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AUTHOR Holleman, I. Thomas, Jr.
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ABSTRACT

The general objective of this study was to devise quantitative guidelines that school officials can accurately follow in using benefit-cost analysis, cost-effectiveness analysis, ratio analysis, and other similar economic analytical tools in their particular local situations. Specifically, the objectives were to determine guidelines for the quantification and measurement of benefits for public educational systems; determine guidelines for the accurate costing of public educational systems; determine simple procedures for the utilization of benefit-cost analysis, cost-effectiveness analysis, ratio analysis, and other pertinent economic analytical tools by educational administrators; and provide examples demonstrating the proper use of such economic analytical tools tailored to typical local educational systems' needs. (Author)

The Use of Economic Analytical Tools in Quantifying and Measuring Educational Benefits and Costs

-by-

I. Thomas Holleman, Jr., Ph. D.

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THE USE OF ECONOMIC ANALYTICAL TOOLS IN QUANTIFYING AND MEASURING EDUCATIONAL BENEFITS AND COSTS

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CHAPTER I

INTRODUCTION

Increasingly, public school and college administrators are being faced with making decisions in which millions of dollars are involved. In most cases, alternative courses of action can be followed. If the wrong course of action is selected from among the various alternatives, not only can large amounts of money be lost but, more importantly, many students will suffer because the educational dollar has been diverted to a project or projects which can probably offer, at best, only a low degree of utility.

In the past, school administrators have been able to rely largely on intuition and value judgment in educational financial decision-making. Such wisdom is still of great importance today. However, because of the complexity of modern educational programs and systems, value judgment in the context of educational finance, should be supplemented with modern decision-making tools.

Today, many school and college systems across the nation are utilizing what is commonly called a Planning, Programming, Budgeting System. It shall be referred to here simply as PPBS. In the opinion of some, PPBS provides the sound approach to decision-making that school officials need. It focuses on the decision-making process, particularly the problems of data and analysis. Its first effort is simply the rational ordering of inputs and outputs, in which the initial emphasis is on the identifiable outputs - major objectives of the

educational processes. It then attempts to order the inputs - educational activities produced by labor, material, real estate - so that comparisons among wide ranges of alternatives are feasible and meaningful.

PPBS starts with the structuring of the problem and progresses with the analysis of the data. Among the analytical tools, cost-benefit or cost-utility analysis that compares benefits (outputs) with resources or costs (inputs) is a most prominent one. Since the objective is to improve the decision-making that occurs in real life, not in an economist's abstract model, PPBS pays special attention to questions of organization and administration, and the politics and pressures of the everyday world. Although this study did not focus its attention on the mechanics and techniques of the comprehensive utilization of PPBS in an educational setting, the study did scrutinize the specialized area of financial decision-making in the local school or college that is utilizing a Planning, Programming, Budgeting system. Financial decision-making in this study was comprised of decision-making situations in which large sums of money are to be expended in some projected future system or project.

Background and Objectives

The first systematic attempt to apply benefit-cost analysis to public economic decisions appears to have taken place in the United States in water-resource development, during the 1930's. A key document in the development of benefit-cost analysis was the Flood Control Act of 1936, which set forth a

standard in the evaluation of proposals for water-resources development the requirement that "the benefits to whomsoever they accrue (be) in excess of the estimated costs".[1] Subsequently, benefit-cost analysis gradually became widely accepted in demonstrating that standards were being met or would be met in many government and business financial investment decisions.

In May 1966, all departments and most agencies of the United States government began using PPBS for the first time. By 1968, 28 states and 60 local governments reported that they were initiating steps for the implementation of PPBS. In the same period, 155 local governments reported that they were also considering the use of PPBS. Many school districts and institutions of higher education, especially the larger ones, also began use of such budgeting systems.[2] The California public schools have been using PPBS in compliance with state law for several years.

In the Fall of 1973, the budget format for a PPBS system will become the official system for accounting in all public schools in Texas. This budget format is outlined in Bulletin 679, issued by the Texas Education Agency. Once the budget format has been installed in the schools, many Texas school officials will most certainly begin use of PPBS in varying manners tailored to their local needs in the years ahead.

In installing a PPB system in any educational system, one major problem immediately appears. Very few educational administrators have a knowledge of the use of such economic analytical tools as benefit-cost analysis or cost-effectiveness

analysis, which are essential for accurate decision-making in a PPBS setting. And, even if the administrator were well versed in their operation, the unsolved problem of accurately quantifying and measuring educational benefits remains. Such quantification of benefits is absolutely necessary in using benefit-cost analysis and deriving an accurate benefit-cost ratio. The problem of cost selectivity also demands careful examination. Accurate methods of cost selection are not currently available as a guide to administrators. Thus, the general objective of this study was to devise quantitative guidelines that school officials can accurately follow in using benefit-cost analysis, cost-effectiveness analysis, ratio analysis and other similar economic analytical tools in their particular local situations. Specifically, the objectives of this study were as follows:

1. To determine guidelines for the quantification and measurement of benefits for public educational systems.
2. To determine guidelines for the accurate costing of public educational systems.
3. To determine simple procedures for the utilization of benefit-cost analysis, cost-effectiveness analysis, ratio analysis and other pertinent economic analytical tools by educational administrators.
4. To provide examples demonstrating the proper use of such economic analytical tools tailored to typical local educational systems' needs.

Status of Current Research

As early as the 1940's, leading experts in educational finance such as Paul R. Mort made attempts to quantify educational benefits.[3] None of their studies were satisfactory. In fact, as recently as 1967, according to Herbert J. Kiesling, former staff member of the Assistant Secretary for Program Coordination, United States Department of Health, Education, and Welfare,

> Only one writer has thus far made any attempt to quantify educational benefits from compensatory educational programs on the elementary and secondary level in economic terms. This is Thomas Ribich in his forthcoming book which will be published by the Brookings Institution. To do this Ribich has had to make a series of assumptions which are by his admission heroic of necessity at this stage of the art.[4]

Currently, the only research which has been conducted and published with regard to this problem has been in the area of benefits derived from government investments.[5]

Two books, to date, have been published which consider the use of benefit-cost analysis or marginal analysis by school officials. The books are by Harry J. Hartley[6] and Frank W. Banghart.[7] Their mention of these economic analytical tools is very brief and elementary and lacks details. Numerous studies have been made by the Rand Corporation, the Brookings Institution, and various government analysts in the proper usage of economic tools in the government arena. Various studies of cost-effectiveness analysis for higher education have been made, such as the unpublished dissertation by James S. Dyer, but scholars have been negligent in researching the fields of elementary and secondary education concerning this

subject.[8]

In general, according to Hartley, "Research is needed in the broad area of the economics of education and into specific types of quantitatively measured techniques."[9]

Procedures

The following were general procedures for the conduct of this research:

1. The studies of leading economists and government analysts were reviewed;
2. Techniques developed in these fields which proved applicable to education, especially educational finance which was the main focal point of this study, were selected;
3. These selected economic analytical tools were applied to education;
4. Guidelines were established that school and college officials can use in applying economic analytical tools to the local educational problems that might occur in financial decision-making for their institutions.

Limitations of the Study

It was not within the province of this study to investigate the opposite end of the spectrum -- progress reporting and control. The main problem of such monitoring is to keep track of programs where the major decisions have been made, or to try to detect impending difficulties as programs are being implemented. Research in this area will remain an

important area for future studies.

Notes

[1]Stephen A. Marglin, Public Investment Criteria: Benefit-Cost Analysis for Planned Economic Growth. Cambridge, Mass.: The M. I. T. Press, 1967, p. 16.

[2]Fremont J. Lyden and Ernest G. Miller, eds., Planning-Programming-Budgeting: A Systems Approach to Management. 2nd ed. Chicago: The Markham Publishing Company, 1972, p. 1.

[3]Paul R. Mort, William S. Vincent, and Charles A. Newell, The Growing Edge: An Instrument for Measuring the Adaptability of School Systems. New York: Metropolitan School Study Council, Teachers College, Columbia University, 1946.

[4]Herbert J. Kiesling, "Title I of ESEA: Some Program Analysis." Unpublished paper, Department of Economics, Indiana University, 1967, mimeographed, pp. 55-56.

[5]Robert Dorfman, ed., Measuring Benefits of Government Investments. Washington, D. C. : The Brookings Institution, 1965.

[6]Harry J. Hartley, Educational Planning-Programming-Budgeting: A Systems Approach. Englewood Cliffs, N. J.: Prentice-Hall, 1968.

[7]Frank W. Banghart, Educational Systems Analysis. Toronto, Ontario: The MacMillan Company, 1969.

[8]James S. Dyer, "Cost-Effectiveness Analysis for Higher Education." Unpublished Ph.D. dissertation, University of Texas at Austin, 1969.

[9]Hartley, op. cit., p. 250.

CHAPTER II

BENEFIT-COST ANALYSIS IN EDUCATIONAL FINANCIAL DECISION-MAKING

Educational Investments and their Accompanying Benefits and Costs

Major investments in education on the school district or local level should be made only after a decision-making process has been carefully followed from beginning to end in a logical and carefully conceived methodological fashion. If proper procedures are followed the selected investment should yield the greatest returns, both economic and social, in comparison to the returns expected from alternative investments considered via the decision-making process.

The decision-making process as conceived herein is an all-inclusive procedure which would utilize not only specific economic analytical tools but the experience-based value judgment of school officials as well. It should be stressed that economic analytical tools are no panacea in themselves. Value judgment, in the final as well as the formative stages of the decision-making process, must be used to complement any quantitative figures derived through the analytical process.[1]

Educational investment is the allocation of current school district resources, which have alternative uses, to a school activity whose benefits will accrue over the future. Benefits derived from a business firm engaged in some manufacturing process take the form of tangible goods and services. However, benefits derived from the productive efforts of a

local school usually take the form of intangible goods and services. On the other hand, the cost of an investment is the benefit that could have been derived by using the resources in some other activity. Stephen A. Marglin clarified the relationship of benefits and costs. He wrote:

> The meaning of costs, like the meaning of benefits, depends on the objective: Costs and benefits are simply two sides of the same coin. As benefits measure the contribution of a programme to an objective, so costs measure the extent to which activities that the programme displaces elsewhere in the economy would contribute to the objective.[2]

An educational investment is justified if the benefits anticipated are greater than the costs. This is, of course, the focal point of the search for an optimality condition for any productive activity. It follows that benefit-cost analysis is simply a means of assessing the worth of educational investments. It involves the enumeration and evaluation of all relevant costs and benefits over a period of time. For any educational investment to be selected over alternative investments, benefits should exceed costs, or as expressed mathematically, $\frac{B}{C} > 1$.

A central problem in the evaluation of educational investments is presented by their proration over a period of time. Benefits accrue at different times as well as do costs once the initial investment outlay is made. In compiling or summing of both benefits and costs, the analyst must establish rates of exchange for benefits at certain periods during their projected duration as well as for costs. These rates of exchange will be referred to as the discount rate which must be coupled with an estimated inflation rate for

the same time period because of the anticipated usual decrease in monetary value.

The Traditional Analytical Benefit-Cost Model Updated

Many school administrators have unfortunately made mistakes in compiling benefits and costs in the past. They have simply assumed that benefits and costs can be summed without regard to time period, i.e., to weight the benefits and costs in the present and future time periods equally. This has introduced an immediate flaw into their analysis for two factors: (1) the opportunity cost, and (2) time preference of capital.

Opportunity cost of capital means that a given investment must be compared to alternative investments having like opportunity for yielding deferred benefits and accumulating deferred costs. Time preference of capital means that present benefits to be derived from an investment are preferred to future benefits of equal value from the same investment. In other words, discounting of benefits in accordance to time preference can be justified on the principle of diminishing marginal utility, that "from the point of view of the present, equal increments of benefits are less desirable, the longer the economy must wait to reap them."[3]

In order to put future benefits and costs on the same level as present benefits and costs they must be discounted and deflated in order for accurate comparison. Once future benefits and costs have been discounted and deflated back to the point where decisions are being made the analyst can then

speak of them in terms of the present value of benefits or costs. Thus the present value of future benefits can be defined as total future benefits of a selected program discounted and deflated to present day total benefits expressed in current or present value. If i is the interest rate of return on the given investment, then 1 unit of resources invested there would yield 1+i units of benefit in 1 year, $(1+i)^2$ units in 2 years, and $(1+i)^t$ units of benefits in t years. Including a deflation rate in the equation would read $(1+i+r)^t$ units of benefits. Henceforth, let

B = benefits received annually
C = costs per year, including the charge on capital
K = fixed investment
O = operating, maintenance and routine replacement costs incurred annually
R&D = Research and development costs usually incurred during the planning stages
i = interest rate (yearly)
r = inflation rate (yearly) referred to here as the deflation rate
B_{irT}=Benefits discounted and deflated (total
C_{irT}=Costs discounted and deflated (total)
T = T<u>th</u> year ahead, in which the last benefits and costs are expected to accrue
t = Given year time period.

Mathematically, the present value of total cost can be expressed as $\sum_{t=1}^{T} \frac{0}{(1+i+r)^t} + K + R\&D$,

the present value of total benefits can be expressed as

$$\sum_{t=1}^{T} \frac{B}{(1+i+r)^t},$$

and the benefit-cost ratio can be expressed as

$$\sum_{t=1}^{T} \frac{B}{(1+i+r)^t} \left[\sum_{t=1}^{T} \frac{0}{(1+i+r)^t} + K + R\&D \right]^{-1}$$

Placing the ratio on an annual basis by dividing numerator and denominator by

$$\sum_{t=1}^{T} \frac{1}{(1+i+r)^t},$$

we derive $$\frac{B}{C} = \frac{B}{R\&D + K + O\left[\sum_{t=1}^{T} \frac{1}{(1+i+r)^t}\right]^{-1}}.$$

and letting $$R\&D+K+O\left[\sum_{t=1}^{T} \frac{1}{(1+i+r)^t}\right]^{-1} = C_{irt},$$ and

$$B\left[\sum_{t=1}^{T} \frac{1}{(1+i+r)^t}\right]^{-1} = B_{irt},$$

we can write $$\frac{B}{C} = \frac{B_{irt}}{C_{irt}}.$$ [4]

Given i, r, and T, numerical values for C_{irt} and B_{irt} can be obtained from almost any standard financial/mathematical table.

The precise operational sense in which B_{irt} and C_{irt} are expressed at present value in the above model has been given. It follows that the chosen investment is justified against making an equal investment in the alternative only if the discounted and deflated cost C is less than the discounted and deflated value of the benefits B. If the present value of an investment, discounted at the rate of return of an alternative course considered, falls short of the cost, it should certainly not be undertaken; if any investment is made in this case it should be in the alternative investment route with the greater benefit-cost ratio.[5]

It must be hypothesized here that in the above model it is possible to achieve the same benefits at each point of time throughout the life of the investment in order to eliminate erratic and unforeseeable outcomes. The possibility of uniform outcomes is highly likely in real life situations or in actual practice as long as management remains of the same quality and no significant difference in the economy of scale of the investment occurs, i. e., an unforeseen fire which might destroy a wing of a school plant which might decrease benefits or increase costs of the chosen investment, or, more fortunately, additional future benefits might be derived from year 10 on of the operation by adding a new wing to the existing facility being considered.

It is possible that in some rare situations both alternative investments being considered may have highly impressive benefit-cost ratios. In this case the opportunity cost criteria will not provide the answer. The solution to this problem depends wholly upon the available aggregate volume of resources as compared to current aggregate costs incurred coupled to the value judgment of the school administrators involved.

Besides the criteria imposed on the benefit-cost model by the opportunity cost and time preference of capital postulates, another must be added which is referred to in welfare economics as Pareto Optimality. Pareto Optimality, a macro-economic concept, can be defined as any number of efficient states of economic affairs from which it is impossible to deviate so as to make one person or group better off without making some other person or group worse off. Since the benefit-cost model

developed herein is not concerned with macro-economic or nation-wide issues, the macro concept of Pareto Optimality must be modified to fit the purposes of the local school or college system. Samuel B. Chase, Jr., used the following passage in describing how the Pareto Optimality concept could be adapted to the local situation to be read as simply

> a requirement that the public sector investment programme be designed so that additional gains towards any one goal are unobtainable except by reducing the performance of the program with respect to other goals, then efficiency is itself the primary aim of the benefit-cost analysis.[8]

Efficiency must be the primary criterion for any benefit-cost study. The concept of efficiency will be investigated in Chapter V.

Selection of the Appropriate Discount and Deflation Rates

A word of caution must be added in regard to the selection of an appropriate discount rate for any analysis. Many analysts in the local school or college situation can err by selecting the current interest rate in local banks for prime borrowers or any easily obtained figure such as the widely publicized rates on government bonds. Such selection is inappropriate and can cause error to occur in the benefit-cost analysis. For the local educational situation the rate of discount should be based only on investment alternatives available to the particular individuals or firms to whom the school or college shall most probably sell the bonds used in financing the venture. Since bids on the bonds shall be taken according to law with the bonds being sold to the lowest bidder,

a survey of all local area schools or colleges which have sold bonds in recent months should be made and an appropriate average of such bids should be selected as the discount rate. This in essence is reality and the eventual low bid for the bonds issued for the chosen investment will probably vary only a few hundredths of a percentage point.

The rate of inflation is easier to figure. Almost any U. S. News and World Report, Wall Street Journal or major local newspaper carries the Consumer Price Index which will give at a glance the aggregate annual average increase in prices for the present year. For example, the 1973 yearly average price increase in May 1973, was at 7.2 percent according to the Consumer Price Index in July 2, 1973 issue of U. S. News and World Report. More elaborate indices are available in Economic Indicators printed by the U. S. Government Printing Office, Washington, D. C. A long-term average rate should be selected; this rate can be derived by taking the average increase over the last five years and projecting the same rate of increase into the future.

The Problem of Bias in Educational Benefit-Cost Analysis

It is easy to recognize that bias can enter any benefit-cost study because the analyst failed to be objective in the criteria selected for determining benefits and/or costs. This danger is readily apparent in the situation in which a panel of experts may be selected to formulate criteria for measuring benefits of an educational program. Unfortunately, one or two of the panelists may have a self-interest in preventing the

passage of the bond issue because of the conviction that risk may be involved. Thus, the criteria so derived would interject bias into the analysis because of unfavorable subjective appraisals of the dissenting panelists.

Frederick M. Scherer of the Department of Economics, Princeton University, offered this solution as a possibility to avoid risk-aversion biases:

> ...one might cope with the panelists' possible risk-aversion biases by coupling the comparisons of the expected net benefits for each program pair with the answers to some such questions as this: "Of which program's future value are you more confident?" The choices would lead to a ranking of programs on the confidence (or, inversely, uncertainty) dimension. If a significant rank correlation between the benefit ranking and the confidence ranking emerged, one would suspect risk-aversion biases.[6]

Perhaps the most common interjection of bias into benefit-cost studies occurs because of the failure of the analyst to use one or a combination of the following three approaches:

1. The Fixed Budget (Cost) Approach. In the situation where the educational investment is limited because of a ceiling on expenditures set because of budgetary constraints, the analyst attempts to determine that alternative investment most likely to produce the highest benefits for the fixed budget level or arbitrarily fixed level of resources.[7] See Figure II.1.
2. The Fixed Benefit Approach. For a specified level of benefits to be attained for each alternative investment considered, the analyst attempts here to determine that alternative most likely to achieve the specified level of benefits at the lowest cost.[8] See Figure II.2.

