column but Rejected by the Scheme at the Top of the Table.[b]			
		Actual	Efficiency	Scheme #1	Scheme #2
Actual	21		10 (8.100)	8 (6.125)	8 (6.125)
Efficiency	21	10 (8.100)		6 (4.167)	4 (2.250)
Scheme #1	21	8 (6.125)	6 (4.167)		6 (4.167)
Scheme #2	20	7 (5.143)	3 (1.333)	5 (3.200)	

[a] The number of projects chosen in each cateogry is determined by the constraint that the total ACP share of project costs does not exceed $24.75 m. Project 10 (Louisianna) was not included in the selections because it would exhaust almost half the budget. It was also rejected by the National ACP Development Group.

[b] McNemar's chi-square statistic is given in parentheses. For comparison, $X^2_{0.90}(1) = 2.71$ and $X^2_{0.95}(1) = 3.84$.

SOURCE: Table 10.

scheme or one of the models which considered equity adjustments a priori. The efficiency choices were not statistically different from those which would result under either of the ex ante models. While statistical evidence of a difference between the two ex ante weighting schemes was slight, the difference can be attributed to the unrealistic assumption, used in constructing the summary distribution weight, that project benefits would be distributed across counties according to the current income distribution.

Conclusion

The National ACP Development Group, which is responsible for the final decision regarding project selection, did not choose its 1979 projects based on efficiency criteria only; nor was its decision based on a desire to redistribute income to needy regions. Although these factors had an effect on the final selections, the evidence indicates that other factors were perhaps more important to the policy-makers. In the end, the models usually employed by economits to model decision processes, such as that used by the NDG in choosing projects, seem to be wanting.

Six agencies are represented in the decision-making process. Assuming that each agency could somehow construct a consistent ranking of the 44 proposed projects, it is unlikely that the final ranking of projects would be transitive. The NDG believes that their choice process is appropriate and workable, even though it may not result in the properties economists desire of welfare rankings. The enigma of construction social welfare functions is, therefore, illustrated in this case study.

Case Study: Corps of Engineers, North Pacific Division

The Army Corps of Engineers has some discretion in its selection of projects. This is true, in particular, of the Section 107 (River and Harbor Act, 1960) and Section 205 (Flood Control Act, 1948) programs. An analysis of the Corps' decisions, under these two Acts in the Pacific Northwest during the 1976-1981 period, indicates that choices were based primarily on the values of the benefit-cost ratios. This selection criteria agrees with the Corps' nominalist, arithmomorphic philosophy.

Nineteen projects considered by the Corps' North Pacific Division were analyzed--five of these are Section 205 projects and the remainder are Section 107 projects, mainly small boat harbor construction. No projects with a BCR less than 1.0 were selected. As indicated in Table 14, in only three cases were projects with a BCR lower than that of a rejected alternative chosen. Further examination reveals, however, that the decision-makers did not deviate from efficiency choices, as measured by the benefit-cost ratio.

A Section 205 project with a BCR of 1.2 was chosen over another Section 205 project with a BCR of 6.7. However, the flood control program with the lower BCR was accepted two years prior to the rejection of the one with the higher BCR. Further, Section 205 and Section 107 projects are not comparable since funds made available under the River and Harbor Act [1960] cannot be used for flood control programs.

Two Section 107 projects with BCRs of 3.1 and 1.4 were rejected while projects with benefit-cost ratios of 1.3 and 1.2 were accepted. The reason for this can be attributed to the fact that the projects were considered in different fiscal years. The accepted projects were

Table 14. Project Selection by the Army Corps of Engineers, North Pacific Division, 1976-1981.

Rank and Project Identifier[a]	8CR	Project Cost ($000s)	Authority[b] (Section)	Approval or Rejection Date
1	6.7	1,850	205	Mar-81
2*	5.3	1,400	107	May-81
3*	4.3	1,700	107	Apr-80
4*	3.1	1,800	107	Feb-79
5*	3.1	1,900	107	Apr-79
6	3.1	1,700	107	Jan-81
7*	2.6	1,900	107	Jun-78
8*	2.2	730	107	Oct-80
9*	2.1	1,200	107	Apr-77
10*	1.8	560	107	Feb-80
11	1.4	1,700	107	Mar-81
12*	1.3	1,500	107	Feb-76
13*	1.2	1,600	205	Jan-79
14	0.9	1,700	107	Jul-80
15	0.7	330	107	Dec-80
16	0.7	1,900	205	Apr-80
17	0.6	540	205	Mar-81
18	0.4	1,010	107	Mar-81
19	0.1	2,800	205	Nov-80

[a] Projects denoted by * were actually chosen.

[b] Section 107 projects are authorized under the River and Harbor Act [1960]; Sector 205 projects were authorized under the Flood Control Act [1948].

SOURCE: Barnhill 1981.

adopted five and two years, respectively, before the projects with the higher BCRs were rejected. The rejected projects need to be compared with another Section 107 project which was accepted in the same year (1981) that the others were rejected. This project had a BCR equal to 5.3.

Based on the evidence, one can only conclude that the Army Corps of Engineers, at least the North Pacific Division, consistently selects projects, over which they have discretionary authority, according to the values of the benefit-cost ratio. The implicit assumption is that society's welfare per dollar expended increases in direct proportion with the numerical value of the BCR.

Summary and Conclusion

Philosophical differences regarding how best to enhance society's welfare account for some of the differences in the criteria and processes public agencies employ in project selection. Except for the Army Corps of Engineers, the public agencies studied did not choose projects solely on the basis of strict efficiency measures. The evidence indicates that, while regional inequities are taken into account, it appears that the agencies behave inconsistently in selecting projects. One reason is that other factors enter into the decision-making process. Further, the conceptual framework applied by economists is often inadequate and the types of data collected are not always indicative of actual human behavior. Perhaps new approaches, with a different convention, are required if economists are to understand agency decision-making and, in particular, the various views regarding the meaning and measurement of social welfare.

CHAPTER VII

SUMMARY AND CONCLUSION

A large number of public and quasi-public agencies, and such institutions as Congress, are faced with decisions regarding the selection of an appropriate subset of possible projects which will maximize social welfare. Since social welfare is a metaphysical concept, difficulties in designing public policy are bound to occur. The problems are compounded by the fact that differences in psychological viewpoints make it difficult to achieve a consensus regarding which criteria are suitable for judging whether the well-being of society is improved or not.

Summary

In this treatise, social welfare was considered to be a function primarily of the total dollar flow of goods and services and the resulting distribution of income. In policy-making and subsequent program selection, these two variables are represented by the efficiency and distributive equity objectives, respectively. Although conflict between these two objectives is not present in all decisions, in many cases the decision-maker must trade off one desire for the other. In Part II, a theoretical model and several empirical frameworks were developed. These would aid the executive in making explicit the trade offs upon which his actions are based. Analysts working in this area hope that the application of these types of models will result in more consistent decisions and enable the public to better understand why a particular final program was chosen. The procedures

suggested for optimal project selection are briefly reviewed below.

Ideally, the New Welfare Economists wish that public agencies would calculate efficiency measures, such as benefit-cost ratios, for all proposed projects. If an agency is not interested in egalitarian issues and is only interested in maximizing GNP, then it should choose those projects which provide the largest social benefits per dollar of social costs.[1/] Choice should continue from highest to lowest until either the agency's budget is exhausted or the addition to GNP becomes negative. If distributive equity (or some other objective) is considered to be important, then ex post or ex ante (whichever is deemed more desirable) weights can be constructed to take into account the additional objective(s). These weights, which are the subject of Chapters IV and V above, can then be used to determine an equity-corrected numerical ranking of projects. It is argued that, in this way, any factors thought to be important to social well-being can be integrated into the analysis.

In practice, however, decision-makers were found not to separate the various objectives in such a simple manner (Chapter VI). The models developed in Chapter V were not only difficult to apply, but the empirical evidence indicated a reluctance on the part of decision-makers to rely on numerical surrogates for efficiency and equity. This was, in part, due to the fact that the executives did not always share the concretistic perceptions of the model builders.

1/ There is some problem with this statement since GNP does not capture all social costs and benefits, even where these may be measurable. Therefore, the following may not be entirely correct.

