OPTIMALITY IN PRODUCING AND DISTRIBUTING PUBLIC OUTPUTS

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ABSTRACT

The problem of determining the optimal level of output for goods and services produced by government and determining the best means of rationing these among people is an important one. The level of aggregate economic welfare depends on both the output level chosen and the mechanism used to distribute this output. Public decisions make implicit judgments on both output and rationing devices without consideration of their interrelationship and their impact on economic welfare.

This paper presents a framework for analyzing these two kinds of public decisions where a comprehensive economic welfare criterion is adopted. This criterion includes not only the standard economic welfare components of willingness to pay and production costs but also incorporates consideration of equity, equality of opportunity, stigma effects, and exclusion and administration costs. With this comprehensive framework, the efficiency of alternative rationing devices can be analyzed and evaluated. Application of this framework emphasizes the need for joint determination of the optimal rationing device and output level in a world in which economic welfare is multi-dimensional.

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Charles J. Cicchetti and Robert H. Haveman*

Introduction

Defining the conditions for an optimal allocation of goods and service flows among final demanders is a standard welfare economics problem. With maximum economic welfare as the objective and with the distribution of income given, economic theory suggests the optimality of the free, competitive market solution in which the price of service flows is equal to marginal costs.[1] On the basis of this solution, optimal administered pricing rules have been derived for distributing the outputs of decreasing cost activities, governments, "nature", and for correcting externalities.

While these rules form the basis for recommendations of economically efficient government policy, one is struck by the very few instances in which prices of any kind--much less marginal cost prices--are used to allocate public services or facilities. Failure to ration use by the imposition of charges is defended on several grounds--considerations of equity, equality of opportunity, excessive exclusion and administrative costs, and so on. To be sure, if such considerations indicate the existence of real economic costs and benefits, the simple marginal cost pricing rule based on production cost and willingness to pay functions must be modified to account for them. Such modification will likely result in an altered optimal level of output and may entail abandonment of price as a rationing device and the implementation of an alternative rationing system. This paper addresses the problem of determining the optimal level of output and the choice of rationing device when a comprehensive economic welfare criterion is adopted.[2]

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In the first section, we will briefly review the standard marginal cost pricing formulation by focussing on the case of a publicly produced output in which production costs are the only costs and the willingness to pay of demanders the only social benefit.

In sections II-IV, we shall introduce a number of more "exotic" cost and benefit variables which are often regarded as being outside the economic efficiency framework and seldom accounted for in analyses of the efficient production and allocation of public outputs. While some of these variables are functions of the output level given a rationing device, others are a function of the rationing device itself. Both of these kinds of variables must be explicitly considered in choosing an optimal combination of rationing device and output level.

Finally, in section V we specify a comprehensive definition of economic welfare including all of these variables and develop an optimizing procedure for simultaneously determining the appropriate output level and rationing device for allocating the output among potential beneficiaries.

I.

For purposes of exposition, we will employ two highly simplified versions of a more general model in reviewing the marginal cost pricing formulation for allocating publicly-produced outputs.[3]

Assume a demand function for an output flow which relates various levels of willingness-to-pay to units of the output consumed in any finite period of time. Assume further that each unit of output can be enjoyed by one and only one user, that each user can enjoy one and only one unit of output per unit of time, and that demanders can be excluded from the output at some non-negative cost.[4] Thus, the demand function AB of Figure 1 indicates the existence of OB individuals who wish to consume the service, arrayed by their willingness to pay for such consumption.[5]

With respect to supply, assume that there are OC units (physical capacity) of a homogenous output available in the finite time period and that the marginal cost of generating these units is zero.[6] Hence, the short-run marginal cost or supply function is OCE.

With these assumptions, the problem becomes a straightforward rationing problem: How should the OC units of output be optimally allocated to the OB persons who are willing to pay a positive amount for the opportunity to obtain a unit? Clearly, no matter how the question is answered, some demanders--CB in number--will receive zero units.

In this case, the marginal cost pricing formulation would view the willingness-to-pay of demanders as the sole non-zero argument to the social welfare function and would conclude that the services produced by the limited capacity should be allocated to those who value them most highly--as evidenced by the amount which they are willing to pay to obtain the services. Hence, distribution of the OC units of available output to those demanders whose willingness-to-pay for the service equals or exceeds CE maximizes aggregate willingness-to-pay for the available output.

The allocation yielding this maximum will be secured if each demander is charged a price of OF (=CE). Only the OC demanders who value a unit of the output at least as much as OF will be able to enjoy it. The remaining CB demanders automatically exclude themselves by refusing to pay this fee.[7] The maximum attainable aggregate willingness-to-pay has been generated, of which OFEC is in the form of revenue captured by the public sector, leaving a price compensated consumer surplus of FAE.[8]

This simple case can be easily modified to account for non-zero short-run marginal costs. For example, for any constant marginal cost function at or below FE, a price of OF would limit the output to OC, maximizing net benefits. Any constant marginal cost function above FE implies an optimal price equal to marginal costs and greater than OF. Where marginal cost is FE, total willingness-to-pay is OAEC, of which OFEC is absorbed in real costs, again leaving a price compensated consumer surplus of FAE.

The existence of congestion costs related to the level of output can also be readily incorporated into this framework. For example if congestion creates incremental costs of OGH, net benefits would be maximized by allocating the OC units of capacity to as many demanders by establishing a price of OF. Net social benefits would be OAEJG and revenue to the public sector would be OFEC. Should marginal congestion costs be OGH', DB demanders would be excluded from the output by imposition of a marginal cost price of OF'. In this case, net benefits would be OAKG and public revenue OF'KD.[9] If both congestion and production costs exist simultaneously, the two functions can be added vertically to determine the optimal marginal cost price.

II.

Although the analytical framework of section I suggests the rules for using prices to ration a publicly produced output from given capacity so as to achieve maximum economic welfare, this pricing device is seldom employed by policymakers. In this and succeeding sections, the assertions typically offered for rejection of a publicly administered pricing policy will be analyzed and related to the analytical framework of section I.