3. The Fixed Efficiency Approach. The criterion for choice in this approach is least cost (greatest) effectiveness. Alternative means of achieving a prescribed capability or level of effectiveness are studied to determine how efficiency can be attained with the least resources possible. Approach 3 differs from Approach 1 in that an economizing move is made to hold costs as low as possible. In Approach 1, a cost ceiling is imposed, not a cost floor. See Figure II.3.

If any of the above approaches are used the following error in the use of benefit-cost ratios can be avoided:[9]

	Benefits (B)	Costs (C)	B/C
Alternative A	20	10	2
Alternative B	200	100	2

In the above case the analyst has failed to fix either the benefits level or costs level. As a result, the benefit-cost ratio of 2 would lead the unknowing to believe that both alternatives are equal in worth. Nothing could be further from the truth.

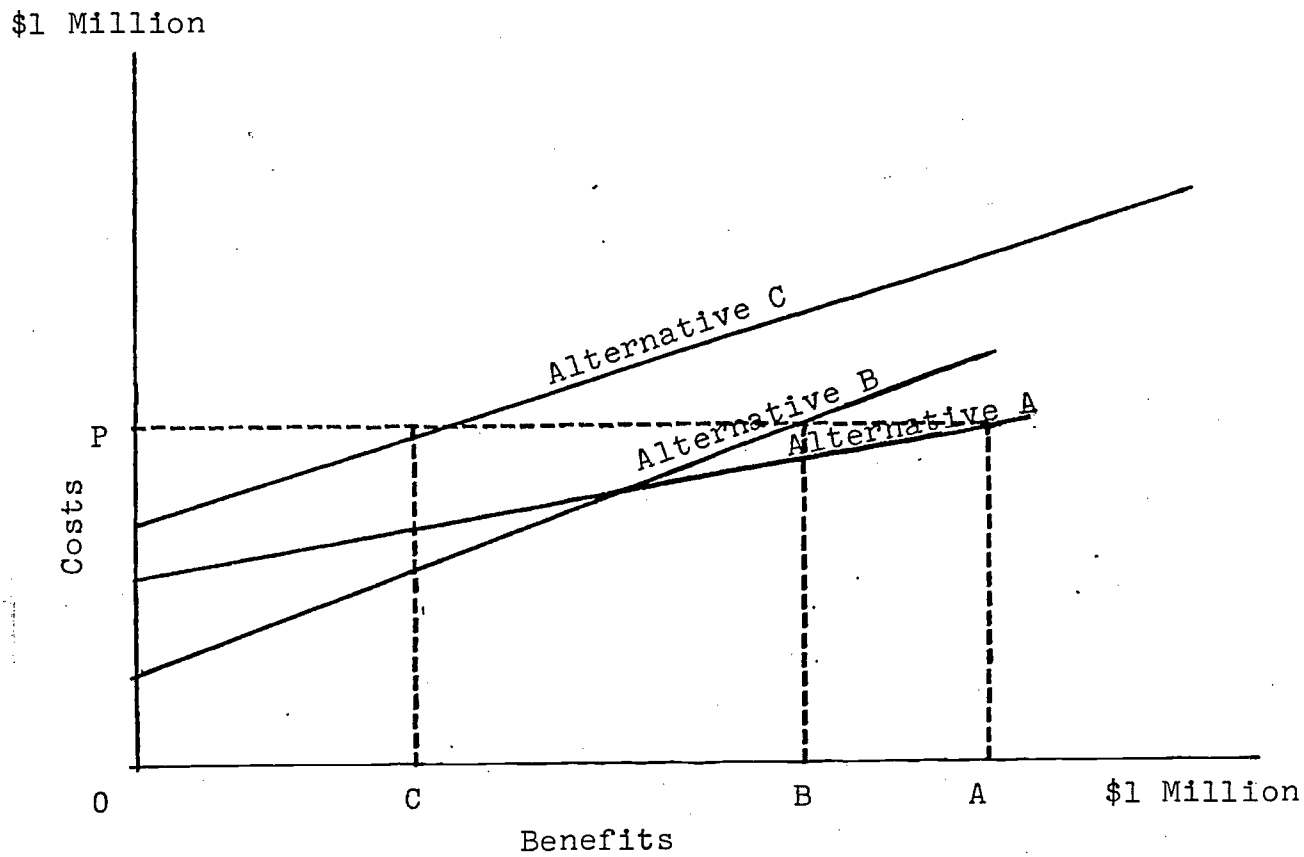


Figure II.1.

Simple graphical outcome of Approach 1 - The Fixed Budget Approach.

P = budget fixation point
A = point of greatest B/C ratio

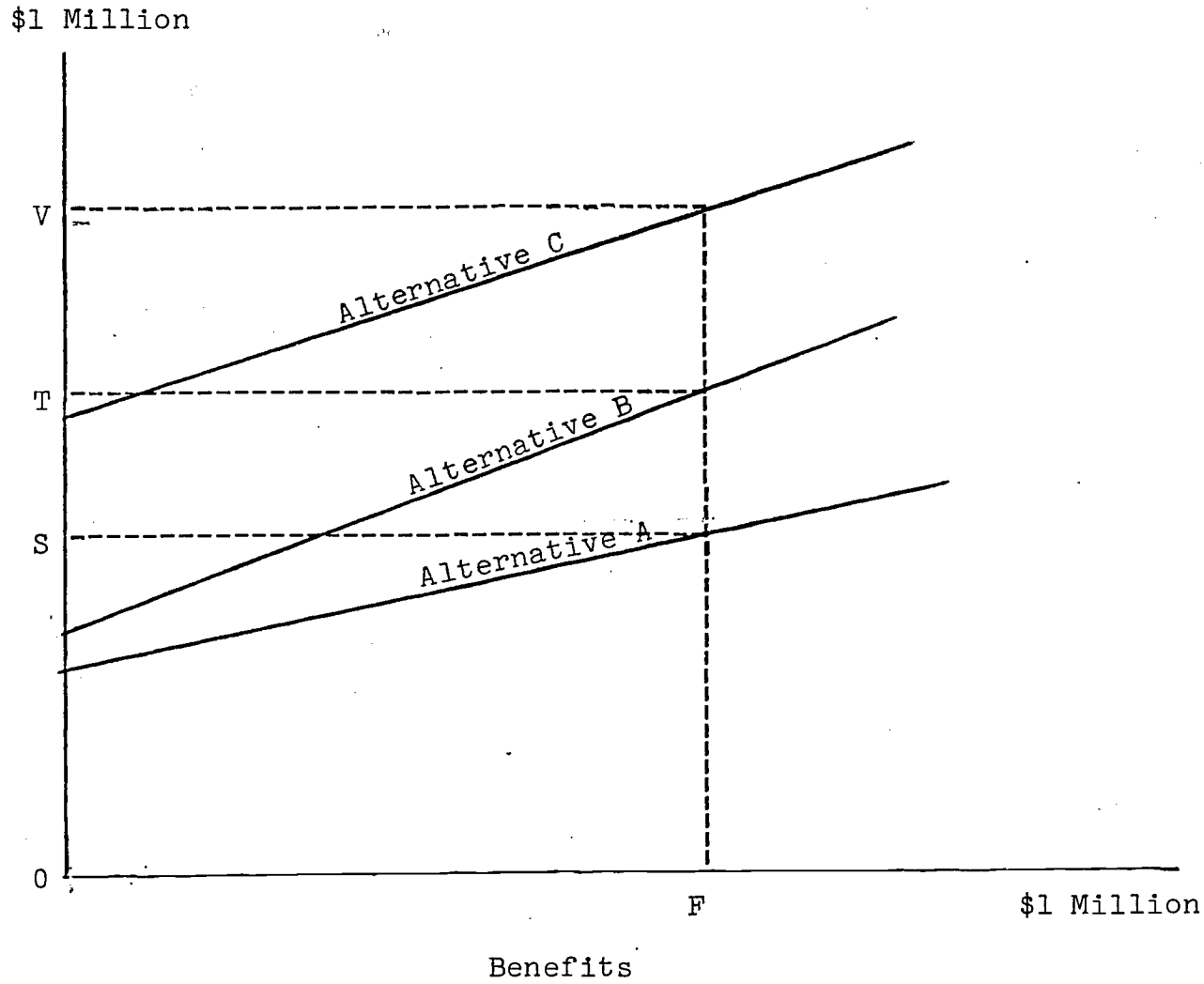


Figure II.2.

Simple graphical outcome of Approach 2 - The Fixed Benefit Approach.

F = benefit fixation point
S = point in which cost is lowest in comparison to fixed benefits

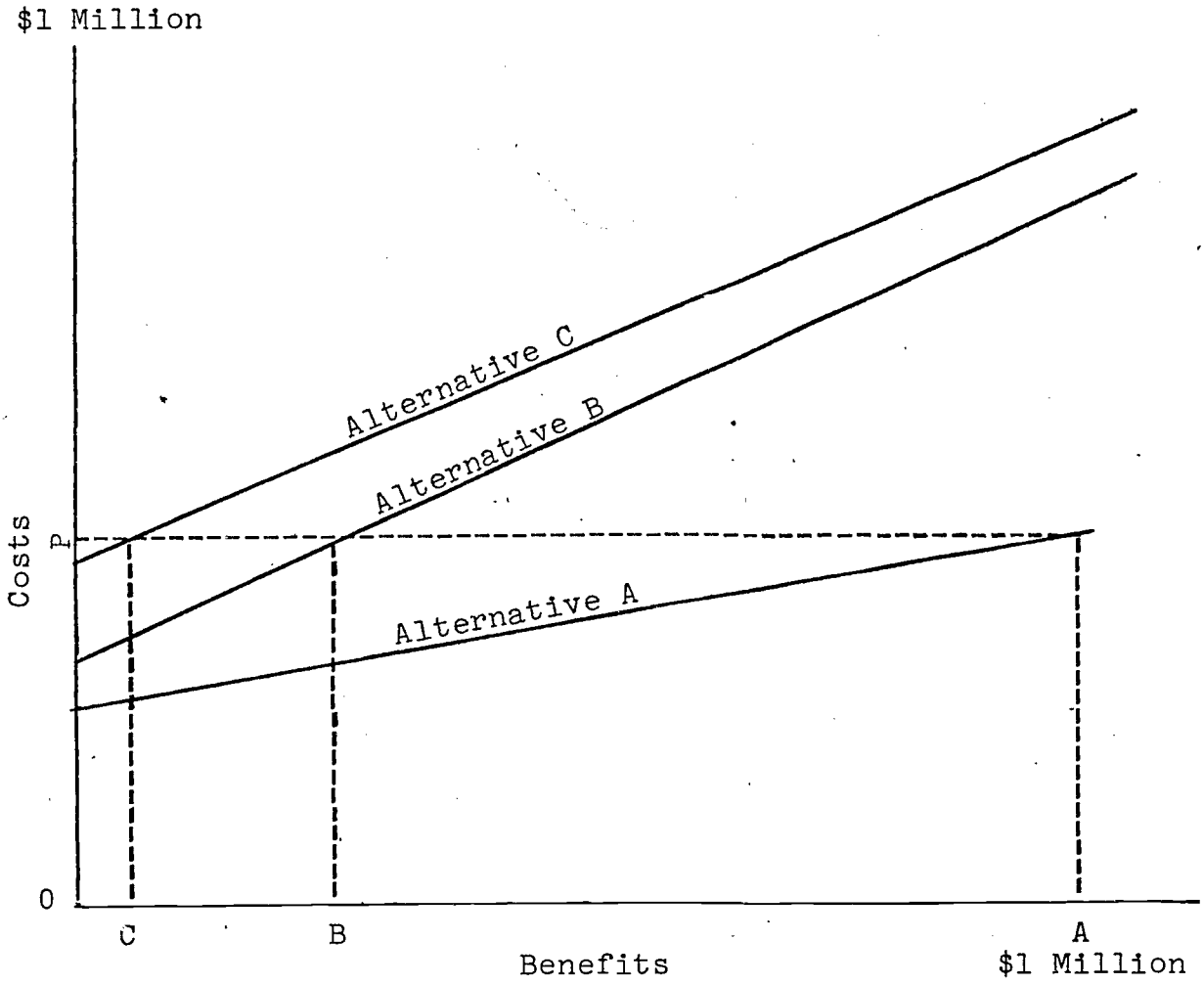


Figure II.3.

Simple graphical outcome of Approach 3 - The Fixed Efficiency Approach.

P = Least cost being considered in analysis

A = Point of greatest benefits derived from least expenditures

Conclusion

A benefit-cost model was established for educational decision-making in the context of educational investments. The economic concepts of opportunity cost and time perference of capital along with Pareto Optimality were used in making the model more viable and realistic for current decisions. The problem of bias being introduced into educational benefit-cost analysis was discussed and solutions offered. The next chapter discusses methods for expressing benefits in numerical terms.

Notes

[1]For additional reading in this area consult Gene H. Fisher, "The Role of Cost-Utility Analysis in Program Budgeting," in Fremont J. Lyden and Ernest G. Miller, eds., Planning, Programming-Budgeting: A Systems Approach to Management. Chicago: Markham Publishing Company, 1972.

[2]Stephen A. Marglin, Public Investment Criteria: Benefit Cost Analysis for Planned Economic Growth. Cambridge, Mass.: The M. I. T. Press, 1967, p. 45.

[3]Ibid., p. 47.

[4]Otto Eckstein, Water Resource Development. Cambridge, Mass.: Harvard University Press, 1958, pp. 55-57. Refer to this text for a presentation of a traditional mathematical benefit-cost model in detail.

[5]Clarification note on B-C or B/C Analysis. By now the reader may have surmised that benefits and costs relationships can be analyzed either through subtraction or division. In subtraction, if costs are subtracted from benefits, net benefits (+) would be the remainder. In division, costs are divided into benefits producing a ratio. In the majority of cases, the ratio of benefits to costs is preferred over the remainder of net benefits because ratios give smaller and easier to compare figures which are weighted in terms of each alternative investment.

[6]Frederick M. Scherer, "Government Research and Development Programs," Measuring Benefits of Government Investments. Washington, D. C.: The Brookings Institution, 1965, p. 69.

[7]Gene Fisher, "The Role of Cost-Utility Analysis in Program Budgeting," Planning-Programming-Budgeting: A Systems Approach to Management. Chicago: Markham Publishing Company, 1967, p. 188.

[8]Ibid.

[9]Ibid., p. 189.

CHAPTER III

APPROACHES TO THE QUANTIFICATION OF BENEFITS OF EDUCATIONAL INVESTMENTS

The greatest obstacle facing educational administrators in the use of benefit-cost analysis is found in the absence of suitable guidelines for expressing benefits in numerical terms. The problem is created because of the nature of the products of the educational process. Instead of producing tangible goods which can be sold by school officials in the market place, schools and colleges produce what is referred to by welfare economists as social goods.

Social goods are the products of public agencies and can be either tangible or intangible in composition. But they differ from privately produced goods. When they are consumed by the public no competition with like-goods is encountered. The reason for the lack of competition is found in the legal monopoly enjoyed by governments and their agencies in the production of social goods and services. In other words, the nature of social goods can be described in terms of goods the consumption of which is non-rival in nature.

If social goods could be sold in the marketplace along with private goods and the environment of competition prevailed, market prices could be used as the measuring gauge of public benefits. This, unfortunately, remains an anachronism as long as social goods are construed to be final goods or products. Richard A. Musgrave, a Harvard economics professor, along with others recognized this difficulty. He suggested that many social goods are not final goods at all but rather intermediate

goods which are used to produce other goods.[1]

The non-rival characteristic of the social good remains in its intermediate status, but the participants have switched from consumers to producers. Since the intermediate social good is used in producing the final private good, benefits derived from the social good can be measured in accordance to the market price of the final private good.[2] Or, in certain cases benefits can be measured in accordance to prices of like intermediate goods. Quantitative techniques for applying market prices to educational benefits will be discussed later in this chapter.

It should be noted that educational benefits as social goods can be measured to some extent as final goods being auctioned in the marketplace. In this situation public schools and colleges would have to charge their pupils and their parents for much of their education. This would in itself nullify the public classification of institutions using such practices. But assuming this was possible and the benefits of public education could be so measured, the task would remain of quantifying the spill-over benefits which are even more difficult to quantify as a final social good. Spill-over or external benefits are so-called in that the benefits of education accrue not only to the student but to the society of which they are members.

This researcher maintains that in the micro situation spill-over or external costs or benefits are generally irrelevant in the financial decision-making of the local public educational system. It is conceded, that in all cases when gov-

ernmental agencies of especially state or national scope are considering investment alternatives, the analysts for these agencies must include external benefits and costs in their calculations. The same point can be argued for giant state university systems. The reason for this is obvious. The decisions of these governmental agencies effect the lives of untold millions of citizens. Such far-reaching consequences with their accompanying immensities must be included in any analysis. However, in the local educational situation the external benefits and costs are negligible by comparison, and, besides this, many external benefits and even costs of the future which accrue from a local educational investment accrue, not in the local school system, but in some area external and many times remote from the school system.

Thus, because of the mobility of parents and students before and after graduation, benefits and costs to society mainly accrue to other geographic areas not in the jurisdiction of the local school. On the other hand, in certain cases where a large metropolitan school system can determine that most of its external benefits and costs remain at 'home' such spill-over benefits and costs should definitely be included in the analysis. This determination must be made by the administrators of the local educational system based on local peculiarities. Since this study was concerned with the norm or usual local educational situation external benefits and costs will be ignored because of their transitory nature. Another reason for exclusion from a benefit-cost study was the consideration of benefits

in this study in terms of intermediate goods and not in terms of final output. The only spill-over effects intermediate goods have are effects on final products which can be measured in terms of price as mentioned above.

Commensurable Benefits and Costs

In the utilization of the Analytical Benefit-Cost Model as designated in Chapter II, the benefits and costs which are to be compared in the various alternatives must both be expressed in the unit of dollar value, benefits must also be expressed in terms of the dollar. That is, they must be commensurable. In concept, this appears quite simple; in practice, it is quite the opposite. The problem arises, as mentioned above, because there is no organized market in which public educational output or benefit can be quantified in terms of market price.

However, even though no overt market mechanism exists for valuing educational output, such social goods have value just as do the products of private industry. Since value can be imputed to educational benefit, the intensity of desire on the part of individuals for such goods can be measured. To an economist, the problem becomes one of imputing values to educational benefit by assessing accounting or shadow prices. Shadow prices in this study, are substitute prices imputed by the analyst to fill the void left in the absence of market prices.

Economic values can be examined in terms of what consumers are willing to give up. This is referred to here as the public's willingness to pay the price required for educational benefit.[3]

Such educational demand, once quantified, can be expressed in a demand schedule which itemizes the public's willingness to pay for the benefits afforded. The demand schedule, in turn, can be transposed to a graph and shown in the form of a demand curve. Benefit estimates can be made from such a derived demand schedule and its accompanying curve.