The decision-making process itself seemed to be geared toward selection criteria different from those which most economists would recommend. Decisions regarding the efficiency-equity tradeoff in public project selection were found to occur via public hearings and/or an arbitration procedure between divergent decision-makers, processes which economists are currently incapable of modeling.

Due to the anomaly between the models discussed in Chapters IV and V and the empirical evidence of Chapter VI, it was necessary to discuss other viewpoints regarding applied welfare economics. This was done in Part I. Psychological types were discussed in Chapter II because it was felt that psychological differences are a major source of conflict in all of science and, for that matter, life in general. In economics, for example, psychological differences between realists and nominalists may explain why the types of models economists usually employ fail to lead to an adequate synthesis of efficiency and equity. Perhaps, as Jung seems to suggest, psychology is the mediatory science to which economists should turn for guidance.

The critique of benefit-cost analysis, and the different constructs of the social welfare function, can also be attributed to psychological differences. The logical positivist psyche is able to separate efficiency and equity for analytic purposes but others may not. Hence, while Scitovsky community indifference curves are based on the inseparability of efficiency from income distribution, the Bergson-Samuelson SWF paves the way for the separation of these objectives. As indicated in Chapter III, this is precisely what benefit-cost analysts do. By invoking (a) the classical Cambridge notion that group welfare is simply the sum of the individual cardinal

utilities, (b) the assumption of constant marginal utility of income, and (c) ignoring the resulting distribution of income, efficiency and equity are effectively separated. Others with a different psychological bent feel uncomfortable with this separation. The result is that the former group has devised an intricate set of compensation tests, which have been severely criticized by the latter.

The most devastating critique of applied welfare economics is due to Georgescu-Roegen. His criticism has shaken the very foundation of neoclassical economic theory, although many economists continue to rely on this philosophism to analyze society's welfare. Rather than seeking new teachings and techniques, they have erected barriers against the various assaults in an attempt to save empiricism and, thereby, welfare economics. The mathematization of economics is one example. The recent emphasis by the Office of Management and Budget on benefit-cost analyses is another. However, alternatives to the pedagoguery of current economic thought are being proposed, especially in the development literature [Georgescu-Roegen 1960 and 1966; Lutz and Lux 1979].[2/]

Conclusion

Georgescu-Roegen emphasizes the need for economists to be more pragmatic, open-minded and universal. It is necessary for them to

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2/ It should be mentioned that Georgescu-Roegen's attack on traditional development policies is aimed at both the neoclassical and Marxist schools of thought. In his "Postscript" [1966] he analyzes the assaults on Marxist dogmas regarding economic development by two Marxist economists--G. Shmelev and J. Tepicht of the Soviet Union and Poland, respectively.

recognize the existence of the dialectical penumbra that surrounds a behavioral science such as economics. Economists should recognize the existence of a hierarchy of needs and wants, as the classical economists did and Abraham Maslow currently does. Wants cannot be reduced to a single value (utility). Economic thought and, hence, welfare applications should, perhaps, be restructured along classical lines. Psychological processes should not be ignored but used to develop a more realistic theory of human behavior.

In the meantime, the models for synthesizing efficiency and equity developed in Chapter V should not be rejected outright simply because they are rooted in empiricism. Indeed, an attempt should be made to implement these, or similar, models on a larger scale since no alternatives currently exist. However, this does not imply that decision-makers should rely solely on the numerical information which these abstractions provide. As indicated in Chapter VI, they obviously do not. Further, economists, or other analysts, should not be upset if their concepts of efficiency and the appropriate tradeoffs with other objectives are largely ignored. Rather, they should recognize that there are other factors involved in the decisions, many of which are nonarithmomorphic and metaphysical in nature.

At the same time, research in other, non-traditional, directions should not be neglected. As much research effort by economists, and maybe more, should be aimed at the penumbra surrounding the current core of economic science. Researchers with a psychological attitude different from that of the logical positivists should be encouraged rather than shunned.

The author hopes that he has pointed the way to at least

one possible orientation which future research can take, especially as it pertains to the resolution of conflicting objectives. It is important, however, to recognize one's own psychological attitude and motivation, and how this author's particular psyche has affected the direction which the research in this treatise has taken.

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APPENDIX A

A NOTE CONCERNING ATTAINMENT OF THE SOCIAL PRODUCTION FRONTIER

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A NOTE CONCERNING THE ATTAINMENT OF THE SOCIAL PRODUCTION FRONTIER

The purpose of this note is to consider the conditions under which it may not be possible for society to attain its production frontier, let alone the Pareto Optimum Optimorum. The main reason is that the economy diverges from the assumptions required for perfect competition to hold. Therefore, the discussion shows that there is nothing sacrosanct about society's production possibility frontier because, in the real world, the frontier may not be realized.

The issues addressed are the following: Is the social transformation function stable with respect to changes in income distribution? Can the Pigouvian method of taxes and subsidies result in attainment of the social transformation frontier, or the Pareto Optimal Optimorum, when distortions exist in the economy? What kinds of distortions prevent the market economy from reaching economically desirable positions?

The social production frontier depends on the amounts of labor and capital which the various economic agents are willing to provide. Hence, the transformation frontier depends, in an indirect way, on the individual utility functions. For example, a redistribution of income in favor of wage-earners may result in a reduction of society's work effort. In terms of the Edgeworth-Bowley production box--where the optimal combinations of inputs are determined--the dimensions of the box change. The technical efficiency locus from which the transformation function is derived shifts and, as a result, the social

production function also shifts.

Further, any factors which affect individual preferences (causing the utility map to change) will cause the social transformation curve to be altered in ways that cannot be predicted a priori. While these added complications are almost always assumed away, they should be recognized.

Graaff [1963] considers the case where perfect competition still holds and there are no externalities. Two firms (A and B) each producing two outputs (X and Y) are assumed to exist. Firm A possesses a certain type of "entrepreneurial input" which is not available to firm B. This specialized input causes A's production possibility curve to be convex to the origin--i.e., increasing marginal returns prevail over the range of output combinations. Firm B faces decreasing marginal rates of return and its production possibility curve is concave to the origin.

By using a diagrammatic device which Hicks [1939, p. 703] attributes to Kaldor, the social transformation curve can be found.[1/] However, the combination of outputs represented by the tangency point, K in Figure A-1, where the marginal conditions hold, represents a point of minimum profit for firm A. At that price ratio firm A would specialize in production of Y, as indicated by point E in Figure A-1.

Which of these points is socially desirable? Knowledge of the SWF is required. To reach the socially preferred position may re-

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[1/] The social transformation curve is constructed as follows. The production possibility curve for firm B is reversed and superposed on that of firm A, keeping the axes parallel as in Figure A-1. This method of compounding allows one to combine the outputs of the two firms on one graph.