One common reason offered for rejecting a charges policy for rationing publicly provided outputs is that a user charge or pricing policy is an <u>inefficient</u> rationing device. The efficiency model of the economist, it is implied, neglects certain critical categories of costs. These include the research costs required to estimate the correct price or user fee, the costs of announcing, imposing, and collecting the price or fee, and the costs of policing the allocation of output to insure that those not paying the fee are denied the output.

To the extent that such informational, organizational, and administrative costs exist,[10] they must be estimated for all alternative rationing devices and evaluated in choosing among them. In evaluating the the marginal cost pricing formulation, some of these costs must be regarded as fixed with respect to output. Others will be a direct function of the output to be allocated. In formulating the optimal pricing rule, these latter (or variable) costs may influence the optimal level of output to be distributed and, in turn, may be reflected in the price charged. The former (or fixed) costs do not affect the optimum output level or the optimum price or fee. However, in choosing among alternative rationing devices both components of cost must be considered. This choice requires comparison of the present value of the willingness of beneficiaries to pay for the output with the present value of production and distribution costs for all optimally implemented rationing devices.

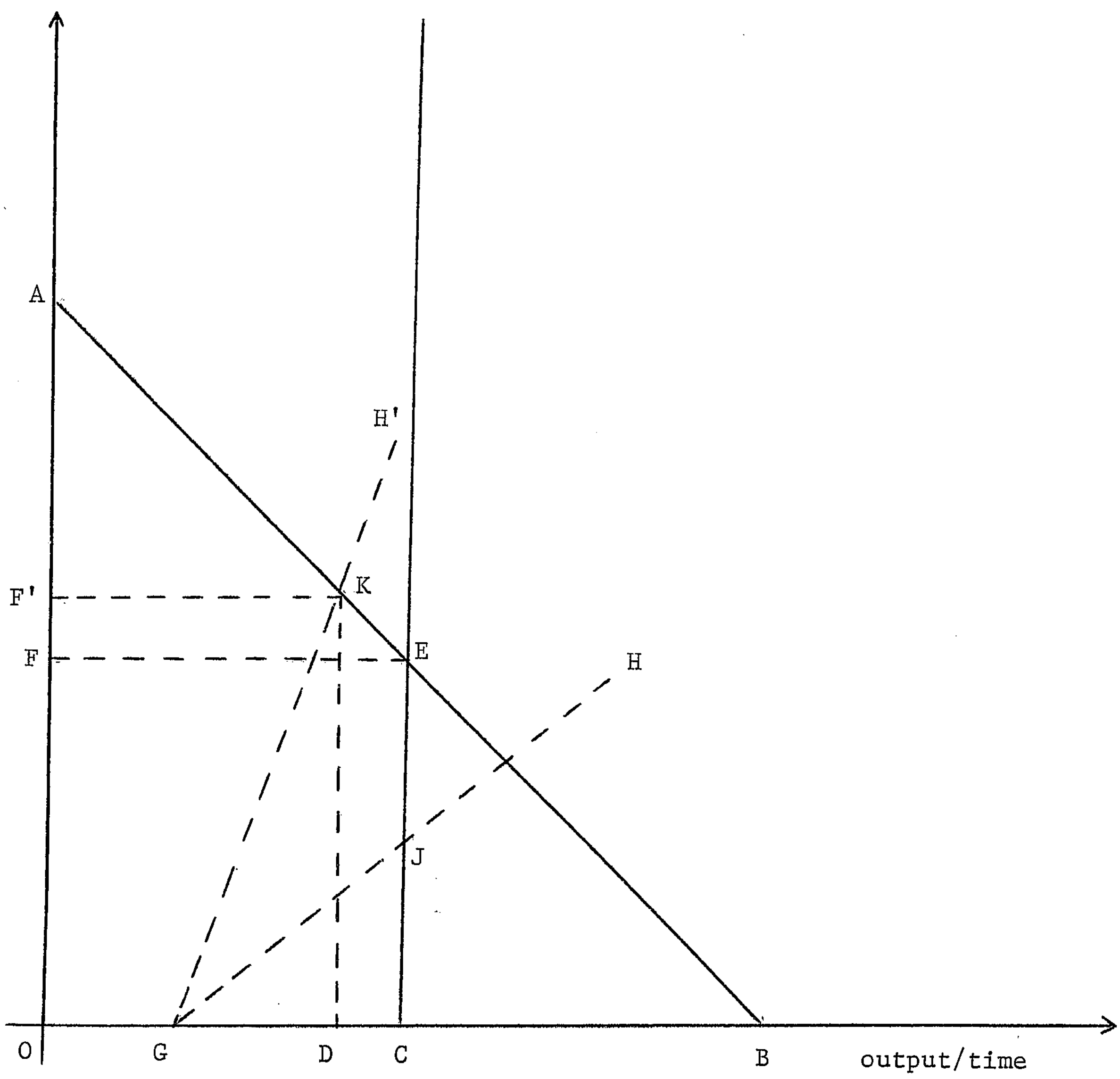


Figure 1

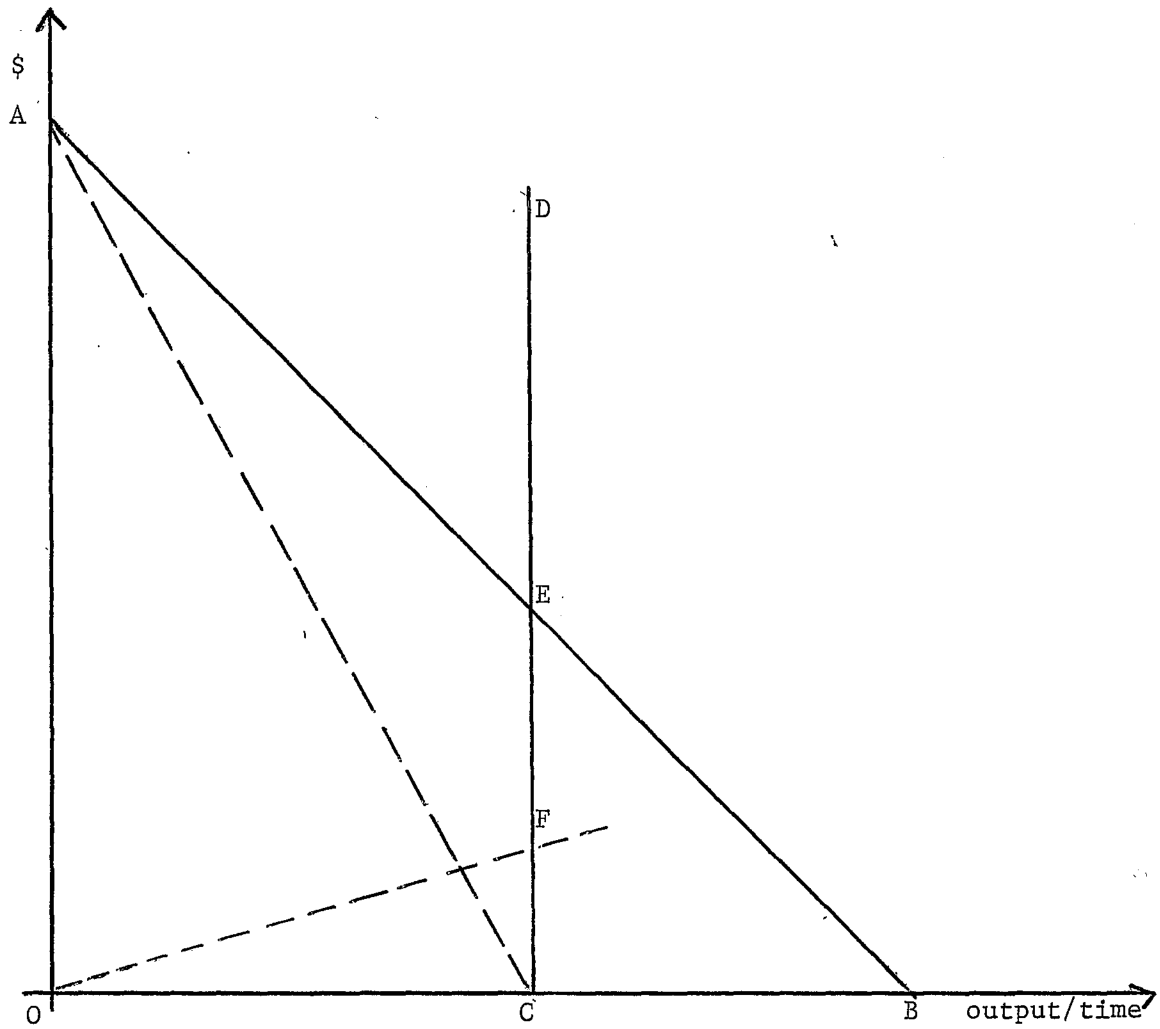


Figure 2

While the variable distribution costs may affect both the present value of willingness-to-pay and the present value of costs, the fixed distribution costs will affect only the present value of costs.[11]

For example, consider a governmental unit contemplating provision of an output with the willingness-to-pay and production cost functions of Figure 2. Again AB represents the marginal willingness-to-pay function; production costs are zero; and physical capacity is set at OC. Assume there are two alternative rationing devices: the imposition of an optimal price of CE and a zero price-equal probability lottery system. While both devices restrict the number of demanders to OC, assume that only the former entails variable distribution costs (indicated by OF) and that the fixed rationing cost of the pricing system is $X more than the fixed rationing cost of the lottery device. If the cost and demand functions are known with certainty, and if, on economic efficiency grounds, the decisionmaker chooses the lottery system as a rationing device, then the extra rationing costs associated with the marginal cost pricing rule--OFC + $X--must exceed the area CAE.[12] Under these circumstances, the decision to abandon the marginal cost pricing rule would be consistent with the efficiency criterion.

III.

A second reason which has been offered for abandoning the pricing rule is that such a rationing policy is inequitable. Allocation by prices, it is pointed out, denies output to those demanders whose willingness to pay is less than the price which is established. Because income level is correlated with the willingness to pay for any normal good, those demanders