Total willingness to pay includes not only the price that the public is willing to pay for educational benefit but also consumers' surplus, or that which the public would pay in addition to the price if necessary to obtain the same benefit of education. Examining consumers' surplus from an individual person's demand schedule, a consumer pays a price for a commodity that is less than or equal to the benefit he receives from the commodity. This concept is illustrated in Figure III.1 in connection with the individual's demand curve.

Assume that the market price for the commodity is $3. At that price, the consumer demands 4 units of the commodity. As one follows that demand curve upward to the left, it becomes evident that the consumer is willing to pay more and more for less and less. In fact, the consumer, based on his demand for the commodity, would be willing to pay $6 for just one unit. From this information, it should be recognized that when the consumer is making a purchase of 4 units at the price of only $3, he is actually enjoying a surplus by receiving excess benefits from the first, second, and third units. The consumer, at the price of $3, is paying less for those units than he would be willing to pay. The first units of output are then

valued much higher than the last units of output according to the individual consumer's surplus illustrated in this figure. The aggregate demand curve and consumers' surplus is found by adding all such individual demand curves together including the total sum of the area under each curve. Naturally, the size of the aggregate consumers' surplus depends upon the elasticity of demand or its fluctuation possibilities which in turn is dependent upon the characteristics of the consumers and the circumstances and environment in which the marketing takes place.

In this first case of commensurable benefits and costs, prices were computed by use of a demand curve that relates prices to quantity and thus provides information which can be used in computing the economic worth of an educational investment.[4] Actual shadow prices will be used in the second case. The benefits of the project were designated as the total worth of the output to all those individuals who use it. These benefits were then measured by considering consumers' surplus, or the area as shaded under the demand surve as in Figure III.1.

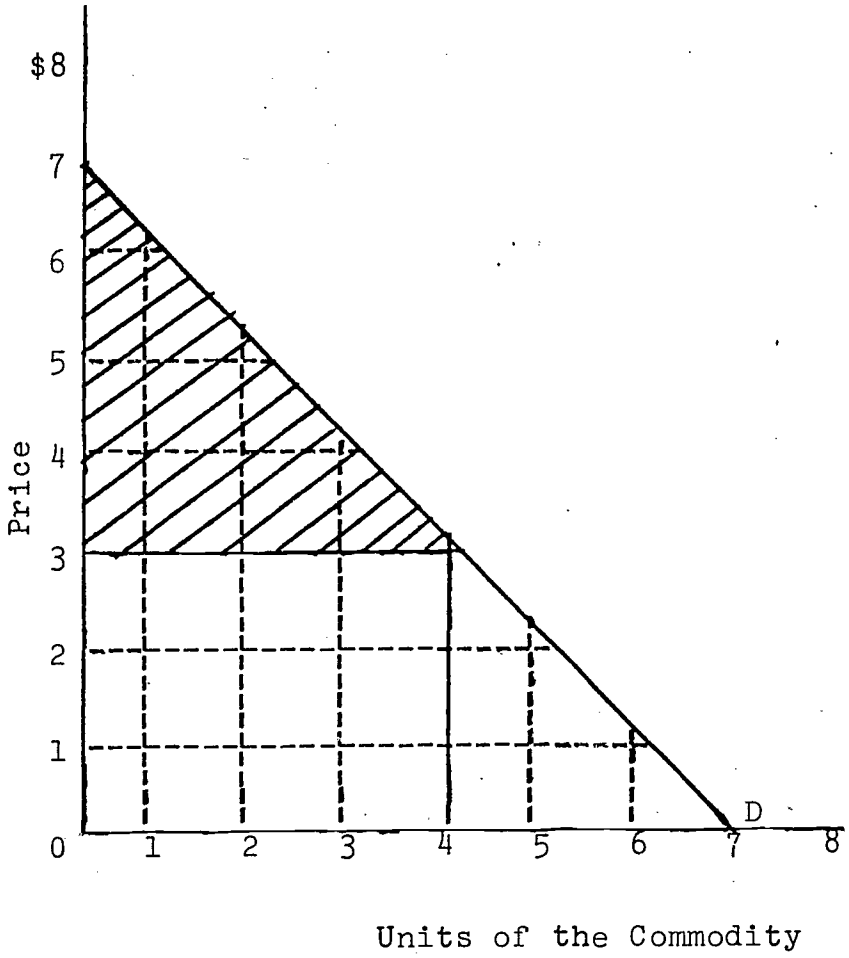


Figure III.1. An individuals demand curve with the area beneath the curve representing consumer's surplus.

In this example, assume that a southern state college of moderate size is considering the erection of an activities building. The new structure is to be of a revolutionary new design called a 'bubble' or 'balloon building'. Such structures are supported by interior air pressure rather than posts or walls. In comparison to conventional masonry designs, they are "inexpensive, light-weight, portable and capable of being blown into all sorts of shapes..."[5] Structures of this type are currently being used by Harvard University as a track and field house, Antioch College as an activities building, and LaVerne College uses several as covers for a sports court, radio station and other facilities. Harvard's building, dubbed 'The Bubble', has been in use for 5 years. Fabric structures like this have a life span of from 3 to 25 years and can also withstand winds in excess of 100 miles an hour, depending on the type of material and its thickness.[7]

The structure being considered in this example was designed for a lifespan of 5 years. It can be used for basketball, indoor track, gymnastics and special activities. It has a seating capacity of 5,000 with an average of 20 events per year being anticipated. The R & D phase will take one year. The R & D funds will be arbitrarily set at $15,000 assuming the site did not have to be purchased. The investment in the structure will be $178,200 payable in the second year with estimated operating costs of $17,200 a year beginning at the end of the second year and continuing through the seventh year. It will be assumed in this example that the costs are expressed in present values and that the total projected cost would be $280,700 over the seven

year period. In order for the program to be acceptable, benefits of the investment must be in excess of this total figure or, as a ratio, must be > one.

In the compilation of benefits, alumni gifts, students services and building use fees designated specifically for the activities building, were summed directly from projected expectations based upon past receipts. Consumer surplus was imputed only from the aggregate demand curve for tickets priced at $2 for general admission. Since primary benefits were viewed here as the value of the output of the project to those who use it, then the proper accounting of the building's benefits, or the social worth of this facility, was measured by the shaded area under the demand curve as illustrated in Figure III.2. This function indicated what consumers would pay for the various units of benefit. Such an estimate measured the total willingness to pay on the part of the users of the facility over a one year period.

The consumers' surplus derived from the demand curve in Figure III.2 was found to be an average figure of $300,000 per year. This amount plus an anticipated average of $25,000 per year from student fees and alumni gifts equals total benefits of $1,625,000 when projected over the five year period. The benefit-cost ratio was derived by dividing the total benefits of $1,625,000 by the total costs of $280,700 which equals approximately 5.8. If this facility had been compared to an alternative facility of masonry design, it is easy to see that the costs of the masonry building would be so high that its benefit-cost ratio would be much lower, perhaps as low as 1.5±.

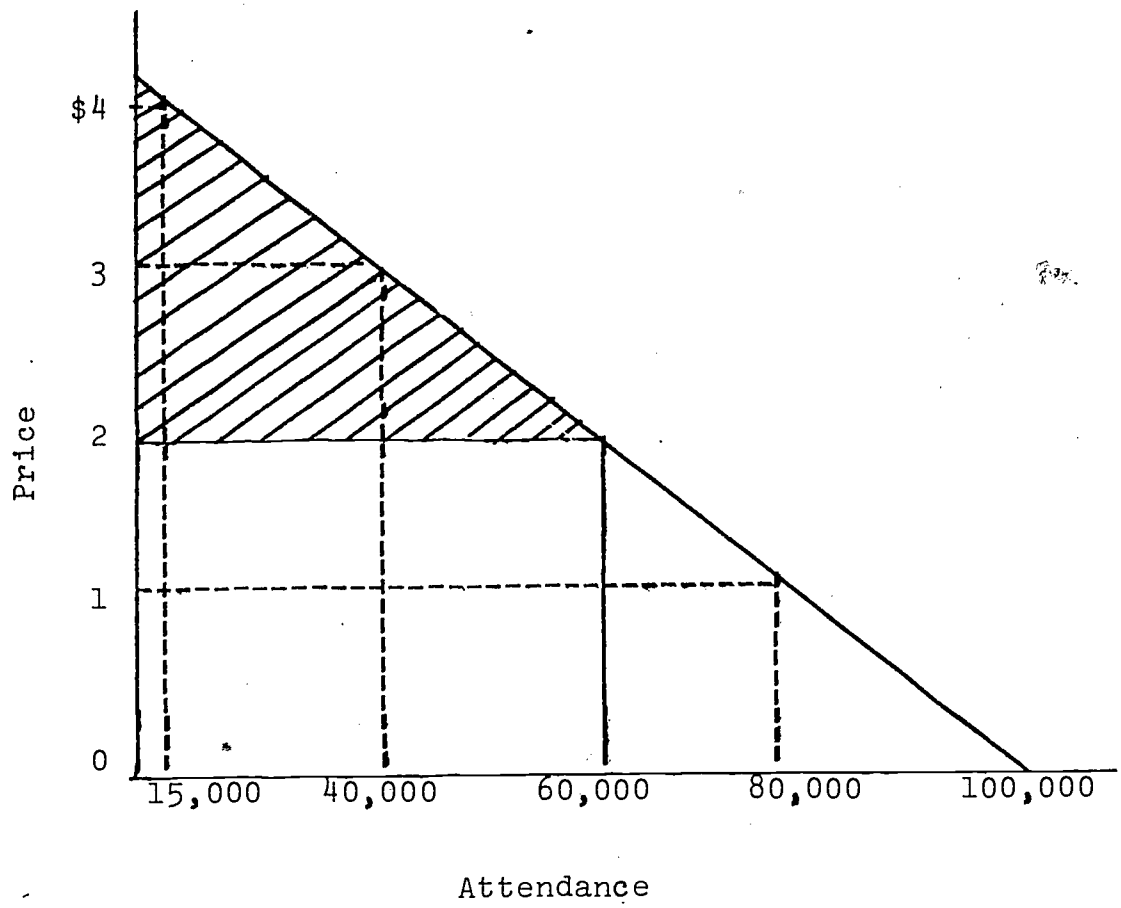


Figure III.2. Demand Curve showing Consumers' Surplus. (The demand curve for tickets was projected for one year and shown in present value.)

In the use of shadow prices, computation replaces the market. Such computation if focused upon the question of what price would be required to clear the market if it could be charged. Shadow prices, unlike market prices which are revealed in the operation of the market, must be indirectly estimated often through questionnaires, or some technique such as the Delphi Method or scenario writing. In this second brief case of commensurable benefits and costs, the benefits and costs for a community education program for adults are to be compiled by the local school administration. In this situation, shadow prices can be used in that tuition charges for similar programs in area junior colleges can be utilized as the basic substitute price. Once the demand schedule has been tabulated, the demand curve should be drawn with the shaded area beneath the curve being counted as consumers' surplus. Consumers' surplus represents total benefits. Costs can be easily summed in that established facilities of the public school are utilized at night. The only costs are administrative and instructional, utilities, and teaching supplies. R & D and investment costs are inherited or sunk costs in this example and should not be included in the analysis.

Similarly, in quantifying benefits for a public education system or program, tuition charges for students at area private schools can be utilized as shadow prices. Costing for such an analysis is discussed fully in Chapter IV.

In many situations, shadow prices may be very difficult to formulate and quantification of benefits may prove impossible. Instead of proceeding blindly from this point in the

decision-making process, the administrator can utilize various qualitative techniques that have evolved from operations' research and operational games. Two such techniques are scenario writing and the Delphi Method.

According to E. S. Quade, scenario writing

> is an effort to show how, starting with the present, a future state might evolve out of the present one. The idea is to show how this might happen plausibly by exhibiting a reasonable chain of events. A scenario is a primitive model. A collection of scenarios provides an insight on how future trends can depend on factors under our control and suggests policy options to us.[8]

Scenario writing can be useful if a resourceful administrator can obtain the time of experts or specialists in the area in which alternatives are to be devised. Each expert, by either expressing his views on paper or into a dictaphone, can provide many ideas and insights into future possibilities for educational systems and programs. As an added bonus, experts via scenario writing may give clues as to valid approaches in devising shadow prices or substitution ratios.

The second technique for qualifying benefits is the Delphi Method. This is a group approach which "subjects the views of individual experts to each other's criticism without actual confrontation ... direct debate is replaced by the interchange of information and opinion through a carefully designed sequence of questionnaires."[9] The exercise manager, or director of the group carefully formulates each questionnaire in logical sequence and opinion feedback is derived by computing consensus from the early part of the program. The process continues until group consensus is reached or the conflicting viewpoints

have been pinpointed.[10]

The Delphi Method can prove invaluable to the educational administrator, not only in obtaining expert opinions, but by conducting the same procedures with community leaders that are willing to cooperate in such brain storming. Many educational benefits to the community can be qualified and verbally expressed from such carefully conducted, yet loosely structured, sessions.[11]

The traditional method of quantifying benefits in terms of income accruing to a student or graduate in the form of higher wages because of additional schooling or a different program has not been discussed. This has been thoroughly covered by other researchers and deserves only mention here. Also, for the same reason, additional benefits such as reduced unemployment, the holding in school of students who have little interest in academic subjects, reduced vandalism and delinquency, reduced welfare payments and the like have not been considered for reasons given above. These are all valid benefits, but benefits in this study were limited to the intermediate and not final output of the educational process.

Incommensurable Benefits and Costs

Among the tests for preferredness, benefit-cost analysis is the most important and perhaps simplest to use. Naturally, the most simplistic usages of benefit-cost analysis would be found in the analysis of alternatives whose benefits and costs are most easily quantified. Analyses of this degree are

usually found when benefits and costs are both measured in different units, that is, they are incommensurable.

If benefits and costs are incommensurable the most accurate approach to their analysis is through graphical models rather than the usual mathematical model approach described in Chapter II. The underlying reasoning for this exclusion is that in mathematical comparisons of diversely expressed units the outcome of analysis would be highly biased because of the failure to weight both benefits and costs on the same measurement scale. For example, no true mathematical comparison of the number of students graduated from a system and dollar costs of such a system can be derived unless the number of students graduated is quantified in terms of dollars or vice versa. A graph must be used to illustrate this example. In such circumstances, the economic tool is referred to as cost-effectiveness rather than benefit-cost analysis because of the incommensurable nature of the analytical process.[12]

Assume that the administrative officials of a large west coast central city school district are examining alternatives for the establishment of new high schools in their district. The alternatives have been limited to either new schools based on the conventional self-contained classroom in the departmentalized high school they are currently using (designated System A) or to the establishment of a new system based on the Trump Plan and its emphasis on team teaching (designated System B).[13] Let it be assumed further that the main objective of the new schools would be to decrease the rising rate of drop-outs which most central municipal schools are encountering; the main

secondary objective would be to provide facilities for a projected 50 percent increase of students over the next fifteen years. Since it will take two years of research and development to formulate all plans and acquire the building sites, two years will be allocated for the R & D costs. It will take one additional year for the buildings to be constructed for which the investment costs will be allocated. In the fourth year students will begin attending the new schools and benefits will begin to accrue in that year. Operating costs will naturally begin in the fourth year with the opening of the new schools and will continue throughout the lifetime of the physical plants. However, benefits and costs will be projected only 15 years which shall be arbitrarily set as the lifespan of each alternative system (15 + 3 = 18 years).

The costs for each system are summarized below in millions of dollars expressed in present values, i.e., both discounted and deflated:

	System A	System B
R&D.....	50.0	100.0
Investment per school.....	3.0	4.0
Operating cost per school... (yearly)	1.5	2.0

As an incommensurable case, the Fixed Benefit Approach shall be used in this cost-effectiveness analysis. Benefits, following the main objective, will be expressed in the number of students that actually graduate. The number of graduates expected from each system shall be set at 75,000 students. Student capacity per school for System A is projected at 2500 and System B, 4000 students. System A schools will graduate 500 students per year; System B schools, 1000 per year.

The proper graphical sequence in cost-effectiveness analysis is shown beginning with Figure III.3 and progressing through Figure III.5. Figure III.3 compares the number of graduates per system to the corresponding number of schools. Figure III.4 compares the cost of each system in present values to the number of schools. In Figure III.5, the common denominator of Figures III.3 and III.4, the number of schools, is removed and substituted with the number of graduates.

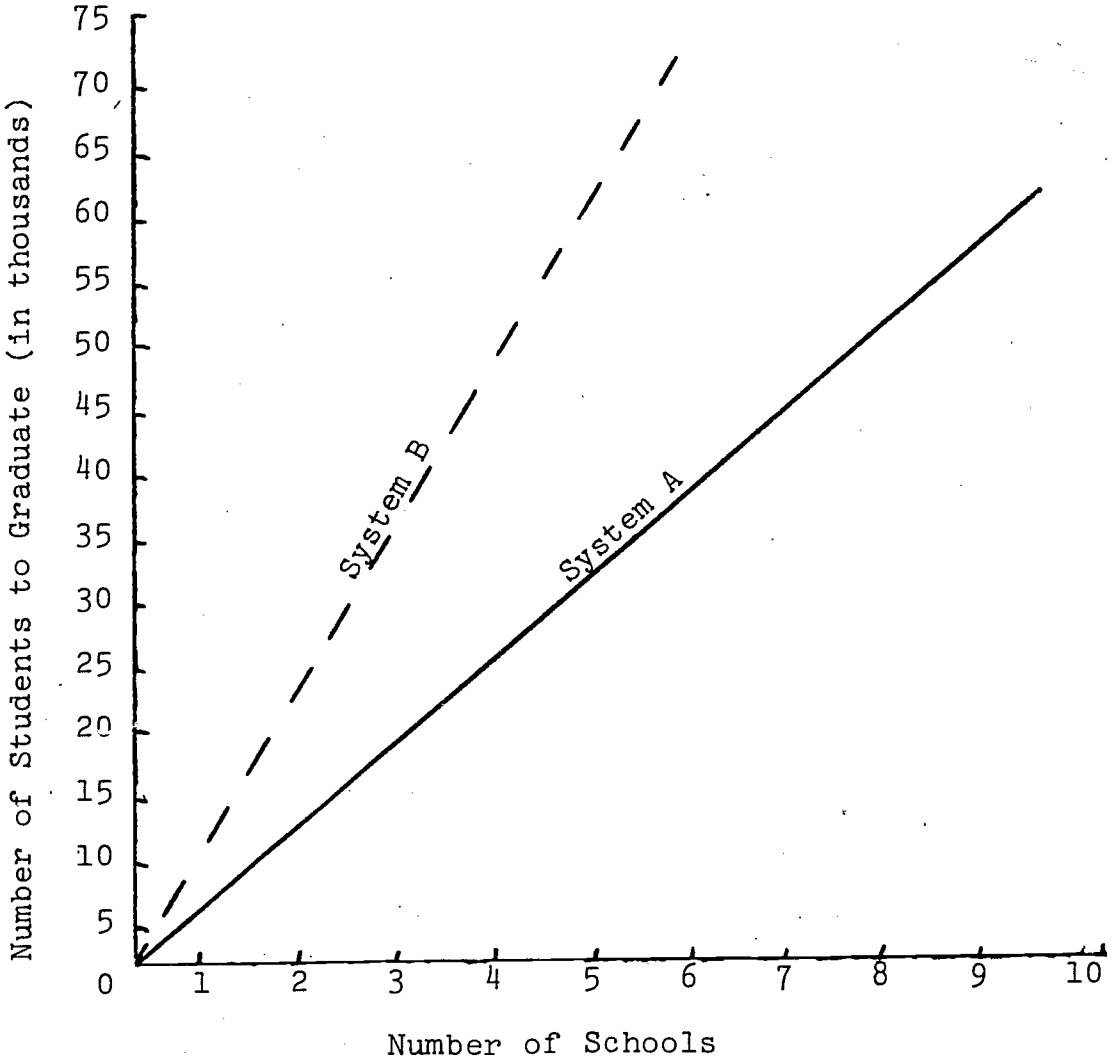


Figure III.3. Number of graduates contrasted to the number of schools.

