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Why Distribution Is Important: An Examination of Equity and Efficiency Criteria in Benefit-Cost Analysis

by

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prepared for the
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WHY DISTRIBUTION IS IMPORTANT: AN EXAMINATION OF EQUITY AND EFFICIENCY CRITERIA IN BENEFIT-COST ANALYSIS

by

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FOREWORD

In its *Eighth Annual Review* the Economic Council of Canada lays great emphasis on the distributional aspects of public programs and policies. Some programs that concentrate on particular groups or sectors of the population have a specific and intended distributional impact. On the other hand, many policies and programs have a distributional impact which is a side effect of actions designed to accomplish other ends.

Because of the importance of the problem and the fact that it is still to a very large extent an unexplored area of Canadian policy, the Council invited Professor Walter Hettich of Carleton University to undertake a background paper on the use of distributional criteria in program evaluation. Professor Hettich was asked to review the subject in a short, concise fashion and to set it out in terms that would be reasonably clear even to those without an extensive technical background.

As is the usual practice with a study commissioned by the Council, the contents are the responsibility of the author. Publication under our auspices means that the Council considers the present study a worthwhile contribution to public knowledge and the understanding of economic issues.

Sylvia Ostry, Director
Economic Council of Canada

INTRODUCTION

In May 1968 an article appeared, signed by the Minister of Finance, in which it was announced that the Government of Canada would adopt the programming, planning, budgeting system (PPB). According to the minister, the new system will provide government management with

(1) clearly defined goals;

(2) adequate means to determine the best mix of resources to be used to achieve these goals;

(3) a meaningful way to measure and report how well goals are being met, and how efficiently resources are being used.[1]

While high hopes about PPB may be justified, many problems raised by the new system of management remain unresolved. The present paper deals with what is perhaps the most crucial issue -- the goals or objectives that government decision-makers are expected to pursue. Two goals -- efficiency and equity -- are singled out for special attention. The paper analyses implementation of these goals through benefit-cost analysis -- an essential ingredient in PPB. Since the emphasis is on theoretical issues, the discussion will make use of a highly simplified model of the decision-making process.

EFFICIENCY

Decision-makers in government are faced with limited budgets; they cannot carry out all the projects which they consider worthwhile. Because of resource constraints,

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[1] See [3], p. 166. The Federal Government has also issued an official guide to PPB and the use of benefit-cost analysis [7].

the decision-maker must be selective: he must choose those projects which result in the best use of his budget. Selectivity calls for criteria according to which projects can be compared and evaluated. Once proper criteria have been established, projects can be ranked from those which perform best down to those which are the least attractive. The decision-maker is then in a position to allocate his funds. Starting at the top of the list with the most preferred proposal, he approves projects in descending order until his budget is exhausted. In this manner, the best allocation of resources is achieved by his agency or department.[1]

While the basic steps in budgetary allocation may appear simple and straightforward, the process is in reality complicated and difficult. First, it is difficult to establish proper criteria to be used as a basis for comparison. In addition, criteria -- once they are chosen -- must be quantifiable; performance, however defined, must be measurable in numbers. Since most agencies have a variety of projects that may differ widely in size, time horizon and physical characteristics, evaluation and ranking pose theoretical as well as practical problems.

As is now widely known, economists have developed benefit-cost analysis to deal with problems of comparison and evaluation. Benefit-cost analysis derives its theoretical basis from welfare economics, a body of work that tries to establish the conditions for the optimal allocation of resources. Because of its roots, benefit-cost analysis has traditionally emphasized economic efficiency as the main criterion for judging and ranking project proposals. The best project is the one that makes the largest net contribution to National Product.

To estimate the net contribution, project benefits and costs must be assessed in monetary terms. Benefits are generally evaluated at market prices. Thus the value of increased crop yields resulting from an irrigation project will be estimated at projected prices. Other benefits, such as flood control, may be more difficult to assess. Estimates of damages prevented will have to be made and must be included in the benefit total. On the cost side, the analyst must likewise attempt to cover all aspects of the project. The literature on

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[1]It is assumed that projects are neither interdependent nor mutually exclusive.

benefit-cost analysis contains much discussion of the problems arising in the measurement of project benefits and project costs. Since the technique has been applied in widely different fields, ranging from water resource management to education and manpower training, the catalogue of measurement problems is large. Nevertheless, it has proven fruitful in most areas of government policy.