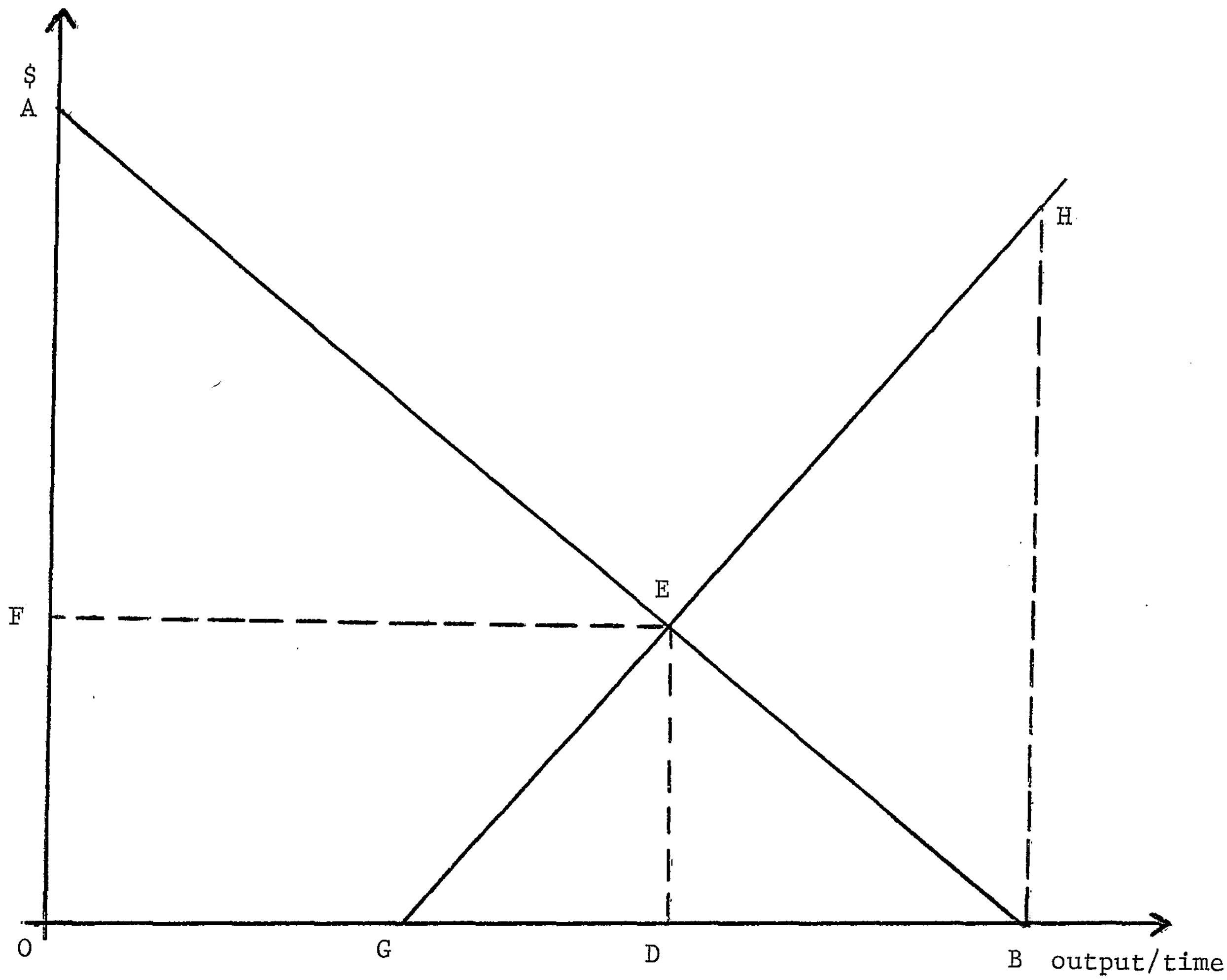


Figure 3

which are excluded tend to be poorer than those supplied. It is asserted that such disparity in the treatment of high and low income people has economic welfare effects which must be considered in choosing among rationing devices.

The basis for this conclusion can be understood by assuming that demand (AB) and cost (OCD) conditions are as depicted in Figure 2, and further that the only two available rationing devices--marginal cost pricing and zero price-equal probability lottery--have equal fixed and variable rationing costs. If the latter rationing device is adopted by a public authority motivated by the efficiency criterion and with full knowledge of all effects, it must be concluded that the present value of the distributional or equity "costs" associated with the standard pricing rule are equal to or exceed CAE, the willingness-to-pay benefits foregone.[13]

A similar conclusion holds if congestion is present and the alternative to marginal cost pricing is no rationing at all. Consider Figure 3 in which OGH is the marginal congestion cost function and AB is the compensated willingness to pay function. In this case, no capacity constraint is present. With congestion, the marginal cost pricing formulation would suggest setting a charge of OF, indicated by the intersection of OGH and AB. If, instead of pricing, a policy of unrestricted access is chosen by a knowledgeable, efficiency-motivated decisionmaker, the benefits from eliminating the distributional "costs" of the marginal cost pricing solution must have been assigned a value equal to at least area EHB.

This incorporation of equity effects into the analysis of optimal choice among the distribution techniques available for rationing public outputs rests on the consistency of equity considerations with the notion of Pareto efficient choices.[14] Indeed, if individual utility functions are interdependent, citizens will not be indifferent to the pattern of distribution of outputs controlled by them or their elected representatives. Nor will they be indifferent among the available mechanisms through which the distribution will be made even if they do not make use of the publicly produced output themselves.[15] Attainment of efficiency, then, even in its most restricted sense, requires that such equity impacts be an argument in the criterion function for choice among alternative rationing mechanisms.[16]

Implicit in the interdependent utility function argument is the proposition that a family of willingness-to-pay functions exists for the group of grantors, each function associated with a particular rationing device. The level of the willingness-to-pay function for any particular mechanism would depend upon the characteristics (income levels, race, region) of the recipients of the outputs, the characteristics of the rationing device,[17] and the utility functions of the grantor group. While no generally accepted measurement procedure exists for evaluating this equity-based component of economic welfare, several suggestions for deriving weights which reflect taxpayers' preferences regarding distributional effects have been discussed in the recent literature.[18]

IV.

There exist two final candidates for inclusion in a comprehensive welfare criterion for choice among alternative rationing devices. These exhaust the list of primary arguments supporting the adoption of one or another device for allocating public sector outputs.

The first of these effects is prominent in discussions of current cash and in-kind transfer programs. Because of the means by which these public outputs are distributed, many have claimed that recipients are demeaned--that there is a stigma attached to being a beneficiary. To the extent that such stigma or identification effects exist, they imply real economic welfare impacts and should be included in the economic welfare criterion used to choose among rationing devices.[19]

While rationing by price would appear to carry no stigma effect, the opposite is likely to be true for a zero price mechanism in which beneficiaries are identified. However, even in this latter case, the sign of the identification effect is not uniform. While a food stamp plan might imply stigma related costs, the granting of permits to utilize, say, public wilderness areas on the basis of skill or experience would imply identification related benefits.

In distinction to the other effects discussed, the stigma (or identification) variable directly influences the tastes of demanders for the output in question. Hence, the willingness of beneficiaries to pay for the public output--and hence the optimum level of public output to be supplied--is itself a function of the rationing device chosen.[20]

The final effect to be considered in the choice of the optimal output level and rationing device is the value of the information which is automatically generated by alternative rationing devices. To the extent that provision of public outputs involves investment or disinvestment decisions, information regarding the economic welfare effects of and demand for existing outputs is important to the decisionmaker. The efficiency of capacity alterations depends upon the quality of such information. Hence, the differential value of the information generated by the various allocation mechanisms must also be registered in the economic welfare criterion for choice among them. Because the use of prices as a rationing device establishes a minimum level of beneficiary willingness-to-pay as a condition of output provision, it has been argued that this mechanism conveys more information regarding at least this component of economic welfare than do other available mechanisms.[21]

V.

The preceding discussion has emphasized the multidimensional nature of a comprehensive definition of economic welfare. When the welfare effects related to each of these dimensions are appropriately accounted for, the optimal level of output may diverge substantially from that indicated by a simple comparison of marginal production costs and beneficiary willingness to pay. Moreover, under a full accounting, the optimal rationing device may entail no use of prices--let alone marginal cost prices--relying instead on other instruments of exclusion for allocating output among the set of demanders. Because of the interdependence of the choice of the optimal output level and the optimal rationing device, a simultaneous decision on these variables is required.