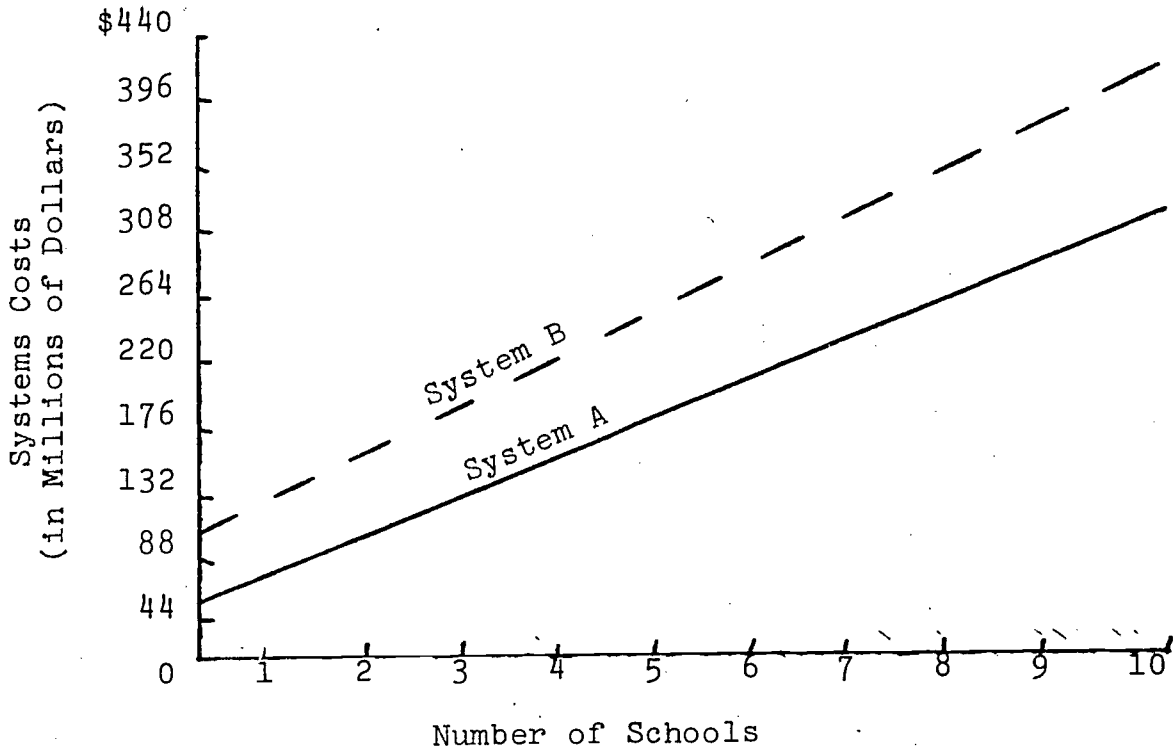


Figure III.4. Systems Costs contrasted to the number of schools.

The following system costs (R & D, Investment, and 15 years of operating costs) are taken from Figure III.4 and are listed in the table in present values:

Costs
(In Millions of Dollars)

System A

#Schools	R&D	Inv	OpC	Total
0	50	--	--	---
5	50	15	112.5	177.5
10	50	30	225.0	305.0

System B

#Schools	R&D	Inv	OpC	Total
0	100	--	--	---
5	100	20	150	270.0
10	100	40	300	440.0

A graph can now be devised to combine benefits (number of students graduated) and costs by eliminating the common denominator of the number of schools as given in Figures III.3 and III.4.

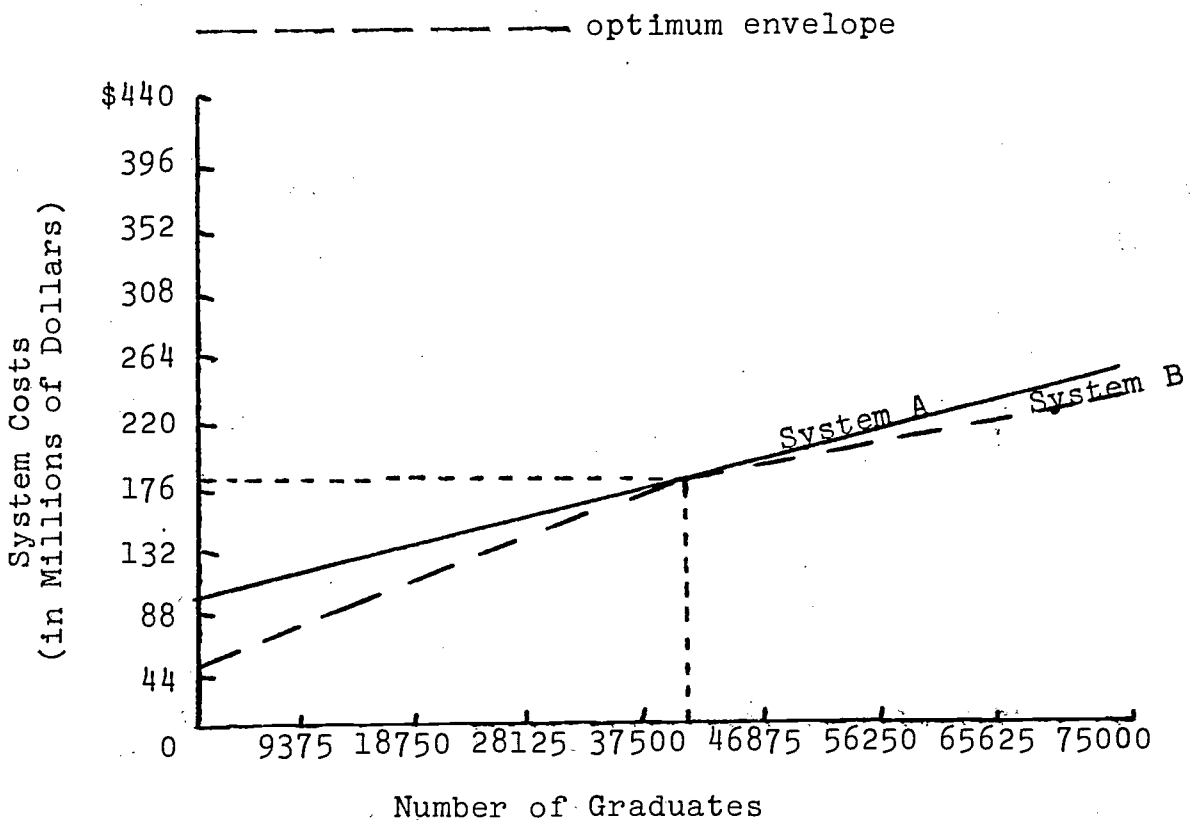


Figure III.5. Benefits (number of graduates) contrasted to costs.

According to the graph in Figure III.5, for all budgets under $191 million, System A is preferred to System B. Conversely, for all budgets above the $191 million point System B is preferred because of the lower costs and equal benefits. In addition, System A would be preferred over System B if the number of graduating seniors was limited to 41,270 or less; System B is preferred if the number of graduating seniors desired is above the 41,270 point. Thus, System B is selected as the program which meets the objectives of the municipal central school district, having the highest benefit-cost ratio based on the Fixed Benefit Approach at the 75,000th graduate mark.

Accuracy must be stressed in the use of graphs. The graph must be drawn to scale and should be drawn on commercially prepared graph paper. The graph paper should be of the type that is ruled into heavy lines one inch apart each way, and subdivided into tenths of an inch more lightly drawn. The horizontal axis of the graph, for example, could be four inches in length and the vertical axis should be three-fourths of that or three inches. Larger vertical and horizontal axes can be used if the same ratio in size is maintained.[14]

In labeling both axes it is important to keep in mind that they are to be labeled in terms of the measuring scale devised in amounts of benefits and costs. Thus, the analyst should plan his scale so that one-tenth inch will stand for an integral number of units of benefits and costs. If a graph is drawn to scale and accuracy is adherred to the results should correspond in accuracy.

Conclusion

Problems encountered in attempting to quantify educational benefits were discussed. Solutions were offered and examined in the context of the degree of commensurability of both benefits and costs. The case method was used in providing guidelines for the solution of like problems in any public school or college setting. Since the emphasis in this chapter was upon quantifying and measuring the output of educational systems--their benefits, the next chapter will logically concentrate upon the input of educational systems--their costs.

Notes

[1]Richard A. Musgrave, "Cost-Benefit Analysis and the Theory of Public Finance," The Journal of Economic Literature, September 1969, p. 800.

[2]Ibid.

[3]Jerry Miner, Social and Economic Factors in Spending for Public Schools. Syracruse, N. Y.: Syracruse University Press, 1965, p. 27.

[4]This procedure was adapted from Marion Clawson, Methods of Measuring the Demand for and Value of Outdoor Recreation. Washington, D. C.: Resources for the Future, Inc., February, 1959; and Jack L. Knetsch, "Outdoor Recreation Demands and Benefits," Land Economics, November, 1963, pp. 387-396.

[5]"Plastic 'Bubbles'--One Answer to Campus Building Needs," U. S. News and World Report, June 25, 1973, p. 88.

[6]Ibid., p. 89.

[7]Ibid.

[8]E. S. Quade, "Systems Analysis Techniques for Planning-Programming-Budgeting," in Fremeont J. Lyden and Ernest G. Miller, eds., Planning-Programming-Budgeting: A Systems Approach to Management. 2nd ed. Chicago, Illinois: Markham Publishing Company, 1972, p. 255.

[9]Ibid., p. 256.

[10]Ibid.

[11]For an example of Delphi procedures, consult N. Dalkey, et al., The Delphi Method, III: Use of Self-Ratings to Improve Group Estimates. Santa Monica, Cal.: The Rand Corporation, 1969.

[12]Aaron Wildavsky, "The Political Economy of Efficiency: Cost-Benefit Analysis, Systems Analysis, and Program Budgeting," Public Administration Review, December 1966, p. 294.

[13]For a description of the Trump Plan please refer to J. Lloyd Trump, Guide to Better Schools. Chicago, Illinois: Rand McNally and Company, 1969.

[14]J. P. Guilford, Fundamental Statistics in Psychology and Education. 4th ed. New York: McGraw-Hill Book Company, 1965, pp. 31-32.

CHAPTER IV

THE COSTING OF EDUCATIONAL INVESTMENTS

The Three Cost Areas

The aim of cost-benefit analysis is to maximize "the present value of all benefits less that of all costs, subject to specified restraints."[1] The quantification and measurement of benefits has been discussed in this context and now costs, which are of equal importance to any analysis, must be examined. As in the case of benefits, a long run view must be taken in terms of time in that costs are estimated not only for the present or immediate future but also for the life of the project. All costs directly attributable to the project must be included. The costing procedure involves the formulation of estimates for the three cost areas of research and development, investment, and operating costs. The aggregate cost thus derived from the summation of the three areas must be discounted and deflated so as to obtain its present value.

The three cost areas as used in this study appear to have first been widely used by the United States Air Force and then adopted by various other governmental agencies and departments. The simplicity and inclusive nature of these cost classifications make them highly useful and appropriate for the formulation and presentation of educational costs.

The National Science Foundation used the following definitions of R & D:

> Basic Research is research in which the primary aim of the investigator is a fuller knowledge or understanding of the subject under study rather than a practical application of it.
>
> Applied Research is directed toward the practical application of knowledge and covers research projects that represent investigations directed toward discovery of new scientific knowledge and have specific commercial objectives with respect to products or processes.
>
> Development is the systematic use of scientific knowledge directed toward the production of useful materials, devices, systems, or methods, including design and development of prototypes and processes.[2]

In situations in which the examination of alternatives for educational investment might mean the purchase of land or real estate, the expenditures on such property must be included in the R & D category. This is recommended in that the site should be purchased as early as possible, even before the R & D stage if possible, to avoid additional costs once the public becomes aware of the schools' demand for property. In addition, architect fees for the development of plans for a new school plant would logically be included in this category also. Another example of an R & D cost would be the fees paid to consultants engaged for a study involving the use of automated teaching machines as opposed to traditional teaching methods. The list could be expanded much further, but the primary rule in compiling R & D costs is to include all expenditures incurred during the planning stages. Sunk costs, or costs expended on prior studies or prior real estate or capital acquisitions, are not to be included in any way in the compilation of costs for benefit-cost studies. The subject matter for all benefit-cost studies is always future

costs and benefits, never costs or benefits accrued in the past.

Investment and operating costs in Air Force studies are defined as follows:

> Investment: Capital (one-time) costs required beyond the development phase to introduce a new capability into operational use.
>
> Operating Costs: The annual costs required to operate and maintain a given capability for an element throughout its projected life or operational use.[3]

Figure IV.1 illustrates the relation of the three cost areas to time:[4]

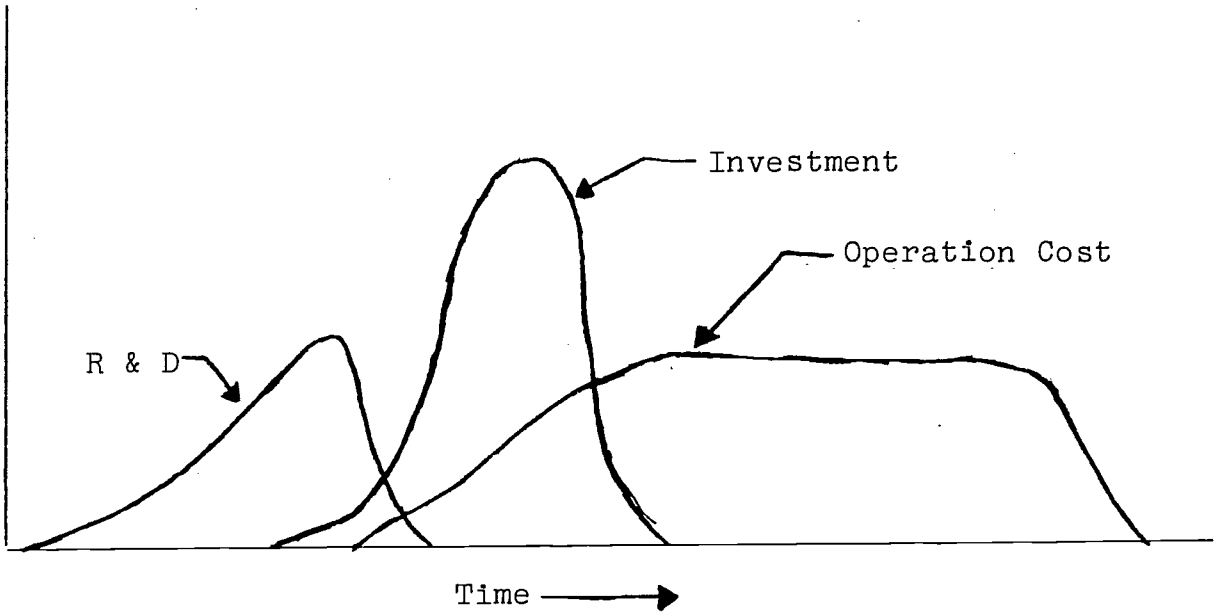


Figure IV.1. Life-cycle costs.

Economic Factors in Cost Estimation

One approach to measuring the costs of an educational investment is that of the costing of the economic factors of production which are required in proper proportions before a system's operations can commence or continue operations. These factors of production are simply termed here as the input mix. Classical economists referred to the factors of production as land, labor, capital, and entrepreneurship. The factors land and entrepreneurship are now commonly referred to respectively as material and management. If all factors of the input mix, material, labor, capital, and management are combined in their proper proportions at the right time and place in the form of a tangible educational investment, output or benefits from the derived system will result. Naturally, optimum returns to scale would result if the factors of production could be combined in optimal proportions which should be the goal of every investment.

The costs derived from the concerted operation of the factors of production can be simply added together and discounted for the total aggregate system cost. Functionally, the process may be represented by the discounted production function for a simple firm, which may be written as

$$C = \sum_{i=1}^{T} \frac{f(m + l + c + e + r\&d)}{(1+i+r)^t},$$

C standing for total aggregate cost, f standing for function, m for material, l for labor, c for capital, and e for entrepreneurship or management. Research and development costs must

also, of course, be included in the formula if such R & D costs are not sunk costs, or costs incurred before the investment decision is made. The discount-deflation rate is the denominator.

Such itemization of an educational investment's costs is usual practice when school administrators lack economic training. And, such itemization is not incorrect. However, if economic analytical tools are to be properly utilized in the financial decision-making process, the educational administrator in the role of the economic analyst must pursue a more complex approach and consider costs from the opposite end of the production spectrum - that of output.

From the focal point of output, the three cost areas of research and development, investment, and operating costs must be estimated. Since research and development and investment costs must be incurred before the system begins operation, their costing is focused usually on the first two to four years. After this, the operating costs continue throughout the projected life and operation of the system. Thus, of the three cost areas, operating costs have the highest degree of sensitivity to system output.

Operating cost has two components, fixed and variable cost. Fixed cost may be defined as an operating cost which does not increase or decrease as the total volume of output increases or decreases in the short run period. Variable cost is that operating cost which increases or decreases as the total volume of output increases or decreases during a particular period, whether short run or long run in duration. In con-

ventional accounting for PPBS such costs are usually referred to as indirect (fixed or 'overhead') cost and direct (variable) cost.

When operating costs are considered as a function of output their sensitivity to output Q can be mathematically expressed in terms of the following cost components of total system operating cost C, with Δ being read as "the absolute change of":

Total system operating cost	= C,	$\Delta C/\Delta Q>0<\infty$
total fixed cost	= F,	$\Delta F/\Delta Q=0.$
total variable cost	= V,	$\Delta V/\Delta Q>0<\infty$
Average system operating cost	= A,	$\Delta A/\Delta Q>0<\infty$
average fixed cost	= F,	$\Delta F/\Delta Q>0<\infty$
average variable cost	= V,	$\Delta V/\Delta Q>0<\infty$

These cost components are naturally expressed in terms of a short run period in which fixed costs retain their same accounting value. In the long run, economists view all costs as variable because the system being analyzed would have encountered a change in physical scale, thus forcing a change even in fixed cost or overhead. For cost-benefit studies a short run period should always be considered in which the period, thus defined, could last as long as thrity or forty years, or as long as the system maintains its input mix within the confines of its original scale of operations.