One aspect of the measurement problem demands some special attention. As pointed out, evaluation of benefits and costs is, as far as possible, carried out in market prices. However, governments often operate in areas where markets fail. They provide so-called public goods, e.g., goods or services that cannot be supplied efficiently through decentralized markets. They are also active in areas where social and private costs diverge. When such divergence exists, we have externalities or benefits and costs that are not captured fully by anyone participating in a market transaction. Again, market prices are not appropriate, and imputation of values may be difficult. In those cases where benefits or costs cannot be evaluated properly because of external effects, the analyst must be careful to indicate the bias that omission introduces into his estimates.

While the measurement of benefits and costs in monetary terms may allow comparisons of projects in different fields, another important concept in benefit-cost analysis makes it possible to deal with projects having widely different time horizons. As long as interest rates are positive, benefits of equal size which will accrue in different time periods are not of equal value to the decision-maker. Returns that are realized quickly can be reinvested quickly. To make benefits and costs comparable in time, they must be discounted to the initial project year. When projects are ranked, proper discounting must have taken place.

It will be appropriate to mention briefly the various technical methods available to the analyst who wants to compare and rank projects. One of the most widely used ranking devices is the internal rate of return. It is that rate which makes the time stream of benefits equal to the time stream of costs. The project with the highest internal rate of return will be the most preferred one, e.g., the project with the highest economic efficiency. A second approach uses so-called present values. The analyst adopts an "appropriate" interest rate which he uses to discount both benefits

and costs.[1] Next, the costs are subtracted from the benefit total, leaving discounted net benefits for the project. The third method is similar to the second one. Again benefit and cost streams are discounted by a chosen rate of interest. The sum of discounted benefits is then divided by the sum of discounted costs to obtain the benefit-cost ratio. As will be clear, any project with a ratio larger than one has benefits exceeding total costs. In most cases, the choice of method is one of convenience, and all three methods will yield identical or closely similar project rankings.[2]

Before completing the discussion of project choice based on the criterion of economic efficiency, one must draw attention to a limitation imposed on the decision framework. The description so far applies to a decision-maker who tries to achieve the best possible allocation of a fixed budget. No attention has been given to the larger question of how the budget constraint was established. While the scope of the discussion will remain limited to situations with a fixed budget constraint, it will be useful to digress briefly and to draw attention to the broader theoretical problems that arise when budgets are variable. In the more general situation, the theorist must determine both the optimal budget size and the best allocation of the agency's budget. Broadly speaking, welfare economists have argued that the internal rate of return for the "marginal" project, e.g., the last one on the agency's list to be undertaken, should equal the social rate of return. The social rate of return, on the other hand, will be close to the marginal rate of return on capital in the private sector.[3] This allocation rule ensures that resources in both the private and the public sector are used in a manner that

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[1]There has been considerable controversy about what interest rate government decision-makers should use to discount benefit and cost streams. See [2] for a review of theoretical issues.

[2]The ranking of projects can be affected by the choice of method. For a further discussion of discounting criteria, see [16] and [10], pp. 47-69.

[3]The social rate of discount has been the subject of much debate in the theoretical literature. For a discussion of the issues, see [2] and the ensuing debate in the 1969 December issue of the *American Economic Review*. Dan Usher's comment is of particular interest.

maximizes National Product. Thus the efficiency criterion is applied consistently throughout the economy.