In this section, we will present an optimizing framework for determining the simultaneous choice of rationing device and output level when the physical capacity for producing the output is given and known. This framework is based on a multidimensional concept of economic welfare, defined to include rationing costs, equity effects, stigma effects, and information effects, in addition to the standard effects of beneficiary willingness-to-pay and production and congestion costs. There are three separate dimensions to this framework: First, the benefits and costs associated with each argument of the comprehensive definition of economic welfare [W (I) (i=1,n)]; second, the alternative rationing devices [R (J) (j=1,m)] ; and third, various levels of public output [C (K) (k=1,p)] .[22]

In contemplating the variables in this model, it should be noted some of them may vary with output level and be fixed over rationing devices. Others may vary over rationing devices and be fixed over the range of output levels. Still others may vary over both rationing device and output level. For this reason, the solution of the model may be considered in several steps. If we assume that the physical capacity for producing the output is determined exogenously (for example, the size of a wilderness area or the square footage of a hospital), the following kinds of information are needed to choose the optimum rationing device and output level:

1. The gross marginal willingness-to-pay function of demanders ranked from highest to lowest for each rationing device;
2. The short-run marginal production cost function;
3. The schedule of rationing, congestion, stigma (or identification), and information provision costs and benefits associated with each output level and each rationing device;
4. The distribution of 1. to 3. net benefits and costs among individuals of various income (race, region) categories;
5. The schedule of equity weights obtained from the completely defined social welfare function.

If we let W (I) represent the components of the economic welfare criterion and R (J) represent the alternative rationing devices, we can form an n by m matrix (D) in which each cell (D_{ij}) displays the net benefits [Benefits (I) - Cost (I)] for one welfare component (i) {given a level of output [C (K)]} and one rationing device (j). Through application of the equity weights, these net benefits have been adjusted to reflect the pattern by which they are distributed among various socio-economic groups. For example, D_{ij} might represent the net equity weighted stigma costs associated with the marginal cost pricing allocation technique at a given output level.

The first step is to determine which rationing device maximizes economic welfare at any given output level. To find this, the D matrix is pre-multiplied by a unit row vector of size (1xn), which forms a row vector Z of size (1xm), as indicated by:

$$\underset{(1xn)}{(1\ 1\ .\ .\ .\ 1)} \cdot \underset{(nxm)}{\begin{bmatrix} D_{11} & D_{12} & \cdots & D_{1m} \\ D_{21} & & & \vdots \\ \vdots & & & \vdots \\ D_{n1} & \cdots & \cdots & D_{nm} \end{bmatrix}} = \underset{(1xm)}{(Z_1\ Z_2\ :\ Z_m)}$$

The optimization rule for this problem, then, is to select the maximum Z_j (j=1,m), where Z_j represents the sum of net equity weighted benefits over all of the economic welfare components for a given rationing device R(j) and predetermined output level.

A similar approach is useful for accomplishing the second step. If we now fix the rationing device the problem becomes the determination of the level of output which maximizes a multidimensional economic welfare criterion.

Presuming the desirability of a discrete calculation (e.g., 90 percent of physical capacity, 95 percent of physical capacity, etc.), we can form an N by p matrix (F) of net benefits (costs) for the N components of economic welfare [W (I). (i=1,N)] and the p proportions of physical capacity [C (K), (k=1,p)], given a particular rationing device R(J). A given matrix entry, F_{ik}, would represent the net equity weighted benefits for the ith benefit (cost) component at the kth level of output given a predetermined rationing scheme.

To determine the welfare maximizing level of use the F matrix is premultiplied by a (1xn) unit row vector, which produces a (1xp) row vector Y of size (1 x p), as indicated by:

$$(1\ 1\ \ldots\ 1) \cdot \begin{bmatrix} F_{11} & F_{12} & \cdots & F_{1p} \\ F_{21} & & & \cdot \\ \cdot & & & \cdot \\ \cdot & & & \cdot \\ \cdot & & & \cdot \\ F_{N1} & \cdots & \cdots & F_{Np} \end{bmatrix} = (Y_1\ Y_2\ \ldots\ Y_p)$$

$$(1 \times N) \cdot (N \times p) = (1 \times p)$$

Welfare is maximized, given the assumed rationing device, by choice of the output level which corresponds to the maximum value of $Y_k (= \sum_{i=1}^{N} F_{ik})$.

By repeating the former calculation of either Z row vectors for each of the p output levels or the Y row vectors for each of the m rationing devices, we can form an mxp matrix X, where each term $X_{jk} (= \sum_{i=1}^{N} W_{ijk})$ represents the net benefits (summed over all of the components of economic welfare) for the jth rationing device and kth output level.

A more general solution to this problem can be developed as an integer programming formulation as follows:[23]

$$\text{maximize} \quad \sum_{i=1}^{N} \lambda_{jk} W_{ijk}$$

$$\text{subject to:} \quad \sum_{j=1}^{m} \lambda_{jk} = 1$$

$$\sum_{k=1}^{p} \lambda_{jk} = 1$$

$$\lambda_{jk} = 0 \text{ or } 1$$

The final step involves the selection of the rationing device and output combination which maximizes economic welfare. The optimizing rule is to select the maximum valued X_{jk} requiring the enforcement of output level k and the institution of rationing device j.

VI.

In this paper, we have analyzed the choice of rationing device and output level in the distribution of publicly-produced goods and services. Our objective was to discern the basic factors which interact to determine the optimal rationing device and output level in a world in which economic welfare is a multidimensional variable. In pursuing this objective, we developed an analytic framework for organizing and analyzing information pertinent to this choice.

The basic analytic framework appropriate for the choice of a rationing device and output level is the benefit-cost framework of welfare economics. In a world in which economic welfare is an aggregate of several components, the benefit-cost framework becomes a multidimensional framework and solving for the optimal rationing device and output level involves optimizing over devices, outputs, and components of economic welfare.

In constructing this framework, we found that when the criterion of economic welfare is multidimensional--involving allocation, equity, stigma, (identification) and informational benefits and costs in addition to the standard demand (willingness_to_pay), production and congestion effects--there is no reason to presume the optimality of any particular rationing device, marginal cost pricing included. Moreover, the optimum output level may bear little relation to that at which marginal production costs equal marginal willingness to pay. Only an analysis of the full range of economic impacts can discern which rationing device and output level will lead to a welfare maximum.