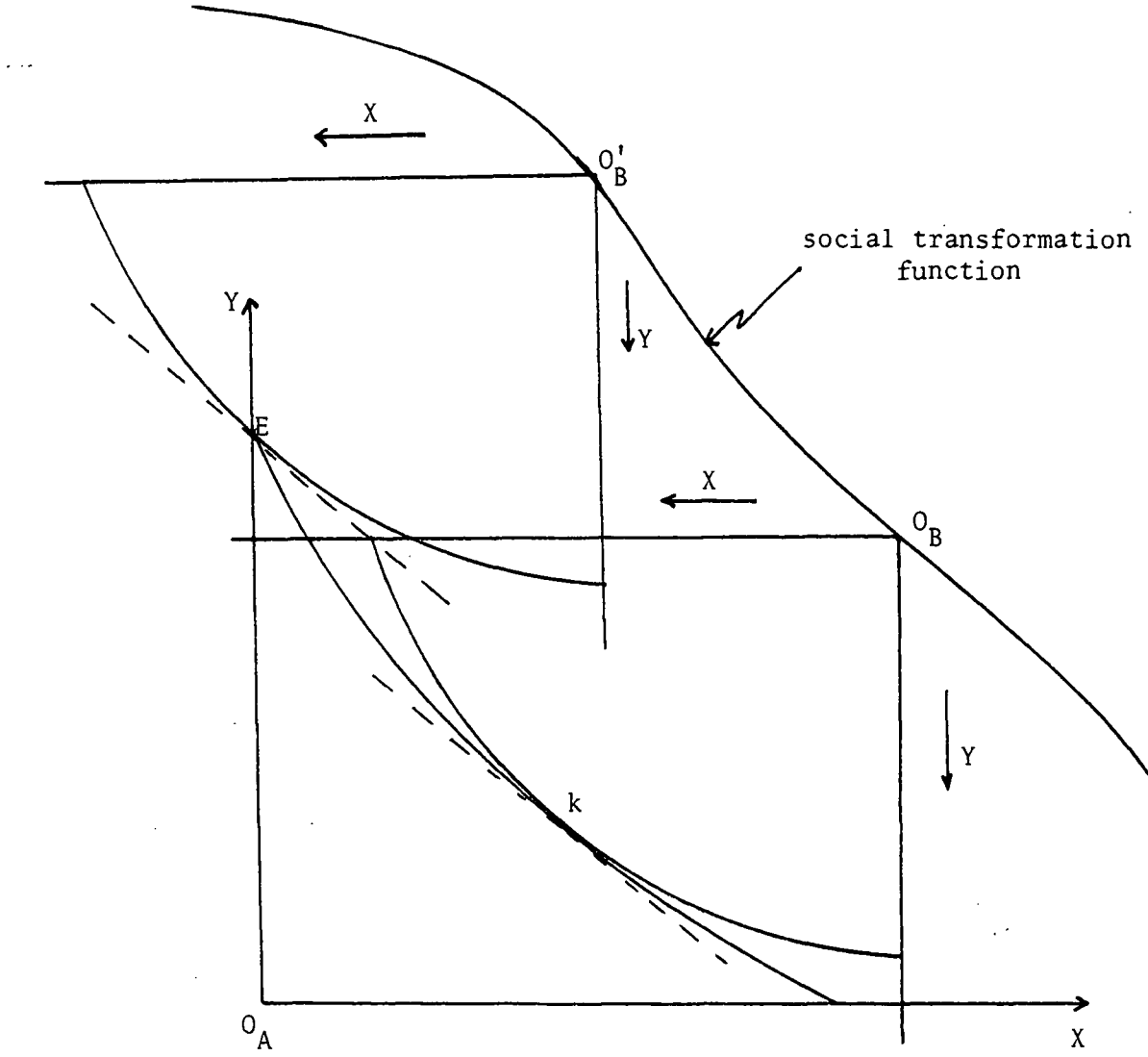

Figure A-1. Construction of the Social Transformation Function.

quire a system of taxes (and subsidies). "But the taxes may be very complicated; and it may be a somewhat emaciated version of perfect competition which eventually emerges" [Graaff 1963, p. 26]. The required tax corrections, if any, are discussed below.

The following model is similar to that found in Archibald and Wright [1974]. The model is useful for illustrating two ideas. First, it shows that the Pareto Optimum Optimorum can be achieved in the presence of an externality by the Pigouvian tax and subsidy solution. Second, given the existence of several distortions in the economy, it indicates that it may not always be possible to reach the production frontier. If this is true it may be better to do nothing.

Assume four goods are produced by three perfectly competitive industries. One of the goods is "poison," Z. Poison is produced as a by-product in the production of steel (X) and is a harmful input in the production of flowers (Y). The wheat (W) industry is unaffected by the poison. The technology is assumed to be asymmetrical so that only the producers of steel can clean up the pollutant. The others can only avoid the externality.

The production functions are:

steel:	$X=f(R_X)$;	$f' > 0, \quad f'' < 0$
flowers:	$y=g(R_y,Z)$;	$g_1 > 0, g_{11} < 0, g_2 < 0, g_{22}$?, g_{12} ?
poison:	$Z=\emptyset(X,R_p)$;	$\emptyset_1 > 0, \emptyset_{11} < 0, \emptyset_2 < 0, \emptyset_{22}$?, $\emptyset_{12}$?
wheat:	$W=h(R_w)$;	$h' > 0, \quad h'' < 0$.

There is a single mobile resource, R, used in the production of steel (R_X), flowers (R_y) and wheat (R_w), and in the prevention of poison (R_p). (The production functions are assumed continuous and partial

derivatives are denoted by subscripts with the subscript i denoting the i^{th} argument of the function.)

A single, well-behaved welfare function (not necessarily the social welfare function) is assumed to be maximized. The Lagrangian is:

$$L = U(x, y, w) + \lambda_1[x - f(R_x)] + \lambda_2[y - g(R_y, \phi\{x, R_p\})]$$

$$+ \lambda_3[w - h(R_w)] + u[R - R_x - R_y - R_w - R_p],$$

with first order conditions:

(a) $U_x + \lambda_1 - \lambda_2 g_2 \phi_1 = 0,$

(b) $U_y + \lambda_2 = 0,$

(c) $U_w + \lambda_3 = 0,$

(d) $-\lambda_1 f' - u = 0,$

(e) $-\lambda_2 g_1 - u = 0,$

(f) $-\lambda_3 h' - u = 0,$ and

(g) $-\lambda_2 g_2 \phi_2 - u = 0.$

From the first order conditions we obtain:

(1) $\frac{U_x}{U_y} = \frac{g_1}{f'} - g_1\phi_1,$

(2) $\frac{U_w}{U_g} = \frac{g_1}{h'},$ and

(3) $g_1/g_2 = \phi_2.$

In equation (1) $g_1\emptyset_1$ represents the divergence between private and social marginal costs. Equation (2) is the usual utility maximizing condition between two perfectly competitive industries while (3) is the efficiency condition.

Pigou argues that we need a tax to correct for the divergence between the private and social marginal cost resulting from the externality. The poison produced by the steel industry must be taxed.[2/3/] The tax function is $T=T(Z)=T[\emptyset\{f(R_x),R_p\}]$. The profit function for the steel industry becomes:

$$\Pi_x = P_x \cdot f(R_x) - R_x - R_p - T[\emptyset\{f(R_x), R_p\}].$$

The first order conditions are:

(4) $P_x f' - 1 - T'\emptyset_1 f' = 0$ and

(5) $-1 - T'\emptyset_2^{*} = 0.$

Similarly, maximizing the profit functions of flowers and wheat gives:

(6) $P_y \cdot g_1 - 1 = 0$ and

(7) $P_w h' - 1 = 0,$

respectively.

From equations (1), (2) and (6) we find that the optimal price of X in units of R is

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2/ Unless the output of poison is taxed, R_p will be set to zero. Taxing steel may only reduce steel output (and hence poison). But we want to reduce the output of the pollutant, not steel.

3/ Tax revenue is assumed to be neutrally distributed.

$$p_x^* = \frac{1}{f'} - \frac{g_2}{g_1}\phi_1.$$

Equating this to the price of X in equation (4) gives:

$$T' = -\frac{g_2}{g_1} > 0.$$

The optimal tax equates the marginal cost of abatement to the price of abatement.

The optimal tax rate can only be found by solving the primal problem. This implies that the central authority must have the knowledge necessary to determine the optimal amount of pollutant.[4/] If this is known then the authority could achieve Pareto Optimum Optimorum simply by setting the allowable output of poison at its optimal level.

It can be shown that if the central authority subsidizes the victim (y) without taxing the villain (x) then the "neutral" industry is affected.[5/] Wheat producers must also be subsidized as is obvious from (2). A Pareto Optimum Optimorum can be achieved, however.

The more interesting case is what happens when other distortions exist. Will the local tax solutions to the externality problem be appropriate? Is it possible to achieve Pareto Optimum Optimorum?

Archibald and Wright show that when there is one invariant distortion in the economy along with the externality, then Pareto Optimum Oprimorum can still be achieved.[6/] However, the prices in all the

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[4/] For an excellent discussion of this see Bator [1957, p. 395 footnote].

[5/] (See Archibald and Wright 1974, pp. 12-16.) It should be noted that although Archibald and Wright call the steel producer the villain, this may not be the case. Legally, he is not a villain if the law states that he is free to pollute the environment. On this issue see Coase [1960] and the subsequent literature.

[6/] Mark-up pricing is an example of an invariant distortion. Price must be set according to $P_W=(1+\theta)/h$ if there is a monopoly of wheat using mark-up pricing (see Archibald and Wright 1974, pp. 17-22).

other sectors must also be corrected. If this is not possible it may be better not to proceed with the Pigou tax solution.