EQUITY

Orthodox benefit-cost analysis starts from the premise that, in project selection, it does not matter who the beneficiaries of a program are and what group of the population bears the costs. A dollar of increased income to a poor man is valued equally as a dollar of added income for a rich man. Benefits that accrue in the Maritimes are valued in the same manner as benefits that are realized in the wealthier provinces. The reason for this approach does not lie in a disregard of the distribution of income as has at times been alleged. It derives rather from an assumption made in welfare economics. It has long been assumed in economic theory that the best way to achieve the desired income distribution is through a policy of costless transfer payments. The welfare economist argues that allocation and distribution should remain separate. Projects should be chosen according to the efficiency criterion alone. Distribution policy, on the other hand, can be carried out according to established standards of justice or equity by means of taxes and monetary transfer payments.[1]

The separation of efficiency and equity in project selection has come under attack in recent years.[2] A number of economists have argued persuasively that the assumptions of welfare economics are not applicable in this regard. Transfer payments are not costless; they involve both administrative and political costs. Even more important -- governments do not try to separate efficiency and equity; typically they want to pursue both objectives in project selection. In order to be

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[1]For a recent restatement of this position, see [15], pp. 803-805.

[2]Eckstein's work has been particularly influential [4]. Freeman's article [5] offers the most elegant theoretical treatment of the reasons for integration of efficiency and equity criteria while Maas [9] provides the most spirited attack on the separation of efficiency and equity.

useful, the analyst should therefore adapt himself and respond to the intentions of the decision-makers.[1]

Authors in public finance have always recognized the importance of government programs for the distribution of income. Until recently, most empirical work was, however, confined to the analysis of the redistributional aspects of taxation. In Canada, work undertaken for the Royal Commission on Taxation has for the first time thrown light on the incidence of government expenditures.[2] It demonstrates that the distribution of benefits favours the lower-income groups. This may be taken as a clear indication that governments pursue redistributive aims through many of their programs. Analysis of overall incidence can be supplemented by more detailed analysis of specific projects or activities. Work of this kind again makes the distributional intent apparent.[3]

While distributional questions are discussed most frequently with reference to personal income, other aspects of distribution are equally important for project analysis. In a federal state such as Canada, regional criteria assume a separate significance. Allocation according to efficiency alone disregards not only the income of beneficiaries; such analysis also assumes that the location of benefits is not a relevant consideration. Since the aim calls for maximization of *National* Product, it does not matter where the increase in income occurs.

Everyone who is acquainted with political life in a federation knows that regional considerations are of primary importance in government policy. Again, the assumptions of welfare theory are not fully applicable. As one well-known Canadian economist has pointed out, federations differ in a crucial respect from unitary states. There is no presumption that National Product

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[1]For a more detailed discussion and an application to U.S. investment policy, see Maas [9].

[2]See [6], Chapters 3 and 4.

[3]Haveman's work on the distributional impact of public investment in water projects in the Southern United States is particularly instructive [8]. It should be noted that the incidence of benefits does not have to favour the lower-income groups. In some programs, distributional intent seems to work in the opposite direction.

should be maximized. Instead one must argue that it is the income of regions or provinces that is of primary relevance in a federation.[1] As a result, the regional incidence of benefits becomes an important variable in federal programs.

While income and region are the two categories most generally used in analysing distributional incidence, others are also relevant for policy. Governments often want to provide benefits to special groups such as, for example, Indians and Eskimos, the aged, the unemployed, etc. If programs are aimed at specific groups, distributional objectives must be formulated in reference to them. One should note that analysis of benefits by income group, region, or some other characteristic, often raises problems that are even more difficult to overcome than those arising in the measurement of project benefits and project costs. Statistical data may be hard to come by, and rough estimates may be necessary to create a basis for the comparison of programs.

INTEGRATION OF EFFICIENCY AND EQUITY CRITERIA

If one accepts both efficiency and equity as objectives in program evaluation, how can the two aspects be integrated in the analysis? In answering this question, it will be useful to recall the selection problem faced by a decision-maker with a budget constraint. In this new situation, he must rank projects according to both their efficiency and their distributional implications. As before, his goal remains a suitable ordering of projects.