We have also discerned that the choice of an optimal level of output is intimately joined with the choice of rationing device. When economic welfare is multidimensional and costs and benefits vary over both rationing devices and output levels, the optimal rationing device and output level must be determined jointly.

Finally, this analysis has substantial implications for theories of the non-public--non-private sector. It, for example, suggests one reason why the private sector produces very similar outputs to some of those distributed by the public sector. Implicit in our analysis is the proposition that choice of a rationing technique other than marginal cost pricing will leave a residual of demanders who 1) have been excluded from the publicly provided good or service and 2) possess a willingness to pay for the output which exceeds the privately-borne marginal cost of producing and distributing it. When this situation exists either the excluded demanders will find it in their interests to cooperate in the production of the good or service for themselves or the private sector will produce to meet the residual demand.

NOTES

[1]See Nancy Ruggles, "The Welfare Basis of the Marginal-Cost Pricing Principle," Review of Economic Studies, Vol. 17 (1949-50) and "Recent Developments in the Theory of Marginal Cost Pricing," Review of Economic Studies, Vol. 17 (1949-50) for a review of the early marginal cost pricing literature. See also William Vickrey, "Some Implications of Marginal Cost Pricing for Public Utilities," American Economic Review, Vol. 45 (May 1955); B. P. Beckwith, Marginal-Cost, Price-Output Control (New York: Columbia University Press, 1955); and Jerome W. Milliman, "Beneficiary Charges and Efficient Public Expenditure Decisions," in U.S. Congress, Joint Economic Committee, The Analysis and Evaluation of Public Expenditures: The PPB System, 1969.

[2]In our analysis, we will deal simultaneously with two dimensions of production and distribution: output level from a fixed capacity and rationing device. A related question is: Given a comprehensive definition of economic welfare, what is the optimal level of productive capacity for producing output X, using rationing device Y? This issue is one of changes in the existing stock of public facilities and is therfore concerned with the public investment policy. It will be discussed only peripherally here. It should be noted, however, that the optimal stock of capital is not independent of the level of output flow provided and the rationing device employed to allocate that flow. For further discussion of the relationship between rationing existing capacity and investing in additional capacity, see John V. Krutilla, "Efficiency Goals, Market Failure, and the Substitution of Public for Private Action," in U.S. Congress, Joint Economic Committee, op. cit.; John V. Krutilla and Anthony C. Fisher, "Operational Concepts of Optimal Recreation Capacity for Low Density Resource-Based Recreational Facilities," in process; and Edna Loehman and Andrew Whinston, "A New Theory of Pricing and Decision-Making for Public Investment." Bell Journal of Economics and Management Science, Autumn, 1971, pp. 606-625. The last of these references discusses the relationship of optimum capacity and pricing (or allocation) policy, focussing on the investment implications of an "incremental cost" pricing policy for increasing returns activities with joint costs.

[3]The assumptions generating these versions of the model will be retained throughout the paper, unless indicated otherwise. The conclusions yielded by these versions of the model stand if these conditions are relaxed, though their derivation is not as straightforward.

[4]These constraints describe a number of common publicly-produced services. Consider, for example, the use of a recreation facility, the use of a public parking lot, the use of the court system, or the use of a public health clinic during some limited period of time.

[5]It should be emphasized that the output discussed here is assumed not to have joint supply or public good characteristics. Moreover, it is assumed that the total willingness to pay for units of the output is represented by the demand functions of the users of the facility or output, i.e., no external benefits or costs are present. This will be relaxed later.

[6]Implicit in this assumption is the proposition that the public investment has been financed by taxpayers and not by charges designed to cover full costs, including investment costs. For the possible efficiency and equity consequences of this assumption, see Lochman and Whinston, op. cit.

[7]It should be noted that imposition of either a uniform price of OF or discriminatory pricing can accomplish this result. See A. M. Henderson, "The Pricing of Public Utility Undertakings," Manchester School, Vol. 15, No. 3, September, 1947. An equivalent allocation device would be to auction off the optimal number of units of the service.

[8]Additional economic welfare of CEB is available and could have been generated had OB units of output been available. The addition of CB units of homogeneous capacity is a problem of investment policy in which the costs of the addition must be compared to the CEB additional welfare available to be tapped.

[9]This analysis of congestion costs applies to the case in which it is assumed that quality deterioration in the output induced by congestion is adjusted for by compensating demanders for the deterioration so as to maintain the willingness to pay function unchanged as the level of output is permitted to rise above OG. The basic marginal cost pricing formulation can also accomodate congestion-induced quality deterioration when no compensation is provided to demanders, although the formulation is substantially more subtle. Without compensation, the marginal user bears some share of total congestion costs. Hence, rationing the output to the optimal level need not rely solely on user charges. The optimal user charge in this case will be less than marginal congestion costs. See C. J. Cicchetti and R. Haveman, "Congestion and the Pricing of Public Services," in process.

[10]For a more complete discussion of the costs associated with use of the pricing mechanism, see Steffan Linder, "The Cost of Prices," forthcoming.

[11] This distinction between fixed and incremental distribution costs and their differential relevance to the pricing and output decision, on the one hand, and the decision regarding choice of rationing device, on the other, applies as well to the other components of economic welfare which we will discuss.

[12] If the equal probability lottery is designed to limit the output of the facility to OC, the willingness to pay schedule shifts from AB to AC, implying a reduction in the benefits of the facility to users of CAE. See Joseph J. Seneca, "The Welfare Effects of Zero Pricing of Public Goods," Public Choice (Spring, 1970), pp. 101-10

[13] See the Appendix for a discussion of the distribution of outputs among users under rationing devices other than the zero price-equal probability lottery and marginal cost pricing.

[14] See Harold M. Hochman and James D. Rodgers, "Pareto-Optimal Redistribution," American Economic Review (September 1969) pp. 542-57 and A. Myrick Freeman III, "Income Redistribution and Social Choice: A Pragmatic Approach," Public Choice (Fall 1969), pp. 3-23

[15] See Irwin Garfinkel, "Is In-Kind Redistribution Inefficient?" Discussion Paper, Institute for Research on Poverty, University of Wisconsin. Here Garfinkel demonstrates the role of grantor utility functions in attaining optimality in programs with income distribution effects. He also specifies the conditions under which in-kind redistribution generates more economic welfare than equivalent direct income transfers.