Now consider the case of a non-invariant distortion in commodity space. Assume a monopolist in the wheat industry adjusts price to maximize profits according to his perceived demand curve. The demand for wheat is perceived to be

$$W = D(P_w, P_x, P_y).$$

Substituting quantities for prices of competitively produced goods, we can write the constraint in output space as

$$m(x, y, w) = 0.$$

The earlier Lagrangian is augmented by the constraint as follows:

$$L = U(x, y, w) + \lambda_1[x - f(R_x)] + \lambda_2[y - g\{R_y, \emptyset(x, R_p)\}]$$

$$+ \lambda_3[w - h(R_w)] + u[R - R_x - R_y - R_w - R_p] + \Pi m(x, y, w).$$

The first order conditions are:

(a') $U_x + \lambda_1 - \lambda_2 g_2 \emptyset_1 + \Pi m_1 = 0,$

(b') $U_y + \lambda_2 + \Pi m_2 = 0,$

(c') $U_w + \lambda_3 + \Pi m_3 = 0,$

(d') $-\lambda_1 f' - u = 0,$

(e') $-\lambda_2 g_1 - u = 0,$

(f') $-\lambda_3 h' - u = 0,$ and

(g') $-\lambda_2 g_2 \emptyset_2 - u = 0.$

It is obvious that the optimality conditions for second-best can no longer be reduced to the simple "pairwise" rules of (1) and (2). First-best rules continue to hold where m_i are zero; if all the m_i are zero, we have the invariant distortion again. And from equations (e') and (g') we find that we can still reach the efficiency frontier; i.e., (3) still holds. Existence of monopoly in the wheat industry does not alter the optimal pollution tax, but this tax alone does not ensure attainment of the efficiency frontier. However, there may not be enough corrective instruments available to achieve the full set of second-best conditions.

If the resource, R, is monopolized the augmented Lagrangian becomes:

$$L = U(x, y, w) + \lambda_1[x - f(R_x)] + \lambda_2[y - g\{R_y, \emptyset\ (x, R_p)\}]$$

$$+ \lambda_3[w - h(R_w)] + u[R - R_x - R_y - R_w - R_p] + \Pi m[f(R_x),$$

$$g\{R_y, \emptyset(x, R_p)\}, h(R_w)].$$

For this distortion in input space the first order conditions become

(a'') $U_x + \lambda_1 - \lambda_2 g_2 \emptyset_1 + \Pi m_2 g_2 \emptyset_1 = 0,$

(b'') $U_y + \lambda_2 = 0,$

(c'') $U_w + \lambda_3 = 0,$

(d'') $-\lambda_1 f' - u + \Pi m_1 f' = 0,$

(e'') $-\lambda_2 g_1 - u + \Pi m_2 g_1 = 0,$

(f'') $-\lambda_3 h' - u + \Pi m_3 h' = 0,$ and

$$(g'') \quad -\lambda_2 g_2 \emptyset_2 - u + \Pi m_2 g_2 \emptyset_2 = 0.$$

In this case it is obvious that it is not possible to get to the efficiency frontier. The same would be true if more than one monopolist existed in commodity space when we have an externality. Archibald and Wright conclude that:

> "In the real world we have to contend with uncorrected final goods distortions and input distortions. It follows that, in spite of its invariance to final goods distortions, the optimal pollution tax can only be recommended 'piecemeal' as an 'act of faith'" [1974, p. 26].

APPENDIX B

EXAMPLES OF PROJECT SELECTION CRITERIA AND PROJECT SCORE SHEETS FOR PUBLIC AGENCIES

APPENDIX B

EXAMPLES OF PROJECT SELECTION CRITERIA AND PROJECT SCORE SHEETS FOR PUBLIC AGENCIES

U.S. Forest Service Criteria for Range Improvement Projects

611.2

RANGE ANALYSIS AND MANAGEMENT HANDBOOK 1/

*- CHAPTER 600 - ECONOMIC ANALYSIS OF RANGE IMPROVEMENTS AND PROGRAMS.

610 - INTRODUCTION.

611 - Purpose Of The Analysis. The primary purpose for completing an economic evaluation is to provide better information to the decision maker regarding the financial, environmental, and social costs and benefits of various range management programs, projects, or project alternatives. Some minimum amount of information gathering and documentation is needed to improve decision making and to rank projects for program planning and budgeting.

An economic analysis assumes there is more than one alternative to meet an objective or program need. The key is to describe the best alternative or program to meet the objectives in the most efficient manner.

611.1 - Forest and Rangeland Renewable Resources Planning Act (RPA). An economic analysis is required under RPA. For example: the Resource Planning Act of 1974 states in part (sec. 3): ".... the program shall include, ... (2) specific identification of program outputs, results anticipated, and benefits associated with investments in such a manner that the anticipated costs can be directly compared with the total related benefits."

The recommended program is directed at increasing the production of AUM's, and correcting unsatisfactory range conditions in a cost-effective manner. This, also, includes social concerns. For example, "cost-effective opportunities for meeting interim production targets are to be met within the constraints of region social needs." This may be interpreted to mean that even through the investment cost in dollars, to increase or sustain AUM's, may be higher than in other regions, the higher investment costs may be cost-effective because they maintain established regional and local community needs.

611.2 - National Environmental Policy Act (NEPA). The Environmental Assessment Report, requires that alternative actions be considered and analyzed. An economic analysis of the proposed range project plan and alternatives is required by NEPA and established policy. -*

1/ Forest Service Handbook 2209.21 (latest update).

*- 612 - Economic Analysis Approach. To rank alternatives and to prioritize development proposals, a cost effectiveness analysis must include the following:

Financial Analysis
Environmental Analysis
Social Well-being Analysis

All three are equally important in analyzing range improvement projects. For example, in some cases, a project may have high initial costs and require extensive fences to be effective. The dollar value of the expected increased grazing in AUM's may be less than the investment cost and not be a financially significant project. However, there could be important environmental or social benefits that make the project cost effective.

The purpose is to describe an analysis method that is relatively simple and easy to accomplish. Much of the information needed will be taken from project plans. However, some information needed may be scarce, difficult to obtain, or simply unavailable. You may have to make projections using the information available. The projections may have limited reliability, particularly the projections used in the environmental quality and social well-being analysis. This can be partly overcome by using your best judgement, and documenting the assumptions you have used.

612.1 - Financial Analysis. For the financial analysis, the costs (inputs) and benefits (outputs) are measured in dollars. This analysis of a project proposal will provide the user with a Benefit-Cost Ratio (B/C), Net Persent Worth (B - C = NPW), or the Internal Rate of Return (IROR). In the financial analysis, efficiency is used as a measuring stick for deciding between various alternatives. For range improvement work, this concerns getting as much dollar measurable output, such as AUM's, as possible from the limited amount of funds.

To complete a finanacial analysis, all costs and benefits over the project life must be discounted to their present worth. The Invest III or RANGE RAM computer programs are available, however, the procedures outlined in this chapter are an adequate alternative to these programs.

612.2 - Environmental Quality Analysis. The effects on environmental quality of a proposed project are characterized by their non-market or non-monetary nature. The analysis is based on a subjective rating of various criteria that are described below. A comparative ranking of the relative costs and subjective ranking of benefits can be documented. -*

*- 612.3 - Social Well-Being Analysis. Examples of beneficial effects on social well-being from a proposed project are contributions to the equitable distribution of real income and employment, rural community stability, and other social opportunities. They are integrally related to the basic values and goals of society and are not usually subject to monetary evaluation. The analysis is based on a subjective rating of various criteria that are described below. A comparative ranking of the relative costs and a subjective ranking of benefits can be documented.

620 - FINANCIAL ANALYSIS PROCEDURE

621 - Introduction. For the financial analysis, the costs (inputs) and benefits (outputs) are measured in dollars. Economic benefits and costs should be converted to a common dollar base (present value). Discounting Discounting
is a method used to determine the present value of future costs or expected benefits, when the cost and benefits are spread out over time. The mechanics of the process are not difficult. It should provide a decision maker the comparative Benefit-Cost (B/C), Net Present Worth (B-C = NPW), or Internal Rate of Return (IROR), to make economic choices. The results of this analysis should be considered together with the nonmarket benefits.