Early writers on benefit-cost analysis who recognized the importance of distribution recommended that the decision-maker be provided with a set of tabulations displaying the distributional consequences of each project. Estimated benefits (or net benefits) were to be classified by income group, region, or other population characteristics considered relevant. The decision-maker was expected to use this information in conjunction

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[1] See [18]. Scott's article provides a comprehensive review of federal goals and their economic implications.

with data on internal rates of return or benefit-cost ratios calculated purely on the basis of the efficiency objective.[1]

Tabulations are no doubt useful, especially when programs are large and complex. They do not, however, solve the problem of a decision-maker who must rank a large number of projects with widely differing distributional consequences. In his case, a more formalized approach is called for in order to arrive at a systematic selection.

The decision-maker's possible courses of action can be summarized in a set of rules.

(1) Ignore distribution and exhaust the budget on the most efficient projects.

(2) Ignore efficiency and finance the projects with the most desirable distributional consequences.

(3) Establish a minimum level of efficiency and select according to the equity criterion.

(4) Establish a minimum distributional requirement and select according to efficiency.

(5) Develop an explicit preference function between equity and efficiency in order to rank projects.

The first rule requires little comment. It represents the "orthodox" strategy in which distributional objectives are absent. The second rule represents the opposite extreme. Efficiency is now disregarded, and selection is governed by equity only. It is only with rules (3) to (5) that the real problem begins to emerge. When two objectives are pursued jointly, a trade-off is involved. Since efficiency and equity are frequently competing goals, more of one means less of the other.

The third and fourth decision rules resolve the conflict of goals through minimum standards. In effect, the

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[1]See [21], especially pp. 178-190, for examples and a brief review of the literature.

decision-maker first selects a subgroup of projects -- those which satisfy the minimum requirements -- and then proceeds to rank them according to a single criterion. If his budget is not exhausted by the relevant subgroup of projects, he re-evaluates and relaxes the minimum standards set for preselection. In this way, all his funds will be allocated. The use of minimum distributional requirements is quite common in government agencies. The poverty program in the United States provides a number of good examples. Thus, retraining programs had to benefit primarily those with income levels below $3,000.[1] Minimum requirements can also be defined in geographic terms. This occurs where only projects from stipulated regions or designated areas are considered for adoption although projects in other parts of the country might yield higher returns.[2]

The imposition of minimum standards of distribution and the ranking of projects according to distributional objectives both require the formulation of explicit and measurable equity criteria. The necessity to quantify distributional judgments is even more pronounced when we adopt rule (5) which calls for the development of an explicit preference function between equity and efficiency. This approach provides for the most systematic resolution of the conflict in objectives. The decision-maker is forced to make explicit the extent to which he is willing to forgo efficiency (economic returns) for distributional ends.

With the use of general notation, net benefits produced by a project for an individual or a group of individuals can be written as[3]

$$\lambda^i (p\ \beta^i - C^i)$$

where λ^i = the marginal utility of money for person i or group i;

β^i = physical or service benefit accruing to i;

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[1]The most systematic discussion of the poverty line as an equity criterion in human resources projects is contained in Chapter IV of David Sewell's study dealing with training projects in the United States [19]. Poverty lines are also discussed in [17], Chapter 2.

[2]For a theoretical treatment, see [11] and [12].

[3]See [4] and [12], p. 882.

p = market price of β^i;

C^i = i's contribution to the cost of the project

When efficiency is the only objective, λ^i will be equal to one. When equity considerations enter, on the other hand, λ^i assumes different values for different persons or different groups. The development of an explicit preference function forces the decision-maker to assign values to λ^i that reflect his judgments about the marginal value of money to different beneficiaries. If he believes, for example, that an additional dollar of benefits provides less utility or satisfaction to a wealthy man than to a poor one, he will assign a lower weight to net benefits going to wealthy persons than to net benefits accruing to persons with a low income.

The construction of an explicit preference function or system of weights is useful because value judgments must be made explicit and because the implications of different such judgments on project selection can be tested in a systematic manner. In effect, this approach allows the decision-maker to conduct sensitivity analysis with regard to distributional assumptions. Since the costs of various distributional judgments in terms of forgone economic returns are not obvious in most cases, such sensitivity analysis provides the best basis for choosing the desired trade-off between objectives.