[16] Although the equity component of a comprehensive economic welfare criterion is typically taken to refer to the pattern in which outputs are distributed among individuals of different income levels, another interpretation is possible. In some policy areas, equality of opportunity of equality of access to public outputs appears to be an important argument in the utility function of grantors. If this is the case, it is the efficiency of an allocation device in attaining the equality of opportunity goal which is of relevance in the welfare criterion.

[17] For example, the extent to which the allocation (or redistribution) device is amenable to abuse or mishandling is of apparent concern to taxpayers--or at least to their elected representatives.

[18]See Robert H. Haveman, Water Resources Investment and the Public Interest (Nashville: Vanderbilt University Press, 1965); A. Myrick Freeman III, "Project Design and Evaluation with Multiple Objectives," in U.S. Congress, Joint Economic Committee, The Analysis and Evaluation of Public Expenditures: The PPB System, 1969; and Burton A. Weisbrod, "Income Redistribution Effects and Benefit-Cost Analysis," in Samuel B. Chase, Problems in Public Expenditure Analysis (Washington: Brookings Institution, 1968).

[19]See Joel Handler and Ellen Jane Hollingsworth, The Deserving Poor (Chicago: Markham Publishing Co., 1971)

[20]For a discussion of the basis of the stigma effect and its impact on the demand of direct beneficiaries for the output in question, see Burton A. Weisbrod, "On the Stigma Effect and the Demand for Welfare Programs: A Theoretical Note," Discussion Paper, Institute for Research on Poverty, University of Wisconsin, 1970.

[21]For an elaboration of the informational benefits and costs present in various cases of public sector provision of goods and services, see Roland McKean and Jora Minasian, "On Achieving Pareto Optimality--Regardless of Cost," Western Economic Journal, 1968, pp. 14-23. See also John V. Krutilla, op. cit.

[22]The optimal level of output is synonymous with the optimal proportion of physical capacity.

[23]We owe the development of this point to Professor Karl G. Maler of the Stockholm School of Economics who commented on an earlier draft of this paper.

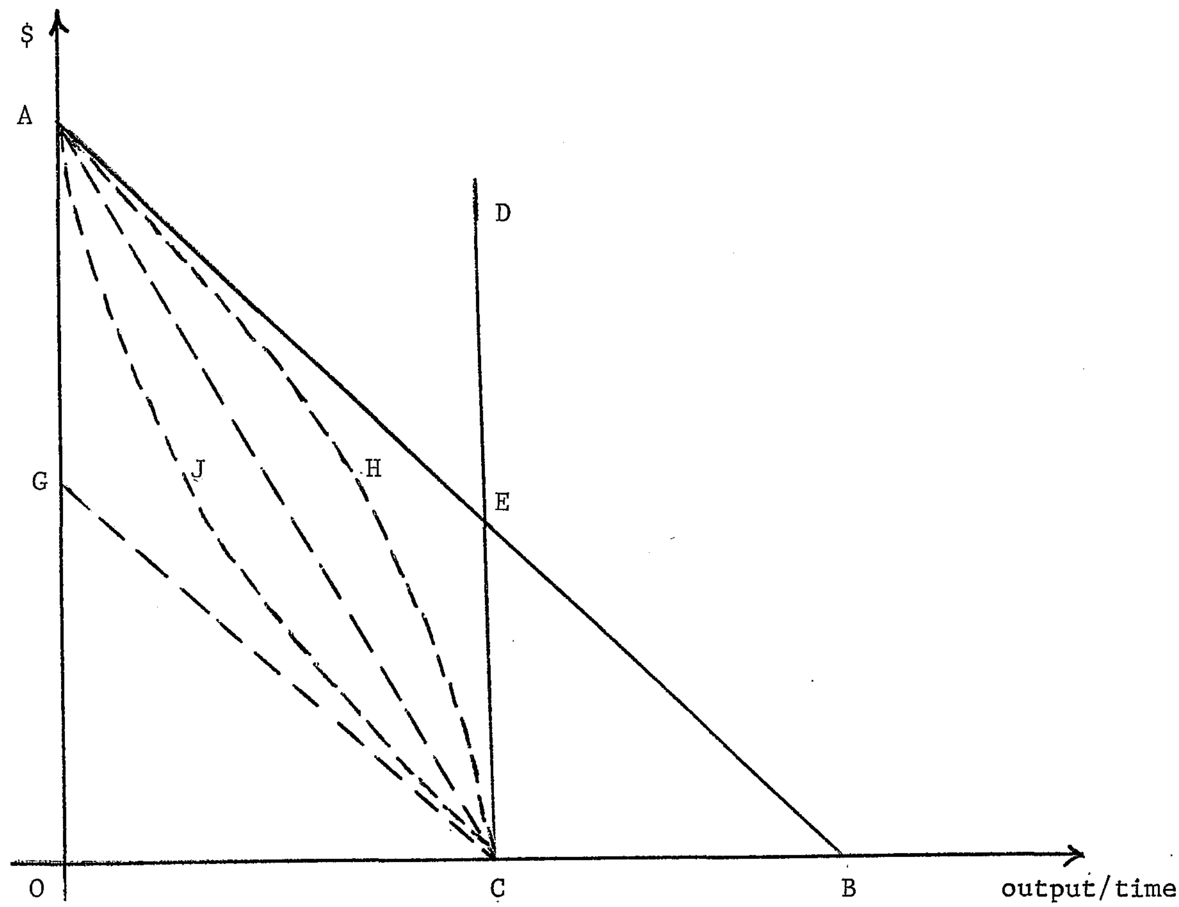
APPENDIX

Non-Price Rationing, Economic Welfare, and Equity

While the equity effects associated with use of the marginal cost pricing formulation are typically presumed adverse, it should be emphasized that each available rationing device entails a different equity effect and in choosing among them these effects must be considered. It is reasonable to expect that the equity impact associated with any particular rationing device is closely related to the level of willingness to pay of the direct beneficiaries of the service. For example, in Figure A-1, if income and willingness-to-pay are perfectly correlated, choice of that allocation device which maximizes the distribution of outputs to low income people will generate a minimum-bound willingness-to-pay function of GC and (as compared to the marginal cost pricing rule) a reduction of willingness-to-pay of GAEC. Such a mechanism is superior to the standard pricing rule if the "equity benefits" exceed GAEC. Similarly, if a zero price lottery meehanism with equal probabilities among all demanders implies a linear willingness-to-pay function of AC, lottery devices with higher probabilities attached to higher than to lower income people will yield a willingness-to-pay function which is concave from the origin, such as AHC in Figure A-1. Conversely, an allocation system favoring low income demanders will yield a convex willingness-to-pay function such as AJC. Again, such devices are superior to the standard pricing rule if the gains to non-direct beneficiaries (grantors, taxpayers) from particular distribution patterns exceed the losses in willingness-to-pay experienced by direct beneficiaries.