The above operating cost components are related in this manner:

$$C=F + V = \sum_{i=1}^{m} F + \sum_{i=1}^{n} V;$$

$$A = \frac{C}{Q} = \overline{F} + \overline{V}$$

$$= \frac{F}{Q} + \frac{V}{Q} = \left[\sum_{i=1}^{m} F\right] \Big/ Q + \left[\sum_{i=1}^{n} V\right] \Big/ Q.$$

The distinction between the total system operating cost C, the average system operating cost A, and the marginal system operating cost M may be seen in the cost schedule in Table IV.1.

Table IV.2. System Cost Schedule.

Unit	Output Q	C $	A $	M $
1	10	60	6.00	----
2	22	70	3.18	.83
3	36	80	2.22	.71
4	52	90	1.73	.63
5	67	100	1.49	.67
6	78	110	1.41	.91

Since marginal cost is simply the increase (decrease) in the total cost resulting from the production of one more (less) unit of output, it is found as follows:

$$M = \frac{\Delta \text{ Total Cost per additional unit}}{\Delta \text{ Total Output per additional unit}}.$$

In reference to the relationship between average and marginal costs, it might be noted that the following characteristics always prevail as graphically demonstrated in Figure IV.2. For the average cost to rise the marginal must be $>$ the average; for the average to remain the same the average and marginal costs must be equal (point P); for the average to fall the marginal cost must be $<$ the average cost.

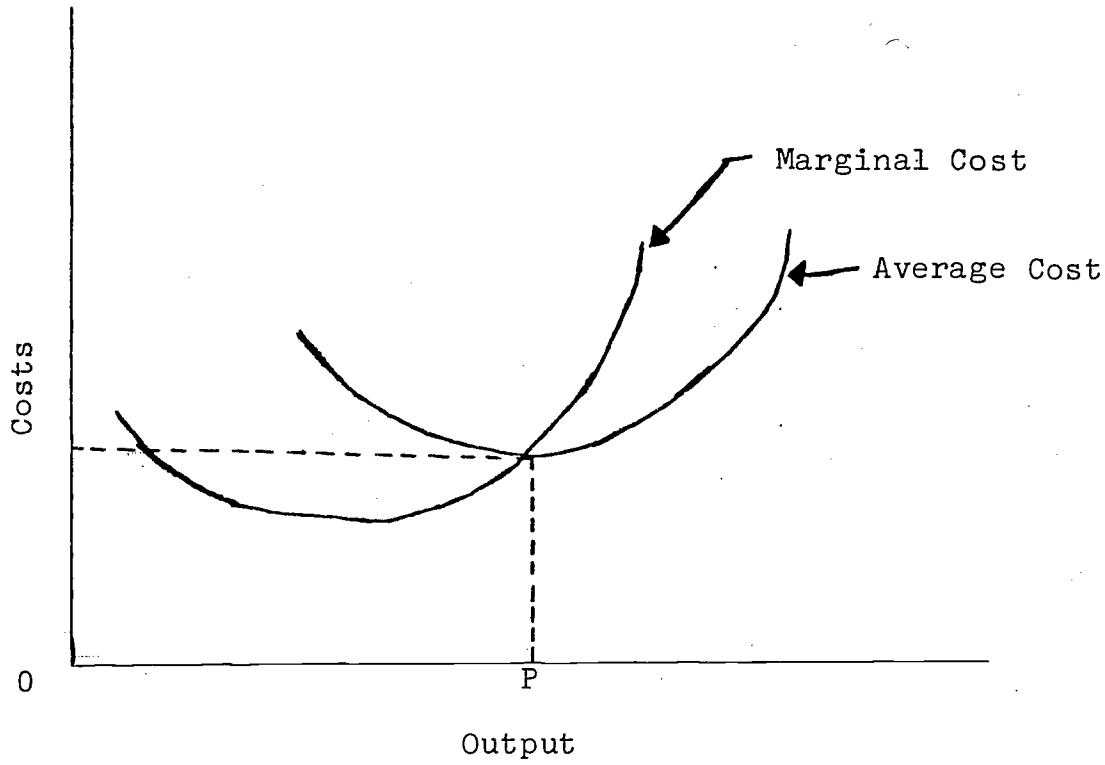


Figure IV.3. Average Cost-Marginal Cost Relationship Profile.

The marginal costs and average costs are important in the analysis of an educational system. Once the marginal cost and average cost curves have been constructed as in Figure IV.3, a demand curve such as described in Chapter III can be added to the graph for further analysis. In Figure IV.4 a simple example is given which shows a marginal cost curve, an average cost curve, and a demand curve. According to Harold Hotelling in his Econometrica article, consumers' surplus or the net benefit to society from the operation of a public project is the area between the demand and marginal cost functions (shown in the shaded area of the Figure).[5] Hotelling hypothesized that if this area over the entire operating life of the project exceeded the original investment cost, the project was

to be undertaken. According to the costing guidelines of this Chapter, R & D Costs should be added to investment costs for analysis purposes.

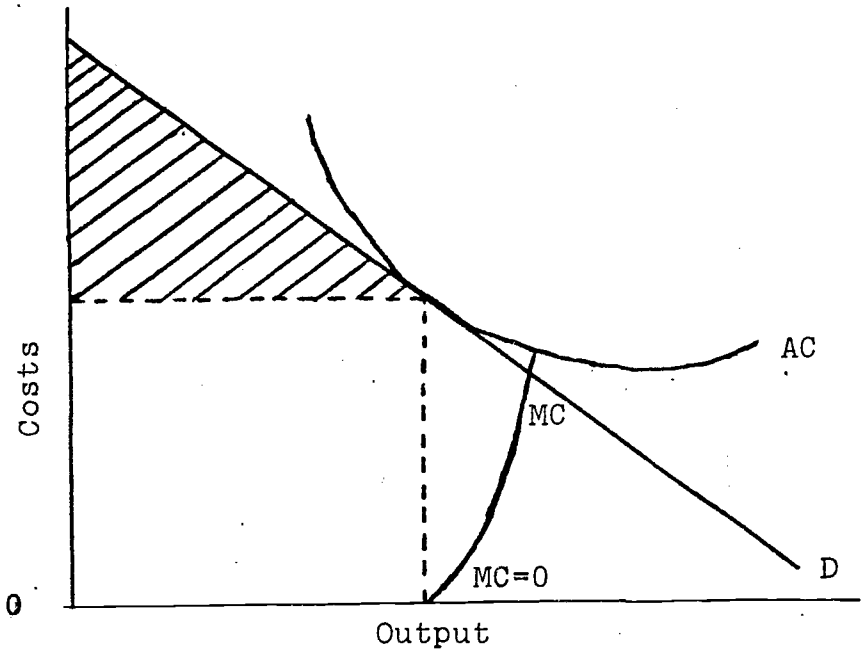
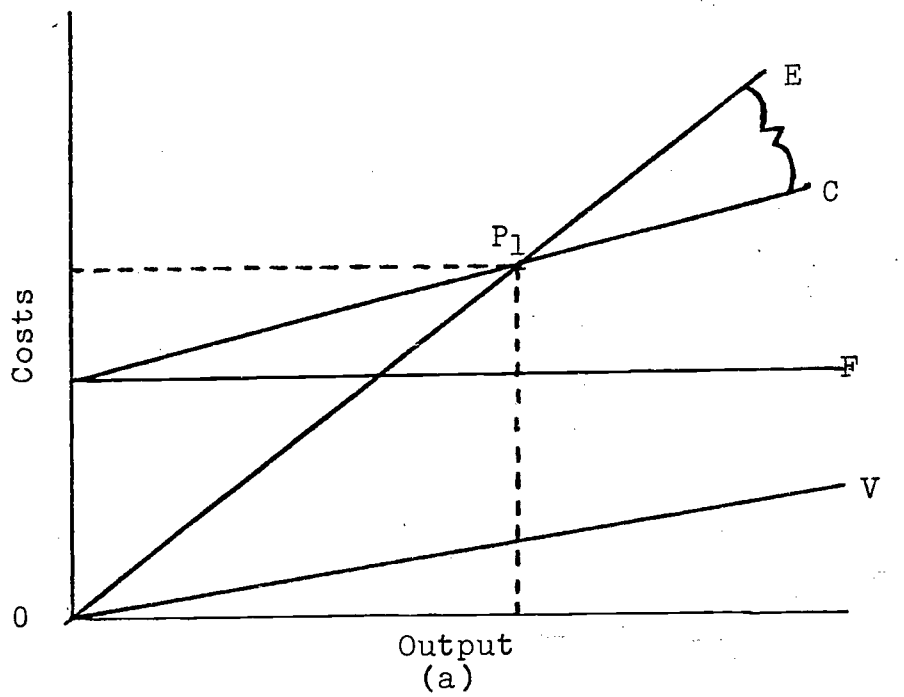


Figure IV.4. Graph illustrating the relationship between AC, MC, and D in measuring consumer's surplus (shaded).

Another way of analyzing cost as a function of output is to observe the intersection of the total effectiveness or benefit curve (shown in terms of output) and the total cost curve, known as the break-even point P. A break-even analysis is of particular importance to a cost-effectiveness analysis when the ratios of the fixed cost to the variable cost are widely different among the competing alternatives. For comparison, consider two systems that have the same benefit or effectiveness curve E and also reach the same total system cost C. The only difference in the two systems being the ratio of fixed (investment) cost F to variable (operating) cost V, as shown in Figure IV. 5a and b.



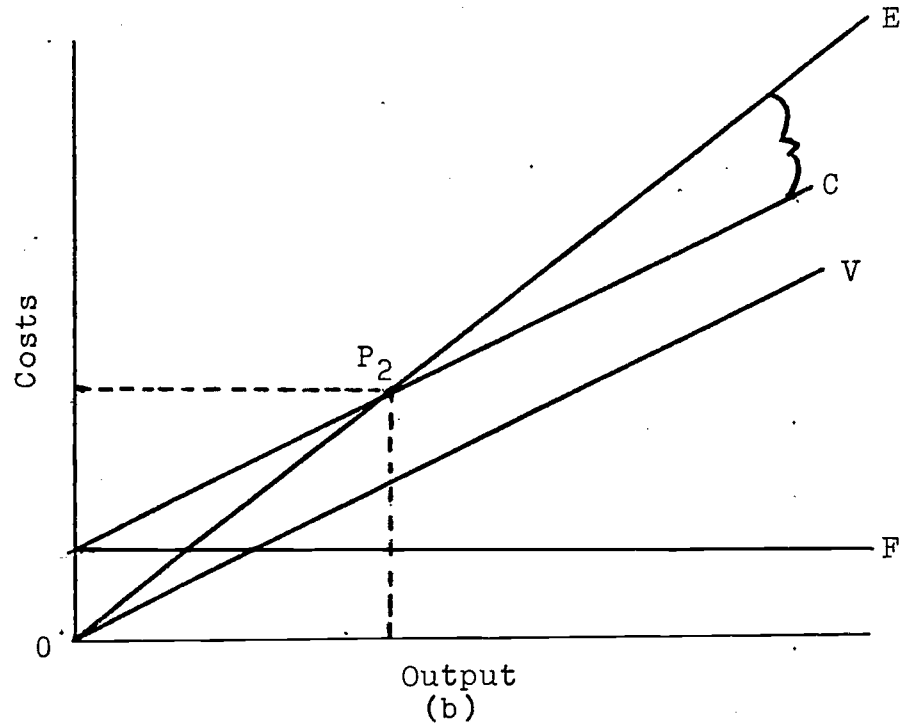


Figure IV.5. Break-even Charts

Even though the two systems may have the same benefit or effectiveness curve and the same total system cost at the same output level, their net benefit over time, the rate of change in the net benefit, and their break-even points may be widely different. Systems with the higher fixed cost therefore would be relatively less desirable than systems having the higher variable cost.

A financing decision may have to be made between renting or purchasing equipment. The break-even charts can be used to resolve this problem also. The curves in Figure IV.5 would maintain the same appearance. The break-even chart in (a) would represent the purchase alternative with its high fixed cost/low variable cost; (b) would represent the rental alternative with the low fixed cost/high variable cost.

Cost Matrix Model

In order to systematically synthesize and examine the three cost areas, a cost matrix model may be devised patterned after Figure IV.6. As shown, the cost matrix may be constructed by arraying the cost areas into a two-dimensional field consisting of system functions and cost functions to be considered in the study. Such a cost matrix provides a checklist of the cost and system functions to be considered in a study thus providing, at a glance, aggregate and subaggregate figures identifying areas of overlap or omission derived through the costing process.

AREA	SYSTEM FUNCT.	COST FUNCTIONS					PRESENT VALUE
	Modules	Capital	Maint.	Admin.	Instruc.	Totals	
R & D	#1					Σ	
	.					.	
	.					.	
	.					.	
	.					.	
	n					Σ	
	Total R & D	Σ	Σ	Σ	Σ	Σ Σ	Σ Σ
INVESTMENT	#1					Σ	
	.					.	
	.					.	
	.					.	
	.					.	
	n					Σ	
	Total Invest.	Σ	Σ	Σ	Σ	Σ Σ	Σ Σ
OPERATING COSTS	#1					Σ	
	.					.	
	.					.	
	.					.	
	n					Σ	
	Total Op. C.	Σ	Σ	Σ	Σ	Σ Σ	Σ Σ
OPERA.	Total op. c. (x) yrs	Σ	Σ	Σ	Σ	Σ Σ	Σ Σ
R&D + In.	Total R&D + Investment					Σ Σ	Σ Σ
All	Total System Cost					Σ Σ	Σ Σ

Figure IV.6. Cost Matrix Model

Incremental Costing and The Incremental Cost Model

The educational decision-maker may be confronted with alternatives which have an identical resource base. In such a case, the analysis must begin at and progress from the existing resource base. The sunk cost in the inherited facility is not to be excluded in the cost estimates of any of the alternatives considered. The problem is to determine how much additional output or benefit would result from some additional expenditure. The additional expenditure is referred to as marginal or incremental cost which results from the addition of resources to the base resources of the existing system. The additional benefit derived from the marginal expenditure would likewise be called marginal benefit.

The simple concept of incremental costing can be illustrated by the incremental cost model as shown in Figure IV.7. Let it be assumed that the existing resource base is the main classroom building on a particular junior college campus. The decision is focused on the feasibility of adding a new wing either designed to incorporate a more modern performance based style of instruction (System B) or maintaining the conventional instructional methodology (System A) currently used in the existing facility. Note in the figure that the existing structure is not included in the cost estimate for either alternative, and that only costs are considered, not benefits.

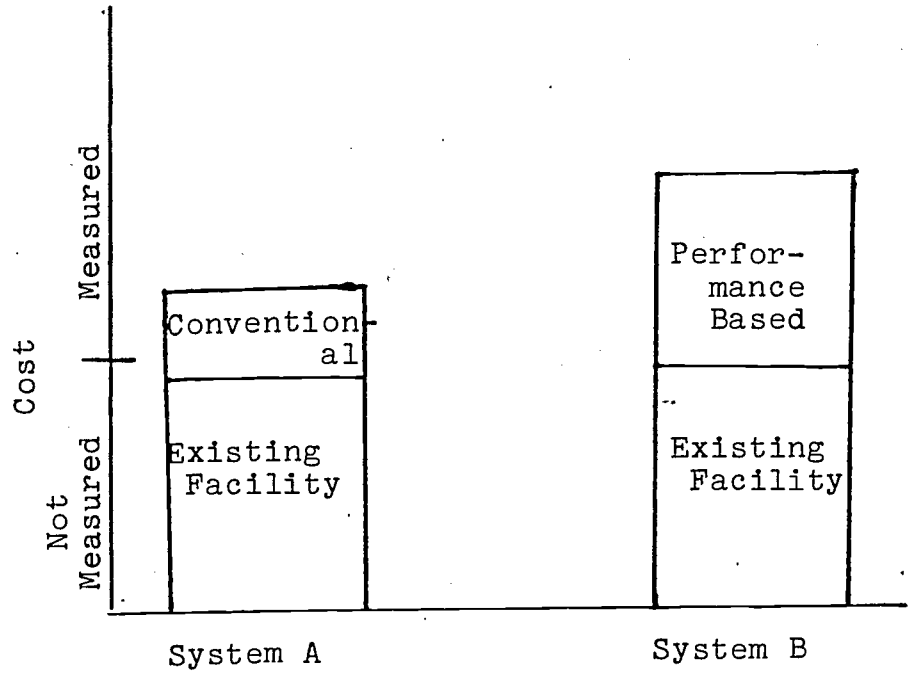


Figure IV.7. Incremental Cost Model

Costing Guidelines Summarized

Costing, as well as the quantification and measurement of benefits, remains an art and cannot be considered a science. Therefore, there are no set rules or procedures that can be followed in all cases which can insure the derivation of reliable cost estimates. Only general guidelines can be advanced which offer basic ingredients or elements which if included in a study should provide a basis for successful costing.

The following statements are brief costing guidelines that should be observed in all cost estimates for cost-effectiveness or cost-benefit studies.[6] They should not be construed to be totally inclusive in content because unique costing problems may arise in connection with some analyses.

1. All significant costs that might affect the choice of alternatives should be included in the analysis. All phases of the life cycle of a system should be considered for inclusion--research and development, investment, and operating costs. Normally, studies will need to include costs for all three phases to make certain that the complete costs' impacts are presented.

2. Both variable and fixed operating costs should be considered a part of the total system cost and should be included in the study.

3. Sunk costs (i.e., costs which can reasonably be assumed to have been expended prior to the beginning of the time period examined in the study) are not relevant and should be excluded.

4. In order to permit proper evaluation and understanding of the work, each study should be fully documented as to the source, techniques, cost-estimating relationships and assumptions used to develop the costs. Where different contractors are performing, say, parallel R & D studies, it is also necessary to be able to identify any major differences in costing assumptions among the contractors. Preferably, an individual cost factor sheet should be provided on each system considered in the analysis. The sheet would summarize the cost and planning factors utilized in the study in such a manner that an outside analyst could reconstruct the summary costs presented in the study.

5. Costs for cost-effectiveness or cost-benefit studies should be discounted and deflated according to the guidelines

presented in Chapter II.

6. In order to achieve consistency and comparability among cost studies, the cost element categories and data used in the study should be compatible with the latest information from such sources as The Cost of Education Index, 1967-1973, found in the January 1973 issue of the School Management journal.

7. The exact quantity of any proposed hardware that would eventually be procured can seldom be completely resolved at the time of the study. It is thus desirable that the cost information supplied permit estimation of costs at various quantities within a reasonable range of possibility, as excursions from the cases directly examined in the study might prove necessary.

8. The level of detail to which systems should be broken down and for which costs are to be displayed depends upon the nature and depth of the individual study. The originator of the study should specify in advance the level of detail needed.

9. The major problem in cost analyses is that of preparing the basic cost estimates. A costing format such as the cost matrix model in Figure IV.6 should be utilized for accuracy and easy reference.