622 - Benefit-Cost Ratio. Benefit cost analysis expresses discounted benefits and costs as a ratio of dollars returned for each dollar of cost.

$$\text{Benefit-Cost ratio} = \frac{\text{present value of economic benefits}}{\text{present value of costs}}$$

For purposes of subjective ranking, for range programs in Region 6, a benefit-cost ratio above 1.5 is highly significant. A ratio of 1.0 to 1.5 is significant. A ratio of 0.7 or higher, but less than 1.0 is moderate. A ratio less than 0.7 is low. Range program benefits should be at least 0.7 of program costs to have a "go" project based only on dollars returned for each dollar invested.

The project life should be equal to the economic or physical life, whichever is shorter. Economic life is the period of time over which the project will yield net benefits. The expected life of range improvement practices will vary considerably. A range seeding may be effective for 20 years, an allotment division fence may be good for 30 years or more, and certain management practices may not be predictable beyond the 10 year permit period. However, for analysis purposes, assume the project life to be 20 years even though some management practices and improvements properly maintained might actually be longer. -*

*- Table 1 - COMPOUND DISCOUNT MULTIPLIER

Discounted SINGLE payment multiplier equals the value of a one dollar payment discounted for N years.

	RATE OF INTEREST		
No. of Years Hence	.070	.100 1/	.150
1	.93458	.90909	.86957
2	.87344	.82645	.75614
3	.1630	.75131	.65752
4	.76290	.68301	.57175
5	.71299	.62092	.49718
6	.66634	.56447	.43233
7	.62275	.51316	.37594
8	.58201	.46651	.32690
9	.54393	.42410	.28426
10	.50835	.38554	.24718
11	.47509	.35049	.21494
12	.44401	.31863	.18691
13	.41496	.28966	.16253
14	.38782	.26333	.14133
15	.36245	.23939	.12289
16	.33873	.21763	.10686
17	.31657	.19784	.09293
18	.29586	.17986	.08081
19	.27651	.16351	.07027
20	.25842	.14864	.06110

1/ This rate is the OMB Circular A-94 required discount to be used for evaluating Federally founded projects.

The 7, and 15% rate have been used for determining financial sensitivity of projects in the Forest Service program development and budget process. -*

*- Table 2 - COMPOUND DISCOUNT MULTIPLER.

Discounted ANNUAL payment multiplier equals the present value of an annual payment of one dollar of N years.

	RATE OF INTEREST		
YEARS	.070	.100	.150
1	.93458	.90909	.86957
2	1.80802	1.73554	1.62571
3	2.62432	2.48685	2.28323
4	3.38721	3.16987	2.85498
5	4.10020	3.79079	3.35216
6	4.76654	4.35526	3.78448
7	5.38929	4.86842	4.16042
8	5.97130	5.33493	4.48732
9	6.51523	5.75902	4.77158
10	7.02358	6.14457	5.01877
11	7.49867	6.49506	5.23371
12	7.94269	6.81369	5.42062
13	8.35765	7.10336	5.58315
14	8.74547	7.36669	5.72448
15	9.10791	7.60608	5.84737
16	9.44665	7.82371	5.95423
17	9.76322	8.02155	6.04716
18	10.05909	8.20141	6.12797
19	10.33560	8.36492	6.19823
20	10.59401	8.51356	6.25933

1/ This rate is the OMB Circular A-94 required discount to be used for evaluating Federally funded projects.

The 7, and 15% rate have been used for determining financial sensitivity of projects in the Forest Service program development and budget process. -*

*- Project example:

A range allotment project involves both structural and non-structural practices and additional administration costs. The project life is 20 years. The initial installation is in year 0. When using the discount Tables 1 and 2, it is assumed that the costs occur at the beginning of the year, and the benefits occur at the end of the year. This is confusing when discounting costs and benefits over several years. Therefore, it is best to assume the initial installation costs occur in year 0 and the cost will not be discounted since the discount factor for this single payment from Table 1 will be 1.00. Benefits are not assumed to occur in year 0.

The costs are listed as:

year 0	Installation	$40,000
year 1-20	Increased Admin.	$150/year
year 2-20	Maintenance	$400/year
year 10	Heavy maintenance	$4000

Benefits are saved and/or increased AUM's as follows:

year 3-5	900 AUM's
year 6-15	1400 AUM's
year 16-20	1000 AUM's

Present Value of Costs:

Year	Amount	Discount Factor (.10)	Present Value
0	40,000	1.00 (Table 1)	$40,000
1-20	150	7.60 (Table 2)	1,140 1/
2-20	400	6.78 (Table 2)	2,712
10	4,000	0.39 (Table 1)	1,560
			$45,412

1/ When an annual payment discount factor occurs over several years such as when $400 is discounted for years 2 through 20, use the factors in Table 2 as follows:

10% Interest

Discount factor year 20 = 8.51356
Less Discount factor year 2 = 1.73554
Factor for year 2 to 20 = 6.78

Thus 6.78 X 400 = $2712 (Present Value) -*

*- Present Value of Benefits: (AUM's = $6.50)

Year	Amount 1 Year	Discount Factor	Present Value
3-20	900 x 6.50	6.03 (Table 2) 1/	$35,276
6-15	+500 x 6.50	3.25 (Table 2)	10,563
16-20	+100 x 6.50	0.69 (Table 2)	449
			$46,288

$$B/C = \frac{\text{PV Benefit}}{\text{PV Cost}} = \frac{46,288}{45,412} = 1.02$$

1/ See footnote page 622-5. -*

*- 623 - Net Present Worth. The net present worth is frequently used to evaluate investment proposals and project alternatives. The net present worth (NPW) of a project is the present value of benefits minus the present value of costs, or:

NPW = PV Benefits - PV Costs

In the above project example:

NPW = 46,288 - 45,412 = 876

When selection of an alternative forecloses other future options it will be helpful to know which one has the greatest amount of return as shown by NPW. The B/C ratio and IROR only show rate of return and the amount of total return could be insignificant.

624 - Internal Rate of Return. What needs to be determined is the average percentage of return gained investment.

The following is an example of how this may be determined using Table 1:

Find the Present Value of Investment (Costs) as in the example above (paragraph 622).

Year	Amount	Discount Factor (.10)	Present Value
0	40,000	1.00 (Table 1)	$40,000
1-20	150	7.60 (Table 2)	1,140
2-20	400	6.78 (Table 2)	2,712
10	4,000	0.39 (Table 1)	1,560
			$45,412

Determine the average AUM's gained or saved.

0-3	years	0 AUM's x 3 years	=	0
3-20	years	900 AUM's x 17 years	=	15,300
6-15	years +	300 AUM's x 10 years	=	4,500
16-20	years +	100 AUM's x 4 years	=	400
				20,200 - 20 yrs. = 1010 AUM's

Average Cost $/AUM = $\frac{\$45,412}{1010}$ = $45/AUM cost of forage produced or saved.

Using Table 1, find the $45 on the horizontal axis (cost of Forage produced and/or saved). Draw a vertical line to intersect the market value of Public Grazing curve at $6.50 1/, and a horizontal line to find the internal rate of return (IROR). IROR = 10%.

1/ Based on the 1976 land use rate for livestock grazing ($6.50) per AUM for the nine western states. This rate is periodically adjusted by the E.R.S. -*

624--2

RANGE ANALYSIS AND MANAGEMENT HANDBOOK

*- Table 1

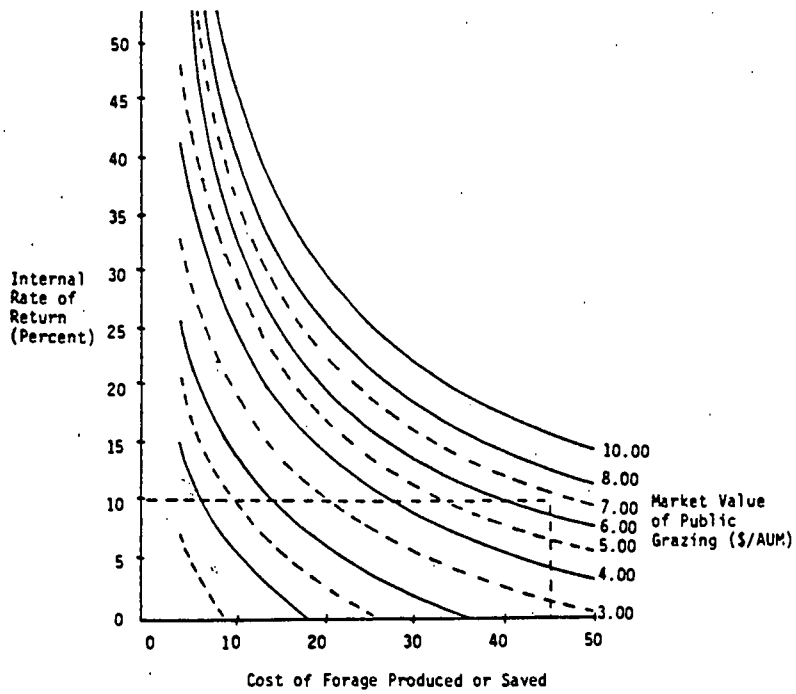

Table 3 is based on the curves developed by Robert W. Sassaman and Roger O. Right, economists, Pacific Northwest Forest and Range Experiment Station, Forest Service, USOA, Portland, Oregon and published in the Journal of Range Management 28(3), May 1975. The time frame for these curves is based on the expected life of the project, which is 20 years.