Project selection assumes additional complexity if more than one distributional objective is to be pursued. Nevertheless the discussion can readily be extended to cover the more complicated case. Integration occurs in two steps. First the analyst determines the trade-off

between distributional goals, constructing a formula to determine the weights (λ^i) as a function of the relevant equity objectives. This may be illustrated with an example from a recent study on grant allocation by the U.S. Economic Development Administration.[1] EDA is legally empowered to make grants-in-aid for projects in areas with high unemployment and/or low incomes relative to the national average. The weighting factor λ^i thus takes on the form

$$\lambda^i = \lambda^i(E^i, Y^i)$$

where E^i indicates an area's employment rate and Y^i represents its median family income. To calculate λ^i, the analyst must choose a specific functional relationship between the dependent and the independent variables. This leads into largely uncharted territory. Since the construction of preference functions for project selection is a new field, the analyst cannot draw on an established body of work. Instead he will have to use discussions with the main decision-makers as a guide for his formulation. The values of λ^i will be affected both by the nature of the algebraic expression chosen to represent the relation and by the weighting that each objective receives in the formula. Sensitivity analysis may again be helpful both in choosing the relationship itself and in determining the actual parameters. In the study of EDA referred to above, the investigators made use of the following formula:

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[1]See [12]. The article deals both with the integration of efficiency and equity and with the use of multiple distributional criteria. Combining empirical application with a brief theoretical discussion, it provides one of the most instructive treatments of the integration issue. It should be noted, however, that the empirical analysis is limited to gross benefits ($C^i = 0$).

$$\lambda^i = a \left(\frac{\bar{E}}{E^i}\right)^{\alpha} + b \left(\frac{\bar{Y}}{Y^i}\right)^{\beta}$$

The symbols $\bar{E}$ and E^i stand for the national average employment rate and for the employment rate in the i-th area. Similarly, $\bar{Y}$ and Y^i represent median family income for the United States and for area i. The symbols a, α, b, and β are parameters for which a fixed value must be chosen by the analyst.[1]

Once a formula for λ^i has been determined, the second step involves no further complications. Integration of equity and efficiency can proceed as before. Weighted net benefits, appropriately discounted, will be maximized and projects will be ranked accordingly. As before, the decision-maker will exhaust his budget by adopting projects in descending order, starting with the top-ranking one. His choice will be based on full and systematic integration of objectives.

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[1] *Ibid.* The choice of parameter values reflects a number of assumptions about the trade-off between increased income and additional jobs. McGuire and Garn stipulate, for example, that one job is valued equally as an increase in income of $\bar{Y}$ dollars if we deal with an area where the unemployment rate and the median income are identical with the national figures. They also assume a diminishing marginal rate of substitution between jobs and income. For a more detailed discussion and a presentation of trade-off curves, see pp. 885-887.

FURTHER OBJECTIVES

Benefit-cost analysis was developed as a technique to assist the decision-maker in allocating his budget efficiently. As the discussion has shown, it can readily be expanded to cover the choice of projects according to the combined goals of efficiency and equity. In fact, the benefit-cost approach is completely general. It can be used to rank projects according to any set of objectives, as long as these objectives can be quantitatively expressed and as long as project costs and benefits can be classified in accordance with the stated goals. Governments do indeed pursue further goals in addition to efficiency and equity. One may mention considerations relating to the balance of payments as an example. Countries suffering from a shortage of foreign currency often impose exchange constraints on selection procedures. A second example -- quite different in nature -- concerns cultural goals. Governments may want to foster the use of a particular language or stimulate the growth of a particular cultural heritage. In Canada a large number of projects initiated by the Federal Government are directed towards these ends.