Conclusion

The three cost areas of research and development, investment, and operating costs were given as the most appropriate areas for educational costing in the context of output. Economic factors in cost estimation were considered in terms of both the input mix and output of the educational process. The costing of educational investments in terms of output was considered the more accurate in that costs in this context have greater sensitivity to output and a study is rendered more viable when approached in this setting. Guidelines for costing were explicitly listed. Various models to aid in the expediting of costing were given. Once benefits have been quantified and the costing of the investment has been carefully conducted, the next concern in a benefit-cost study should be focused upon the efficiency and the effectiveness of educational investments. This is done in the next chapter.

Notes

[1]A. R. Prest and R. Turvey, "Cost-Benefit Analysis: A Survey," The Economic Journal, December 1965, p. 686.

[2]Reviews of Data on Research and Development, National Science Foundation Bulletin 41, Washington, D. C., September, 1963, p. 10.

[3]B. D. Bradley, et al., A New Cost Model to Support Air Force Long-Range Planning. Santa Monica, Cal.: Rand Corp., May 1965, p. 10.

[4]A common graphical presentation of cost-relationships in Air Force studies. For an example, see R. L. Petruschell and J. M. Chester, Total Systems Cost Analysis. Santa Monica, Cal.: The Rand Corporation, January 1963.

[5]Harold Hotelling, "The General Welfare in Relation to Problems of Taxation and Railway and Utility Rates," Econometrica, 1938, pp. 242-269.

[6]Several items for the following guidelines were taken from Costing Guidelines for Department of Defense Cost-Effectiveness Studies, Washington, D. C.: Office of the Assistant Secretary of Defense, Resource Analysis Division, May 1966.

CHAPTER V

EFFICIENCY AND EFFECTIVENESS OF EDUCATIONAL INVESTMENTS

Efficiency has been established as the primary criterion of any benefit-cost study in the local educational system setting as presented in the Chapter II Analytical Benefit-Cost Model. The second most important criterion is that of effectiveness. Upon first examination, one may be inclined to accept the generalization that they both mean nearly the same thing and are always closely related. This is mere presumption. An existing program may be efficient but not effective, or it may be effective but not efficient. Or, a program in a theoretical model could conceivably be both effective and efficient at the same time. The point is, the "efficiency of a program may be unrelated to its effectiveness, adequacy, and appropriateness."[1]

Effectiveness can be defined and should be analyzed in the context of output. It is "the extent to which preestablished objectives are attained as a result of activity."[2] Efficiency can be defined as a ratio between an output (net attainment of program objectives) and an input (program resources expended). It is "the cost in resources of attaining objectives."[3] Of the two definitions, effectiveness can be viewed as the dominant of the two because

> "measures of effectiveness must be obtained before measures of program efficiency can be interpreted since, from the definition of efficiency, knowledge is required of effectiveness as well as resources. Unless the administrator is satisfied with effectiveness, studies of efficiency will be uninterpretable or misleading."[4]

In educational decision-making which involves choices among alternatives for future financial investments, data on efficiency have little value unless data from similar systems that are already or have been in operation can be obtained. The reason for this should be obvious. Cost-effectiveness studies can be made which can formulate very close proximities to actual program outcome for the various alternatives being considered. But in considering efficiency in a context of simulated operation the variables are too great for accurate approximation. Only actual operation of a system and its measurement during its operation could give a valid estimate of efficiency. Since effectiveness must first be measured before efficiency can be analyzed, efficiency measures remain largely in the domain of decision-making once operations have commenced. Thus, effectiveness measures appear to have more importance from the planning aspect, while efficiency, though important to the planner, has its importance to the manager delving into current operations' research of established systems.

Efficiency studies are, of course, extremely important to the educational decision-maker who may be contemplating expansion of a system that is currently in operation. Naturally, efficiency of a system can not possible be the same for all levels of system operation; it will vary from a very low level of efficiency to very high depending upon the extent of operation and the variations in combinations of the factors of production in their given proportions in the input mix. Accord-

ing to the study by O. Lynn Deniston and others,

> It seems reasonable, on the basis of experience, that the expenditures of very limited resources will have little impact (low efficiency); increasing the resources will have a proportionately greater impact (higher efficiency); and finally, greatly increasing the resources will result in only a little more gain (reduced efficiency).[5]

This reasoning is based on the time-honored economic law of diminishing returns. This law expresses the phenomenon that exists when, in successively applying equal amounts of one or two factors of production (real estate, labor, or capital) to the remaining factor or factors, an added application yields a lesser increase in production than the application just preceding. If the law is used only in cases where capital or labor is the constant factor it is referred to as the law of diminishing productivity. In any case there is some ideal relationship among the factors of production that will produce, theoretically, optimum returns to the scale of the system.

Figure V.1 illustrates the law of diminishing returns and its effect upon the output of a typical educational system. Notice, that in the early stages of operation, the efficiency curve is at a very low level of output and that it gradually increases until the point of diminishing returns is reached which is the peak of the curve. The curve then continues downward to the right as efficiency decreases.

The educational administrator, then, is burdened with the responsibility of determining, as nearly as possible, that level of operation of his educational system which has

the highest degree of efficiency. This is not a simple procedure but it can be done, just as effectiveness can be determined through cost-effectiveness analysis as illustrated in Chapter III.

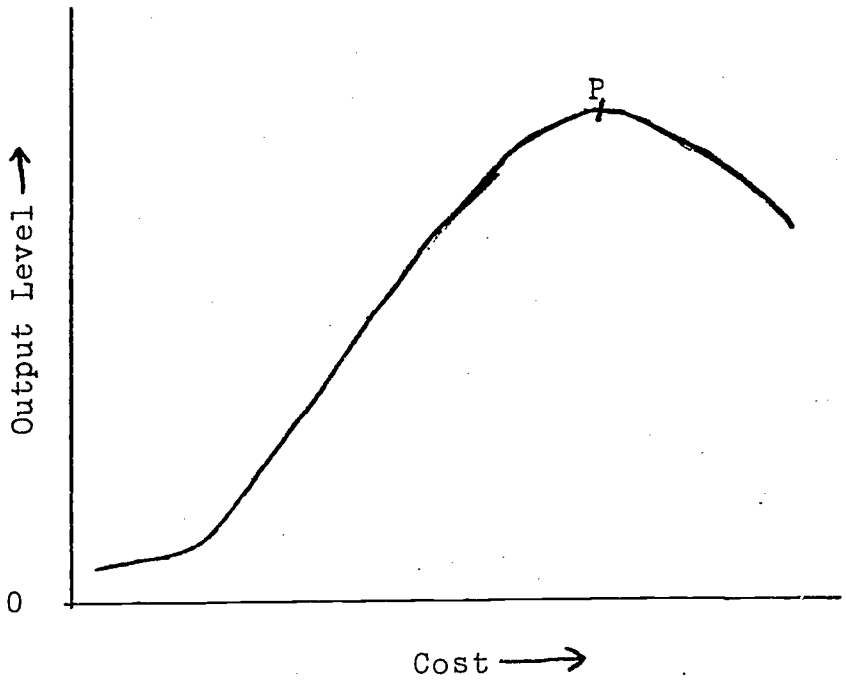


Figure V.1. An Efficiency Curve illustrating the point P of diminishing returns.

Ratio Analysis

In determining the efficiency and effectiveness of any educational system, either in the planning or functioning stages, ratio analysis can be utilized. The term "ratio analysis" is certainly not new to the business world. For example, the "current ratio" (current assets over current liabilities) is a well-known indicator of a firm's liquidity.

Ratios can be devised to control and analyze almost any situation which occurs in the operation of an educational

system. This is true especially in the area of educational finance. The number of areas to which ratio analysis can be applied in education may be less than in business or corporation operational analysis but nevertheless there are several areas that can be probed using this tool. For instance, Spencer A. Tucker lists more than 400 ratios for control in the areas of production, sales, and finance in a typical company's operation.[6] With a little ingenuity, the educational administrator can probably apply many such ratios to his local school's or college's problems.

For the purposes of this study, the following ratios were listed as possible examples of specialized financial ratio studies for educational systems.[7] It should be remembered that benefit-cost and cost-effectiveness analysis are only ratios applied to more generalized total system aspects.

1. Benefits/Working Capital. This ratio measures the effectiveness of the working capital. If the ratio increases, a higher effectiveness level can be assumed. If it decreases, the opposite is true. A low value for the ratio would indicate that benefits are not high enough for the level of working capital; however, satisfactory benefits with an accompanying low ratio would mean that an excess exists in working capital and diminishing returns are being experienced.

2. Benefits/Capital Funds. This ratio tells how much benefit is achieved in comparison to total capital funds (including both working and fixed). Because capital funds are often fairly constant, a year-by-year plot of this ratio is

indicative of the general benefit picture.

3. Fixed Capital/Working Capital. This ratio shows how much of the working capital of an educational system is invested in instructional facilities. When this value is high, so are depreciation and maintenance costs. If the ratio >1, it means that much of the fixed capital is being obtained by credit which indicates a need for additional working capital. A low ratio means that working capital is more liquid and elastic. Generally this ratio decreases slowly from year to year in a static situation as debt is retired and as fixed assets are decreased via depreciation.

4. Current Assets/Current Liabilities. Referred to in business analysis as the current ratio, this ratio measures the ability of the educational institution to meet its current debts promptly. This ratio is not highly accurate because of the monthly vairance in the elements that make up the current assets.

5. Total Debt/Net Worth. This ratio measures the relative amount of capital funds actually possessed by an institution and the borrowed funds it is using. When the ratio >1, this indicates that credit is exceeding the net worth of the institution which means an increase in responsibility to creditors or lending institutions and a relative insecurity and corresponding decrease in the authority of the educational administrators.

For those educational administrators who wish to go further than such simple ratios and relate such ratios to some measure of their entire system's condition, the

technique of multivariate analysis, or multiple regression analysis, can be used. Such calculations are not complex if programmed according to various computer regression programs like those developed for the IBM 360/67 computers.

The Ratio Table and Model

The cost-effectiveness model basically measures the efficiency of a system in terms of the ratio of its output (effectiveness) to its input (cost). In cases in which either cost-effectiveness analysis or benefit-cost analysis is being used and several alternatives are being considered a ratio table can be used for more accurate comparison. In the use of a ratio table an effectiveness index must be developed which utilizes a weighting factor for combining all alternatives into one aggregate index. The cost-effectiveness ratios must be multiplied by a normalization constant which weights all of the alternatives' ratios in terms of unity or 1.000. In order to derive the normalization constant the following formula can be used:

$$\frac{\Sigma WU}{\Sigma E/C_R} = \frac{1.000}{\Sigma E/C_R}$$

where W = weight, U = unity or 1.000, R = ratios, E/C = efficiency-cost ratio. The following Table V.1 provides an example of such a ratio table.

Table V.1. Ratio Table

Alternative	E/C		Normalization Constant		W
A	2.75	x	0.25	=	0.6875
B	1.00	x	0.25	=	0.2500
C	0.25	x	0.25	=	0.0625
	= 4.00	x	0.25	=	1.0000

In some instances in which many alternatives are being considered, it may be desirable to go further and plot a ratio graph showing all alternative E/C ratios. The E/C ratios would in turn be bounded by either maximum or minimum cost or effectiveness lines in order to provide, at a glance, selection of the alternative which gives the highest effectiveness obtainable for a given cost as in Figure V.2, or, conversely, the least-cost solution for a given effectiveness.

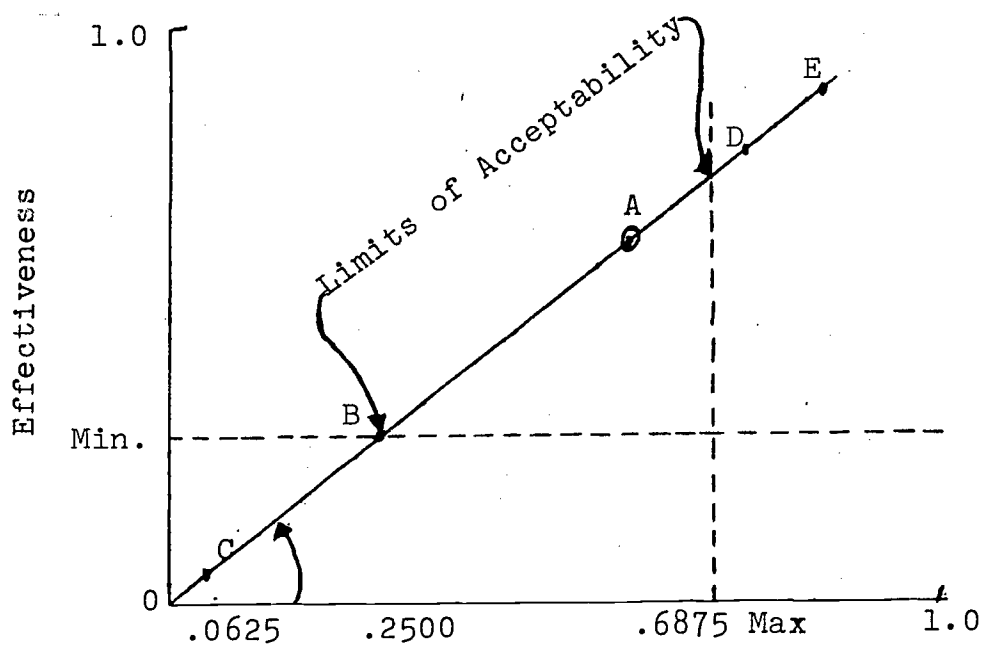


Figure V.2. A Cost Ratio Model using the Fixed Budget Approach.

Alternative A (circled) in Figure V.2 provides the highest effectiveness within the bounds of the set cost limit. Alternatives D and E provide higher effectiveness but are beyond the given cost acceptability. Alternative B would barely meet the minimum effectiveness criteria.

The Indifference Curve Model

The work of Vilfredo Pareto laid the theoretical foundation for the use of indifference curves. Eventually known as the subjective theory of value the concept introduced by Pareto was that "one commodity may be substituted for another in consumption in such a way as to leave the total level of utility unchanged."[8] In other words, the individual consumer of like goods can be "indifferent" to the quantity of two or more goods he might consume as long as the summation of their utilities is always equal to the total preference of that consumer for those goods.

The utility preference of the educational decision-maker can be fitted into the same basic subjective theory of value. For instance, suppose an administrator is considering two differentiated systems, A and B, both of which can be adopted in the same identical amount. Assume also that the expected value of aggregate cost for each system is the same as well as identical per unit cost. Assume further that the expected value of unit and aggregate effectiveness is the same. According to the subjective theory of value the decision-maker could therefore choose either all units of system A, all units

of system B, or any combination thereof, since the total utility or benefit obtainable would be identical as well as the same cost being required.

In Figure V.3, the linear hypothetical indifference curve I illustrates graphically the theory of subjective value. The surface of curve I presents a constant marginal rate of substitution between systems A and B. This means that the administrator is always willing to give up the same number of units of system A for system B and vice versa. On curve I, the exchange points at a and b are the same in area thus showing that free interchange between alternative A and B is possible and all combinations would have the same aggregate utility figure.

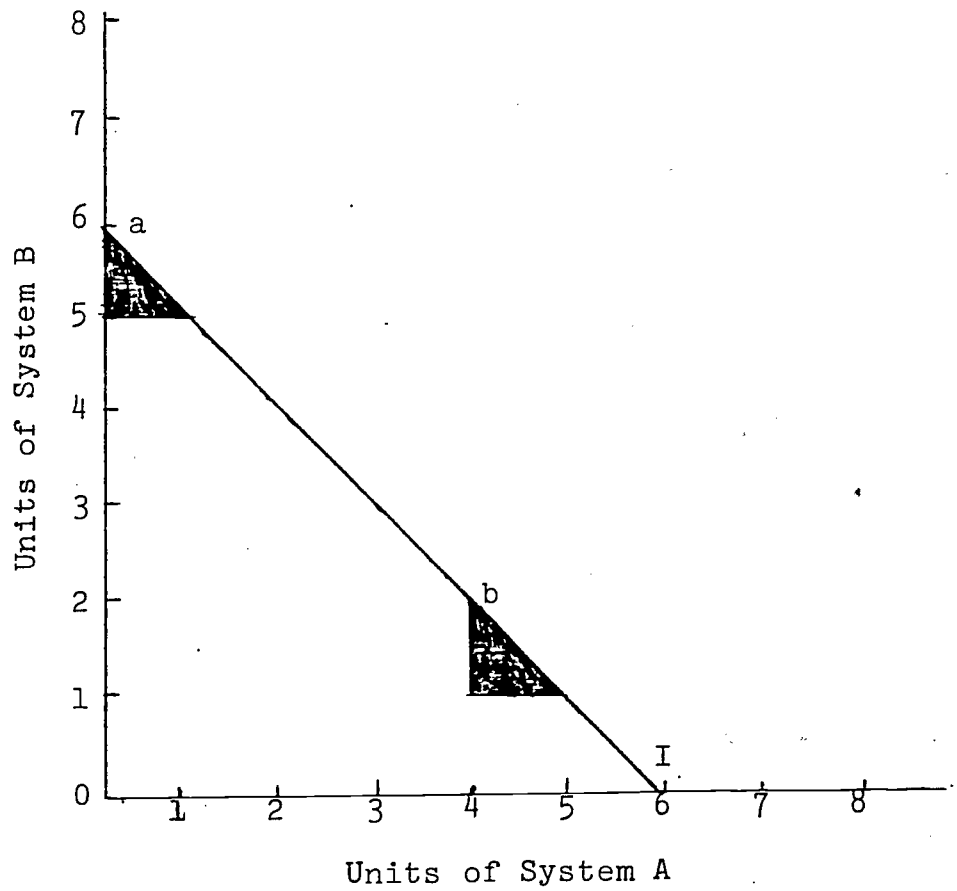


Figure V.3. Hypothetical Linear Indifference Curve.

In Figure V.4, the true indifference curves I_1 and I_2 are nonlinear in nature, concave from above, negative in slope, never intersect, and each passes through each point in commodity space. These are properties possessed by all indifference curves.