-*

*- 630 - ENVIRONMENTAL AND SOCIAL BENEFITS ANALYSIS.

631- Introduction. An analysis of environmental and social factors for each proposal is required in conjunction with a financial analysis to determine if the proposal is cost-effective. So that each Forest is relatively consistent in reporting environmental and social well-being effects for range improvement projects, a rating form has been developed that should be completed for each proposal. A narrative will not be required along with this rating form unless you wish to further explain the importance of various rating criteria. Highly significant local issues that are not addressed Regionally or Nationally should be addressed in a separate narrative.

The following instructions are intended to explain the criteria used to rate environmental and social well-being project benefits. Also included are guidelines for rating the various criteria and calculating a numerical rating that can be used to rank allotments (projects) by priority. -*

*- 632 - Environmental Quality.

1. Rating Criteria. Treatment measures included in the proposed project plan may have a variety of effects on environmental quality. The effects on environmental quality are characterized by their non-market and nonmonetary nature. Beneficial effects are contributions resulting from the proposed project and the area affected by the project. Such contributions generally en-hance the quality of life. There could also be some adverse impacts on environmental quality. For example, large clearings made in pinyon-juniper may adversely affect big game. Another example might be the removal of big sage in key deer winter range..

It may be difficult to identify and describe or measure all of the environmental effects. To help in your analysis, five environmental quality criteria are described:

Erosion and Sediment
Water Qaulity
On-Site Productivity
Esthetic Land Quality
Wildlife Habitat

There may be others that are unique to your project, but use these as a start. These criteria will provide important evidence for judging the value of a proposed range project. In many cases the net environmental quality rating will be equally as important as the B/C or NPW.

To the extent possible, the expected environmental effects both "with" and "without" project should be analyzed in relevant physical terms and a relative rating assigned for each separate factor which indicates the significance it has to the project area. This inventory will be completed for each of the criteria. This information will be used on Form R6-2210-108 to indicate the relative benefit "with" the project, compared to "without" the project. The environmental conditions will not remain static but will tend to change over time regardless of whether the project is installed. The project caused difference is rated. -*

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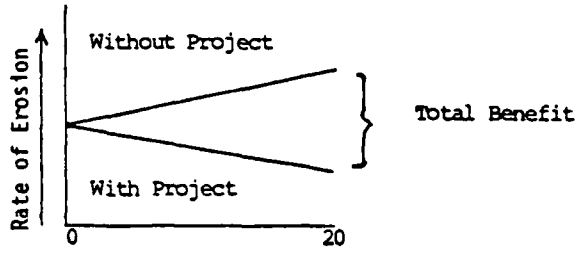
632.1 - Erosion and Sediment (Off-Site). In judging the environmental impact of a proposed range improvement project, the expected benefit from reduced erosion and sedimentation should be qualified. On large water resource projects the benefits for reduced soil loss and reservoir sedimentation may be converted to dollars and used as part of the economic analyses. On most range improvement projects, it is difficult to place a dollar value on sediment since it is hard to physically measure. Therefore, it may be included under environmental quality.

If your proposed range improvement project is expected to reduce downstream sedimentation (off site) and rate of reservoir siltation, it will improve the quality of the environment. The size and type of project and location within the watershed relative to reservoirs and the existing condition of watershed will indicate the relative average annual benefit over the total life of the project (20 years). For example, you may have a situation where because of decreasing plant cover, the relative rate of erosion and sedimentation is increasing. If the project is implemented, this trend would expect to be reversed. The potential benefit would be the difference over the project period as shown below.



To help indicate the relative benefit, consider the following factors:

Sheet and gully erosion (on-site).
Streambank disturbance.
Sediment deposition in channel affecting capacity.
Sediment deposition in reservoirs.
Potential flood damages downstream.

-*

*- 632.11 - Criteria for Rating Erosion and Sediment on Form R6-2210-108. This criteria relates primarily to off-site or downstream impacts.

Highly Significant: Accelerated downstream sedimentation is presently readily apparent. Proposed project is above a reservoir or area of periodic flooding which results in damage to improvements or crops. The proposed project is expected to reduce most negative impacts resulting from grazing use. The benefit will occur during the expected life of the project.

Moderate: Negative impacts will be reduced but there are few improvements downstream.

Minor: Downstream sedimentation from grazing is not a problem but project will help maintain existing condition.

632.2 - Water Quality. The value of surface water is determined by use. The benefits of water quality from the proposed project is associated with reducing the presence of one or more undesirable water quality constituents or characteristics. These benefits may be esthetic or help meet or maintain existing water quality standards. The capability of all surface waters to support life forms or esthetic value should be preserved. Esthetically pleasing waters add to the quality of human experience. Water may be pleasant to look upon, to swim in, to walk or rest beside, and to contemplate. It may provide a variety of active recreation experiences.

The physical characteristics that can be considered in assessing the esthetic value include clarity, color, temperature, turbidity, sediment, litter, and debris. The benefit may be both on-and-off-site.

In rating this criteria, consider the following factors:

1. Improved esthetics

2. Project maintains or improves existing water quality standards.

632.21 - Criteria for Rating Water Quality on Form R6-2210-108.

Highly Significant: Project will help improve esthetics and water quality.

Moderate: Project will help maintain existing water quality. Judging expected water qualtiy benefits is difficult on this project due to the complexity of assessing the various water quality standards. However, none is expected to decline.

Minor: One or more of the physical characteristics of judging water quality is not expected to be maintained, even though some may be improved. -*

*- 632.3 - Improved On-Site Productivity. (Forage Rating). The major objective of range management projects and grazing systems is to maintain or improve forage rating. Good forage rating is the key to assuring the most renewable multiple uses of the resource and sustained yields of resource values. It is difficult to place a dollar value on forage rating. Good vegetative cover is the base for many uses of the range resource and a measure of present and long-term site productivity.

Factors to consider are expected change in forage rating and increased forage production.

632.31 - Criteria for Rating On-Site Productivity - Forage Rating On Form R6-2210-108. The expected benefit relates to improving forage rating which is long-term and produced over the life of the project. Forage rating means improvement over the project life which is up to 20 years.

Highly Significant: Present forage rating is very poor or poor. With the project the rating within 10 years is expected to be fair or better. Production of forage will increase two fold within 5 years.

Significant: Same as above but will take more than 10 years to improve.

Moderate: Rating will improve from fair to good.

632.4 - Esthetic Land Quality: The proposed range improvement practice may enhance the visual scene of the range or forest landscape. For nonstructural range improvement practices, the project is designed where possible to enhance scenic values. This may result in establishing a mix of vegetative cover with a natural diversity of clearings and untreated areas. The benefit is expected to occur over the total life of the practice even though the first few years may have a negative impact because of debris and the time required to establish vegetative cover. Some structural range improvement practices may not enhance landscape as such, but with proper design it will not detract from the scene.

The amount of benefit will relate to the specific area and the extent of human use and enjoyment. Relate to acres of land benefited.

632.41 - Criteria For Rating Esthetic Land Quality On Form R6-2210-108.

Significant: Project will enhance needed visual quality.