The willingness-to-pay impacts of other rationing devices illustrated in Figure A-2. Assume that AD, BD, and CD are demand functions for equal

Figure A-1



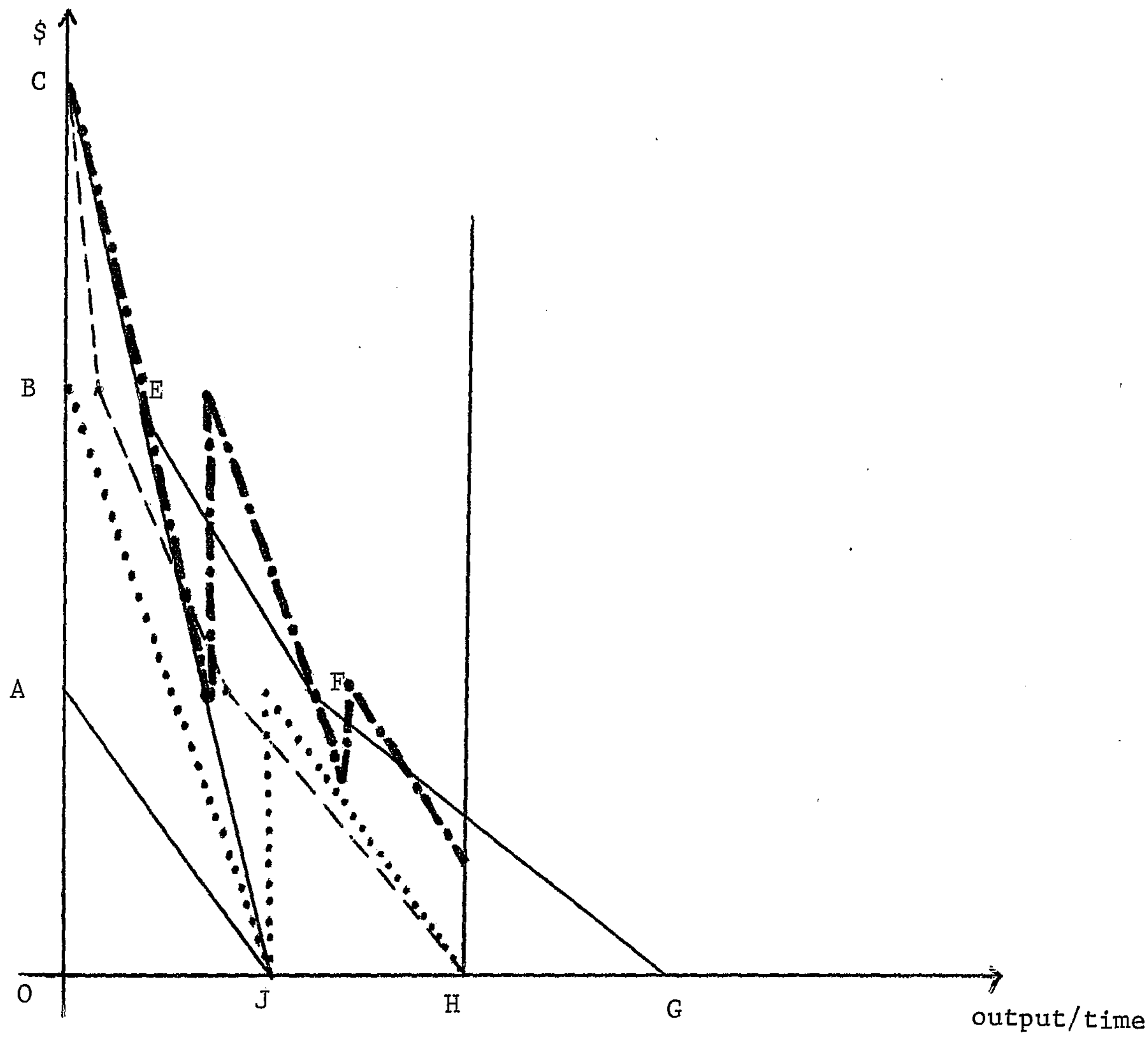
numbers of low, middle, and high income persons, respectively. The function CEFJG represents the aggregate demand function for the entire group of demanders. Let us now assume that capacity of the facility is limited to OH units, and that production costs are zero. If the standard pricing formulation is chosen, a price of HJ will be established, higher income persons would be allocated more units than lower income people and aggregate economic welfare would be maximized at OCEFJH.

A second allocation mechanism might distribute the OH units equally among the three groups, but ration it among the demanders within each group by means of the standard pricing mechanism. Aggregate economic welfare in this case is represented by the area below the discontinuous function (indicated by _._._) and is a smaller value than that generated by the single price allocation mechanism. The single price within each of the population groups is denoted by the height of the three minimum points on the function, with the level of price being positively related to income level.

A third rationing device is the zero price-equal probability lottery, discussed earlier. This mechanism, like the second, would achieve equal utilization among the three income groups, but at the loss of still more aggregate willingness-to-pay. In this case, the willingness-to-pay of users is represented by the area under the dashed line.

Finally, there is the possibility of allocating the capacity to higher income groups only after lower income groups have been satiated. This would generate a willingness-to-pay function represented by the dotted line. The aggregate willingness-to-pay of direct beneficiaries represented by the area under this curve is the minimum possible to attain. Again, the

Figure A-2



allocation device which yields this result may be optimal when the equity desires of non-beneficiary citizens are accounted for.