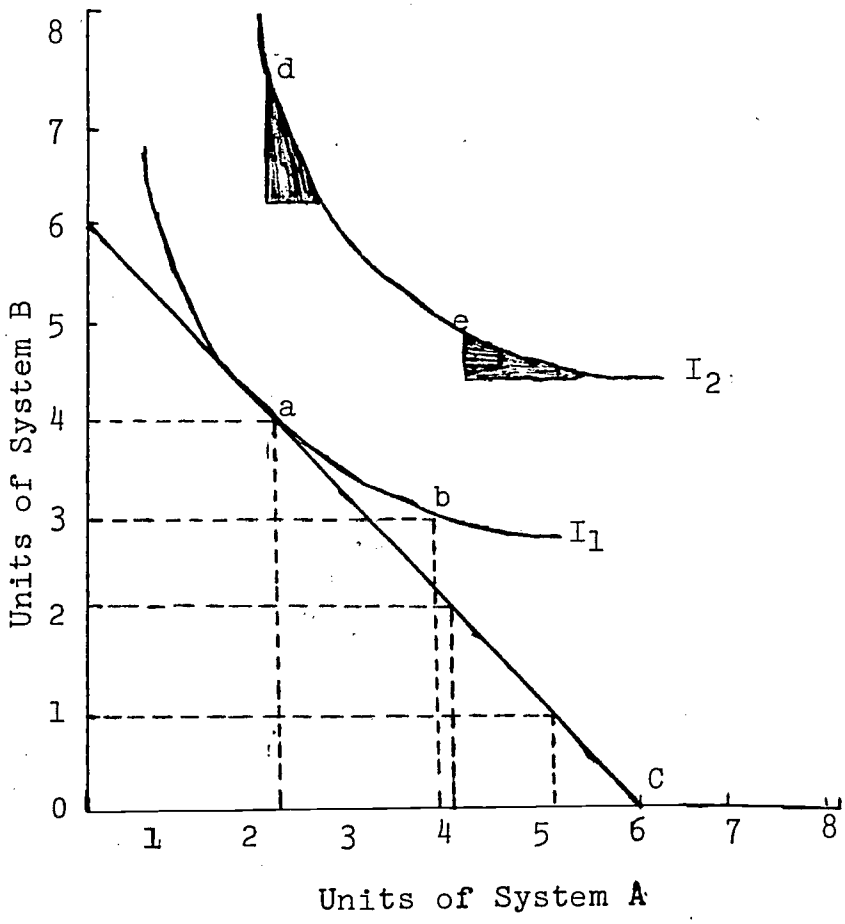


Figure V.4. True Nonlinear Indifference Curves.

Indifference curves I_1 and I_2 in Figure V.4 represent a diminishing marginal rate of substitution of system B for system A. At point e the decision-maker is not willing to give up the larger number of units of system B for system A than he was at point d. The slope of the indifference curve diminishes downward toward the right in a convex profile from below or concave from above. The indifference curve I_2 represents a higher level of effectiveness than I_1 thus an indifference curve that lies to the right and above another always represents combinations of alternatives to the lower curve.[10] The constant cost curve C represents the fixed budget approach to cost-effectiveness analysis and is linear in that the decision-maker is indifferent or transitive because the cost remains the same for all combinations of alternatives. The optimum system combination of this graph is found at 4 units of system B and 2 units of system A because it is the only possible combination that can give an effectiveness level of I_1.

Analysis of effectiveness for different budget levels such as C_1, C_2 and C_3 in Figure V.5 can be made by connecting the points of tangency T_1, T_2 and T_3 by a line E called an isocline. As shown in the Figure an isocline may be defined as "a locus of points along which the marginal rate of technical substitution is constant".[11] The isocline here can be termed an income consumption curve of an educational institution that increases from C_1 to C_2 to C_3 as the institution's purchases of units of systems A and B change as its budget increases for such expenditures.

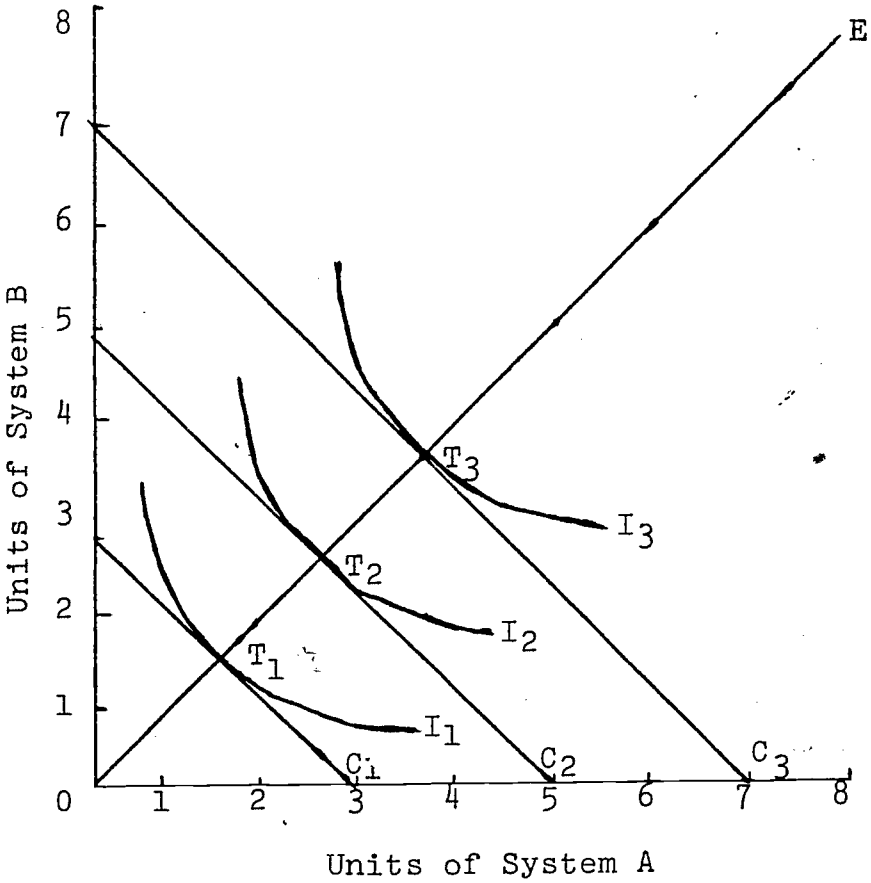


Figure V.5: Isocline-Indifference Curve Relations

Guidelines for the Use of Indifference Curves Summarized

In constructing indifference curves, let it be assumed that there is only one administrator and two systems, A and B. It is also assumed that the decision-maker prefers to have as much of each system as possible. The objective of the administrator in this situation is to maximize benefit subject to a constraint - the amount of money available to invest in the two systems at a given time.

All possible combinations of systems A and B the administrator could conceivably choose, if he were not constrained by a budget, can be shown in Figure V.6 as lying above and to the right of the origin. This area is referred to as the commodity space. Every point within the commodity space represents a combination of systems A and B that may be utilized.

Because of the nature of the commodity space, the administrator is confronted with an infinite number of combinations from which to choose. It is assumed that the decision-maker has the ability to rank all of the combinations in the commodity space according to the level of benefit that can be received from each of them.

Indifference curves are an analytical device. They are obtained by holding the level of benefit constant, and observing the various combinations of the systems that are consistent with the fixed level of benefit (refer to the fixed benefit approach).

$$I_1 = I\ (A,B)$$

where I_1 refers to a constant level of benefit. The indifference curve that can be drawn from this equation is shown in Figure V.7. This indifference curve shows the different combinations of A and B that yield equal benefit to the institution; the decision-maker is indifferent, or has no preference, between the combinations of A and B that lie on the indifference curve I_1.

It should be noted also that all combinations of A and B which lie above and to the right of I_1 are preferred to those combinations along I_1, since the institution receives more of at least one of the systems. For example, points b and c in Figure V.7 yield a higher level of benefit than point a, since the institution receives more of one system and the same amount of the other. Therefore, points b and c must lie on higher indifference curves. In the same context, all points below and to the left of I_1 are less preferred combinations of A and B than those located on I_1.

The indifference curve I_1 in Figure V.7 represents only one of an infinite number of indifference curves for the institution. Figure V.8 contains a portion of the indifference curves defined by the administrator's preference. This is referred to as an indifference map. Such a graph shows the administrator's utility function which is the expression of the relationship between benefit received (I), and the quantity of systems A and B utilized.

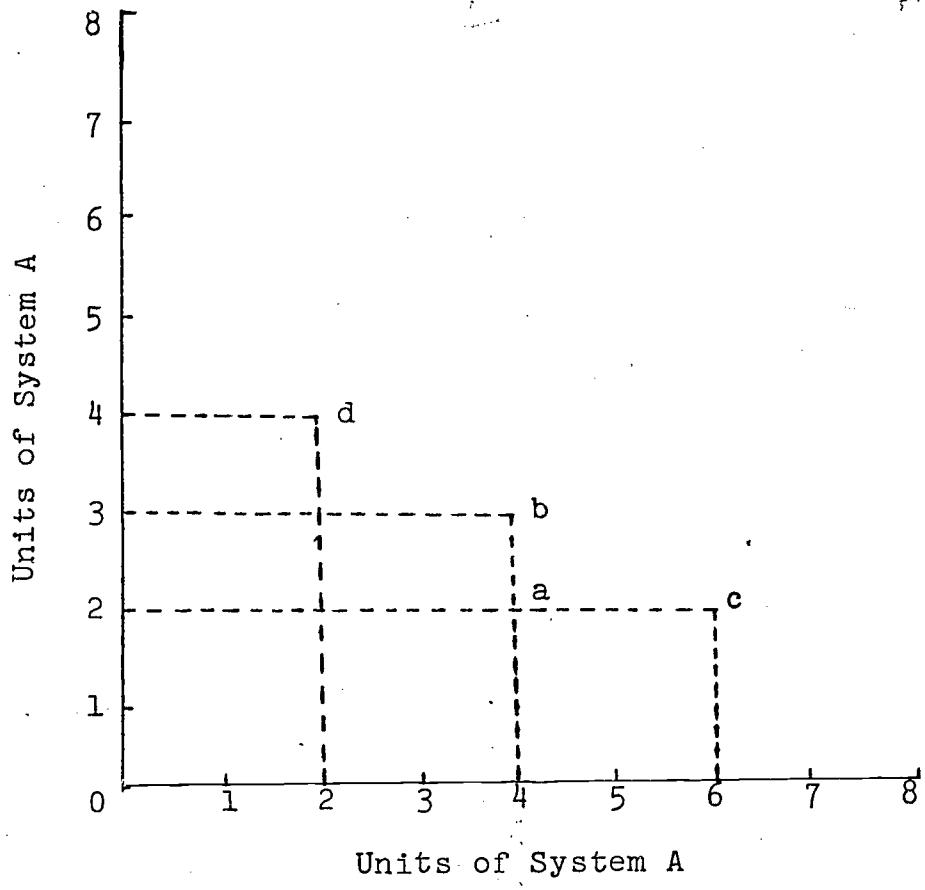


Figure V.6. The Commodity Space for Systems A and B.

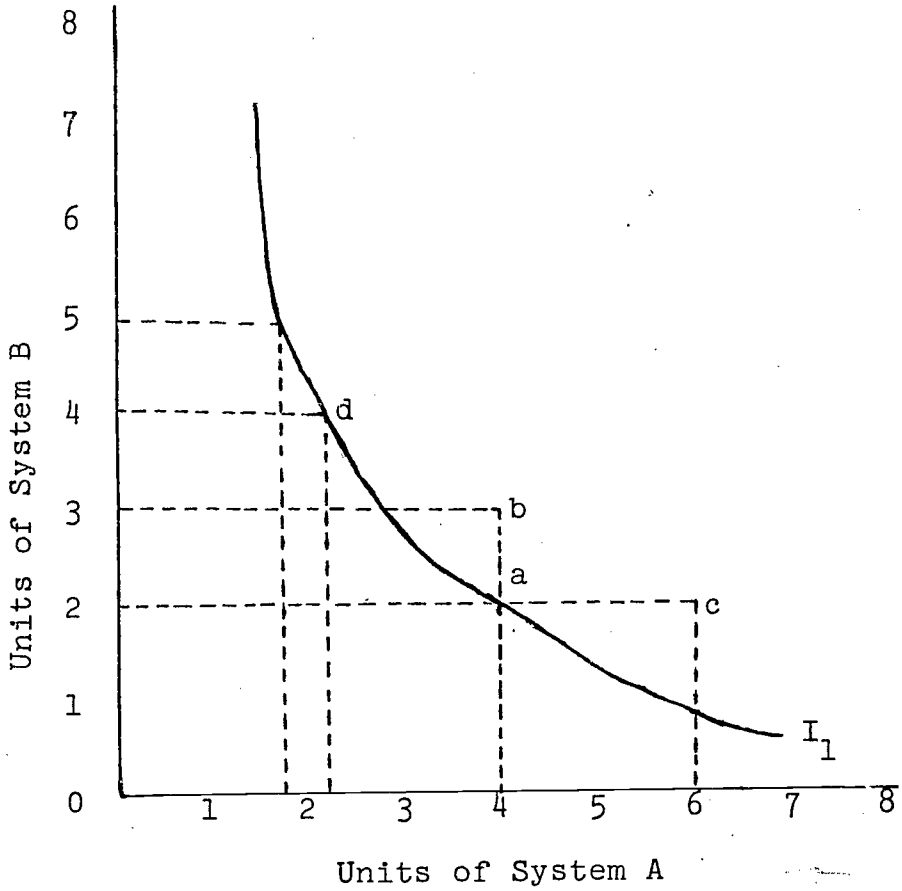


Figure V.7. An Indifference Curve for Systems A and B.

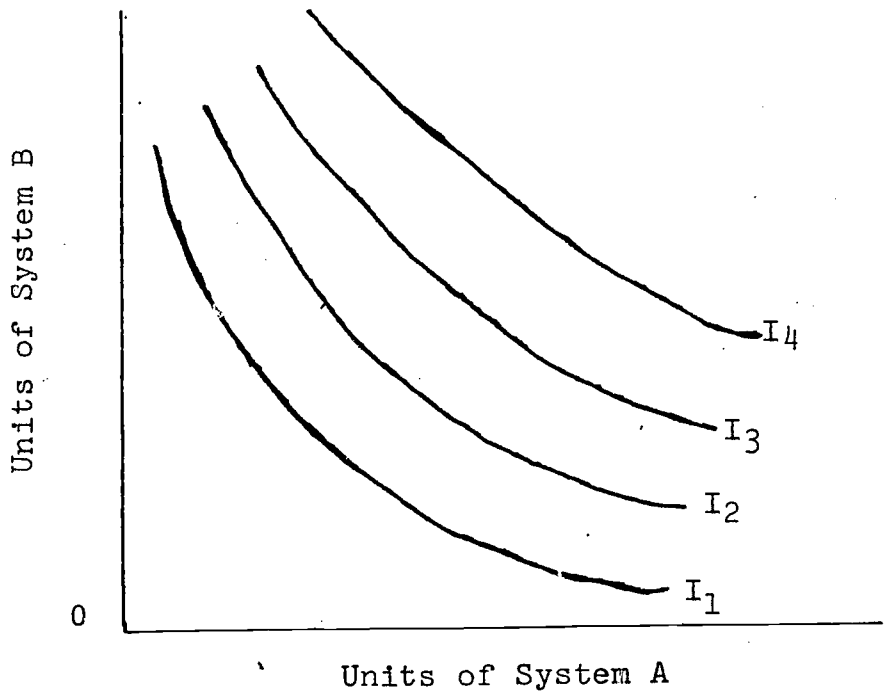


Figure V.8. An Indifference Map for Systems A and B.

Linear Programming

In order to avoid the situation in which the educational decision-maker blindly chooses between units of system A and B, linear programming can provide, in certain circumstances, an accurate solution to such a perplexing problem. The following example should provide an adequate description of the value of linear programming.[12]

In teaching system A let it be assumed that there are thirty computer-assisted instruction stations (CAIS) available with programs in spelling. None is less than nine minutes long nor longer than twenty minutes. If a teaching team can allot no more than forty-five minutes per day for spelling, and knows that it can accomodate 150 pupils by a traditional approach in system B, how many minutes of CAIS instruction and how many minutes of traditional instruction will produce a maximum number of student-minutes of instruction, providing both approaches must be used during the forty-five minute period?

The Problem:

1. A will denote the number of minutes of CAIS instruction.
2. B will denote the number of minutes of traditional instruction.
3. The amount of time spent in system A instruction plus that for system B must equal forty-five minutes, therefore $A + B = 45$.
4. Write the equation $A + B = 45$, as a system of two inequalities:

$$A + B \geq 45$$
$$A + B \leq 45$$

5. The time elapsed for each method of instruction must be positive.

6. In the case of system A, the constraints are:

$$A \geq 9, \text{ and } B \leq 20.$$

7. The system of inequalities to be analyzed is:

(a) $A + B \geq 45$
(b) $A + B \leq 45$
(c) $A \geq 9$
(d) $A \leq 20$
(e) $B \geq 0.$

The polygon of feasible points is the shaded area (including the boundary lines) shown below:

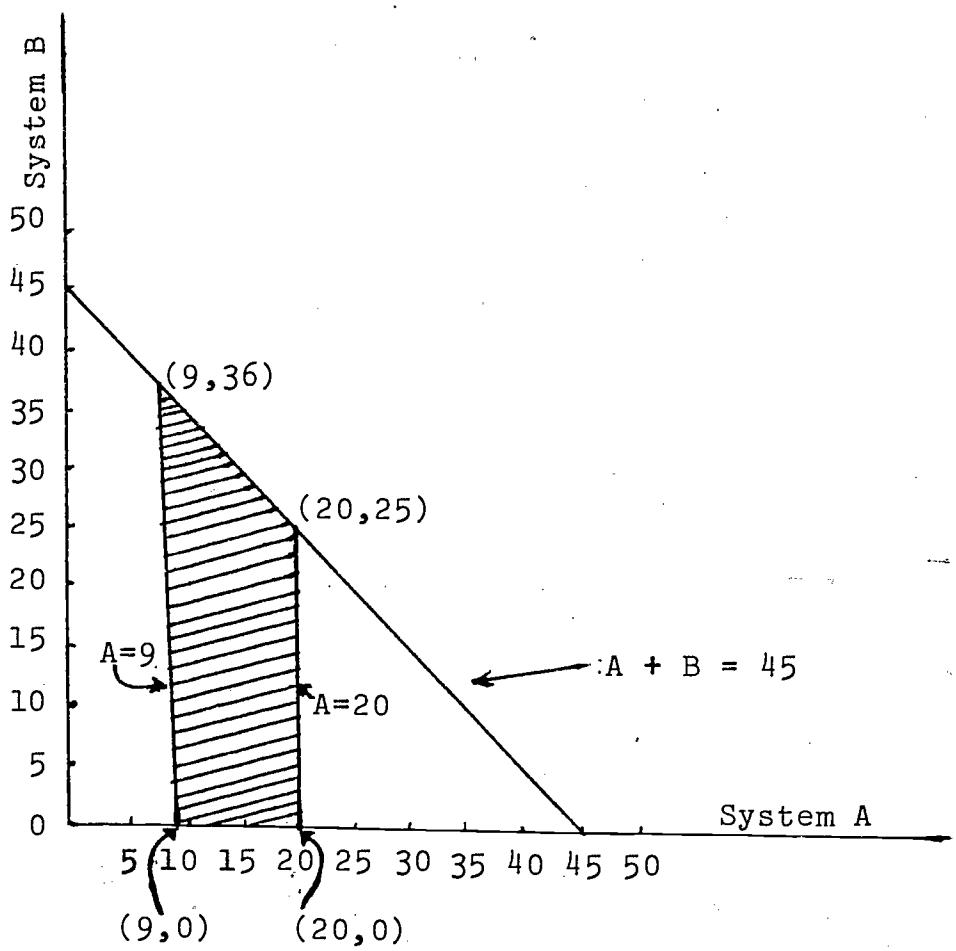


Figure V.9. A Linear Programming Model.

If N represents the total number of student-minutes of instruction, the function to be maximized for an optimal decision will be:

$$N = 30A + 150B ,$$

where the number 30 indicates the number of students that can be instructed by CAIS per minute (system A), and 150 denotes the number that can be taught by the traditional approach (system B) per minute.