Moderate: Needed visual quality will be maintained. -*

*- 632.5 - Wildlife Habitat. Structural and nonstructural range improvement practices are implemented to increase forage production for livestock. However, many of these practices, because of project design and location, also enhance the habitat for wildlife including both game and nongame species. For example, good vegetative cover for range may also provide food and cover for wildlife. The increased hunter-day use which may result from improved wildlife conditions can be quantified in the economic analysis. However, the benefit under environmental quality can be listed here. Normally, a simple statement that the range practice will improve wildlife habitat is not sufficient. Rather, your statement should identify the animal species affected and the magnitude of the effect on the specific wildlife population with respect to the total supply, within the area.

Water improvements, such as spring developments and tank reservoirs, may make drinking water available to several wildlife species over a considerable area. Vegetative manipulation projects may increase the variety of bird species. Other practices may enhance the habitat for deer or elk.

Some range improvement practices, because of changes in plant composition may reduce the population of deer or antelope. This would have an adverse impact on wildlife, and on environmental quality. There is no good way to measure the environmental trade-off. Most range improvement projects are designed to maintain or enhance wildlife habitat.

The benefit is based on the expected increased degree or level of wildlife population over the length of the project life. Consider all wildlife, game and nongame. Give special emphasis to threatened and endangered species.

632.6 - Criteria for Rating Wildlife Habitat on Form R6-2210-108.

Highly Significant: Project will enhance habitat for threatened or endangered species or increase wildlife habitat of game and/or nongame species by 10 percent, and no species, recognized as important on the area, are being impacted.

Moderate: Project will help maintain existing wildlife populations. -*

*- 633 - Social Well-Being. Beneficial effects on well-being are contributions to the equitable distribution of real income and employment to other social opportunities. They are integrally related to the basic values and goals of society and are usually not subject to monetary evaluation.

The social benefits attributed to projects involving range improvement practices are somewhat difficult to evaluate, even in subjective terms. However, the benefits relate to employment in the economy and the family, the relative importance of Federal lands to the livestock industry in the local area, the relative importance of livestock production in the total economic environment of the country or region, stability of the rural community, and benefits affecting the lower income groups and minorities.

Following is a description of criteria to use for arriving at a social well-being benefit.

633.1 - Employment. Increased new employment on range improvement projects probably will not involve many permanent or seasonal jobs. This is, however, one of the primary criteria. Even though the number of jobs, including both Forest Service and permittee related, may not be increased, the project may sustain positions by maintaining production of AUM's. Some projects may be contracted. In such cases, this can be considered new seasonal employment.

Do not include as a benefit, people who are already working that are shifted to this work from some other planned activity, unless the project sustains employment. List as number of new or sustained jobs. Include Forest Service and permittee related.

633.11 - Criteria for Rating Employment on Form R6-2210-108.

Highly Significant: Ten or more permanent and/or part-time jobs.

Significant: Six to nine part-time jobs.

Moderate: Three to five part-time jobs.

Minor: One to two part-time jobs. -*

*- 633.2 - Income Distribution. Who benefits from the project? Does the project produce a significant increase in AUM's or does it sustain the production AUM's which without the project would eventually be reduced to maintain or improve range condition? Most likely, the permittee will benefit from the increased or sustained production. Is the permittee in a low, middle, or high income group, compared to the Regional average? In a community allotment, how many permittees are involved? The project that provides benefits to lower income groups has a higher social value.

List the number of permittees involved that will benefit from the proposed project. Indicate income group as low - medium - high as compared to the Regional or area average.

633.21 - Criteria For Rating Income Distribution On Form R6-2210-108.

Highly Significant: Low income group, and five or more permittees receive project benefits.

Significant: Low income group, less than five permittees.

Moderate: Average income group, and five or more permittees receive project benefits.

633.3 - Community Stability. This benefit relates to preventing disruption of normal business patterns related to factors that may or may not be affected by initiating range projects.

For range improvement projects this will relate to maintaining family stability of the rural community as there continues to be a shift in population from ranching and farming.

What is the relative importance to the local economy of maintaining or enhancing livestock production on federal land? Also, what is the relative importance of the livestock industry in the total economic environment of the Region or Area? A project that helps maintain rural stability in a community which is primarily dependent on the use of forage from National Forest land will have a higher social value than a project where livestock is only a small part of the total economy and/or the community is sustained by other activities, changes in the ranch sector would have a more pronounced effect on the local economy. -*

*- 633.31 - Criteria for Rating Community Stability on Form R6-2210-108.

Significant: Commumunity employment is dependent on National Forest grazing.

Minor: Community employment is not dependent on National Forest grazing.

633.4 - Security of Life, Health, and Safety. The beneficial effects include the contribution to maintaining or enhancing factors affecting life, health, and safety.

About the only item in this category is the extent the project will increase the output of livestock products. According to FRES, meat consumption as well as the demand will continue to increase. The increased production of red meat will result in increased agricultural export, lower relative use of fossil fuels and fertilizer, and lower relative food costs.

633.41 - Criteria for Rating Security of Life, Health, and Safety on Form R6-2210-108. This project by the fifth year is expected to increase or sustain AUM production by:

Highly Significant: 10,000 or more.

Significant. From 2,500 to 10,000.

Moderate: 1,000 to 2,500.

Minor: Less than 1,000.

633.5 - Recreation Opportunity. This type of benefit relates to a range practice that provides the opportunity for increased dispersed recreation.

It is probable that on some vegetative manipulation projects such as opening up areas of brush or relatively dense juniper stands, the improved accessibility for dispersed recreation allow future increased use. The demand or expected actual increased use by hunters and recreation visitor days has a social value.

633.51 - Criteria for Rating Recreation Opportunity on Form R6-2210-108.

Significant: Dispursed recreation for all types of use is expected to increase by more than 10 percent.

Minor: Less than 10 percent. -*

*- 640 - R6 STANDARD ECONOMIC ANALYSIS. In compliance with direction in FSM 2214.11c and 2214.3 a minimum economic analysis is required.

This chapter and Forms R6-2210-108 (Figure 1) and R6-2210-104 (Figure 2) will meet a minimum standard throughout the Region.

Other economic evaluation may be used. However, it is believed this process will provide a standard for comparing priorities, grouping projects and addressing major objectives in the programming and funding process at Regional Forest and District level. -*

640--2

RANGE ANALYSIS AND MANAGEMENT HANDBOOK

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Figure 1

R6 RATING SHEET FOR RANGE INVESTMENT
PROJECTS AND/OR ALTERNATIVES

Forest Yapoo Project IO No. 27

Allotment Name Tule TRI No. 37

Total Project Score (Go-Project = above 10) 15

A. Financial Analysis (B/C ~~and PWN~~ required)

1. Benefit/Cost Ratio 1.2 2. Present Net Worth ____

3. Internal Rate of Return ____ w/capitol costs discounted at ____ %

Subjective Rating for B/C 1/ 10

B. Environmental Quality

	W/Project	W/O Project	Net Change
1. Erosion and Sediment	Dec.	N.C.	M
2. Water Quality	Imp.	N.C.	M
3. On Site Productivity	Double	None	H
4. Estetic Land Quality	Slight	N.C.	M
5. Wildlife Habitat	Imp.	N.C.	M
Subjective Rating	M	____	2/ 5

C. Social Well Being

	W/Project	W/O Project	Net Change
1. Employment	3	0	M
2. Income Distribution	____	____	—
3. Community Stability	____	____	—
4. Security of Life & Health	____	____	—
5. Recreation Opportunity	____	____	M
Subjective Rating	M	____	2/ 0

1/ Financial Rating:

Highly Significant - B/C 1.5 plus = 15 points
Significant - B/C 1.0 to 1.5 = 10 points
Moderate - B/C 0.7 to 0.9 = 5 points
Minor - B/C 0 to 0.6 = 0 points

2/ Environmental-Soical Rating:

Highly Significant = 15 points
Significant = 10 points
Moderate = 5 points
Minor = 0 points