While project evaluation techniques can be adopted to deal with multiple goals, an increase in the number of objectives greatly complicates the analysis, especially if an explicit trade-off function is desired. Data requirements also grow, often at a rapid rate, and the analyst's efforts may run quickly into decreasing returns. There is, however, an even more serious danger. The proliferation of objectives generally leads to suboptimization. Project selection in a particular agency or department may be optimal when judged according to the agency's own set of criteria. On the other hand, the same selection would have to be rejected if more general and basic criteria were used.[1]

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[1]An examination of the Federal Government's guide to PPB and benefit-cost analysis [7] makes the danger of suboptimization apparent. On page 18 it is suggested that the following statement might serve as a summary of objectives for the Department of Agriculture: "To increase food production for domestic consumption and export and to promote the economic welfare of those engaged in farming." The use of resources to increase food production is efficient only, when judged from an overall point of view, if the affected crops are not in

Economists will argue that efficiency and equity are in a real sense the two most basic objectives. As pointed out earlier, benefit-cost analysis is an outgrowth of welfare economics. Welfare theory recognizes two major concepts for judging an economy's performance: efficiency and distribution. In the theoretical model, optimal allocation of resources requires both the achievement of a set of marginal conditions and the existence of a welfare function.[1] The efficiency and the equity criteria are considered completely general because they apply in both the private and the public sectors. Suboptimization is thus avoided in the theoretical model.[2] This is most easily seen in the case where efficiency alone governs project selection. Efficient allocation in the economy as a whole will occur when the internal rate of return on the *marginal* public project is equal to the social rate of return. If this equality does not hold, total output can be increased by shifting resources out of the public sector into private use or out of the private sector into public use.

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excess supply. In those cases where governmental support programs are needed to restrict supply, resources should not be invested in order to increase yields. Such conflicts in goals are common in the agricultural programs of several western countries.

Multiple objectives are not the only, or even the major, cause for suboptimization. For a more general discussion of the phenomenon of suboptimization in government programs, see [13], pp. 41-43.

[1]See Bator's classic article [1] for a summary of welfare theory.

[2]From a strictly theoretical point of view, distributional criteria should be used in project selection only if the same distributional objectives cannot be achieved more cheaply by transfer programs. This is the case if utility functions are independent -- the usual assumption in welfare economics. For a more detailed theoretical discussion, see [5].

CONCLUSION

Benefit-cost analysis, at the practical level, is as much an art as a science. The information requirements for systematic project analysis often force the decision-maker to fall back on rules of thumb and other short-cut techniques. Elaborate studies are costly, and good analysts are often in short supply.

The present paper does not deal with problems of measurement although it is recognized that analysis of such problems is of great importance if benefit-cost techniques are to be successfully applied. The paper has been designed to deal with basic objectives in project selection and to demonstrate how different criteria can be combined in a systematic manner. Efficiency and equity have been stressed as the two primary goals and a major section of the paper has dealt with techniques for integrating them in the decision-making process.

Benefit-cost analysis and the related technique of program budgeting have only recently been introduced into the Federal Government. Both hold out the promise for important improvements in the governmental decision-making process. Unfortunately, little is known so far as to how successful the application of these techniques has been in Canada. An evaluation of their use is much needed. To the outside observer, it appears in addition that objectives should be further clarified. Systematic integration of equity and efficiency criteria in the evaluation of regional development programs in particular could improve selection procedures in federal programs. The discussion in this paper demonstrates that problems of regional disparities can be approached with systematic decision-making techniques. One may hope that Canada, with its special characteristics and its strong tradition of decentralization, will lead the way in research on the integration of economic efficiency and regional equity as primary policy goals.

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Medium-Term Capital Investment Survey—1968 (EC21-2/1968)	B. A. Keys D. S. Rothwell F. G. Thompson	Relevé des projets d'investissement à moyen terme—1968 (EC21-2/1968F)
Medium-Term Capital Investment Survey—1969 (EC21-2/1969)	B. A. Keys F. G. Thompson M. Heath	Relevé des projets d'investissement à moyen terme—1969 (EC21-2/1969F)
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Why Distribution Is Important: An Examination of Equity and Efficiency Criteria in Benefit-Cost Analysis

by Walter Hettich

Economic Council of Canada