Substituting the values of the corner points of the graph in the function, the minimum and maximum values of the function will now be considered under the above constraints. The values are:

$$\begin{aligned} N(9,0) &= 30(9) + 150(0) = 270 \\ N(9,36) &= 30(9) + 150(36) = 5670 \\ N(20,25) &= 30(20) + 150(25) = 4350 \\ N(20,0) &= 30(20) + 150(0) = 600 \end{aligned}$$

Since the largest value of the function N occurs at the point (9,36), the optimal situation of the maximum number of student-minutes of instruction, under the constraints that both systems must be employed during the forty-five minute period, will exist with nine minutes devoted to CAIS instruction and thirty-six minutes to the traditional system.

A Willingness-To-Pay Chart

In this case, assume that the public school superintendent in a moderate sized city has decided to survey his entire system in order to gain insight into community support for the educational program. Such a study should give him some indication of community attitude in regard to the effectiveness

of the educational program. The simplist, and perhaps most accurate approach in this situation, is to begin with the basic 'willingness to pay' formula

$$W_{Pt} = \frac{\sum TV_f}{\sum TV_c},$$

where W_{Pt} is the willingness to pay ratio for year t, TV_f is total votes cast 'for', and TV_c is total votes 'cast' in the school's bond election for the year t. By using this formula the superintendent can form willingness to pay ratios for every bond election ever held in his district.

For the purpose of his present study, however, the superintendent would probably only be interested in bond elections conducted in recent years. Analysis of recent elections would give a much better indication of current attitudes towards local education than those elections of earlier years.

In the aggregate sense, when expressing total willingness to pay over a period of time in which several bond elections were held, the formula would be

$$W_{Pt} = \sum_{t=1}^{T} \frac{TV_f}{TV_c}.$$

After computing a willingness to pay ratio for each year, the superintendent's next step would be to draw a graph such as found in Figure V.10. In this figure, the years in which bond elections were held are placed along the ordinate scale in correspondence to their willingness to pay ratios which were placed on the abscissa. The ratios must be plotted on a 45° curve.

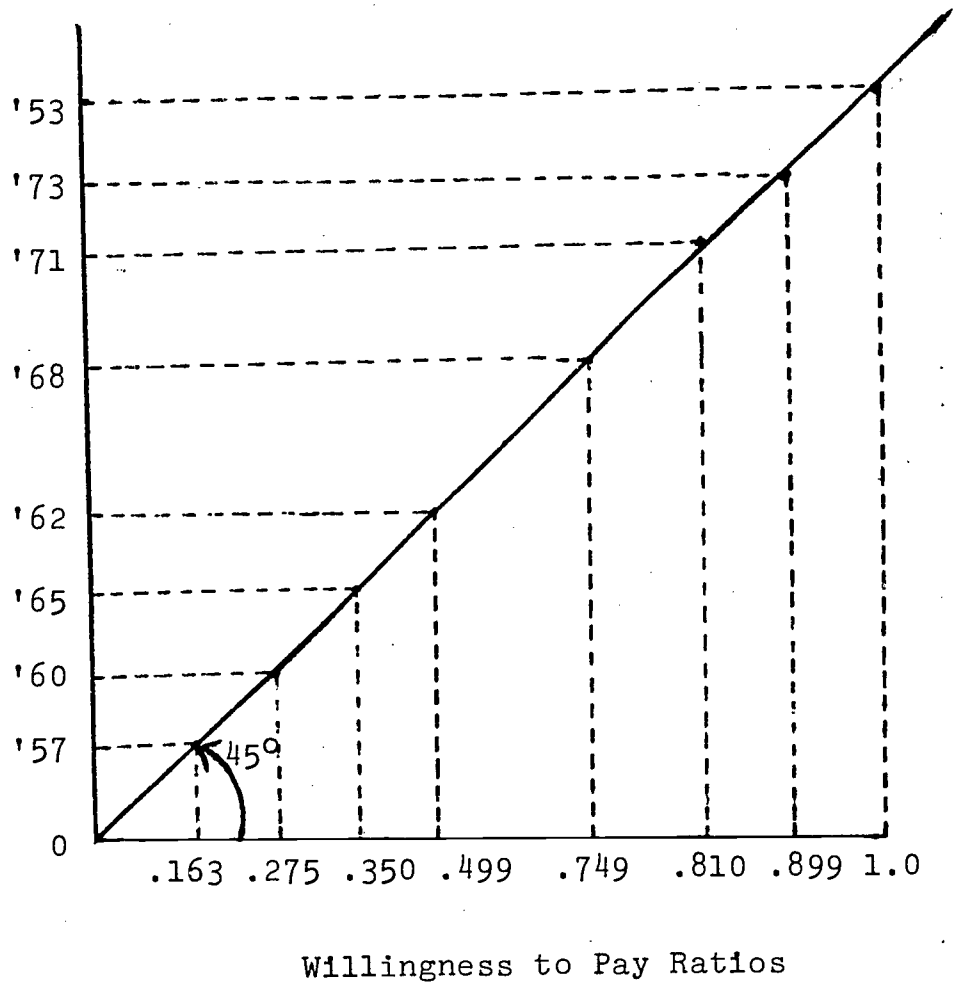


Figure V.10. Ratio Graph showing Willingness to Pay Ratios and their corresponding years.

By examining this graph in Figure III.4 carefully, the superintendent can gain insight into basic community attitudes toward the educational program based on the comparison of the willingness to pay ratios of different important bond election outcomes. For example, a very high ratio for the year 1953 would indicate a very favorable community attitude toward the then current program; a low ratio for the year 1960 would indicate a poor level of community support.

Conclusion

Efficiency and effectiveness as concepts were compared, contrasted, and interrelated. Ratio analysis was used in examining effectiveness and efficiency of educational systems in both generalized and specialized situations. Indifference curves and linear programming were offered in rectifying situations in which two systems and their combinations must be analyzed. Specific findings of the preceding chapters and this chapter are listed next in the Summary and Findings.

Notes

[1]Lynn Deniston, et. al., "Evaluation of Program Effectiveness and Program Efficiency." in Fremont J. Lyden and Ernest G. Miller, Planning-Programming-Budgeting: A Systems Approach to Management. 2nd ed. Chicago, Illinois: Markham Publishing Company, 1972, p. 143.

[2]Ibid.

[3]Ibid.

[4]Ibid., p. 161.

[5]Ibid., p. 165.

[6]Spencer A. Tucker, Successful Managerial Control by Ratio-Analysis. New York: McGraw Hill, 1961, p. 10.

[7]Many concepts for these ratios were taken from a phamplet by David K. Polacsek, et. al., Computerized Ratio Analysis: An Aid to Decision-Making. Ann Arbor, Michigan: Industrial Development Division, Institute of Science and Technology, The University of Michigan, 1968.

[8]C. E. Ferguson, Microeconomic Theory. 3rd ed. Homewood, Illinois: Richard D. Irwin, Inc., 1969, pp. 18-19.

[9]Ibid., p. 22.

[10]Ibid., p. 20.

[11]Ibid., p. 172.

[12]This example of linear programming was taken from Joseph E. Hill, How Schools Can Apply Systems Analysis. Bloomington, Indiana: The Phi Delta Kappan Educational Foundation, 1972, pp. 30-34.

CHAPTER VI

SUMMARY AND FINDINGS

This study has concentrated on the area of financial decision-making in the context of public education administration. Various economic analytical tools were selected which were deemed appropriate for such procedures. The selected economic tools were revised or updated to meet the needs of the educational administrator. Once enunciated in the form of models, simple examples were provided to illustrate possibilities of their usage in various financial decision-making circumstances. In most cases, where possible, guidelines for the proper usage of such tools were explicitly stated and listed; in other cases, such guidelines were contained only within the examples because the examples were sufficient in and of themselves in projecting methodologies.

Summary

Among the tests for preferredness, benefit-cost analysis and its counterpart, cost-effectiveness analysis, present the simplest and soundest approaches to educational financial decision-making. Benefit-cost analysis was established as the approach to use when both benefits and costs being examined by an analyst can be quantified in the same units or are commensurable in expression. In situations in which costs and benefits are incommensurable or expressed in diverse units, cost-effectiveness analysis was presented as the economic tool to use.

For analyses of commensurable cases, the traditional Analytical Benefit-Cost Model was updated to include not only a discount rate but a deflation rate as well. Such inclusion was based on the factors of opportunity cost of capital and time preference of capital. In addition, Pareto Optimality was introduced into the model on the micro or local educational setting in order to establish an environment in which efficiency ranked paramount as the basic objective of any educational investment; effectiveness was ranked second. Guidelines were developed to aid educational administrators in the selection of the appropriate discount and deflation rates to be utilized in any analysis. Procedures were also developed for determining the effectiveness and efficiency of educational investments.

In the analysis of incommensurable cases, cost-effectiveness analysis was utilized. Since the benefits of educational investments in incommensurable cases are not quantifiable in dollars, simple graphs, drawn to scale, were presented as the most accurate method of deriving proper comparisons between systems. Steps for their proper usage were proposed.

The use of shadow prices was suggested as the most appropriate method in quantifying benefits which lent themselves to the commensurable category. Once prices are formulated for educational benefits being considered in the context of intermediate social goods, a demand schedule can be formulated. From the demand schedule, a demand curve can be devised from which consumers' surplus is calculated. Consumers' surplus, thus derived, was considered a measure of educational benefit because it measures the total worth of the educational system to those who

immediately benefit from it. Any additional revenues directly received by the system are to be included in the compilation of benefits. Scenario writing and the Delphi Method were suggested as proper procedures for deriving shadow prices or for the purposes of qualitative analysis in instances where shadow prices cannot be formulated.

Since there is always the danger that bias might be introduced into any benefit-cost or cost-effectiveness analysis, three approaches were suggested as aids in eliminating this problem. They were the Fixed Budget Approach, the Fixed Benefit Approach, and the Fixed Efficiency Approach. Any one of these approaches, or combinations thereof, were viewed as frames of reference upon which any analysis might be soundly constructed and conducted.

The proper costing of educational investments was also given high priority in this study. The three cost areas of research and development, investment, and operating costs were given as the most appropriate areas for educational costing in the context of output. Economic factors in cost estimation were considered in terms of both the input mix and output of the educational process. The costing of educational investments in terms of output was considered the more accurate in that costs in this context have greater sensitivity to output and a study is rendered more viable when approached in this setting. The Cost Matrix Model and the Incremental Cost Model were offered as invaluable tools in cost analysis. The use of break-even charts was suggested when two or more systems are being considered which have the same benefit and the same total cost yet one is more

acceptable than the others because of differences in their variable and fixed costs.

In the determination of the efficiency and effectiveness of educational systems, ratio analysis was presented. Such an economic tool was viewed as important to the control and analysis of many financial situations which might occur through the operation of an educational system. Among certain ratios offered for the analysis of specialized areas of an educational system's financial program were benefits/working capital, benefits/capital funds, fixed capital/working capital, current assets/current liabilities, and total debt/net worth. It was pointed out that benefit-cost analysis and cost-effectiveness analysis were also ratio analytical tools but that each dealt with the more generalized total systems aspects.

A ratio table and accompanying model were introduced in order to illustrate graphically the efficiency of a system in terms of the ratio of its output to its input. A formula was developed which would allow educational administrators to express cost-effectiveness ratios in terms of unity. From figures derived through the usage of such a normalization constant, a ratio table was formulated. A ratio model was then constructed which exhibited the weighted ratios on a 45° linear line extending upward to the right from the origin. With the ratios plotted along this line, minimum effectiveness and maximum cost lines were drawn showing the 'limits of acceptability'. All ratios falling outside of such limits would of course be rejected from consideration. The highest ratio within the limits of acceptability represented the alternative system which should be accepted

according to the analysis.

A unique 'willingness-to-pay' chart was developed which, although it was only indirectly related to educational financing, could give the educational administrator, at a glance, some indication of community attitude toward his institution's overall program. A willingness to pay formula was formulated which expressed in ratio form the community support of an institution based on past performance in bond elections. The ratios thus derived were plotted on a 45° linear line extending upward to the right from the origin showing their correspondence to the years listed on the ordinate scale and the ratios given on the abscissa.

Indifference curves and the subjective theory of value were used to demonstrate an administrator's reaction and attitude toward two or more differentiated systems which can be adopted in the same identical amount and for the same cost. True indifference curves applied to educational systems' analyses were discussed with basic guidelines for their construction given. The usage of indifference curves in connection with different budget levels was also described. Linear programming was offered as the solution for an administrator's dilemma in selecting combinations of two systems in optimum amounts.

Findings

There were several major discoveries relating to this research. Firstly, there was the finding that educational output or benefit could be measured as an intermediate good and not

necessarily as a final good as proposed in most current studies. A study by Musgrave in this area was cited, but Musgrave mentioned education and other public services as intermediate goods that must be measured in terms of final output. This study demonstrated that this was not necessary in every circumstance, but that in many cases shadow prices for intermediate goods can be calculated, from which, once a demand schedule and accompanying demand curve are devised, consumers' surplus can be estimated. Consumers' surplus was accepted as educational benefit in this study because it represents the social value of education to those who immediately benefit from it. External and spillover benefits were relegated to the domain of the macro situation, and, in most cases, were excluded from the micro situation unless the peculiarities of the local educational system warranted their inclusion in a study.

Secondly, in the selection of the appropriate discount rate by educational analysts, it was argued that the rate of discount should be based only on investment alternatives available to the particular individuals or firms to whom the school or college will most likely sell the bonds used in financing the venture.

Thirdly, there was added to the traditional fixed budget approach and the fixed benefit approach of benefit-cost and cost-effectiveness analysis, a third approach called the fixed efficiency approach. This approach differed from the traditional approaches in that an economizing move is made to hold costs as low as possible and a cost floor is imposed, not a cost ceiling.

Fourthly, ratio analysis was suggested as an approach for measuring effectiveness and efficiency of educational investments.

A willingness-to-pay formula and chart were developed along with the adaptation of several well-known economic ratio analytical tools to educational systems or programs analyses.

Finally, indifference curves, well-known economic devices, were applied to educational decision-making when optimum combinations of two systems or programs are desired by administrators. Linear programming was offered as a solution to sound systems' and programs' allocation in decision-making. Additional research needs to be conducted in situations in which three or more programs or systems can be combined in optimum amounts at the same time.

This study has certainly not exhausted all areas of inquiry into educational financial decision-making via the use of economic analytical tools. Quite to the contrary, it is hoped that this research will in some way instill in other educational economists the desire to probe ever deeper into this most vital and timely subject.

BIBLIOGRAPHY

Banghart, Frank W. Educational Systems Analysis. Toronto, Ontario: The MacMillan Company, 1969.

Bradley, B. D., et al. A New Cost Model to Support Air Force Long-Range Planning. Santa Monica, Cal.: The Rand Corporation, May, 1965.

Clawson, Marion. Methods of Measuring the Demand for and Value of Outdoor Recreation. Washington, D. C.: Resources for the Future, Inc., February, 1959.

Costing Guidelines for Department of Defense Cost-Effectiveness Studies. Washington, D. C.: Office of the Assistant Secretary of Defense, Resource Analysis Division, May, 1966.

Dalkey, N., et al. The Delphi Method, III: Use of Self-Ratings to Improve Group Estimates. Santa Monica, Cal.: The Rand Corporation, 1969.

Deniston, Lynn, et al. "Evaluation of Program Effectiveness and Program Efficiency." Planning-Programming-Budgeting Systems Approach to Management. Edited by Fremont J. Lyden and Ernest G. Miller. 2nd ed. Chicago, Illinois: Markham Publishing Company, 1972.

Dorfman, Robert, ed. Measuring Benefits of Government Investments. Washington, D. C.: The Brookings Institution, 1965.

Dyer, James S. "Cost-Effectiveness Analysis for Higher Education." Unpublished Ph.D. dissertation, University of Texas at Austin, 1969.

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

Ferguson, C. E. Microeconomic Theory. 3rd ed. Homewood, Illinois: Richard D. Irwin, Inc., 1969.

Fisher, Gene. "The Role of Cost-Utility Analysis in Program Budgeting." Planning-Programming-Budgeting: A Systems Approach to Management. Edited by Fremont J. Lyden and Ernest G. Miller. Chicago, Illinois: Markham Publishing Company, 1967.

Hartley, Harry J. Educational Planning-Programming-Budgeting: A Systems Approach. Englewood Cliffs, N. J.: Prentice-Hall, 1968.

Hill, Joseph E. How Schools Can Apply Systems Analysis. Bloomington, Indiana: The Phi Delta Kappan Educational Foundation, 1972.

Hotelling, Harold. "The General Welfare in Relation to Problems of Taxation and Railway and Utility Rates." Econometrica, 1938.

Kiesling, Herbert J. "Title I of ESEA: Some Program Analysis." Unpublished paper, Bloomington, Indiana: Department of Economics, Indiana University, 1967. (Mimeographed.)

Knetsch, Jack L. "Outdoor Recreation Demands and Benefits." Land Economics, November, 1963.

Lyden, Fremont J., and Miller, Ernest G., eds. Planning-Programming-Budgeting: A Systems Approach to Management. 2nd ed. Chicago, Illinois: The Markham Publishing Company, 1972.

Marglin, Stephen A. Public Investment Criteria: Benefit-Cost Analysis for Planned Economic Growth. Cambridge, Mass.: The M. I. T. Press, 1967.

Miner, Jerry. Social and Economic Factors in Spending for Public Education. Syracruse, N. Y.: Syracruse University Press, 1965.

Mort, Paul R., Vincent, William S., and Newell, Charles A. The Growing Edge: An Instrument for Measuring the Adaptability of School Systems. New York: Metropolitan School Study Council, Teachers College, Columbia University, 1946.

Musgrave, Richard A. "Cost-Benefit Analysis and the Theory of Public Finance." The Journal of Economic Literature, September, 1969.

Petruschell, R. L., and Chester, J. M. Total Systems Cost Analysis. Santa Monica, Cal.: The Rand Corporation, January, 1963.

"Plastic 'Bubbles'--One Answer to Campus Building Needs." U. S. News and World Report, June 25, 1973.

Polacsek, David K., et al. Computerized Ratio Analysis. An Aid to Decision-Making. Ann Arbor, Michigan: Industrial Development Division, Institute of Science and Technology, The University of Michigan, 1968.

Prest, A. R., and Turvey, R. "Cost-Benefit Analysis: A Survey: The Economic Journal, December, 1965.

Quade, E. S. "Systems Analysis Techniques for Planning-Programming-Budgeting." Planning-Programming-Budgeting: A Systems Approach to Management. Edited by Fremont J. Lyden and Ernest G. Miller. 2nd ed. Chicago, Illinois: Markham Publishing Company, 1972.

Reviews of Data on Research and Development. Washington, D.C.: National Science Foundation Bulletin 41, September, 1963.

Scherer, Frederick M. "Government Research and Development Programs." Measuring Benefits of Government Investments. Edited by Robert Dorfman. Washington, D.C.: The Brookings Institution, 1965.

Tucker, Spencer A. Successful Managerial Control by Ratio-Analysis. New York: McGraw Hill, 1961.