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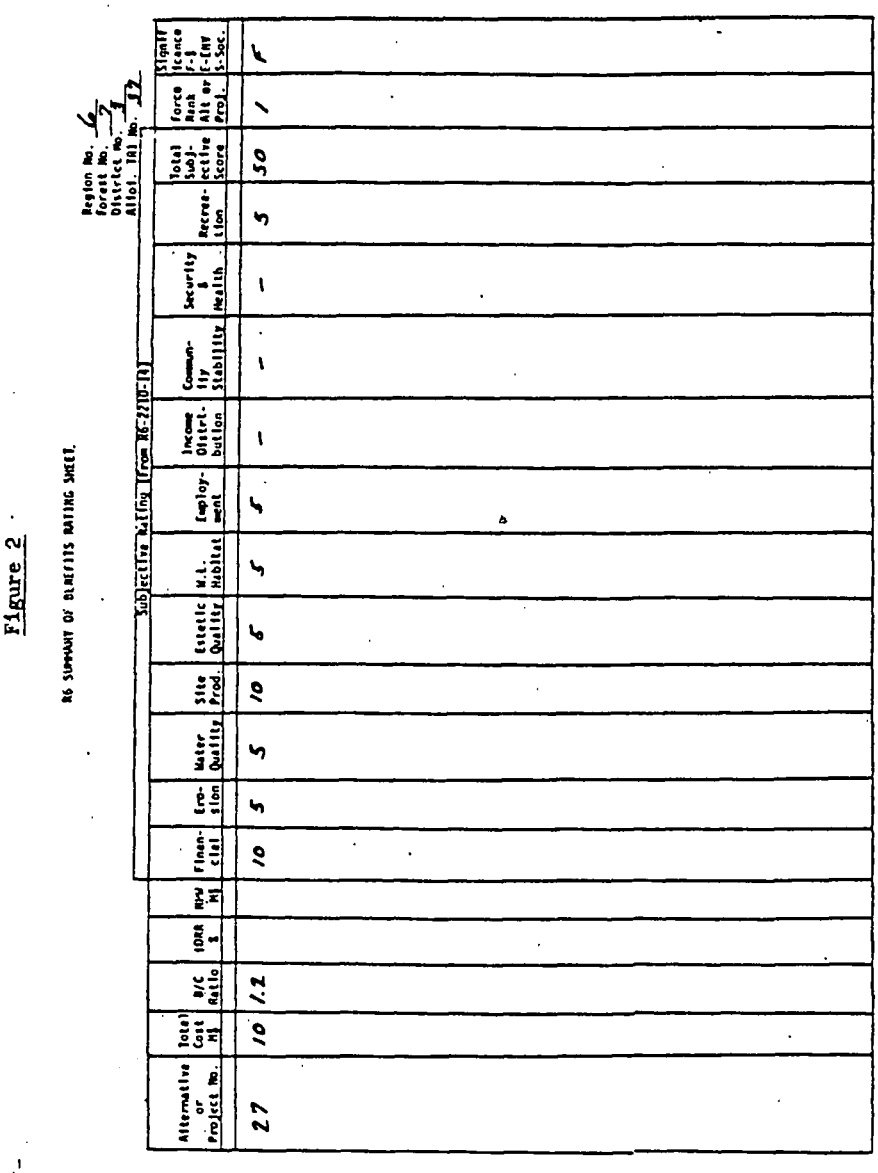
R6-2210-108
5/79

- R-6 FSH 10/79 AMEND 1 -

Figure 2



R6 SUMMARY OF BENEFITS RATING SHEET

Region No. 6
Forest No. 7
District No. 3
Alloc. Unit No. 12

Alternative or Project No.	Total Cost M$	B/C Ratio	IORR %	RVU M$	Financial	Erosion	Water Quality	Site Prod.	Estetic Quality	W.L. Habitat	Employment	Income Distribution	Community Stability	Security & Health	Recreation	Total Subjective Score	Force Rank Alt or Proj.	Significance F-S F-Env S-Soc.
	Subjective Rating (from R6-2210-IV)																	
27	10	1.2			10	5	5	10	6	5	5	-	-	-	5	50	1	F

R6-2210-104
4/79

- R-6 FSH 10/79 AMEND 1 -

ALLOTMENT PRIORITY RANKING — Warm Springs Area

Allotment Name/No.	$000's Benefit	$000's Total Cost	$000's Federal Cost	(B-NFC) ÷ FC	EE Rank	EQ Rank	Average Rank	Modifier: Econ. Mitigation	Change	Modified Ranking	Explanation for changes in ranking: Exceptions	Final Ranking
Howe Peak	208.5	21.0	16.0	12.72	1	1	1	0	0	1	(1)	2
Sawmill Canyon	154.8	22.3	20.3	7.53	3	16	9.5	0	0	9.5	(10)	10
Cedarville	92.1	13.6	13.6	6.77	4	14	9	0	0	9	(8)	8
Horse Creek	32.6	4.8	2.4	12.58	2	12	7	0	0	7	(5) Critical Watershed--N. Bend	3
Kyle Canyon	7.9	1.6	1.6	4.94	7	20	13.5	.10	-2	11.5	(13)	13
Pass Creek	333.5	71.1	61.1	5.29	6	8	7	0	0	7	(6)	7
Mahogany Butte	101.5	30.2	30.2	3.36	8	2	5	0	0	5	(2) Fish Cr. Anadromous fishery	1
Hawley Mountain	201.3	60.9	60.9	3.31	9	15	12	0	0	12	(15)	16
Wet Creek	19.9	9.8	9.8	2.03	10	9	9.5	0	0	9.5	(11)	11
Jumpoff	38.0	22.6	16.6	1.93	11	3	7	.10	-2	5	(3)	5
Summit	117.7	75.8	75.8	1.55	13.5	17	15.25	0	0	15.25	(18) Critical big game winter range.	14
Warm Springs	43.0	27.7	27.7	1.55	13.5	18	15.75	.20	-4	11.75	(14)	15
Briggs	202.1	33.0	33.0	6.12	5	7	6.0	0	0	6	(4)	6
Bear Canyon	13.7	9.2	9.2	1.49	15	19	17	0	0	17	(20)	20
Spring Canyon	141.7	111.2	111.2	1.27	16	4	10	.10	-2	8	(7) BLM/FS Cooperative Management Plan	4
Burnt Canyon	12.1	10.7	10.7	1.13	17	13	15	0	0	15	(17)	18
Williams Creek	21.8	20.3	20.3	1.07	18	10	14	.20	-4	10	(12)	12
Bernice	92.2	51.8	51.8	1.78	12	6	9	0	0	9	(8)	9
Uncle Ike	24.9	24.4	24.4	1.02	19.5	5	12.25	0	0	12.25	(16)	17
Wigwam	38.7	37.8	37.8	1.02	19.5	11	15.25	0	0	15.25	(19)	19

Score Sheet for ACP Water Quality Projects

Name of Project _____

County(s) _____

Selection Criteria	Rating (1-10)	Weight Factor	Score
1. Project Description			
A. Objectives as in RE-229 being addressed.	_____	2	_____
B. Size of Project (area, farms, etc.)	_____	2	_____
C. Other land use information, map, soils types, etc.	_____	1	_____
2. Water Quality Problem			
A. Severity of Water Quality Problem	_____	3	_____
B. Other conservation problems that may be solved at the same time	_____	1	_____
C. Public benefits	_____	2	_____
3. Relationship of Application to 208 Plan			
A. 208 Plan and Application Relationship (Plan approved, application for identified area, solving priority problems)	_____	2	_____
B. Involvement of USDA Agencies in 208 process	_____	1	_____
4. Measures Needed and Estimated Cost			
A. Adequacy of measures needed	_____	2	_____
B. Estimated cost (ACP practices, estimated funding, State Reserve, Regular ACP, etc.)	_____	2	_____
C. Other funds available for use in project area on treatment of water quality problem. (EPA, State or local government, private sector, etc.)	_____	2	_____

Score Sheet for ACP Water Quality Projects (continued)

Name of Project _____

County(s) _____

Selection Criteria	Rating (1-10)	Weight Factor	Score
D. Recognition of new solutions to water quality problems	_____	1	_____
5. Other Programs and Commitments			
A. Assistance (other than financial) available from Federal, State and local agencies	_____	3	_____
B. Ongoing Federal program which might assist	_____	1	_____
C. Local interest and readiness for solving the problem	_____	2	_____
6. Potential Project Accomplishment			
A. Extent to which water quality can be improved within 3-year strategy (including potential for LTAs, or mini-LTAs, anticipated participation)	_____	2	_____
7. State and local ACP Development Committee Endorsement	_____	2	_____
Total Score	_____		_____

Scorer _____

Agency _____